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UI GreenMetric
World University Rankings

Proceeding of The 5th International Workshop on UI GreenMetric World University Rankings (IWGM 2019)

Sustainable University in a Changing World: Lessons, Challenges and Opportunities

University College Cork, Ireland
14-16 April 2019
iwgm.ui.ac.id

PROCEEDING OF THE 5th INTERNATIONAL WORKSHOP ON UI GREENMETRIC WORLD UNIVERSITY RANKINGS (IWGM 2019)

Sustainable University in a Changing World:
Lessons, Challenges and Opportunities

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ISBN 978-979-456-799-9

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Preface

This proceeding contains invited papers from the International Workshop on UI GreenMetric World University Rankings (IWGM 2019). This 5th International Workshop on UI GreenMetric is organized by the University College Cork, Cork, Ireland. It was the second event to be conducted outside Indonesia.

The workshop is an academic forum for Rectors, Vice Rectors, and Director of Sustainability and Facilities, of UI GreenMetric participants. These universities have shown a lot of development in achieving best positions in each category at the UI GreenMetric Rankings.

In this workshop university leaders share experience and effort in improving sustainable environment in their respective campuses. This forum aimed at providing an opportunity for the top leaders of participating universities to explain their university's excellence in sustainability and Green Campus. We hope that this event will provide an opportunity for developing network and collaboration on sustainability management among global university. Furthermore, this workshop will be a medium in which we can hear and accommodate some feedbacks or comments from the participants to improve our questionnaire to evaluate university performance. This year there were 21 invited speakers for paralell sessions and 23 participants for poster session, which shares their best practices in respective universities. Moreover, this event was attended by H.E. Mr. Simon Coveney, Ireland's Deputy Prime Minister and Dr. Michael John O'Mahony, Director of the Environmental Education Unit, an Taisce (The National Trust for Ireland).

We convey our greatest appreciation to all distinguished speakers and chairs from University College Cork - Ireland, Universidade do Minho – Portugal, Mahidol University - Thailand, University of Turin - Italy, Universidad Nacional de Colombia - Colombia, University of Nottingham - UK, Umwelt - Campus Birkenfeld - Germany, Miguel Hernández of Elche University - Spain, Dublin City University - Ireland, Inseec U - France, Federal University of Santa Catarina - Brazil, University of Sao Paulo (USP) - Brazil, King Mongkut.s University of Technology Thonburi - Thailand, University of Groningen - Netherland, Universidad Autónoma de Occidente - Colombia, Universiti Utara Malaysia - Malaysia, Université de Sherbrooke - Canada, University of Limerick – Ireland, University of Milan-Bicocca - Italy, National Pingtung University of Science and Technology - Chinese Taipei, Shinshu University - Japan, Wageningen University & Research - Netherland, King Abdulaziz University - Saudi Arabia, Universita di Bologna – Italy, Riga Technical University – Latvia, RUDN University - Russia. We also appreciate to all full paper for poster session from Chulalongkorn University - Thailand, Universidad de Alicante - Spain, Al-Zaytoonah University of Jordan - Jordan, Universitas Sumatera Utara - Indonesia, Universidade do Minho – Portugal, Srinakharinwirot University - Thailand, University of Valladolid - Spain, University of Central Punjab - Pakistan, Chaoyang University of Technology - Chinese Taipei, National Cheng Kung University - Chinese Taipei, Escuela Superior Politécnica De Chimborazo - Ecuador, Bogor Agricultural University (IPB) - Indonesia, Universitas Indoensia – Indonesia, Universitas Gadjah Mada - Indonesia, Siam University - Thailand, Roma Tre University - Italy, Universitat Politecnica de Valencia - Spain, University of Chieti and Pescara - Italy, RUDN University - Russia, University of Zanjan - Iran, National Chi Nan University - Chinese Taipei, Holy Spirit University ok Kaslik - Lebanon, Università degli Studi di Padova – Italy.

We thank the conference proceeding contributor for their papers. This conference has attracted active participation from many high rank officials from many universities. In total, we have participants from 89 universities of 34 countries, in which we have Austria, Brazil, Canada, Colombia, Ecuador, France, Germany, Hungary, Indonesia, Iran, Ireland, Italy, Japan, Jordan, Kazakhstan, Latvia, Lebanon, Malaysia, Malta, Netherland, Pakistan, Poland, Portugal, Russia, Saudi Arabia, Slovakia, Spain, Sweden, Taiwan, Thailand, Tunisia, Turkey, United Kingdom, and US on the list. This large number of participants indicated that ranking has been widely acknowledged a great tool for improving standard of university infrastructure management. We thank all participants and all stakeholders for making this International Workshop on UI GreenMetric 2019 a fruitful and memorable event.

Editorial Team

Riri Fitri Sari, Nyoman Suwartha, Junaidi

Welcome Message – Rector of Universitas Indonesia

Dear Rectors, Vice Rectors, University Leaders, Campus Sustainability Officers and all participants. Welcome to the 5th International Workshop on UI GreenMetric 2019 at University College Cork, Ireland.

This is the highlight of all the national workshop conducted worldwide during our world tour in 2018. In 2018 the national workshops of UI GreenMetric have been conducted in Iran, Kazakhstan, Saudi Arabia, United Kingdom, Colombia, Brazil, Pakistan, Malaysia, Indonesia, Latvia, Russia, Chile, and France. I personally thank our hosts and national coordinators who have been generously committed to lead the UI GreenMetric movement in their country.

I am honored to wish all distinguished university leaders from 35 countries in this annual gala event hosted by the University College Cork in this beautiful city of Cork

I am delighted to know that after 10 years UI GreenMetric has grown to be a knowledge hub and a great living in university network. Our workshop has also become an experience sharing event in which we can learn from each other in implementing sustainable campus infrastructure.

I am pleased to see the strength of our network in which many universities with strong SDGs achievement priority have taken part and show their consistent strength.

I wish you all a constructive and productive time during the conference and hope your stay is enjoyable in Ireland.

Prof. Dr. Ir. Muhammad Anis, M.Met.
(Rector of Universitas Indonesia)

Welcome Message – Rector of University College Cork

We warmly welcome you to the 5th International Workshop on UI GreenMetric World University Rankings (IWGM 2019) at University College Cork. UCC is ranked in the top 50 universities for learning and teaching in Europe. Our campus, which dates back to 1845, was the first in the world to be awarded a Green Flag from the Foundation for Environmental Education and the only university outside of the United States and Canada to be awarded a Gold STARS rating for the advancement of sustainability.

The world is changing and preparing our students to be global citizens is a key ambition of our university. University College Cork, as the Irish national coordinator for UI GreenMetric, is delighted to welcome you to our campus on the 14th-16th April 2019 to share best practice in driving local action for global impact across each of your institutions. We hope that the networking opportunity provided will stimulate greater cooperation between our universities to solve some of the world's greatest problems.

Prof. Patrick G. O'Shea
(President of University of College Cork)

A Glimpse of UI GreenMetric Rankings & Its Network

Dear university leaders, welcome to the 5th International Workshop on UI GreenMetric 2019. This is the second annual event after the Istanbul Meeting in 2017. We would like to thank our host, University College Cork for showing the hospitality to our network of green universities.

The spirit of UI GreenMetric networks has echoed worldwide. In 2018 the national workshops of UI GreenMetric have been hosted by the University of Zanjan Iran, Ferdowsi University of Mashad Iran, Atyrau State University Kazakhstan, King Abdulaziz University (KAU) Saudi Arabia, Nottingham University United Kingdom, National University of Colombia, University del Rosario Colombia, University of Sao Paulo Brazilia, Pakistan Higher Education Commission, University Utara Malaysia, Institut Teknologi Sepuluh Nopember (ITS) Indonesia, Riga Technical University Latvia, RUDN University Russia, Universidad Tecnica Federico Santa Maria Chile, dan Inseec U France. We thank the hosts and national coordinators that have been generously committed to lead the UI GreenMetric movement in their respected country.

We thank Rectors and high rank university officers from 35 countries who are willing to share their experience and efforts in improving sustainable environment in their campuses. We are delighted to receive news that our network members have also been recognised worldwide in terms of its sustainability programs and great concern on the contribution towards SDGs achievement.

The aim of this workshop is to provide an opportunity for UI GreenMetric participants to show their university's excellence and also to provide an opportunity for cooperation in sustainable campus management. In this international workshop, in addition to the limited slot for presentation, for the first time we organised a poster session. Participating university leaders will share their achievement in leading sustainability related programs in their campuses. We hope that this event will be the discussion ground among many universitiy leaders. We hope that you will return back home with some detailed programs inspired by your colleague.

This proceeding book consists 42 papers, in which 23 papers have been presented during the conference due to the limitation available time. It covers the 6 indicators used in UI GreenMetric, i.e. Setting and Infrastructure, Energy and Climate Change, Waste Management, Water Management, Transportation and Education.

We would like to thank all the speakers for their contribution to this workshop and the proceedings. We also thank all workshop participants for their active participation in the workshop. Enjoy your visit to Cork and this beautiful University College Cork campus as well as Irish traditional heritage.

Prof. Dr. Ir. Riri Fitri Sari, MM., MSc.
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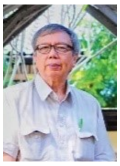

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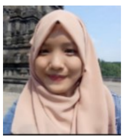

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UI GreenMetric World University Rankings: Background of the Ranking

Initiation of the Ranking

The UI GreenMetric World University Ranking is an initiative of Universitas Indonesia which is being launched in 2010. Prof. Gumilar Rusliwa Soemantri Stated that it is a part of strategy of raising its international standing. The University hosted an International Conference on World University Rankings on 16 April 2009. It invited a number of experts on world university rankings such as Isidro Aguillo (Webometrics), Angela Yung-Chi Hou (HEEACT), and Alex Usher (Educational Policy Canada). It was clear from the discussions that current criteria being used to rank universities were not giving credit to those that were making efforts to reduce their carbon footprint and thus help combat global climate change.

Aim of the Ranking

The aim of this ranking is to provide the result of online survey regarding the current condition and policies related to Green Campus and Sustainability in the Universities all over the world. It is expected that by drawing the attention of university leaders and stake holders, more attention will be given to combating global climate change, energy and water conservation, waste recycling, and green transportation. We hope that the ranking will be useful to university leaders in their efforts to put in place eco-friendly policies and manage behavioral change among the academic community at their respective institutions.

Creating the Ranking

Universities that wish to participate are asked to provide numeric data on a number of criteria that can give a picture of their commitment to the greening of their campus and putting in place environmentally friendly policies that support sustainability. The criteria include such baseline information as the size of the university, both spatially and in terms of population, the campus location and the amount of green space; and also information on energy use, transport, water use and recycling and waste treatment. In addition, it will ask about efforts being made by the institution towards establishing green policies and management.

Methodology Used to Create the Rankings

- **The philosophy behind the rankings**
  We based our instrument on a broad philosophy that encompasses the three Es: Environment, Economics and Equity.

- **The criteria**
  We selected criteria that are generally thought to be of importance by universities concerned with sustainability. These include the collection of a basic profile of the size of the university and its zoning profile, whether urban, suburban, rural. Beyond this we want to see the degree of green space. The next category of information concerns electricity consumption because of its link to our carbon footprint. Then we want to know about transport, water usage, waste management and so on. Beyond these indicators, we want to get a picture about how the university is responding to or dealing with the issue of sustainability through policies, actions, and communication. In the first version of the methodology, used in 2010, 23 indicators were used within the five categories to calculate the ranking scores. In 2011, 34 indicators were used. Then in 2012 we leave the indicator of "smoke free and drug free campus environment" and used 33 indicators to evaluate the green campus. In 2012, we also categorize the indicators into 6 category including education criteria. One change being considered is the formation of a new category for sustainability education and research. In 2015 the theme was carbon footprint. We add two questions related this issue in the energy and climate change section.We also improved our methodology by adding a few sub-indicators that related to water and transportation in the 2015 ranking. A major change in methodology was done in 2016 by considering new trends in sustainability issues. In 2017, It is started to request some documentation for prove as an evidence. In 2018, we strated the lesson so that achievement of each university can be revealed from the siquence urutan of development condition, base on data from previous year.

- **The scoring**
  Scoring for each item will be numeric so that our data can be processed statistically. Scores will be simple counts of things, or responses on a scale of some sort.

- **The weighting of criteria**
  Each of the criteria will be categorized in a general class of information and when we process the results, the raw scores will be weighted to give a final calculation. The weighting Criteria can be found in Fig.1.

- **Refining and improving the research instrument**
  While we have put every effort into the design and implementation of the questionnaire, we realize that this seventh year-round is bound to have shortcomings. Therefore, we will be reviewing the criteria and the weightings continuously to reflect input from participants and state of the art developments in the field. We welcome your comments and input.

- **Data collection**
  Data will be collected through online system between May-October of the year, from the universities we have contacted and who are willing to provide information.

- **The results announcement**
  The results of the metrics is annually released in December.

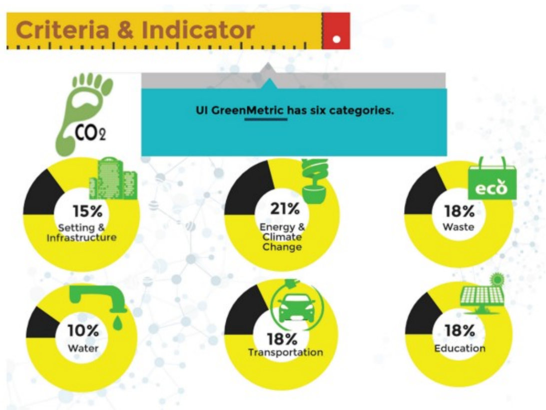

Figure 1. UI GreenMetric ranking criteria and weighting

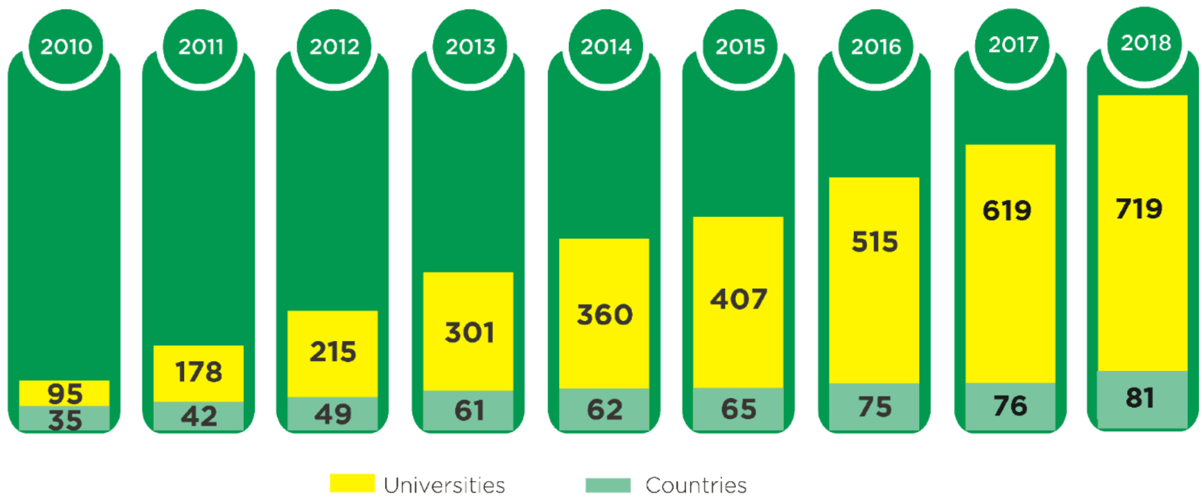

Figure 2. Number of UI GreenMetric's participating universities 2010-2018

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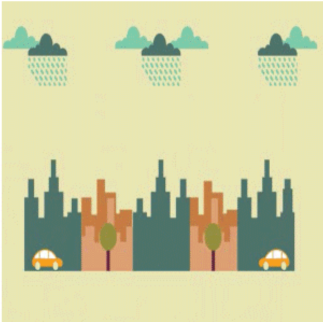
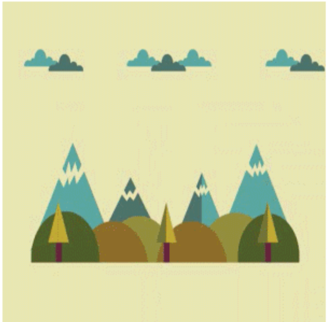
Issues and Innovation in Managing Setting and Infrastructure



Eco-University Policy and Implementation of Mahidol University, Thailand

Kitikorn Charmondusit*[1, a], Puttised Tantimekin[2, b], Malulee Leamlaem[2, c]
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Abstract. Mahidol University (MU) has been living a long history for over 129 years, which is recognized as a large higher education institution comprising of academicians and professionals in every field, both in arts and sciences. Salaya campus is the main campus of MU, where is located in Nakorn Pathom province, west of Bangkok, Thailand. MU has driven the eco-university policy for sustainable development on campus and in the surrounding community by creating a balance of economic, social and environmental dimensions which will lead to efficient use of resources, social equality and improved quality of life of staff, students and the surrounding community. The university aims to reduce greenhouse gases by at least no less than 25% within the year 2021 in comparison with gas emissions of the base year 2016. This plan complies with Thailand policies in accordance with its ratification of the Paris Agreement in reducing greenhouse gases by no less than 20-25%. To achieve this goal, the university has adopted three strategies including: (1) Promotion of an increase in resource efficiency; (2) Promotion of low carbon technology and innovation to reduce greenhouse gases; and (3) Promotion of community engagement.

Keywords: eco-university, community engagement, green campus, greenhouse gas, resource efficiency

1. Introduction of Mahidol University[1]

Mahidol University (MU) has its origins in the establishment of Siriraj Hospital in 1888 by His Majesty King Chulalongkorn (Rama V), and the hospital's medical school is the oldest institution of higher learning in Thailand, granting its first medical degree in 1893. Later becoming the University of Medical Sciences in 1943, Mahidol University was renamed with great honor in 1969 by H.M. King Bhumibol Adulyadej, after his Royal Father, H.R.H Prince Mahidol of Songkla. MU has since developed into one of the most prestigious universities in Thailand, internationally known and recognized for the high caliber of research and teaching by its faculty, and its outstanding achievements in teaching, research, international academic collaboration and professional services. This diversified institution now offers top quality programs in numerous social and cultural disciplines, including the most doctoral programs of any institution in Thailand, yet has maintained its traditional excellence in medicine and the sciences.

MU has three campuses in the Bangkok metropolitan area: the large suburban campus at Salaya in nearby Nakhon Pathom province, where is the main campus of MU, and two inner-city campuses in Bangkok Noi and Phayathai in the Bangkok area, in addition to a downtown high-rise office site for the College of Management. There are also provincial campuses in Kanchanaburi (west of Thailand), Nakhon Sawan (north of Thailand) and Amnaj Charoen (north-eastern of Thailand) provinces.

MU is organized into 17 faculties (responsible for both research and teaching), 7 institutes (mainly focusing on research), 6 colleges (mainly focusing on teaching) and 9 centers (mainly providing academic services). MU has approximately 24,000 students, of whom some 15,500 are undergraduate students and some 8,300 are postgraduate students. It also has a total of 3,000 academic staff responsible for teaching and research, as well as some 6,500 academic assistants, 5,900 administrative staff, and 8,700 other employees (including hospital employees).

2. MU Eco-University Policy

In 2015, MU has been launched the "Eco-University" policy, which drives university for sustainable development on campus and in the surrounding community by creating a balance of economic, social and environmental dimensions. This will lead to efficient use of resources, social equality and improved quality of life of staff, students and the surrounding community. The university aims to reduce greenhouse gases by at least no less than 25% within the year 2021 in comparison with gas emissions of the base year 2016. This plan complies with Thailand policies in accordance with its ratification of the Paris Agreement in reducing greenhouse gases by no less than 20-25%. To achieve this goal, the university has adopted three strategies including: (1) Promotion of an increase in resource efficiency; (2) Promotion of low carbon technology and innovation to reduce greenhouse gases; and (3) Promotion of community engagement. The eco-university strategy was summarized and illustrated in Fig. 1.

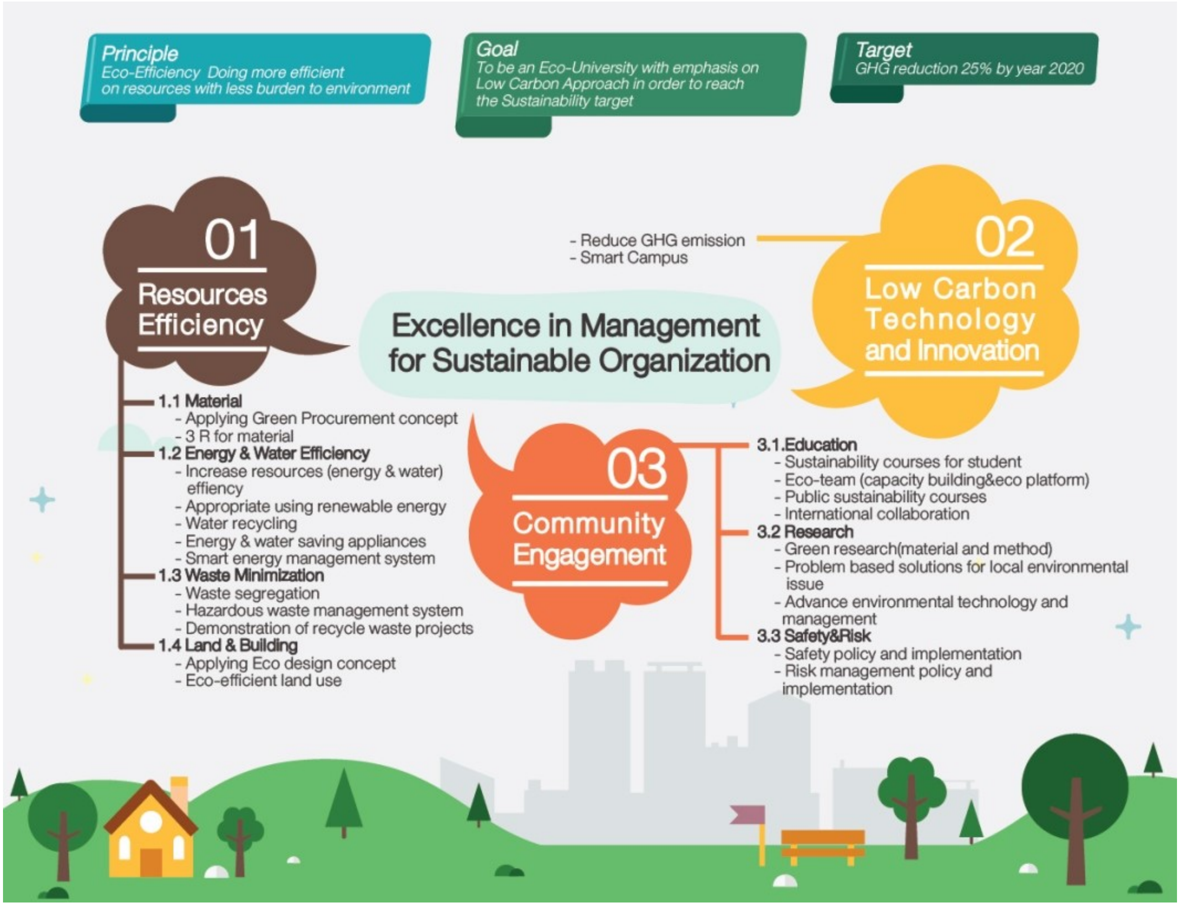

Figure 1. The summarization of eco-university strategy

3. Eco-University Indicator and Monitoring

MU has emphasized sustainable corporate management which is a strategy in the university operation through work agreement to set operational goals between the university and faculties. With respect to this agreement, the faculties shall report their performances at the end of the agreement period, and one of the report topics shall be the performance results following six eco-university indicators including raw materials, energy use, water use, wastes, buildings and greenhouse gases [2]. The criteria of each eco-university indicators are shown in Table 1.

Table 1. Eco-university indicator and criteria

Indicators	Criteria
1. Material	Over 50% of purchased green product procurement
2. Energy	No increase in energy consumption
3. Water	No increase in tap water consumption
4. Waste	Segregation of waste must be required
5. Building	There is over 50% of green building elements.
6. Greenhouse	100% of the carbon footprint for organization assessment in all work units has been completed

3.1. Material

The university has paid attention to the environment and sustainable development, therefore it organized a seminar project of "green product procurement" in accordance with United Nations' sustainable development goals No. 12: Sustainable Production and Consumption. The seminar was intended to introduce criteria, rules and regulations of green product procurement to the university's work units (including faculties, college, institute, and center). Regarding the performances of the university work units in 2017, 15 more work units were qualified according to raw material criteria, and each faculty had a tendency to use more environmentally friendly product than in 2016. The percentage of green product procurement comparing between 2016 and 2017 is shown in Fig. 2.

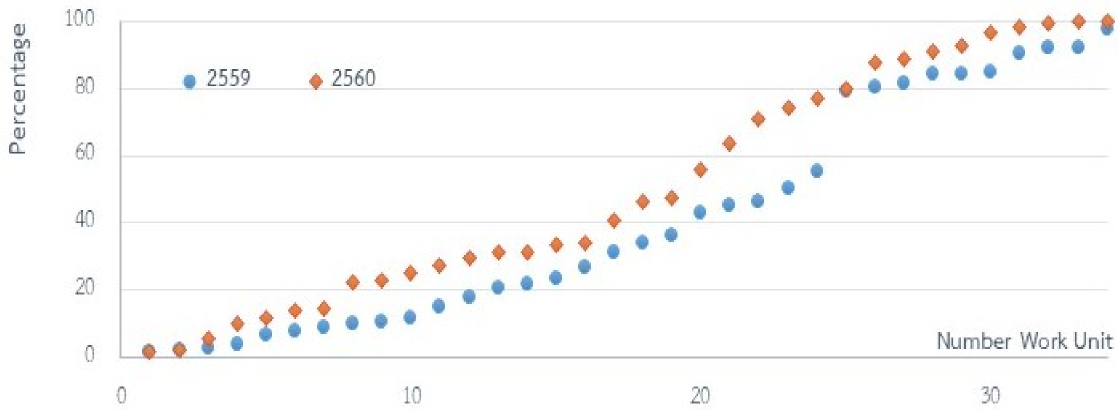

Figure 2. The percentage of green product procurement comparing between 2016 and 2017

3.2. Energy

In 2017, The total electricity consumption of MU was 261,989.04 MW, most of which was used by the work units providing medical services. The comparison of total electricity consumption between 2016 and 2017 is illustrated in Figure 3. It was indicated that 21 work units, or 11 more work units this year, were able to reduce the use of electricity; compared with those in the previous year, accounting for 2,224.68 MW of decreasing power. In addition, MU has been operating energy-saving projects, for instance, producing electricity from solar renewable energy and solar cells, production of biodiesel from used cooking oil. The university also organized activities to promote energy conservation and energy saving such as MU Light Out and MU Energy Award.

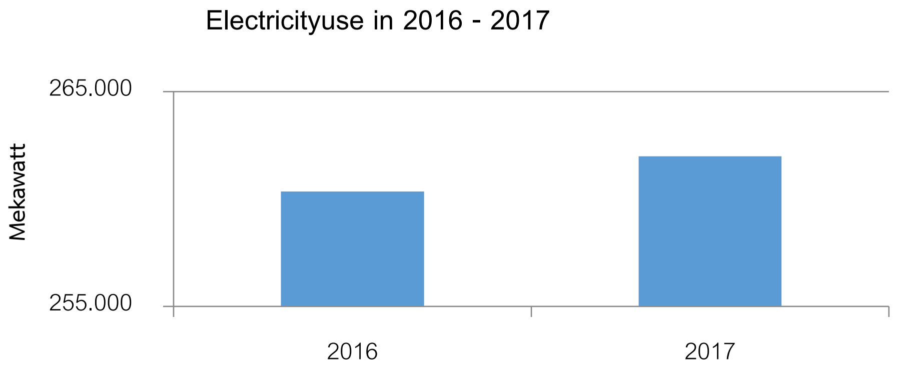

Figure 3. Electricity consumption in 2016 and 2017

3.3. Water

The total water consumption of MU in 2017 was 4,447,043.57 cubic meters. There were 9 more faculties or a total of 21 work units reducing water consumption, which was a total decrease of 85,972.11 cubic meters, compared with that of the previous year (Fig. 4). The recycle of treated wastewater project was implemented in order to reach more number of water reduction. it has been working most effectively, causing 71.2% of treated water to be reused on the campus, which can save 111 m3 of tap water per month (2,300 baht per month), and reduce greenhouse gas emissions by 3 kg CO2 eq/ month. In addition to its high capacity with only 150,000-baht investment and a 5-year payback period, the project became a good model for other workplaces of Mahidol University.

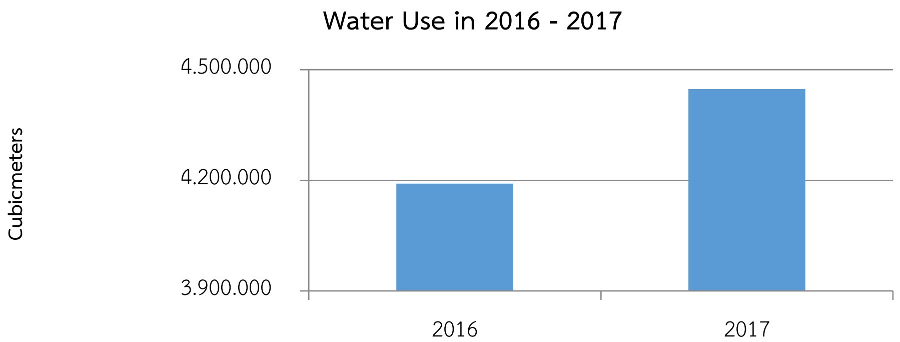

Figure 4. Water consumption in 2016 and 2017

3.4. Waste

MU has been running a campaign on the separation of garbage by providing waste sorting bins in all the work units; however, the collection of waste sorting data is still challenging. In 2017, it was indicated that the waste database became improving and there was an increase in waste sorting by 12.47% compared with that in the previous year. This might have resulted from the cooperation of all work units in data collection. In addition, the university developed the recycling waste bank project whose operational database was systemized. It was revealed in 2017 that the purchase of recycling wastes through the project rose to a total of 1,207 tons.

3.5. Building

MU has pushed forward the environmentally friendly features of the work unit buildings to meet green building criteria in order to minimize their impact on the environment and reduce negative effects on staff health. In comparison with the previous year assessment, in 2017, a total of 20 workplace buildings or 6 more of them were qualified to meet 50% of criteria for eco-friendly building features.

3.6 Greenhouse Gas

The university has organized the MU Carbon Footprint Program in which the collected data of resource use have been calculated to find the number of greenhouse gases emitted by the organization [3]. The program has been well-cooperated by all work units in providing the required information. According to the previous year performance, a total of 16 work units emitted 9,264 tons CO_2eq, and a total of 33,111 tons CO_2eq was emitted from activities taking place on the campus in 2017. As a result of these facts, the university set up some projects to reduce greenhouse gas emissions including: (1) waste recycling, (2) reduction of plastic bags, (3) carbon capture and storage in biomass, (4) reduction of energy; and (5) changing appliances into power saving/energy conservation. After the implementation of the projects, the emission of greenhouse gases decreased by 3,654 tons CO_2eq or 12% of the total greenhouse gas emissions in the same year.

4. Conclusion

MU is determined to be a world-class university. In order to reach excellence in management for the sustainable organization, the eco-university policy is one of the focused policies. The 3 strategies with 6 core indicators of eco-university have been implemented, which can drive environmentally friendly and sustainable development activities following the 17 sustainable development goals [4].

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Green as a Decision-Making Driver for Planning Infrastructures and Actions

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Abstract. Moving from ad hoc and occasional actions to the design of new infrastructures, sustainability has progressively become part of the decision-making process of the University of Turin. In an attempt to meet the need of environmental sustainability expressed by the university community made of researchers, students and technical staff, the Athenaeum has therefore launched a Green Office (UniToGO), dedicated to the development of sustainable initiatives in five areas (energy, mobility, waste management, green public procurement and food) collected in a three-year Action Plan and an annual Sustainability Report. At the meanwhile, the University has made environmental sustainability the core feature in the design of new buildings, setting and infrastructures.
The aim of the paper is to retrace and model the governance evolution, which led to incorporate environmental sustainability as a starting prerequisite of the decision-making process. Two case studies will show how sustainability has been integrated into design, construction and fruition of services and spaces in single buildings as well in a university campus. The first is about the eco-innovative food and beverage vending machines service, the second one is about the design of the new scientific campus in Grugliasco through a LEED certification process and a cross-cutting approach.

Keywords: eco-innovative vending-machines, environmental governance, green office, sustainable buildings

1. Introduction

Several studies investigate the crucial relation between Universities and the territorial context showing how they can play a vital and dynamic role in their local areas. As *anchor institutions* [1, 2] that can foster city development in economic and social terms, a relevant *helix* for economic and social innovation of the territory by interacting with the other three helices represented by the government, companies and local communities in the quadruple helix model [3, 4, 5], these organizations are facing today several challenges to become *civic universities* [6] characterized by seven relevant features: sense of purpose, active engagement, holistic approach, sense of place, willingness to invest, transparency and accountability, innovative methodologies.

If it is known that the university can be a central actor of change, there are many ways to become it: the path is not obvious, and it can follow different routes according to variable geometries of relevant dimensions that must be adapted according to the territorial context and the organizational form of each university.

The next paragraphs illustrate the way taken by the University of Turin through the description of strategies and tools developed for fostering the environmental governance, and through the presentation of two case studies. The first is about the eco-innovative food and beverage vending machines service, the second one is about the design of a new scientific campus through a LEED certification process.

2. Green Governance at University of Turin

The University of Torino (UniTo) is large scale public Athenaeum located in Piedmont, in the heart of the Alps. With a community of almost 80,000 students, faculty and staff, widely scattered in more than 100 locations, grouped in 7 hub areas, around the city center and key urban places of the entire Region, UniTo is one of the largest Italian Universities conceived according to the model of urban campus.

Except for engineering and architecture, the 27 Departments carry out scientific research and organize courses in all disciplines in 4 study areas: natural sciences and technology, life sciences and medicine, economic, juridical and social sciences, arts and humanities.

The impact of its daily activities on the city life and environment is therefore massive and the University of Turin is seriously committed to contributing to the sustainable development of society. In order to reach the goal "Increasing the social, economic and environmental responsibility of the University of Turin" of its

Strategic Guide Lines 2016-2020 [7], UniTo is acting both on the planning side - to design its future actions, services and buildings with a sustainable and innovative approach - and on the current managing of the existent structures, to transform them into environmentally sustainable locations to study and work.

Since 2013 the University realizes an annual *Sustainability Report* with the aim of accounting the Athenaeum's sustainability performance in economic, social and environmental responsibilities to the stakeholders [8, 9]. The Report adopts the Global Reporting Initiative (GRI) guidelines version G4, and is based on a materiality matrix focused on four steps: identification, prioritization, validation and review. The outcomes of the UniTo stakeholder engagement process has been used as a source of information for the elaboration of the matrix.

The commitment to strengthening environmental sustainability is also reflected in the relationship with local stakeholders, including public administrations and utilities directly involved in various actions, and in the participation at international and national networks. The most relevant network at the national level is the University Network for Sustainable Development (RUS), founded in 2015 by the Conference of Rectors of Italian Universities (CRUI) to spread the culture of sustainability and sharing good practices, both within Universities and in the broader community. This network is the "first experience of coordination and sharing between all Italian universities committed to promoting issues of environmental sustainability and social responsibility, to orient their institutional activities towards goals of integrated sustainability" [10]. The UniTo commitment in RUS will allow both to increase the positive impact of the actions developed, thanks to sharing of the best practices and to contribute the attainment of the Sustainable Development Goals of the 2030 United Nations Agenda.

To strengthen and give operational substance to its commitment to the environment in 2016, the university has established the Green Office UniToGO in charge of reducing the University's environmental impact by engaging of the whole university community.

2.1. UniTo Green Office – UniToGO

UniToGO is at the same time an administrative structure of the Division Real estate, Logistic and Sustainability and a project, a process and a context of comparison, coordination and planning. It is coordinated by the Dean's Delegate to the Environmental Sustainability and is composed of a General Coordination and five thematic working groups initially identified as priority areas of intervention. The General Coordination, in charge of outlining the guidelines and of connecting with the Athenaeum government bodies, is composed by the Dean's Delegate for Environmental Sustainability, some Vice-Rectors and some managers of the administrative divisions involved, firstly the Real estate, Logistic and Sustainability one.

The thematic working groups work on five strategic assets pursuing the following aims and purposes:

- *Energy*: improvement of energy efficiency, decrease its consumption and reduce the Green House Gases emissions;
- *Food*: improvement of the quality and sustainability of food consumed within the University;
- *Green Public Procurement*: increase the amount of ecological public purchases of the University;
- *Mobility*: enhancement of sustainable mobility options for the university community, reducing the car use and strengthening the active mobility;
- *Waste*: spreading over the whole university the differentiated disposal collection and upgrading the waste cycle management.

The activities of planning, design and implementation led by the thematic working groups are supported and connected by the Project Management Unit and strengthened in the processes of information, dissemination and participation thanks to the Coordination Communication and Engagement.

UniToGO takes advantages of the several competencies from all the members of the university community: research staff (professor, research fellows and scholarships researchers) that provides multidisciplinary and methodological guidance and facilitate the relationship with the areas of training and research; administrative and technical staff that ensures technical and procedural skills necessary for the initiatives implementation and favors the connection between central and decentralized structures; and students' representatives that contribute to transmitting the student population's needs and facilitate their involvement and awareness, also through cooperation with student associations and thanks to the contribution of collaborators, volunteer students.

In order to reduce the University's environmental impact and to increase the environmental responsibility, as stated by the Strategic Guide Lines 2016-2020 of the University of Torino, UniToGO developed the *Environmental Sustainability Action Plan* [11], a 3 years-planning and programmatic document that identifies the objectives and declines them into actions and detailed activities for each thematic working group. The *Environmental Sustainability Action Plan* presents different typologies of interventions: from the structural ones planned in a medium-long term that require a large budget and complex technical design and planning project, to the soft ones that can be realized in the short-medium term, with a lower budget and an easier design activity.

To systematize the activities of the working groups and to give programmatic organicity to the Plan, all the actions are structured along three complementary lines of intervention:

- *know*: build a shared base of knowledge on the environmentally sustainable initiatives launched within the University of Turin and about possible areas of intervention, and about good practices through the analysis of literature and current research, with particular attention to the experiences of sustainable universities and campuses in Italy and abroad;
- *engage*: intensifying networking activities within the university and with relevant stakeholders at a local, national and international scale. Through a capillary communication, the engagement actions aim at engaging in the activities of UniToGO all the interesting subjects and at transferring and sharing scientific and technological knowledge with the local actors;
- *change*: design and implement interventions aimed at effectively reducing the environmental impact of the University. The actions aim to enhance the existing university context and identify areas of intervention to improve the Athenaeum environmental performance, starting from the concepts of rationalization and reduction of consumption, materials recycling and procedures optimization.

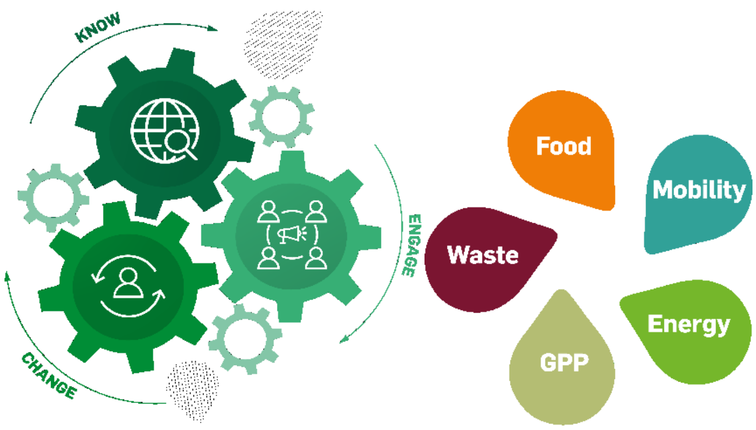

Figure 1. UniTo Green Office approach

The next paragraph will present two case studies that refer to the dimension of the change but are in close synergy with the activities of knowledge and engagement. Both cases show how sustainability has been integrated into the design, construction and fruition of services and existing and future spaces.

3. Concrete Experiences of Sustainability

3.1. Vending machines: a participative and eco-innovative tender process design

Starting from April 2017, the University, in collaboration with UniToGO, has launched a process of reordering of the service of automatic distribution of snack food product and beverage (vending machine), to improve it in terms of quality and environmental sustainability. The opportunity to fundamentally re-think the vending machine service requirements was offered by the participation to SPP Region project [12]. This H2020 project aimed at promoting the creation and expansion of European regional networks of municipalities working together on sustainable public procurement (SPP) and public procurement of innovation (PPI). The 7 networks involved in the project regional networks collaborated directly on tendering for eco-innovative solutions, whilst building capacities and transferring skills and knowledge through their SPP and PPI activities even in the sectors of food and catering services [13]. The starting points for this process were a comprehensive benchmark ad needs analysis complemented by a process of community engagement as Fig. 2 shows.

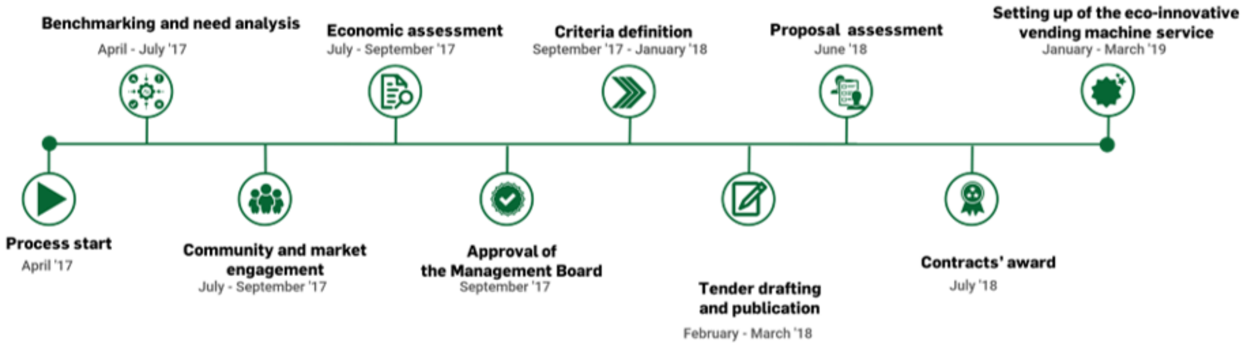

Figure 2. Timeline of the eco-innovative tender process design

Moving from the guidelines of the Joint Research Centre working group "Green Public Procurement for Food and Catering Services" [14] and the Italian Ministry of the Environment's "Environmental Minimum Criteria" (CAM in Italian) related to canteen services and food supplies for public contracts [15], The working group Food and GPP of UniToGO analyzed the most relevant eco-features in 20 green contracts from Universities and public institutions. The aim of this analysis was to find the best practices and new starting points for reference. Between April and June 2017, a study about the location, quantity, type and model of all the vending machines located in the different buildings, together with an overview of the status of the various vending machine contracts, was carried out. UniToGO also measured the energy consumption of the different vending machines (hot drinks, cold drinks, confectionery) to get an insight into the overall energy consumption. 279 vending machines were identified, located in 60 university buildings (offices, libraries, classrooms, laboratories, departments) throughout the city. The study showed a varied picture in terms of suppliers (15), contractual conditions, types of distributors, goods and services offered, prices for users. The preliminary analysis, therefore, revealed a clear need to regulate the automated vending service within a common frame of reference and a wide margin for improving the quality and efficiency of the service. This was further confirmed by the results of a questionnaire "What are you looking for in an eco-innovative VM" that was submitted in July 2017 to the university community. The analysis of the 1,245 responses highlighted a strong interest amongst students, researcher and administrative staff for eco-innovative solutions improving the sustainability of the service. The community proved to be particularly sensitive to energy efficiency and environmental sustainability. Responses also show strong demand for healthier food and drink as well as for food suitable for different dietary requirements (food regimes, allergies, intolerances). The student community, in particular, expressed interest in making water dispensers available to decrease the impact of plastic bottles. During the pre-procurement stage, beyond the internal community, the University also involved the operators of the service of the vending machine by launching a market consultation process in July 2017. Suppliers and stakeholders were invited to attend an open consultation workshop where they were asked to respond to several questions about the feasibility of eco-feature requirements for vending machines, market readiness and capacity to offer eco-innovative solutions. The University met 9 different supplies. It was clear from the market responses that some suppliers (especially the bigger ones) are moving toward the more sustainable provision of goods and services. It was also evident that the form of an open supplier workshop undermined the quality of the answers, especially where new technologies could result in a competitive advantage during the scoring of the tender proposals. Thanks to the use of the skills coming from the different Departments and Directions about the legal, economic, environmental, energy, food-related features of the automatic distribution service, all the inputs coming from the university community and the market feedback have been collected and systematized in the drafting process of the call for tenders, published on March 2018 [16]. It is there elaborated a tender inspired in general terms by the principles of eco-innovation according to the definition set by the European Commission in the communication COM (2011) 8991 [17], along with principles of affordability, far-reaching presence, as well as accessibility to a healthy diet (Fig. 3) as defined by the international debate and in particular by the WHO [18] and the Italian Ministry of Agriculture and Forestry in collaboration with INRAN [19].

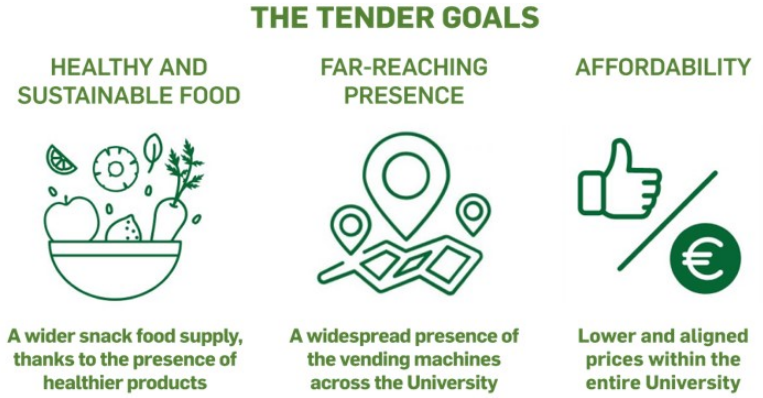

Figure 3. The overall goals pursued by the vending machine tender

The tender set minimum standards in terms of energy efficiency and the provision of healthy and affordable products, as well as introducing tap water dispensers. During the evaluation phase, further points are also awarded relating to waste management, sustainable delivery and awareness raising, amongst other aspects [20]. The tender was awarded in July 2018 and since January 2019 the phase of setting up of the eco-innovative vending service has started and it will be concluded by March 2019.

As the main final outcomes, the food supply of the vending machine in the University has been enriched with the addition of healthy snacks and a balanced nutritional intake, tap water dispenser has been introduced in the university buildings along with an overall improvement of the energy efficiency of the vending machines with improved energy class (A+) and LED lighting. Some amelioration actions for the waste management were also introduced such as the use of plastic compactors and the collection and re-use of coffee grounds.

3.2 Scientific and strategic project for the new University Campus in Grugliasco (Città delle Scienze).
The project of the new scientific hub in Grugliasco (Italy) will develop synergies between the departments of Agricultural, Forest and Food Sciences, Veterinary Science that already reside in Grugliasco, and the scientific departments of Chemistry, Life Sciences and Systems Biology, and Earth Sciences currently located in Turin. This new sciences hub will provide a unique and shared site for research, teaching, and technology transfer to start-up and companies. It will generate great benefits to the socioeconomic and cultural system of the Piedmont Region, as well as the metropolitan area of Turin and Grugliasco [21].

In this framework, University and local institutions have convergent objectives in the field of social innovation, knowledge dissemination, and economic impact. According to Goddard [22], the preliminary project has considered that Universities are now asked to redefine their social role in order to:

1) be actively engaged with the wider world, as well as with the local communities;
2) take a holistic approach to engagement, seeing it as an institution-wide activity, not confined to specific individuals or teams;
3) have a strong sense of place, recognizing the location’s role in forming the identity of the institution;
4) have a sense of purpose;
5) be willing to invest to have an impact beyond the academy;
6) be transparent and accountable towards their stakeholder and the wider public;
7) use innovative methodologies such as social media and team building in their engagement activities with the world at large.

In the new green Campus:

- educational spaces (18,000 m^2) to accommodate 5,000 students, classrooms for teaching, study rooms, common areas and student services, lunch rooms;
- research laboratories (40,000 m^2);
- business incubator (1,000 m^2);
- sports center (indoor and outdoor);
- places of relationships which to link the campus and the city with a new urban park (40,000 m^2); and the Piedmont Region cycle path system - Corona Verde project will be placed.

The designers were asked to follow the LEED® protocol (Leadership in Energy and Environmental Design) to achieve the certification in the gold category [23]. In the Italian context, the LEED® protocol indicates a certification system of environmental sustainability, issued by a third party, to evaluate the project, the construction, and the management of buildings.

The first step in the preliminary project of the new campus was referred to as energy-optimization and environmental quality criteria. The objectives consisted of the limitation of resources consumption, minimization of environmental loads, and quality of indoor environments. This objective was achieved by applying appropriate design strategies to integrate the building in the context and optimize the exploitation of renewable resources. From the beginning, the design promoted sustainable land use through the application of eco-sustainability and biocompatibility principles.

This has been possible adopting an East-West orientation with excellent results in terms of winter energy consumption for heating. In fact, the energy index resulted in "almost zero energy buildings" (less than 30 kWh/m^2 per year), which is consistently below the values required by the current legislation. Even in the summer, overheating phenomena of rooms (with consequent discomfort of occupants) have been avoided.

In the next design steps (i.e., definitive and final projects), the buildings will be integrated into the surrounding environment with the use of bio-sustainable and biocompatible construction materials, thus using wherever possible recycled and recyclable (at the end of their life cycle) materials. The buildings will follow the bioclimatic principle in the architectural design.

In summary, the sustainability objectives that will be achieved consist of:

- minimization of energy consumption for winter heating through the Est-West orientation of buildings;
- adoption of passive systems for summer cooling;
- use of recycled and recyclable building materials with minimal environmental impact and no-emissions throughout their life cycle;
- optimization of natural lighting systems according to energy saving and visual comfort principles;
- minimization of electricity consumption through photovoltaic panels;
- the decrease in water consumption through automatic faucets, water saving toilet boxes, rainwater recovery for the fire-fighting tank and irrigation of green areas.

The “Square of relationship” will be the pulsing heart of the Campus where “sustainability” will find full accomplishment. The Square will be the starting for every academic activity, for mobility as per the railway catwalk (Fig. 4), for teaching, for research, for interaction between companies and University, for start-up, for sports, for the citizens who can enjoy the “University”.

Figure 4. Catwalk and green areas

4. Concluding Remarks

The two case studies described herein show how the activation of University as an agent of change and an active player of environmental sustainability is a long way to go, made up of several interconnected steps, that very briefly can be sum up in the following ones:

- a strong initial commitment to sustainability in the University policies (e.g. strategic plans, program agreement);
- the creation of a dedicated structure and instruments to enable the implementation of sustainability into daily actions (e.g. Green Office, Sustainability Action Plan);
- the adoption of communication and accountability tools related to the sustainability (e.g. Sustainability Report, Web and Social Communication);
- community engagement (events, communities of practices, network with students' associations);
- stakeholder engagement through the co-design of strategic planning actions (protocols, agreements);
- membership of university network (best practices exchange, joint research, educational and third mission actions);
- compliance with internationally agreed standards on several topics (energy efficiency, buildings, GHGs emissions).

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Universidad Nacional de Colombia a Multicity-Multicampuses University

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Abstract. Colombia is a diverse and complex country; the *Universidad Nacional de Colombia* (UNAL) its biggest public university is a reflection of that. Founded in 1867 and now with more than 53,000 students and 9,000 professors and staff, UNAL campuses exist in nine cities along our territory, each case with one or various urban campuses -places with historical and modern buildings- and sometimes rural plots outside the municipalities location for agricultural centers, botanical gardens and nature reserves.

The Environmental Management System of the university has a presence in all of those places to increase the ecological potential, supervise resources used, solve waste problems and define environmental policies under the regulation and goals that rule our academy, guided by the Sustainable Development Goals and the UI GreenMetric ranking results.

Keywords: Universidad Nacional de Colombia, public university, Colombia

1. Introduction

In 2018 the *Universidad Nacional de Colombia* got the 51st position in UI GreenMetric between 719 participants (total score: 7275 points), is the fourth (4°) in South America amid 79 participants and second (2°) in Colombia among 37 participants. It is a very good global upgrade considering the previous year (69th position among 619 participants) [1].

Improvement showed in efforts to be sustainable, guided by the environmental policy emanated by The Superior Council (highest university authority) [2]. Mandatory regulation applied to all those in teaching, research, consultancy and management activities of the academy.

However, to advance in our performance, it is important to work mainly in water and energy, our lowest scores in UI GreenMetric, through our Global Development Plan 2021 [3] that among other points seeks, design a plan to manage, lead and promote the environmental sustainability in the campuses through two goals:

- Strengthen the environmental dimension in all the institutional work from the missional axis teaching, research and consultancy, to the strategic processes and management support.
- Promote the environmental sustainability of *Universidad Nacional de Colombia* campuses in compliance with the Sustainable Development Goals of the United Nations Development Program.

2. Colombia, a Multiplicity of Environmental Settings

Colombia is located in the Northwest corner of South America (1,141,748 Km^2 (55%) continental territory and 928,660 Km^2 (45%) marine area, for a total area of 2,070,408 Km^2) [4]. Land and sea in the Equatorial fringe plus the presence of the Andes mountain range crossing the territory (Fig. 1) are fundamental elements that define the natural Colombian environment system, characterized by the diversity and complexity in geological, geographic, edaphic, climatic, biological, ecosystemic, ethnic, cultural and socioeconomic topics [5]. Variety and intricacy that would be divided into geographic areas include:

- Andina Region: In the center of the country, it corresponds with three mountainous chains: Eastern, Central and Western that go from south to north. In its intermediate valleys flow the country's two main rivers: Magdalena and Cauca.
- Caribe Region: In the north of the country bordering the Caribbean Sea is a very heterogeneous zone because it predominates the lowlands but presents the highest peak of the country, the Sierra Nevada of Santa Marta (from the border of the sea it ascends to more than 5,600 meters).
- Orinoquia Region: Starting in the Piedmont of the Eastern mountain range and ending in a spacious system of savannahs in eastern towards Venezuela and south towards the Amazon jungle.

- Amazonas Region: This region corresponds almost totally with the jungle zone in the south-eastern side of the country shared with Brazil and Peru.
- Pacifico Region: To the west of Colombia is a very humid forested stripe between the Pacific Ocean and the Western Mountain range, through Panama in the north and Ecuador in the south [5].

Figure 1. Physical-political Map of Colombia [4]

3. *Universidad Nacional de Colombia* Territorial Presence

The university has a presence in all Colombian regions:

Table 1. Regions, cities and branch names of the *Universidad Nacional de Colombia*

No	Geographic region	City or town	Branch name	Description
1	Andina	Bogotá	Bogotá	Headquarters, first and biggest branch in the Colombian capital
2	Andina	Medellin	Medellin	Second location in size in the 2° Colombian city
3	Andina	Manizales	Manizales	Third branch located on the Colombian coffee region
4	Andina	Palmira	Palmira	Fourth branch close to Cali, the 3° Colombian city
5	Amazonas	Leticia	Amazonia	Close to Brazil and Peru borders on the Amazon river
6	Orinoquia	Arauca	Orinoquia	In proximity to Venezuelan border on the Arauca river
7	Caribe	San Andrés	Caribe	In the Caribbean island of San Andrés close to Nicaraguan border
8	Pacifico	Tumaco	Tumaco	In the Colombian Pacific coast close to Ecuador
9	Caribe	La Paz	La Paz	The newest campus close to the city of Valledupar

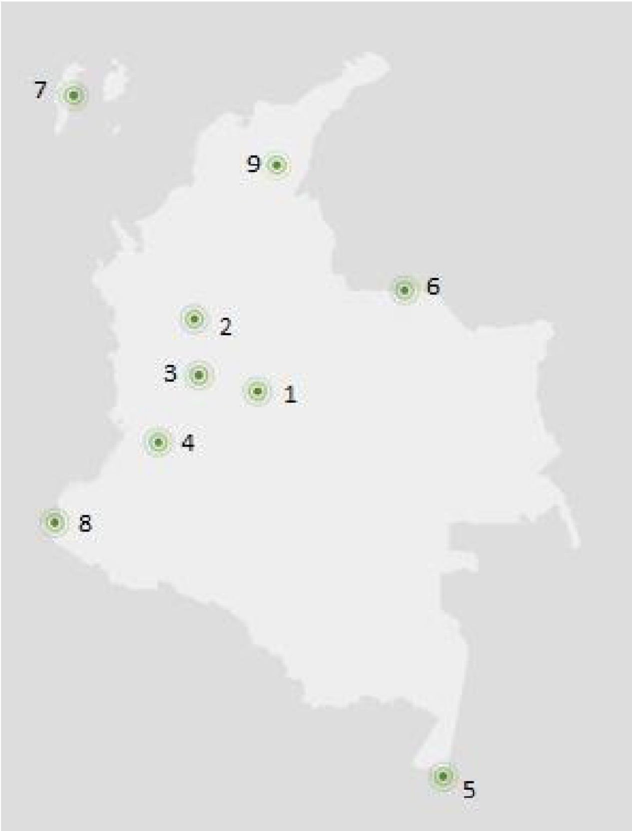

Figure 2. Colombian cities with *Universidad Nacional de Colombia* branch [6].

Table 2. Several campuses in the branches of the *Universidad Nacional de Colombia.*

No	Branch name	Number of campuses	Campuses, buildings, houses, stations, farms, plots etc.
1	Bogotá [7]	15	• University city or “White city” (main campus) • Uriel Gutierrez and Camilo Torres buildings • University hospital “Clinic Santa Rosa de Lima” • San Agustín cloister • National Astronomical Observatory • Jorge Eliecer Gaitán house museum and offices houses • National exploratory building • Training and conventions center • Las Nieves building bookstore • El cable hill radio transmitter • Marengo agricultural center • Roberto Franco Tropical biology station (Villavicencio city) • Paleontological museum (Villa de Leyva town)
2	Medellin [8]	14	• El Volador (main campus) • El Río campus • Robledo campus • Ingeominas and school/kinder garden buildings • El Volador hill • Paysandú agricultural station • San Pablo, Cotové and Piedras Blancas farms and forest station • Corralitos, Santa Rita, Montealvernia and La Esperanza plots
3	Manizales	3	• Palogrande (main campus) • El Cable campus • La Nubia campus
4	Palmira	5	• Palmira (main campus) • Mario González Aranda agriculture and livestock laboratory • The Experimental Centre • Yotoco National Forest Reserve • Sabaletas plot
5	Amazonia	1	• Amazonia campus
6	Orinoquia	1	• Orinoquia campus
7	Caribe	2	• Caribe campus • Botanic Garden
8	Tumaco	1	• Tumaco campus
9	La Paz	1	The most recently-added campus is excluded here because it is in its starting activities.

Is not easy to manage these multiplicity of branches and its campuses, but the Environmental Management System (SGA in Spanish) has presence in all of them, usually solving waste problems, supervising resources use, doing environmental education campaigns, helping the directives to manage the ecological potential and defining green practices (sustainable constructions, energy, water and transport systems, etc.) following the environmental policy emanated by The Superior Council, now guided by the United Nations Sustainable Development Goals and the UI GreenMetric ranking results.

Table 3. Some campuses views of the *Universidad Nacional de Colombia.*

No	View name	Views
1	Bogotá University City	
2	Medellin Robledo campus	
3	Manizales Palogrande campus	
4	Palmira campus	

5	Amazonia campus	
6	Orinoquia campus	
7	Caribe campus	
8	Tumaco campus	
9	La Paz	The most recent campus is excluded here because it is in its starting activities.

4. Concluding Remarks

We need to improve our information systems where it is difficult to distinguish the environmental items like budgets, investments or even courses, research projects and consultancy works. It is important to unify the Geographic Information System in all branches and merge the methodologies in some studies or directly expand our information systems because the systematized information sometimes does not exist.

But it is more important to socialize and engage with these environmental issues in collaboration with the Colombian government that rules the academy and pushes the direction of the university to promote green policies on:

- The generation of renewable energies, decreasing the use of electricity or gas.
- Diminishing the consumption of water, recycling it and depuration of wastewaters.
- The unification of the billing of public services negotiated with lending companies.
- Sustainable construction projects and the maintenance of them.
- Decreasing the use of waste-producing materials.
- Implementing clean purchases for the university and suppliers.
- Promoting sustainable mobility for everyone in the academy.

It is important to define in a better way some UI GreenMetric indicators; there are ambiguities or interpretations of subjects that end with possible mistakes because in a case like ours (a big university with a lot of different places in very diverse locations), indicators like:

- Total area on campus covered in forest vegetation
- Total area on campus covered in planted vegetation
- Total area on campus for water absorption besides forest and planted vegetation

will be measured with different criteria or even double counted because -for us or even others institutions- it is forested or has cultivation is permeable. In the end, it is simply necessary to adopt some UI GreenMetric indicators for multicity - multi-campuses universities.

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Acknowledgment

To Liven Fernando Martinez, Jaime Gavilán Vallejo and all the staff of the SGA offices in all branches of *Universidad Nacional de Colombia*

From Policy to Action toward Sustainable City Campus

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Abstract. Chulalongkorn University (CU), the oldest university of Thailand, is located in the central of Bangkok, the capital city. After the 100th anniversary of the establishment, sustainability is still a main mission of the strategic plan during 2017-2020 announced by the president of university. Actually, the concept of sustainability has been intervened into routine operations, teaching and research affairs for many years before the Sustainable University Policy was officially announced in 2017. The policy is designed to comply with three pillars of sustainability, i.e., environment, economy and society, which five key issues are focused on: (1) Infrastructure and physical feature; (2) Quality of life; (3) Resources and environmental management; (4) Teaching and research; (5) Good governance and engagement. The master plan and action plan were initiated by the CU Committee for Campus Sustainability; subsequently, all activities have been collaborated by all parties including executive, faculty member, student and staff. Sustainable goals and initiatives are set up for many challenges such as green campus, health and equality promoting on campus, ultimate resource use and zero waste, and smart transportation. Some main programs with achievements are present hereinafter.

1. Introduction

Chulalongkorn University (CU), founded in 1917, is the first university in Thailand. The university was named after King Chulalongkorn (Rama V) who announced officially to improve higher education of the country to produce personnel with ability to serve both public and private sectors. CU is located in the central of Bangkok and covers an area of over 1,800,000 square meters in which about 50% is allocated for academic purpose (Fig. 1). Recently, more than 37,000 students (about 70% undergraduates and 30% graduates) are studying at this comprehensive university which provides almost 450 programs including about 90 international programs. Moreover, about 2,800 faculty members and 5,000 support staff are working on the campus. Located in the prime business district of Bangkok, CU has to design the long-term land use planning, particularly for education, revenue, environment and society. It is actually a top challenge for changing traditional practice and pushing forward. However, the university must be knowledge center and paragon for the sustainable development of the country. Both social initiatives and technical innovations should be implemented within the university for community learning which may lead to better quality of life and resilient society. CU has invested continuously for many infrastructures and facilities which are expected to be the learning space for faculty member, student, staff as well as community surrounding the campus. More information is provided at the main website of university (https://www.chula.ac.th) and Green Chula website (http://www.green.chula.ac.th).

Figure 1. Map of Chulalongkorn University showing land plan for academic activities, social and commercial zones

2. Sustainability

Sustainability is one of the main strategic goal of the university plan during 2017-2020. However, many activities and projects have already been proceeded under the concept of sustainability for many years before the Sustainable University Policy was officially announced by the CU president in 2017. This is the first time when the university policy is designed clearly to comply with three pillars of sustainability, i.e., environment, economy and society. Subsequently, five key issues are focused on: (1) Infrastructure and physical feature; (2) Quality of life; (3) Resources and environmental management; (4) Teaching and research; (5) Good governance and engagement. These issues must be intervened into the routine operations, teaching, research, industrial linkage and social engagement. Recently, the CU Committee for Campus Sustainability were appointed and arranged the regular meeting to design the master plan and action plan of sustainability. All activities under the CU sustainability program are collaborated by all parties including executive, faculty member, student and staff. Many challenges including: green campus; health and equality promoting on campus; ultimate resource use and zero waste; smart transportation. Some main sustainability programs with their achievements are reported below.

2.1. Chula zero waste

Chula Zero Waste program aims to change the attitude and behaviour of the CU community in regard to waste reduction. All activities are based on the 3Rs concept (Reduce, Reuse and Recycle). This campaign is also wished to protect all persons from waste-related health risks, to improve the campus environment and to encourage the use of reusable or refillable items. During the operation, CU has collaborated with researchers, communities and private companies to extend this zero waste campaign to the public. Some innovative products have been developed to serve the community. Campaign, economic tools as well as innovative products have been used during the program (Fig. 2).

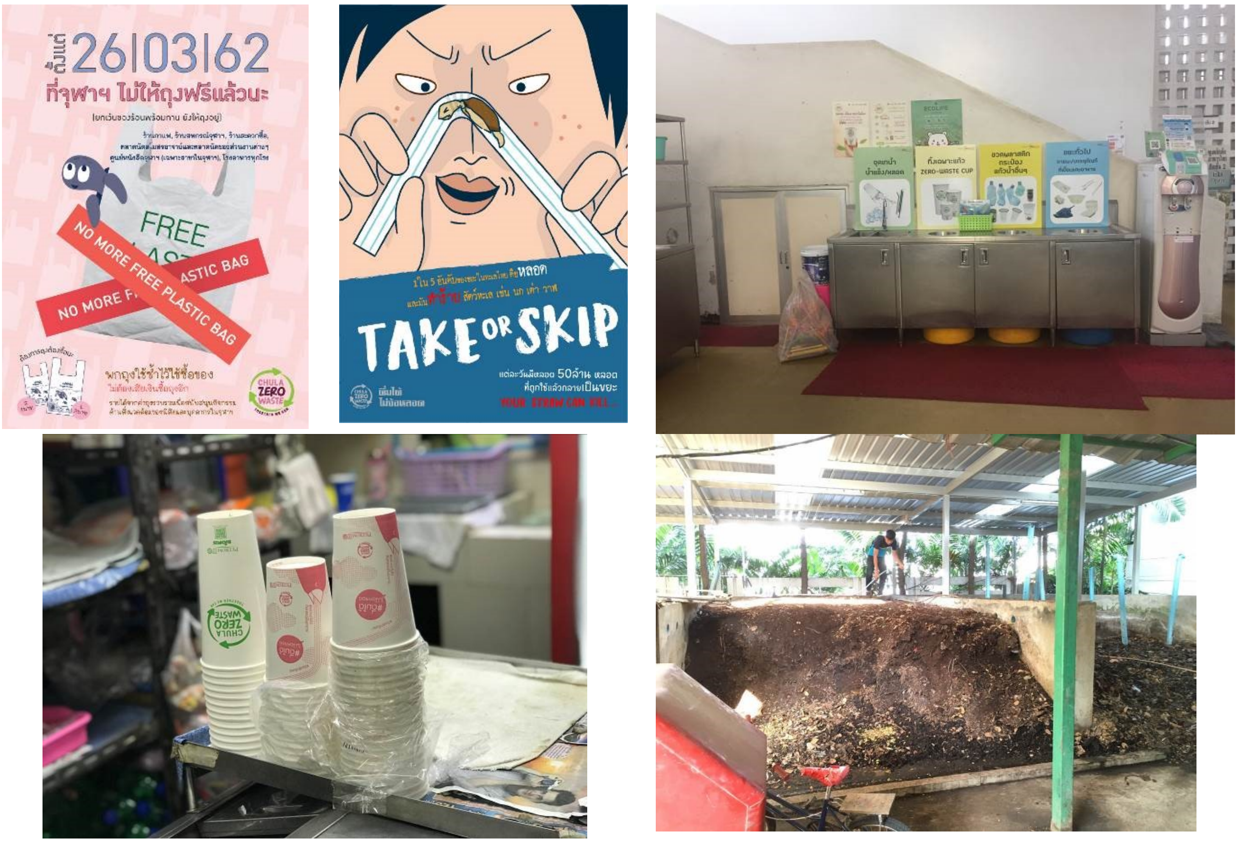

Figure 2. Chula Zero Waste Program providing various campaigns, zero waste cup (an innovative product) and composting facility for waste management throughout the campus

During couple years of implementation, about 2.5 million plastic bags, 2 million single-use plastic containers (bottle and cup), and 85 tonnes of garbage have been reduced. Bioplastic-coated cup (Bio PBS), called zero-waste cup, was initiated by research Center of Excellence on Petrochemical and Materials Technology (PETROMAT) in collaboration with PTT Global Chemical Public Company Limited; the zero-waste cup has been replaced plastic cup used in university cafeterias and canteens before removed to composting facility. More information is available at the website of Chula Zero Waste (http://www.chulazerowaste.chula.ac.th).

2.2. Center for safety, health and environment

Center for Safety, Health and Environment of Chulalongkorn University (SHECU) was established in 2016 according to the safety policy of university. Safety is the first and foremost awareness when conducting research, studying and working on the campus. As an educational institution, CU aims to raise this awareness to all parties. The main goals are to enhance safety of student, faculty and staff, to establish safety standard for all laboratories throughout the university and to motivate a mindset for safety in all student, faculty and staff. More than 850 laboratories are recently under operation; about 70% of them have begun to follow the Enhancement of Safety Practice of Research Laboratory in Thailand (ESPReL) after the official announcement of safety policy. Some labs were speedy improved and complied with the safety standard (Fig. 3). The zero accidence the main strategic targets.

Figure 3. Enhancement of safety practice of Research Laboratory in Thailand (ESPReL) developed by CU research group is used to improve laboratories in the campus. Training and knowledge-sharing activities are also provided by the Center for Safety, Health and Environment of Chulalongkorn University (SHECU)

Campaigns and capacity building programs have been regularly provided to all university members. Actually, the ESPReL was initiated and developed by CU research group under commission of the National Research Council of Thailand (NRCT) and it is now implemented in nationwide universities. Therefore, SHECU is now becoming a training and knowledge-sharing center of the country. More information is available at the websites of Green Chula and SHECU (http://www.green.chula.ac.th; https://www.shecu.chula.ac.th).

2.3. Smart transportation

Alternative smart transportations (Fig. 4) have been initiated and expanded around the campus for the following reasons: to make campus transportation more convenient for student, faculty, staff and the public, to decrease CO_2 emission, to promote exercise via cycling and walking, and to reduce vehicle traffic. Cycling and walking campaign is encouraged; some facilities such as bike lane, cover way and sky walk have been constructed to support the campaign. Moreover, CU sharing bike program providing 120 bicycles with 8 service stations are recently in service around and nearby the campus. Fully electric vehicles including CU

Shuttle Bus, CU TOYOTA Ha:mo and Muv Mi (Fig. 4) are served as smart and green transportation for all CU members and public. Over 300,000 passengers are regularly taking these services every month. Mobile applications have been initiated and engaged to facilitate all passengers (Fig. 4). Actually, some applications was developed to commercial use by the former CU students. More information is provided at the Green Chula website (http://www.green.chula.ac.th).

Figure 4. CU Smart Transportation Projects are operating within the campus and connecting to the surrounding business centers and communities; for instance, cover way, CU sharing bike, various fully electric vehicles (i.e., CU Shuttle Bus, CU TOYOTA Ha:mo and Muv Mi). Mobile applications are available for booking and checking

2.4. Food sanitation policy

University cafeterias and canteens (Fig. 5) serve thousands of customers daily, providing tasty, healthy, low cost food. To maintain hygiene and ensure consumers are protected, the food sanitation policy is implemented to protect consumers from food poisoning and other food illnesses and to become a role model among Thai universities in food sanitation. Moreover, food wastes generated from cafeterias and canteens are utilized as substrates for bioenergy producing. Used cooking oil, more than 3,5000 kg/year is collected and sent to biodiesel production which has been supported by Bangchak Corporation Public Company Limited. Food garbage (about 40-80 kg/ day) is fed into biogas facilities (Fig. 5) based at the campus. These facilities are also designed for research and teaching instruments (http://www.green.chula.ac.th).

Figure 5. Food sanitation is provided at a main student canteen in which biogas facility is set beside

2.5. CU parks

100 Years CU Park (Fig. 6) was officially opened to the public on 26 March 2017. This park was initiated to commemorate CU's centennial anniversary. The achievements are to create green landscapes for educational purposes where the university community and public can exchange knowledge and relax, to provide a venue for individuals and groups to take advantage, to contribute to the "Green Axis" project by extending the green area on the western side of the campus, to create gardens of local vegetation following organic, or natural practices, according to an urban jungle concept and to create a prototype for urban water storage (http://www.green.chula.ac.th). Moreover, Park@Siam (Fig. 6), a small park is located at in the heart of Siam Square, the most famous shopping center in Bangkok. CU constructed this park to increase green area of the city providing to the public.

In addition, CU is working on more projects and activities which are related to promotion of health and equality on campus. All of which follow the CU sustainability roadmap for pushing Thai community toward sustainable development goals.

Figure 6. CU parks including 100 years CU Park and Park@Siam

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Sustainable Development at the University of Alicante: Environmental Management Strategies

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Abstract. For the University of Alicante, University Social Responsibility consists in ethical and transparent relationships between higher education institutions and society; the responsibility includes establishing action strategies in view of contributing to the community's sustainable development, preserving natural resources, artistic-cultural heritage, respecting ethno-cultural diversity and working to reduce social inequalities whatever their cause may be [1]. In this paper, we desribe how measures to foster the University of Alicante's sustainable development were implemented, summarising its main actions and good practices [2].

1. Introduction

In recent decades, there has been a growing awareness that no prosperous economy or society is possible in a world afflicted by so much poverty and such a sharply deteriorating environment. It has become urgent to steer economic development towards respecting the environment and social equity.

The University of Alicante has undertaken Sustainable Development Goals (SDG) through its Social Responsibility Plan [1].

University Social Responsibility (USR) is defined as the university's ability to apply a series of principles and values when conducting its essential functions – higher education and pedagogical training, research and dissemination, organisation management and social participation – by creating communication and participation channels to respond to stakeholder demands.

First, the University of Alicante performed a socio-environmental diagnosis aimed at understanding the university's environmental, socioeconomic and organisational factors, to identify which aspects would require intervention in a later phase.

The sections below describe some of the actions performed by the University of Alicante to foster sustainable development.

2. Sustainable Mobility Plan

Mobility is defined as the ease with which people travel around to meet their needs or to perform their activities. In addition, mobility is one of the factors with the highest impacts on the urban environment.

Based on its Sustainable Mobility Plan [3], the University of Alicante seeks first to learn about the mobility habits of the different groups that make up the university community: Teaching and Research Personnel (hereon TRP), Administration and Services Personnel (hereon ASP) and students; and then test the real possibilities of modifying existing mobility patterns, promoting the use of sustainable modes of transport and thus reducing the use of private motorised vehicles (especially their individual use).

To this end, the actions described below were implemented.

2.1. Car sharing: *Carmate*

The purpose of the *Autocolega* [4] campaign is to encourage the sharing of private vehicles on journeys to and from the university by members of the university community (students, TRPs and ASPs), thus reducing fuel consumption, emissions and traffic congestion. Members of the university community can publish empty seat offers and requests on the programme's website and are thus put in contact with people who follow the same routes at compatible times.

2.2. Electric cars for internal trips

The University of Alicante uses electric cars and encourages the University's own staff and that of the range of outsourced services (maintenance, cleaning, security and gardening) to use electric cars for internal campus transfers, both of people and light goods.

2.3. Bicycles
Regarding bicycle transport, a number of centres within the University of Alicante dispose of bicycles for internal use, available to the University's staff. There are 3 bike lane access points and a free bicycle loan point on the campus. They are part of the bicycle loan network, called Bicisanvi, that belongs to the City Council of San Vicente del Raspeig [5].

2.4. Public transport
To foster the use of public transport [6], the University of Alicante offers all members of the university community a free shuttle service [7] allowing Renfe commuter line passengers to get to and from the university.

2.5. Electric bikes - BiciUA
The University of Alicante disposes of 22 electric bicycles [8] to promote sustainable displacements between the campus and the University of Alicante Science Park. These bicycles are available to university staff members who need to travel between the Science Park and the campus for work-related purposes.

2.6. "Cycling to the UA" workshops
To encourage sustainable trips to the campus, the University of Alicante has organised a series of training initiatives directed to the university community to encourage cycling as a means of sustainable urban transport. The initiative is part of the "Cycling to the UA" project [9, 10].

The project includes the following activities:
- "Learn to ride a bike" workshop (beginner level).
- "Learn to ride a bike" workshop (intermediate level).
- "Bicycle maintenance and basic mechanics" workshop.

2.6.1. "Learn to ride a bike" workshop
Learning to ride a bike is the first step towards personal autonomy: bicycles can be used as a means of transport to go to work or study. The skill is generally assumed to have been acquired by adulthood. Nothing, however, is further from the truth: according to Spain's 2017 Bicycle Barometer, 12.3% of the country's population does not know how to ride a bike [11]. Some people know how to keep their balance but are scared to ride. For this reason, two bike riding course levels were established (beginner level and intermediate level).

2.6.2. "Bicycle maintenance and basic mechanics" workshop
There is widespread ignorance, even among regular bicycle users, on how to maintain bicycles in a good condition, perform the most recommended revisions and how to repair glitches and disadjustments arising through bicycle use. Learning about these issues leads to safer journeys, money-saving and can even prevent incidents.

2.7. Kits for bicycle maintenance and self-repair
Another strategy adopted by the University of Alicante to encourage cycling trips to the campus consists in handing out bicycle repair kits [12]: caretakers in different campus buildings make them available to any member of the university community cycling to the campus, to mend punctures or to solve any small unforeseen breakdown, so they can thus continue their journey.

2.8. Charging stations for electric vehicles
The University of Alicante has installed three charging stations for electric vehicles [13] on the campus, available to all university community members.

2.9. "Move around the UA" challenge
On the occasion of the European Mobility Week 2017, held each year between 16 and 22 September, the University of Alicante launched the "Move around the UA" challenge [14] that runs throughout the academic year in collaboration with CicloGreen [15].

A series of challenges were launched during the academic year: members of the university community could earn awards for sustainable kilometers travelled by bike, on foot or rollerblading.

A total of 64,065 Km was covered and 14,776 Kg of CO_2 were prevented from being released into the atmosphere [16].

The University of Alicante has also responded to different calls on the CicloGreen platform in which other universities and companies also participated. The UA won the challenge held during the 2017 European Mobility Week, "RetoSem". A total of 8,942 kilometers put the UA in first place [16].

The University of Alicante had also previously won the "30 days by bike" challenge [17] launched by CicloGreen, accumulating 13,507 km.

3. Waste Management

The University of Alicante currently manages the following waste:

- Hazardous chemical waste
- Sanitary and veterinary waste
- Urban solid waste
- Pruning remains
- Batteries (alkaline and button cell batteries)
- Paper/cardboard
- Containers
- Glass
- Printing and ink waste
- Electrical and electronic equipment waste
- Construction and demolition waste
- Expired medications
- Mobile phones
- Ink and toner cartridges
- Industrial oils and cooking oils (outsourced services)
- Reusable material and donations
- Used writing material

3.1. Hazardous chemical waste management [18]

Regarding chemical products, the pilot factories of the Chemical Technology Centre (*CTQ*) building of the University of Alicante, dispose of a series of legalised warehouses to store hazardous chemical products, in accordance with current legislation (Royal Decree 379/2001).

A total of 6 storage areas are doted with fluid retention containers, fire-resistant walls and doors, a liquid-tight flooring and liquid-tight first 10 centimetres of wall, explosion-proof luminaires, etc.

The university disposes of a list of hazardous waste classified into 25 groups based on incompatibility. It was detected that within this 25-group classification, 2 residues within a same group may coexist in the same container yet be chemically incompatible and when mixed in the same container, could react and produce a dangerous reaction. This is the case, for example, of nitric acid and hydrochloric acid. As they are an oxidising acid (nitric acid) and a non-oxidising acid (hydrochloric acid), mixing them can produce a reaction and release gases.

Each family of waste is assigned a color code so that different types of waste are visible to the naked eye.

	Flammables
	Toxic (solid)
	Corrosive (Organic acids)
	Corrosive (Inorganic acids)
	Corrosive (Alkali)
	Toxic (liquid)

Figure 1. University of Alicante chemical product warehouses

In the same way, a complete protocol was developed encompassing the procedures for collecting and delivering hazardous waste to ensure the correct use of containers, labelling, filling and handling, etc.

3.2. Transfer of goods

The University of Alicante disposes of a transfer procedure [19] of inventory items to non-private and non-profit institutions. The goods have fallen into disuse at the university but have not yet reached the end of their useful life and can be reused by these institutions.

3.3. Urban waste [20]

The University of Alicante has a Waste Park with large containers to hold urban waste. They are collected selectively on campus:

- Paper and paperboard
- Containers
- Glass
- Flat glass
- Appliances
- Pruning remains
- Construction and Demolition Waste
- Electrical and electronic equipment
- Urban waste

All this waste is delivered to external management companies authorised by the Generalitat Valenciana to perform this activity.

3.4. Selective collection of writing material.

The "Recycling is Beautiful" project (*Reciclar es Bello*) [21] **is a civic education initiative** that encourages the recycling of disposal writing material that encourages the recycling of disposable writing material. This type of recycling avoids mixing the materials with the rest of the waste, thus generating less non-recyclable waste and recovering some of it to be reused as raw material.

3.5. Selective collection of plastic caps

Via the University of Alicante's "Uncap your solidarity" project ("*Destapa tu solidaridad"*) [22], containers have been located in different campus buildings for the selective collection of caps. The caps deposited in these containers by the members of the university community are delivered to associations that collaborate with the University of Alicante.

3.6. Selective collection of organic matter [23]

The University of Alicante has joined the "The 5th container" ("*El 5º contenedor"*) campaign led by the Council of San Vicente del Raspeig to selectively collect the organic fraction from the campus's cafeteria kitchens allocating it to compost production. Organic matter accounts for approximately 40% of total waste produced in Spain.

3.7. Reduction of plastics [24]

As part of its social responsibility towards society and the environment, the University of Alicante, in its quest for leadership and adaptation to the new contextual framework, has formulated three lines of intervention to address the issue of plastics:

- Reducing the consumption of plastics on the campus.
- Encouraging recycling initiatives and improving the efficiency of the process.
- Encouraging the whole university community to reflect on the need to establish a new relationship with its closest environment.

A total of 25 specific actions have been established to be implemented in our institution on a medium term, estimated up to the 2022-2023 academic year. These actions aim at achieving four objectives:

- Reduce plastic and packaging waste generated at the University of Alicante.
- Encourage recycling actions and improve the efficiency of the process.
- Increase UA recycling system efficiency.
- Raise awareness among the university community to increase the adoption of environmentally sustainable consumption habits and life.

4. Energy

4.1. Photovoltaic solar energy

The University of Alicante disposes of a photovoltaic plant: this plant generates electricity for the internal consumption of the pilot research plants of the "Chemical Technology Centre" (CTC) and participates in a company that owns a photovoltaic power plant located in Alicante's Science Park.The CTC is connected to the grid and produces electricity to supply the local distribution company.

The CTC photovoltaic plant [25] disposes of a solar farm with 1,062 panels of 38.4 Wp, which generates 61.5 MWh/year and saves 31.2 t/year of CO_2 emissions. This plant emerged as a research project to study the potential of combining totally clean energy such as solar energy, with another technology considered environmentally acceptable, and with great technological possibilities, i.e. electrochemistry for water treatment.

The photovoltaic power plant [26] connected to the grid, installed in the University of Alicante Science Park, with an initial size of 100 kW over approximately 2,600 m^2, results from a collaboration agreement between the University of Alicante, the Caja de Ahorros del Mediterráneo (*CAM*), and the Unión Fenosa company. The agreement clearly aims at fostering photovoltaic energy and facilitating the development of research projects allowing to boost and consolidate this renewable energy.

The installed photovoltaic generator system of 103.51 KWp and with a 100 kW inverter, consists essentially of monocrystalline, polycrystalline and amorphous panels with bidirectional fixed and mobile structures and inverters of varying power (3,8 kW, 5 kW, 6 kW).

4.2. Energy efficiency

In recent years, the University of Alicante has launched a range of projects on campus allowing to save energy consumption in the buildings that are part of the project. Of note among these projects:

- the replacement of small air conditioning machines with high energy efficiency equipment.
- the replacement of large centralised air conditioning systems.
- the improvement of thermal envelopes
- the use of LEDs for outdoor lighting

5. Water

5.1. Desalination plant

The University of Alicante disposes of a desalination plant that uses reverse osmosis [27], allowing to use brackish water from aquifer water (i.e. water that is not suitable for human or agricultural consumption, located under the campus of San Vicente del Raspeig) for irrigation. The treated water is mixed with 15% untreated brackish water to adapt its characteristics to use as irrigation water and is stored in a pond (with aquatic life) located in the University of Alicante's Illustrated Forest, which directly feeds the irrigation system.

5.2. Natural environment

The campus of the University of Alicante in San Vicente del Raspeig illustrates a clear commitment to environmental regeneration: originally defined as a wasteland, green and attractive expanses have been generated over the years.

The UA campus is made of numerous landscaped areas, with green stretches representing 35.2% of the total surface of the campus. In addition to being free from surrounding traffic, the environment is doted with different artificial ecosystems that favour the presence of birds: shade trees with vines and climbing plants, ponds and reservoirs located throughout the campus, cleared arboreal plant formations that are either semi-open or surrounded by scrub, etc. Today, birds that had been unseen for decades nest and visit the campus on sites closest to the University of Alicante.

The campus has a wealth of birdlife, with over thirty species, many of which nest in the campus itself or in the vicinity or go to the university to feed. The presence of plant species producing fruit and edible seeds for some birds as well as the presence of big trees that are especially attractive for some birds favours the flow of certain species to the campus. Similarly, abundant populations of insects and invertebrates, both aquatic and terrestrial, also represent a factor of attraction.

The Illustrated Forest stands out among the campus's artificial ecosystems: it favours the presence of birds thanks to its two artificial ponds (with aquatic life) where the desalination plant water is stored. This Illustrated Forest is today a green area used as a recreation area by both the university community and the residents of Sant Vicent del Raspeig and other nearby municipalities.

The University of Alicante also disposes of a palmetum. A palmetum (or palmetto) is a botanical garden or an area within a botanical garden for the growth, research, conservation and public exhibition of palm species. The University of Alicante palmetum was developed in an area formerly occupied by a bus hangar. Its metallic structure has been preserved as a trace of the past site.

It is also possible to visit the campus cactus collection and the aromatic plant beds.

The University of Alicante carried out an ambitious museum project by creating a rock garden on campus. Ten rocks were selected, with a size ranging from 1 m^3 to 4 m^3:

- Peridotite, Serranía de Ronda (Malaga)
- White marble, Macael (Almería)
- Granatiferous schist, Ocaña (Almería)
- Selenitic plaster, Sorbas (Almería)
- Gneiss metagranite, Los Castaños (Almería)
- Volcanic rock with obsidian fragments, Vera (Almería)
- Emperador brown marble, Yecla (Murcia)
- Calcareous Onyx, Yecla (Murcia)
- Santa Pola reef limestone (Alicante)
- Alicante red marble, La Romana (Alicante)

These specimens are representative of the main types of rocks of the Baetic mountain range: igneous, sedimentary and metamorphic.

6. Infrastructure: Accessibility

In recent years, the University of Alicante has continued with its commitment to adapt all its facilities, not only to favour the movement of persons with reduced mobility, but also to provide conditions related to the physical environment and interrelationships that enhance the quality of life of all users

The university has a Student Support Centre (SSC). Its mission is to offer specific attention to students of the University of Alicante who may be at a disadvantage due to personal, family or socio-economic circumstances or whose academic performance may be affected in view of ensuring their full participation. SSC programmes include the "Programme to support students with disabilities" offering a transport service adapted to persons with disabilities [28].

7. Environmental Management EcoCampus Office

This office [29] is responsible for promoting awareness campaigns and the participation of the university community (TRPs, ASPs and students) in developing proposals and solutions relating to defending and improving the environment; this objective is reflected in its preliminary name: “nature, principles and purposes of the university”. It is also tasked with ensuring proper waste management, rational use of energy resources and water, and developing all kinds of proposals for management actions and environmental quality.

7.1. Awareness campaigns [30]

Some of the campaigns developed by the EcoCampus Office to raise awareness and sensitise the university community include:

- *Save your batteries* selective collection of alkaline and button cell batteries)
- Minimisation of paper consumption
- Selective collection of paper/cardboard and packaging
- *Save the rainforest* in collaboration with the Jane Goodall Institute (selective collection and reuse of mobile phones)
- UA energy efficiency
- Sustainable mobility at the University of Alicante
- Environmental recommendations (both general and directly applicable in the UA) [31]

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Sustainable Development Experience at Al-Zaytoonah University of Jordan

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Abstract. Al-Zaytoonah University of Jordan is a pioneer academic institution in sustainable development in the areas of energy , infrastructure and environmental resource management. The university had accomplished many distinguished infrastructure projects in green architecture and sustainable energy resources. These accomplishments were initiated by the determination of the university to pursue a long range strategic plan of sustainable development in the management of energy , waste, water ,and transportation . In addition, the university devotes a significant amount of its research funds to support research projects in the areas of sustainable development. Among its key achievements in this area are the construction of the Engineering and Technology building and the Sustainable GreenStudent Garden which showcases examples of green energy from photo voltaic panels and wind turbines.The university had witnessed signficant savings from these sustainable energy projects. The university is committed to clean energy through an ambitous infrastructure project generating about 1.754 megawatt hours of electricity. This should reduce the overall carbon footprint and yield significant savings in the operating budget of the university.

Keywords: Environmental, green architecture, Sustainable development, waste management

1. Introduction

Many higher education facilities are pursuing sustainable development long rang plans [1]. These plans are intended to reduce waste and promote use of renewable energy resources and become fully divested from the use of fossil fuels [2]. Others aim to reduce emissions and reach self-sufficiency to produce its needs of food [3]. Worldwide, many institutions seek to reach carbon neutrality [4] through reliance on renewable energy sources and Zero Emission Vehicles. They can manage such achievement in minimizing the consumption of fossil fuels in energy and transportation applications.

Some also incorporate green building concepts in the design of buildings [5] which incorporates many aspects of sustainable development in water and energy efficiency, waste reduction, smart growth and environmentally preferable materials and specifications. At Al-Zaytoonah University of Jordan, these guiding principles and spatial arrangement of the campus support the energy integration within the building and landscape areas, most parts of the surrounding areas are planted with olive trees that have economic value. The campus design provides a large open and green space that minimizes heat island effects. This promotes urban cooling possibilities. The campus master plan shows a lot of green open spaces that are well designed and landscaped. These design solutions enhance the social sustainability of the space and support the "Green infrastructure" approach that affects the microclimate conditions.

The campus provides a sustainable environment integrated with landscape design that create a basic but sustainable life. The Sustainable Green Garden shown in Fig. 1 is an eco-energy friendly area that contains wind turbine and solar panels where the organization of the outdoor areas enhance the social and environmental sustainability of the university campus by providing gathering spaces with computer/mobile charging facilities and Wi-Fi service. Water provision is designed on a mix rainwater harvesting and from underground artesian wells.

The building roof space is used to harvest rainwater to be used for irrigation systems. Water Saving measures include a local septic tank plant. All grey water runs directly to the landscape irrigation systems.

Climate change worries and rising oil prices and ongoing energy security concerns has led to investment in the renewable energy and energy efficiency industries. Sustainable development demands a sustainable supply of energy resources, such as solar and wind which are generally considered renewable and therefore sustainable over the relatively long term. The energy resources are divided into solar radiation, geothermal, wave and tidal, and nuclear. Solar radiation consists of direct solar, stored solar and indirect solar energy. Solar photovoltaic (PV) market installations reached a record growth in Jordan over the previous years. The university has also invested in PV farms over the roofs of buildings throughout the campus to produce its needs of renewable energy. This has proven to be cost efficient and conducive to smart growth and sustainable development.

Figure 1. The sustainable green garden

The university is a comprehensive higher education institution with eight faculties offering twenty eight Bachelor and nine Master academic programs. The university sits on a suburban campus whose area about thirty hectares. The vast majority of its area is open space covered partly by forest vegetation and mainly by planted vegetation with about thirty square meters per person among the total population on campus. This paper will highlight the various accomplishments of the university

In the areas of energy, climate change, waste management, water conservation, environmentally preferable transportation options and strategies. It will also provide some details regarding the university spending on sustainability and research in the sustainable development.

1.1. Energy and climate change

The university uses energy efficient appliances for heating, air conditioning, and Led lighting in all smart buildings. Nearly all electric appliances and devices are equipped with energy saving features that reduce energy consumption. Water is also conserved using economy flushes with low volume toilets. The university also relies on reclaimed water from waste treatment plant to water vegetation on campus. It employs networks of drip irrigation networks to support the growth of landscaping plants and shrubs. It also uses them to water the olive and fruits trees on campus. In all, the campus has about 1661 trees distributed around the campus and has a natural grass stadium with a green area of 5200 square meters. On the average, the volume of reclaimed water used is about 120 cubic meters of reclaimed water every week.

The university mainly produces 1754 kWh of solar energy and about 3 kWh of wind power to support its annual consumption which is estimated to be around 2,500,000 kWh per year. The solar panels are mounted on roofs of buildings on campus as shown in Fig. 2. The average electricity usage is about 303 kWh per person per year. The university is almost electricity self-sufficient and relies mainly on renewable energy resources to meet the demand on electricity on campus. On the average, the university consumes about 10 percent of its electricity from the main grid which is generated from non-renewable sources. This corresponds to a net carbon print of about 150 metric tons annually at a rate of 0.018 metric ton per person per year.

Figure 2. Solar panels mounted on building roofs

1.2. Waste

The university implements introductory partial waste sorting and recycling programs aimed at reclaiming aluminum cans, glass bottles and plastics. The university also is keen on establishing reduction programs of paper and plastic waste on campus. Most of the internal paperwork is done electronically through soft document transfer and archiving throughout the campus operating academic and nonacademic entities. In addition, organic waste from tree trims and cuttings are stock piled for possible reuse as mulch and pit moss for vegetation. The university is contemplating the use of a woodchipper for this purpose. Inorganic waste including toxic medical waste from the nursing and pharmacy faculties are currently handled by a local specialized contractor and disposed off campus. The university also employs its own sewage treatment facility which treats sewage water and reroute it into the irrigation system of the university.

1.3. Water

Water usage at the university is supported through pumping from a nearby artesian well. The water is tested and treated prior to pumping on a daily basis and is subject to universal drinking water standards. Water efficient appliances program is in its early stages to ration the use of water in restrooms by using economy toilet flushes. All reclaimed water resulting from the sewage treatment facility on campus is currently being used within the drip irrigation network.

1.4. Transportation

The university runs a shuttle bus service to the residential areas within its vicinity to bring students to campus. The campus itself is nonresidential and the students use the university buses twice a day for their round trips. These buses are mostly operated using diesel fuel and are well maintained and checked periodically for emissions as a requirement for licensing by the local traffic department. The number of vehicles entering the campus on daily basis is between 500 to 600 vehicles including employee vehicles. The ratio of vehicles on campus is about 0.075 vehicles per person per day. Campaigns to encourage bicycle use by students and employees are underway. Zero Emission Vehicles (ZEV) are rarely seen on campus and an institutional incentive may be necessary to increase their use by employees since they are economic vehicles and the university has an abundant source of electricity to charge them for a nominal fee or for free. This may become one of the initiatives of the university to reduce parking space requirements on campus since these ZEV are smaller in size. Pedestrian paths are available and well maintained during inclement weather conditions.

1.5. Education

The university spends annually about 5% of its operating budget to support research activities in various scientific areas. The funding offered by the university also covers sustainability research. Based on historical records, the university dedicates about 12 % of its entire research allocations towards sustainability research. Sustainability is very well covered in the courses offered by the different disciplines of the university. In addition, university staff had published several papers in sustainability research topics. The university encourages student initiatives aimed at sustainability education and awareness and is in the process of formally establishing a sustainable development administrative entity to oversee the achievement of sustainability goals in the strategic plan of the university.

2. Summary/ Concluding Remarks

The university realizes that the accomplishments in the area of sustainable developments are merely a humble beginning. The smart growth of this sustainable development requires steady efforts in the areas of transportation where hybrid and electric vehicles are the choice for future movement in and around the campus. The use of solar collectors for domestic water use will make hot water available for very low cost. Moreover, the use of solar conditioning systems for space cooling and heating will be a much better option especially when compared to conventional air conditioning systems. The establishment of a periodic and efficient energy audits to identify areas of possible improvement aimed at enhancing the potential of sustainable development.

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The Development of Kwala Bekala Green Technobiz Park (KB-GTP) as Part of USU's Sustainable Green Campus

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Abstract. In response to the increase of competitiveness of a nation in a fourth generation of industrial revolution era, developing a science and techno park (STP) is seen as a strategic solution to the complex problems of economic development, job creation, and new business development. As the North Sumatera province is the main economic hub in the west part of Indonesia; thus, developing a science techno park is a strategic step in strengthening Indonesia's economy. Universitas Sumatera Utara (USU) as one of the biggest higher education institutions in Sumatera Island has to take a major role to realize this strategic plan. USU operates two campuses, the main campus in Padang Bulan and the second campus in Kwala Bekala, Medan, Indonesia. Development of USU's STP, which is called Kwala Bekala Technobiz Park (KB-GTP) will be located in Kwala Bekala, a new campus of USU with a total area of 300 hectares (ha). The areas are divided into several zones including the KB-GTP zone. All the facilities are developed in the accordance with a green campus concept, i.e., UI GreenMetric parameters. This paper presents our efforts in the design and implementation of the KB-GTP using sustainable green campus concept. This will be realized further by maximizing synergies between four major components of innovation: research institutions, business, government and users/communities. This form of quadruple helix model will be adopted and become an integrated part of the development of USU's second campus in Deli Serdang Regency. The results of the research on the green campus concept will be directly piloted at this new campus development.

Keywords: Science techno park, sustainable green campus, UI GreenMetric, quadruple helix.

1. Introduction

North Sumatera province is rich in natural resources such as natural gas, ore mining and smelting of aluminum which is the only one in Southeast Asia. Rivers that are disgorging in the mountains around Lake Toba are also significant natural resources. They are very potential to be the resources of hydropower plants. Moreover, there are many geothermal hot spots in the mountains around Lake Toba as well. North Sumatera province is also famous for its plantation area, and until now, it provides significant contribution to the nation economy. Studies in regional economics strongly point to the fact that proximity to a university is often associated with recent growth of high-tech industries in any regions [1]. Studies also show that a university plays a significant role in interpretation of the technological opportunities as solution for business needs in the region. Therefore, in order to utilize the richness of natural resources in North Sumatera province while maintaining their sustainability, USU has a great responsibility to produce high quality and skillful human resources and become the major force to provide the supporting technologies in the region. Furthermore, as stated in its Strategic Planning 2015–2019 as well as in its University Long Term Plan: Year of 2039, USU has a vision to be a leading university with highest national accreditation and academic excellences which will enable USU to compete globally. In order to do so, USU has assets to support the implementation of high-quality education. USU has campuses with area of 110 hectares and 300 hectares in two locations, palm oil plantation with an area of 550 hectares, experimental gardens, arboretum forests, teaching hospitals, dormitories and messes. All of these assets are located in four different locations, in Medan City, Langkat Regency, Deli Serdang Regency, and Karo District.

Currently, USU has a student body of 51,000 students experiencing increased enrollment of new students every year. All of the academic activities are carried-out at the main campus, Padang Bulan in the City of Medan with an area of 110 hectares as shown in Fig. 1. This campus is also used as a place for administration, research, sports, arts, lecturer housing, and other student activities including agricultural field laboratory. On this campus, USU has built a university hospital on the area of 38,242 m^2. The USU's university hospital has been operating since March 28, 2016. The hospital also received a plenary accreditation on December 30, 2016. Since then, USU continue to improve the operational capabilities of the hospitals including increasing the number of in-patient rooms to deliver wider health services to the people of North Sumatra. In order to provide a good academic atmosphere, USU must maintain high quality facilities and infrastructure in accordance with the national standards set by the Ministry of Research and Technology. In order to anticipate the increased future students, USU in needs to develop its second campus with area of 300 hectares in Kwala Bekala, Deli Serdang Regency. As legal entity state university, USU has the authority to manage its academic and non-academic affairs autonomously. With this autonomy, it enables USU to carry out the management of infrastructure and facilities using a self-regulated mechanism.

Figure 1. Satellite view of USU campuses and map of USU campus in Medan

The approach used in developing the new campus is by adopting the concept of sustainable green campus. Based on this concept, all facilities and infrastructures will be built and developed based on the principle that science and technology should be the major force to increase the sustainability of the nature. The main strategy would be to integrate the Science Techno Park namely Kwala Bekala Green Technobiz Park within the new campus. In order to make the plan feasible, USU will synergize four major components of innovation: research institutions and universities, business, government and communities or users. This model is carried-out in the form of Quadruple Helix [2]. Furthermore, USU is committed to provide graduates that have the capability to manage natural resources on an ongoing basis, with an integrated education system with the specificity of the field such as Agroindustry, Local Wisdom, Sustainable Energy, Natural Resources (Biodiversity, Forestry, Marine, Mining, Tourism) and Technology [3]. As such, it is much expected that KB-GTP will be the main hub for USU to train its graduates to innovate in green and eco-technologies.

2. Quadruple Helix Concept

The concept of developing a new campus of USU uses a quadruple helix (triple helix plus) model, as shown in Fig. 2 and 3. It is desired as stated in the USU's Long Term Development Plan that the new campus combines academic, business, government and user elements to integrate the process of interpreting the technological opportunities as solution for business needs in the region. Just like in the triple helix implementation process [4], implementing a quadruple helix model has its challenges. This is due to the fact that each helix has its own characteristics. Characteristics are governed by the culture and energy of each organization [5]. That is why the existence of Kwala Bekala Green Technobiz Park (KB-GTP) in the new campus is needed as a mediator and facilitator for each helix to communicate and work together.

The second campus is currently being developed starting by designing its master plan as shown in Fig. 4. Using this concept, the Kwala Bekala campus is divided into four zones:

- Zone A: Green Technobiz Park
- Zone B: Academic and Research Complex
- Zone C: Agro-Forestry Area
- Zone D: Water Reservoir and Recreational Facilities

Based on the zoning shown in Fig. 4, the followings are the details of elements to be included in each zone. Zone A which is KB-GTP will occupy around 50 Ha and it includes:

1. Enterpreneurbiz Complex
2. Convention Center Complex
3. Stadium Complex
4. Design and Training Center Complex
5. Design and Training Center Complex
6. Adjunc Facilities
7. Adjunc Facilities
8. Mosque
9. Digital Industry
10. Digital Industry
11. Digital Industry
12. Digital Industry
13. Biogas Plant
14. Biodiesel
15. Fertilizer Plant
16. Animal Feeds Industries
17. Concrete Composite Plant
18. Wood working and Bamboo Processing
19. Rattan Industries
20. Honey industries
21. Aromatic and Fragrance Industries
22. Industries
23. Industries
24. Cosmetics Industries
25. Cosmetics Industries
26. Cosmetics Industries
27. Administration Hall
28. Microhydro power plants

The academic and research Complex which is in Zone B will have an area around 105 Ha and it includes:

1. Academic Complex
2. Reserch Complex
3. Common Lecture Hall
4. Science Center
5. Dormitory

The agroforestry area that is in Zone C has an area of approximately115 Ha. As shown in Fig. 8, it includes:

1. Arboretum
2. Horticulture Area
3. Animal Husbandry
4. Palm Oil Seeding Facility

Water reservoir dan recreational facilities are located in Zone D with an area of 30 Ha.

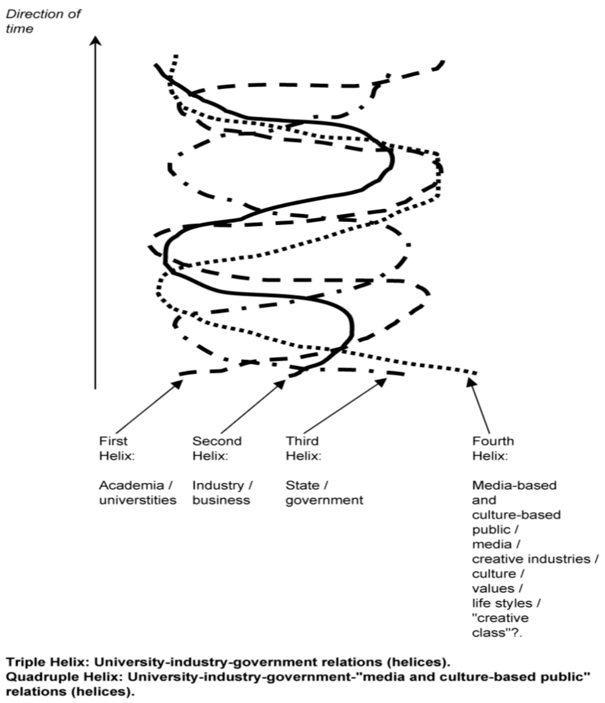

Figure 2. Quadruple Helix Model for USU New Campus Development [6]

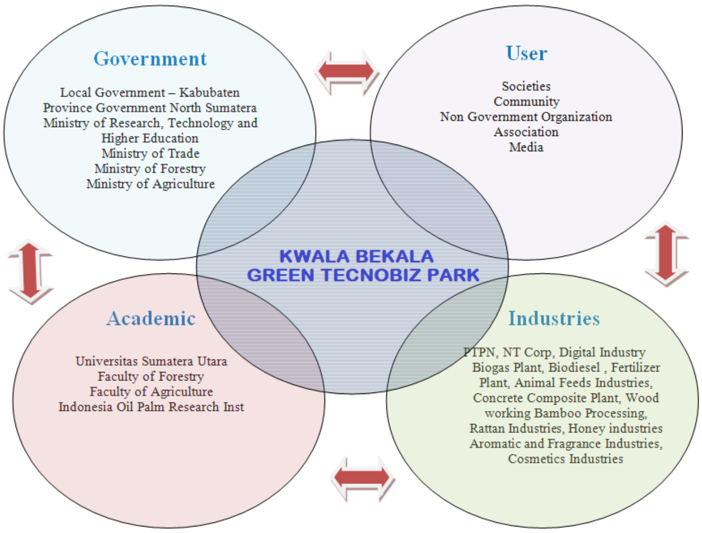

Figure 3. Elements of Kwala Bekala Green Technobiz Park using Quadruple Helix approach

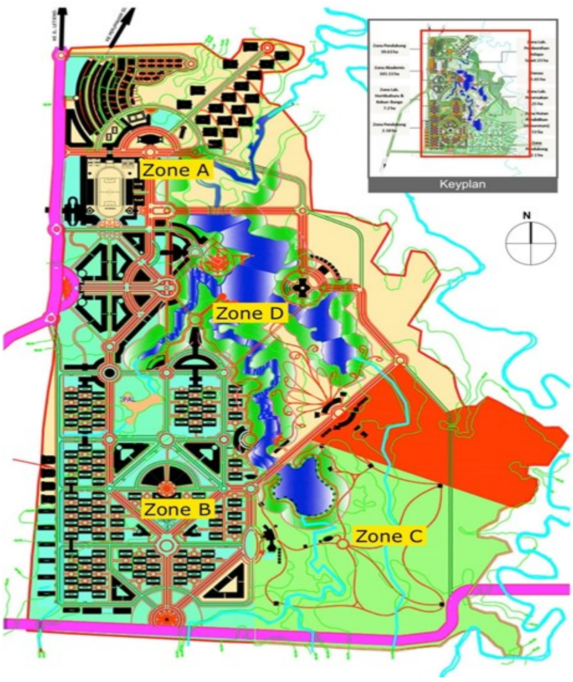

Figure 4. Master plan of USU's Kwala Bekala campus

3. Sustainable Green Kwala Bekala Campus

The entire zone is modeled as a chain of input, process and output described in the diagram in Fig. 5. Zone A is expected to provide innovation based entrepreneur with innovators as input to the incubators. These will generate green and eco-technologies based entrepreneurial to society. Zone B will provide technical excellence and expertise as inputs to be processed at the incubators with input of disseminated technologies. While Zone C is expected to provide the best practical and applicable practices to sustain processes in other zones so as to produce innovative knowledge-based mid-sized enterprises in green environment. As an outcome, it is highly expected KB-GTP can play a role in the real contribution of local economic improvement, resulting in an integration of sustainable agriculture system for example with healthy palm oil development and ultimately able to create new business clusters based on green technology innovation. Some important researches have been carried-out by USU researchers such in the palm oil sector as valuable inputs for the KB-GTP's process.

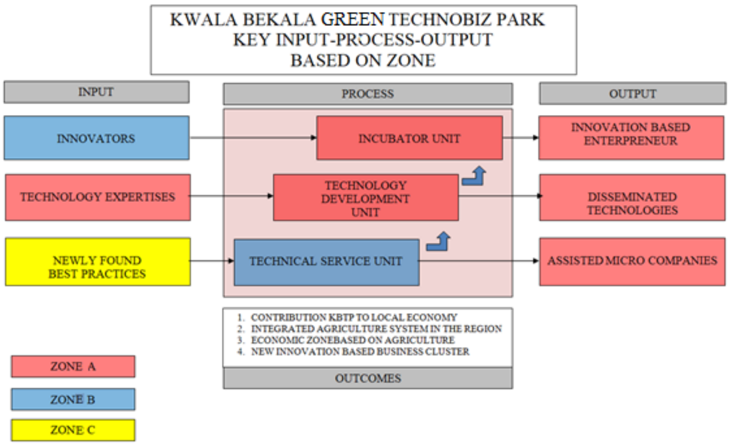

Figure 5. Input-Process-Ouput-Outcomes in sustainable green campus concept

Following criterias in the UI GreenMetric [7] in energy use, transport, water use, recycling and waste treatment as well as efforts being made by the institution towards establishing green policies and curriculum, USU put priorities in building and developing sustainable green campus on the issues as follow:

1) The issue of energy in reducing the consumption of fossil fuels and replacing it by non-fossil fuel energy, renewable energy, conserving and in general any greener and more sustainable alternative source of energy. In infrastructure development, USU should takes in to account on energy efficiency, environmentally friendly materials and designs, the implementation of innovative systems in order to conserve resources, heating and lighting systems, health issues and obtaining standard certificates.
2) In term of waste management system, USU needs to strengthen the concept of re-use of waste for other purposes such as heating, compost and the safe disposal of electronic devices and chemical substances and promoting paperless administration whenever possible as well as using recycled paper in some of its operation. USU needs to utilize appropriate equipment to conserve water, and to run efficient water waste systems.
3) USU requires to promote sustainability by creating awareness among its civitas academica. Sharing knowledge and expertises about environmental problems and possible solutions in the form of scientific meeting and seminars.
4) Efficient management public transportation inside campus is another challenging issue in order to cutting carbon foot print.
5) Investing in research projects organized within KB-GTP can produce eco-friendly technologies and environmentally friendly goods, services and systems. This will follow by the implementation of innovation and new technologies delivered by USU's researchers.

Therefore, USU's effort in developing new sustainable green Kwala Bekala Campus will also include:

1) Reducing waste and increasing recycling in connection with new construction projects.
2) Reusing rainwater and preventing water wastage that can be incorporated into new buildings.
3) Building an environmental and energy management organisation which ensures that sustainability and resource efficiency are part of all major decisions and actions.
4) Involving staff and students more to promote an increased sense of ownership of the sustainability efforts.

USU has the potential to develop the solutions needed to create a sustainable development of society through the existence of KB-GTP. This will strengthen the link between research and practice, as well as the commitment of the organization to the campus' sustainability efforts. It can also strengthen practice-oriented research and teaching within USU. Sustainable campus concepts such as green urban spaces, local rainwater drainage, urban ecology and sustainable landscape planning can be practiced within the university's facilities and new buildings. Through KB-GTP, USU can also establish close collaborations with external parties in relevant areas, such as Deli Serdang Regency, Medan City Administrator, utilities companies and industries. It may also be appropriate to involve public or private think tanks, non-governmental organisations and professional organisations in developing the green campus concept. It is expected that in the period 2019-2024, USU's KB-GTP development can be realized as stated in USU's Long Term Development Plan.

4. Summary/ Concluding Remarks

Science Techno Park is a national program that USU eagers to implement in the Kwala Bekala Campus Area with special emphasis on developing green and eco-technology. Therefore, the development of Kwala Bekala Green Technobiz Park (KB-GTP) follows the development strategy scheme of the National Development Planning Agency of the Republic of Indonesia. Universitas Sumatera Utara continues to make efforts to bring academic and business groups closer to the development of Technobiz Park with the government, the university community or research institutions, the business community, and users as stakeholders. To implement an innovation system, USU seeks to synergize the four main components of innovation into the Quadruple Helix Model with the KB-GTP as the center. USU has several key resources such as agroforestry and arboretum in Kwala Bekala, high quality researchers, early innovative products and eco-technology as part of valuable capital to develop Kwala Bekala Green Technobiz Park.

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BIM as a Tool for Setting and Infrastructure Management

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Abstract. Based on the consistent background and knowledge that the University of Minho (UMinho) has in 'Building Information Modelling', a practical roadmap towards the full BIM digitalization of the infrastructure management process has been recently set-up. After an initial diagnosis stage, the process of BIM implementation formally involves four stages related to the definition of modelling rules/requisites (Stage 1), the preparation of prototype buildings to test the concepts (Stage 2), the enlargement/ generalization of the process towards the Campuses of the UMinho (Stage 3) and a final stage of consolidation and improvements (Stage 4). This paper briefly describes the implementation of the two first steps, with a particular emphasis to the description of the two selected case studies.

1. Introduction

Building Information Modelling (BIM) is a methodology for information sharing and communication amongst all the stakeholders and during all the stages of the lifecycle of a given construction. It is normally supported by a digital model containing data about the geometrical features of the elements that compose the construction, as well as their properties and attributes, regardless of their nature, including physical properties, cost, construction timing, among others.

Even though BIM covers all stages of the lifecycle of construction, the scope of concern in this paper is the stage of operations and infrastructure management, normally termed as BIM-FM (Facilities Management) [1]. BIM-FM takes advantage of the extensive quantity and quality of information available in an as-built BIM model in order to assist operations and maintenance management of the building throughout its entire service life.

In the former UI Green Metric Conference was presented the strategic roadmap that the University of Minho has established towards a more effective and sustainable process of infrastructure management, through the implementation of BIM techniques [2].

Taking into account the lack of dedicated personnel to the preparation of the BIM models of the Campuses of UMinho, the staff involved in the present paper started an engagement of undergraduate students, within the Integrated Master in Civil Engineering, as to use real examples of buildings.

This paper briefly describes the definition of modelling rules/requisites and the simulation of two case studies to test the main concepts.

2. Training of Human Resources

An important adaptation that was made to the initial plan presented in the former UI GreenMetric conference [2] pertains to the anticipation of the training of a group of people that will be involved in the process of implementation of BIM-FM into the University of Minho. The reason for this anticipation is mostly related to the possibility of accelerating the implementation process, by making the potential users understand the possibilities and jargon associated to BIM. In this sense, a group of four members of the staff of the Facilities Management Services of the University of Minho has enrolled to the National Course in BIM, which is led and managed by Miguel Azenha, co-author of this paper. The course is targeted for practitioners of Architecture and Engineering, had a duration of 90 hours. Together with the theoretical background provided, the course challenged participants towards an actual practical application of BIM in a small project, focusing on the individual learning objectives of each participant, which are often diverse (participants include Architects and Engineers). For more information, the reader is directed to the website of this course, or to references [3, 4].

The members of the Facilities Management team that participated in this course were therefore quickly elevated from a low level of knowledge in BIM at the beginning of the learning process (October 2018), to a very reasonable level of proficiency by February 2019. A couple of examples of the models prepared during such assignment are shown in Fig. 1 and 2 for illustrative purposes. The staff members were able to simulate a BIM process, from design up to facility management, hence obtaining the necessary know-how to support the implementation procedure.

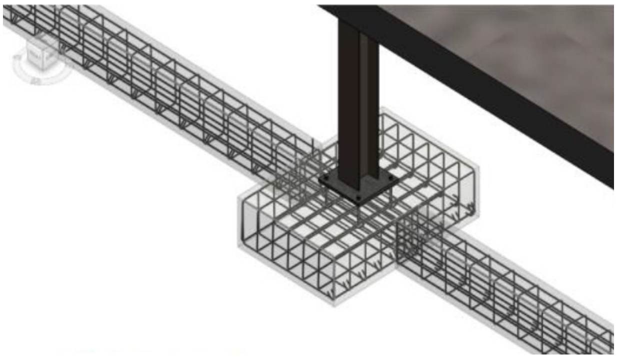

Figure 1. Detailing of concrete reinforcement at foundation level

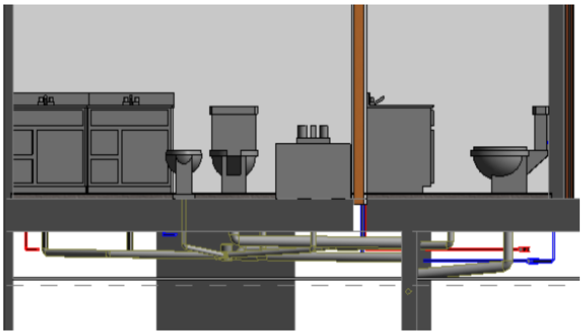

Figure 2. Clash detection for plumbing performed within a suspended ceiling

The process of training allowed more insights to be brought into possible frameworks to adopt in regard to the choice of software, the processes of surveying and modelling, the levels of detail/development/information and the relevant definitions towards an integrated 'Common Data Environment'. To some extent, this can be considered to match the initial plan devised in [2] towards the creation of a small pilot demonstrating model to show to all potential users, with a workshop to be held at M6 (indeed the presentations at the end of the training process were public, with participation of further members of UMinho).

3. The IB-S Building in Guimarães

3.1. Description of IB-S

The Institute of Science and Innovation for Bio-Sustainability (IB-S) develops multidisciplinary research to provide new materials, methodologies and strategies, to support the rehabilitation of built environment. One of the buildings of IB-S was built at the Azurém Campus of the University of Minho (Guimarães). It was designed by Architect Cláudio Vilarinho and built in 2016. The building, illustrated in Fig. 3, has a total area of 2,676 m^2, distributed in 5 floors.

The facade is covered with prefabricated panels of a cementitious matrix material reinforced with micro-fibres, without any conventional steel reinforcement, and consequently not prone to corrosion. The inclusion of pigmentation reduces the maintenance.

Figure 3. Institute of Science and Innovation for Bio-Sustainability (IB-S)

3.2. BIM model of IB-S

IB-S was selected due to its recent construction and good availability of data. Within the Curricular Unit of 'BIM in Civil Engineering: Design and Construction', groups of students were challenged towards the preparation of BIM Models, as an instrument for their learning and evaluation. In line with the above reasoning, the building of IB-S in the Campus of Azurém was selected for a group of 6 students [5], whereas other groups were focused in constructions outside the Campus, which are not of relevance for the present article. The curricular unit was active in the period between February 2018 and July 2018, and supervision/support was ensured directly by co-authors Miguel Azenha and Ricardo Mateus.

Students were given access to the construction drawings of Architectural design, Structural design (mostly reinforced concrete) and MEP design (mechanical, electrical and plumbing). They were requested to produce the 'as-built' model, following several specifications, namely the necessity of adequately classifying objects and spaces, as well as testing the building for use in a simulated 'Facilities Management' context.

The availability of the actual building and its users within 300 m of the classroom allowed the construction of the models to be supported by actual site visits and the 'Facilities Management' implementation to target the actual needs of this specific building, particularly through observation of its use, and interviews with the users.

Students were given full freedom of choice in regard to software, while being encouraged to use solutions of distinct software houses in order to be subjected to interoperability challenges that are often encountered in practice. Therefore, the choices of software for each purpose, also conditioned by the availability of student licensing, are signalled in Table 1.

Some highlights in regard to the models of IB-S are now given, with particular focus on FM-related matters. The Architecture model, performed in Archicad 21 is shown individually in Fig. 4 and 5, as viewed in BIMVision (IFC).

Table 1. Software used in the IB-S case study

Purpose	Software
Model quality assurance and clash detection	Solibri Model Checker 9.8
Architectural modelling	Archicad 21
Structural modelling	Tekla Structures 2017i
MEP Modelling	REVIT 2018
4D/5D	Vico Office R6.5; Navisworks
Facilities Management	REVIT 2018 linked with Archibus v23.2

The model includes all the partitions and outer shell of the building to an adequate level of graphical detail that allows users to clearly identify the building and its rooms. In Fig. 5 it is seen that the architecture model was initially populated with some furniture, which was further enhanced when the model for FM was fine tuned.

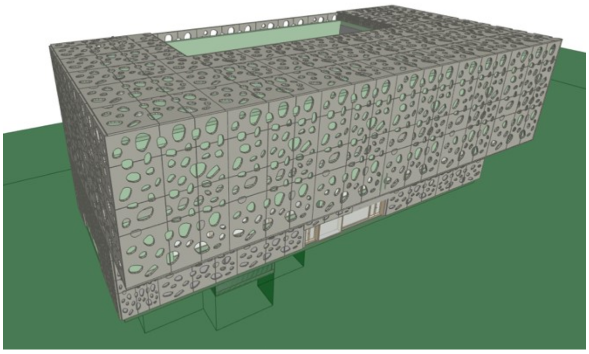

Figure 4. Architecture model of IB-S (IFC Viewer: BIM Vision)

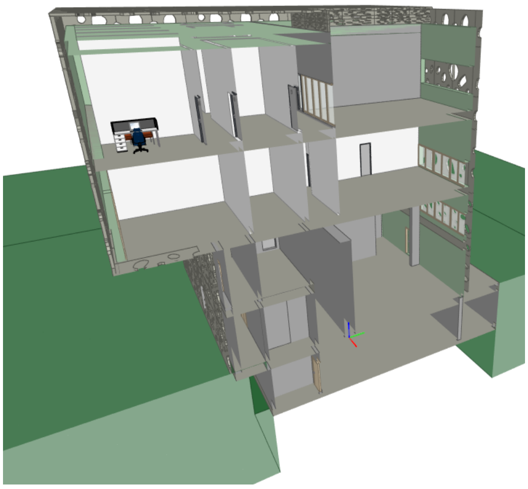

Figure 5. Vertical cut-out view of the architecture model (IFC Viewer: BIM Vision)

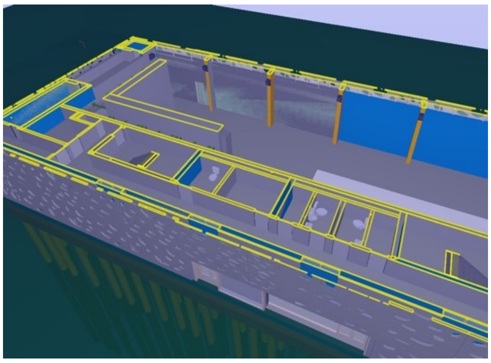

Figure 6. Horizontal cut-out view of the federated model (IFC Viewer: Solibri)

The structural model (developed in Tekla Structures) and MEP model (developed in REVIT) were federated together with the architecture model, as to produce the global integrated information, as shown in Fig. 6 and 7, where the three specialties can be recognized (e.g. toilet seats, piping, structural piles below the building). It is noted that for non-graphical information, strong focus has been given to the adequate tagging of rooms and equipment, following the nomenclature currently adopted at UMinho. The Omniclass classification system was further used for the structure and MEP elements.

Initially, goals for the implementation of facility management in the building were defined. They were: definition of spaces, properties of spaces, maintenance reports, work schedules, work hours, space occupation and utilization, and discretization of one of the floors at the level of equipment and furniture (the third floor was chosen for this). The tools selected for the accomplishment of this work were Revit as the BIM software and Archibus as the FM software (CAFM - Computer Aided Facility Management).

REVIT was used with the intent of preparing the information related to the IB-S building, which would be later transferred to the Archibus Web platform. The latter allows the integration and editing of information, in a bidirectional way, regarding the space utilization, properties of spaces, creation of work schedules, maintenance reports, discretization of equipment, among others. The following paragraphs provide specific information on the achieved developments.

3.2.1. Space and occupancy

Firstly, in the Archibus application for REVIT, the building properties and delimitation of spaces that were attributed in REVIT, were catalogued so that they could be transferred to the Web platform. Then, information regarding the different spaces were added, including department, division, room and floor codes, room and floor numbers, room categories and types. Area and perimeter were automatically catalogued. This allowed the 2D and 3D models of the building to be published on the Archibus online platform, as shown in the example of Fig. 8, where the 3D model of spaces is shown.

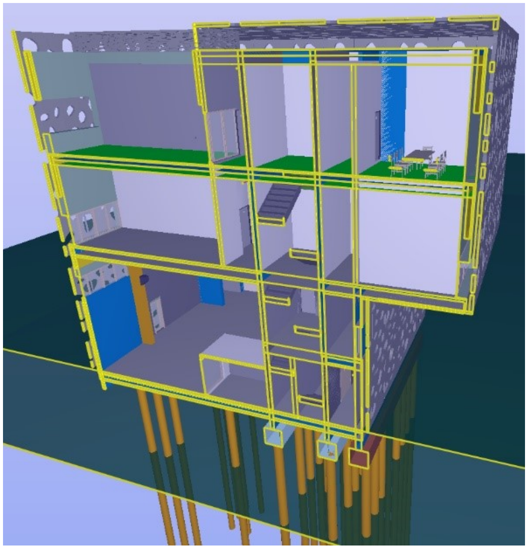

Figure 7. Vertical cut-out view of the federated model (IFC Viewer: Solibri)

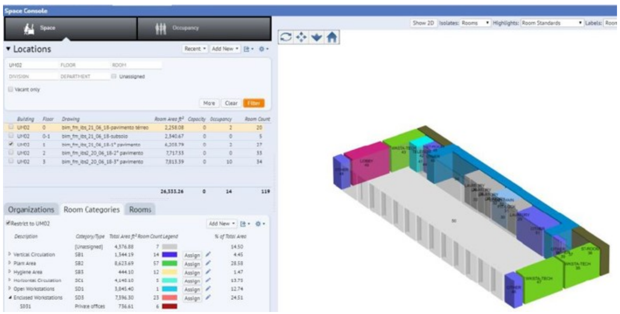

Figure 8. 3D representation of spaces in floor 1, as shown in Archibus [5]

After the spaces were defined, it was possible to define their occupation. The occupants would be the workers, such as the researchers and people responsible for equipment and space maintenance. Several properties were inserted for testing purposes in such concern: shcedule, employee name, company to which he/she belongs, electronic address, phone number, photography with description, building and floor to which he/she belongs, space requested or occupied by him/her, date he/she was hired, who is in charge for him/her, among other additional information. This allows the recognition of the building users in the drawings available in the platform.

The use of BIM sourced data for space management facilitates the identification of individual spaces, hence assisting optimization of space usage. It can also allow for several other useful tasks such as: view and compare inventory and occupancy of multiple floor plans, edit room attributes (such as category, type, department, capacity, area); move or add employees to rooms; use virtual waiting room for employees waiting to be moved; reserve a room for meetings or a laboratory area for tests; identify underutilized areas; speed up decision-making for managers and executives with customizable, easily accessible reports; gain fast access to target information with the extensive filtering options; among others.

3.2.2. Equipment and furniture

One of the floors of IB-S (3rd) was chosen to be populated with all the equipment and furniture elements for testing of the features of equipment/furniture management. Firstly, it was necessary to add the equipment and furniture to the REVIT model, in order to have a schematic representation of them in the Web platform. Similarly, to the space categorization, the characteristics of furniture were attributed, for instance, to tables and chairs, and to equipment and HVAC systems. This included furniture code and standard; and floor, room and building codes to which each furniture belongs. After that, the model was ready to export the data to Archibus. The physical representation of a 2D view in the FM software, including furniture, is shown in Fig. 9.

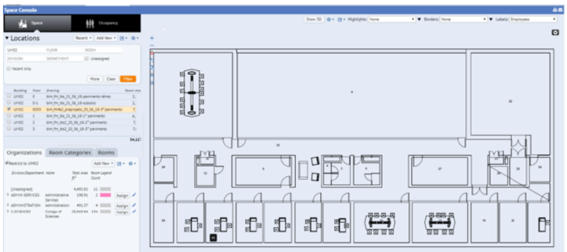

Figure 9. 2D representation of furniture in floor 3, as shown in Archibus [5]

The graphical representation of the asset with the attached data in an integrated manner can assist decision-making, improve answers in emergency situations and equipment failure, and assist the planning of maintenance activities. The registers can improve the use of existing equipment, maintain detailed technical information in a unique place, provide reports with asset distribution to the university and avoid unnecessary purchases of equipment. Additionally, it gives the facility manager more control about the assets, allowing the maintenance team to find them quickly and precisely.

3.2.3. Maintenance

Maintenance and problem reports provide knowledge about issues such as water leakage, lamp failures, damaged equipment, among others that may arise during the building life cycle. Thus, to address any issue that may appear, it is necessary to have all the data related to the building assets stored in the FM Software database. These data encompass price, installation date, model, technical specifications, size, warranty, manuals, activity history, etc. An example of a work report tested in the scope of this work is shown in Fig. 10.

With the integration of BIM and FM software it is possible to: create new work requests; identify work request location on a floor plan; review work request details; estimate, schedule and issue work to a crafts person; produce customized reports for executive and line managers; monitor preventative, corrective and reactive maintenance; monitor depreciation of assets; monitor performance evaluation of building systems.

Work Request Code	*1150001127* *1150001127*	Problem Type	LAB EQUIPMENT
Service Request Code	11311	Work Order	2015000158
Requested by	PROF	Priority	1
Date Requested	6/23/2018	Time Requested	11:13 AM
Building Code	UM02	Floor Code	0
Room Code	6	Equipment Code	DESKT
Division Code		Department Code	
Account Code		Status	Assigned to Work Order
Description	Computador avariado		

Step Responded By	On	Workflow Step	Status	Step Status After
PROF	6/23/2018	Basic	Requested	None
Comments				
SYSTEM	6/23/2018	Basic	Approved	None
Comments				
SYSTEM	6/23/2018	Basic	Assigned to Work Order	None
Comments				

Estimated Cost of Labor	$0.00	Cost of Labor	$0.00
Estimated Cost of Parts	$0.00	Cost of Parts	$0.00
Estimated Cost of Tools	$0.00	Cost of Tools	$0.00
Estimated Other Costs	$0.00	Other Costs	$0.00
Estimated Total Cost	$0.00	Total Cost	$0.00
Other Costs Description			

Figure 10. Example of the type of information included in a work request issued on the FM software [5]

3.3. Towards BIM-based Building Sustainability Assessment

The availability of the BIM model of IB-S created the necessary conditions for its further use towards conceptual improvements in Facility Management context, but also in understanding how it can be used to support life cycle assessment. This opportunity has been taken through a recently started MSc thesis work within the scope of the "Master in Sustainable Construction and Rehabilitation" (co-author Tais Magalhães, supervised by Miguel Azenha and Ricardo Mateus). The thesis work builds upon the existing model and information richness towards exclusive dedication to the preparation of feasible frameworks to apply at the University of Minho. Particularly, the goal is to analyse the BIM model in order to identify the information that is still needed to be gathered by the BIM model in order to allow a comprehensive life cycle assessment of the building, based on the SBToolPT-H building sustainability assessment (BSA) method and by other internationally recognized BSA methods, such as BREEAM and LEED.

A building project can be regarded as sustainable only when all the different dimensions of sustainability – environmental, social and economic – are taken into account. The various issues of sustainability are interrelated, and the interaction of a building with its surroundings has also important ramifications. Common concerns include those of reducing the use of non-renewable materials and water, as well as the production of emissions, waste and pollutants.

As an example, SBToolPT-H covers 25 sustainability criteria that allow evaluating the performance of a building at the level of the most relevant sustainability targets in Portugal, considering the approach of the EN standards in the field of sustainable construction. These criteria are organized in nine sustainability categories (macro indicators) [6]: C1 – Climate change and outdoor air quality; C2 – Land use and biodiversity; C3 – Energy Efficiency; C4 – Materials and waste management; C5 – Water efficiency; C6 – Occupant's health and comfort; C7 – Accessibilities; C8 – Education and awareness of sustainability; and C9 – Life-cycle costs. During the operation stage of a building, different data is needed to allow controlling the building performance in light of the SBToolPT-H method. For the C1 sustainability category, it is necessary to collect the maintenance intervals, the quantity of materials used and related embodied impacts. C2 allows to access the impact of the building in the surrounding environment and parameters such as the control of the storm water runoff and heat island effect, are needed. To assess the performance of the building at the level of energy efficiency (C3) it is necessary to have data connected to the energy consumed in the building for acclimatization (cooling and heating), preparation of hot water and energy consumed in the building integrated systems (e.g. artificial lighting and elevators) and each energy vector used. C4 concerns the type of materials used in the maintenance and renovation of the building (e.g. recycling content of building materials used), green procurement (e.g. type of consumables bought) and the implemented waste policy. For the water efficiency (C5) it is necessary to monitor the amount of water it is consumed in the different uses and to control the volume of grey water that it is recycled and the volume of rainwater it is used. To assess the performance at the level of the C6 (occupant's health and comfort) it is necessary to collect data related to indoor contaminants and hourly operative temperatures in the main building's indoor areas. Regarding the accessibilities (C6) updated information about the distance to public transportation and frequency and distance to other main urban amenities are needed. C8 is related to the building users' awareness and education in the context of sustainability and the availability and content of a user manual and adequate summarized information at the level of each indoor space is of utmost importance. To assess the life cycle costs category (C9) it is necessary to collect the energy and water bills and the costs related to building maintenance and renovation.

BSA methods are based on a set of different and multidisciplinary sustainability criteria. Therefore, although BIM was not developed with the focus of promoting more sustainable buildings, since it allows better information sharing between different stakeholders, it can play an important role to straightforward the assessment of the life cycle performance of buildings. For many sustainability criteria, BIM models can be adapted to provide the necessary data for assessment, even if external software is necessary, reducing the time necessary to assess sustainability. For other criteria, complementary plug-ins are needed to automate the building sustainability assessment process.

4. The School of Engineering

4.1. Introduction

Following the very positive experience of allowing students to participate in the endeavour of digitizing the Campuses of UMinho, the team decided to go one step further in the school year of 2018/2019. On the same Curricular Unit 'BIM in Civil Engineering' mentioned above in Section 3.2, all the students were challenged to produce FM-oriented models of Buildings #1 and #2 of the School of Engineering, as described next.

4.2. School of Engineering - #1 and #2

The Preliminary Study, completed in March 1983, although specifically directed to the installations of the 1st Phase presented a solution for the general plan of the campus. The ceremony of launching and blessing of the 1st stone of the campus of Azurém happened in November 1985. In 1989, after four years, its first buildings were officially inaugurated, housing the School of Engineering and several support services.

Figure 11. School of Engineering

Designed GPA – Grupo de Planeamento e Arquitectura, under the coordination of Architect Bartolomeu Costa Cabral, three extensive parallel bodies were installed with great topographic acuity on platforms at different heights, apparently mimetizing the traditional agricultural terraces.

By joining two of these blocks, a wide glass roof forms the reception atrium in a gesture that, together with several foot-bridges that articulate and physically link it, enhancing the perception of the whole as a unique building. The northern body, at its highest elevation, extends along a street and according to a regular alignment that suggests its future expansion. The south front, on the other hand, fixes the limit of the building in this sense, being discontinuous and open on the park and the hill of the castle.

The second phase of the Pedagogical Complex, if on the one hand confirms this implicit possibility of growth, also marks its limit, by physically and formally enclosing the building. Completed in 1993 and including a group of auditoriums – one of them with a capacity for about five hundred people, which for a significant period served the city lacking of a similar equipment – the work was executed according to a project that gave continuity to the previous architectural solution, Allowing us to read today the whole as a whole, complete and complete.

4.3. The BIM Assignments

The endeavour in the current semester (2nd semester of 2018/2019), that spans February to July 2019, is including all the students enrolled to the BIM Curricular Unit (33 students so far). They are forming a total of 7 groups (of 4-5 each), and Buildings #1 and #2 are attributed in parts to 6 of the groups, whereas the 7th Group is focusing on the adjacent laboratory Building #3. The plan view of the division of the assignments can be seen in Fig. 12.

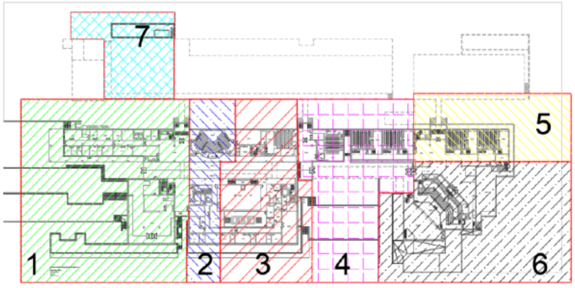

Figure 12. Division of Buildings #1, #2 and #3 in 7 group assignments

It is seen that groups with simpler stretches of the buildings need to cover wider areas as opposed to groups with more complicated parts (e.g. the main auditorium) are given smaller areas to cover. This should keep the work force relatively well balanced in between groups (except for the case of group 5, addressed later). Table. 2. Assignment of classes of objects to individual work groups.

Table 2. Classes of objects to create/manage

Group	Classes of objects to create/manage
1	Surface finishes for floors in general (e.g. tiles). All doors (fire-safety and normal doors)
2	Toilet equipment in general (toilet seat, sink, urinal, etc.)
3	Electro-mechanical equipment (e.g. chillers, network hubs, etc.)
4	Classroom equipment (chairs, tables, projectors, closets, etc.)
5	Windows, skylights, etc.
6	Handrails and elevators
7	Light fixtures, false ceilings, technical railings

As all students are focused in buildings that use the same building techniques, materials and products, it made sense to create a collaborative framework for the production of classes of objects for the model. Therefore, during the first half of the semester in which all the students are dedicated to the preparation of coherent Architectural models (that support the additional models to be modelled afterwards), specific task forces have been setup for each group to model a set of classes of objects that will be used by all groups. In this way, a higher degree of care and time dedication can be given to each class of objects (e.g. doors, equipment) that will be used throughout the entire building. Table 2 shows the distribution proposed to the students.

The buildings to model have a great variety of windows, complex windows and façades, which complicates the work of Group 5. That is the reason why such group has a smaller area to model, as mentioned before, and indicated in Fig. 12.

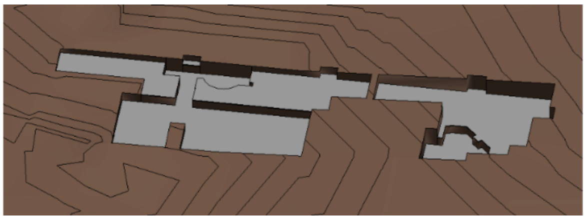

Figure 13. Terrain in which all buildings will be implemented

To keep coherence in the modelling, facilitate a common learning curve, and ease interoperability aspects (particularly in sharing newly created common classes of objects), students were invited to use Autodesk REVIT. Furthermore, specific software training is given to student during classes. A common terrain platform has been given to students in digital form since the beginning, with basis on existing topographic information of the Campus of Azurém (Fig. 13) as to better ensure compatibility of placement of all models, and also contribute towards quicker attaining of results and stronger focus of the students of the engineering modelling/simulation tasks to be done later.

After the completion of the Architectural models towards half of the semester (March), each group of students was divided according to specific targets (and depending on the number of students per group): BIM Management; Structural Engineering; MEP Engineering (potentially sub-divided according to the number of networks); Construction management, Quantity take off and cost estimation; Facilities Management. Particular support and supervision efforts will be made in tailoring facility management scenarios that are feasible for practical implementation at UMinho.

5. Conclusions

BIM can be an essential tool for the architecture, engineering and construction industry to optimise building performance and reduce the environmental impacts of the industry in the future.

The paper provides specific information on the implementation of facility management. The developed models of the IB-S building include the definition of spaces, properties of spaces, maintenance reports, work schedules, work hours, space occupation and utilization, and discretization of one of the floors at the level of equipment and furniture. The Architecture model of the IBS building includes all the partitions with an adequate level of graphical detail that allows users to clearly identify the building and its rooms. The model was also populated with some furniture. The structural model and MEP model were federated together with the architecture model, as to produce the global integrated information.

Given the demand for more sustainable buildings and the amount of data produced during the operation stage of a sustainable building, it is important to create ways to integrate and automate the Building Sustainability Assessment (BSA) methods within the BIM context. In this context, project teams will be able to identify differences between the expected and real performance levels and compare different operation scenarios, without spending too much time, money and other resources.

Acknowledgments

The authors gratefully acknowledge the work and gentle agreement to use the IB-S BIM Model (article and FM definitions), by the authors of Reference [5]: C. Rodrigues, F. Gonçalves, J. Oliveira, J. Salgado, R. Silva, G. Matiazzi.

This work was financially supported by: project POCI-01-0145-FEDER-007633 (ISISE), funded by FEDER funds through COMPETE2020 - Programa Operacional Competitividade e Internacionalização (POCI), and by national funds through FCT - Fundação para a Ciência e a Tecnologia.

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Issues and Innovation in Managing Energy

Growing Bigger and Reducing Carbon - The Challenge

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Abstract. As a major global organization we recognize that we have an environmental, economic and societal impact locally, nationally and internationally. Increasingly our students, staff and local community partners recognize and expect the University to be a leading advocate of sustainability in its teaching, learning, research, decision-making and operations. The University's Global Strategy 2020 clearly defines a mandate for the further development of our sustainability agenda. Over the last 20 years, the University has grown in number and size and our challenge to reduce absolute carbon emissions has been addressed through a combination of efficiency measures, investment in new plant and renewable energy. The University's Carbon Management Plan was published in 2010 and refreshed in 2015/16 and includes targets for reductions in emissions of CO_2 from energy consumption. It identifies the principal areas of energy use and our investment programmes to improve energy efficiency, reduce consumption and generate energy from lower carbon and renewable energy sources. In 2017/18 our Scope 1 and 23 carbon dioxide emissions have shown an absolute reduction of 2.9% or 1,423 t from 2016/17 and down 21,051 t from 2009/10 baseline of 67,998 t CO_2. In the programme's eighth year the University continued investment of £0.6m in projects across all areas of the CMP. Since 2010 our CMP has now invested in excess of £18.8m, with estimated annual savings in the region of 14,034 tonnes of CO_2.

1. Carbon Management Plan (CMP)

The University of Nottingham developed its first CMP in 2009/10 following the Higher Education Funding Council for England's (HEFCE) guidance on the issue as part of its sustainability strategy. It was approved by the University in December 2010 and updated in July 2016 with the main areas of investment to be centered on:

1. Improvements in the energy efficiency of buildings, including insulation, heating & lighting
2. More efficient use of existing equipment
3. Generation of energy from small/medium scale renewable energy systems
4. Major infrastructure upgrades to replace existing plant to reduce energy cost, carbon emissions while at the same time improving system resilience.

The CMP includes a number of specific investment projects and more generic programmes to deliver CO_2 reductions. These focus on the areas of energy saving and energy efficiency for Scope 1 (predominantly gas combustion in boilers) and Scope 2 (electricity use) emissions.

The CMP provided a baseline of CO_2 emissions; sets emission reduction targets; and mapped out a 5-year investment programme implemented to deliver environmental performance improvements and carbon & financial savings [1].

Table 1. The CMP targets and objectives set in the 2010 CMP are:

	Baseline 2009/10	Target 2014/15	Target 2020
Total CO_2 emissions p.a.	68,000 tonnes	54,000 tonnes	41,000 tonnes

These represented reductions from the 2009/10 baseline of 20% on CO_2 emissions by 2014/15.

We continue to prioritize the most energy and carbon intensive buildings and achieve a better understanding of what contributes to our significant 'out of hours' baseload. We are continuing the development of energy strategies for each campus with the overall aim of reducing carbon emissions, improving financial sustainability, system resilience and student experience and wherever possible, deliver income generation via government feed-in tariffs / renewable heat incentive.

Assets of commercial subsidiary companies of the University at Innovation Park and East Midlands Conference Centre Ltd are excluded from reported figures.

2. Performance

2.1. Energy consumption

Overall energy and water costs were £12.2 million in 2017/18, an increase of 5% from the previous year. Both our energy consumption per square meter and per student remained below the Russell Group[1] average.

Energy consumption, i.e. the total of gas and electricity, increased by 3.4% year on year even though floor area was up by 2.6%, student numbers were up by 2.1%, and the weather was significantly colder, indicating a requirement for 7.7% more heating fuels. If the effects of the weather and new buildings are removed, then in a like-for-like comparison, consumption for the last year would have been 192,489 MWh, a reduction of 4.0%.

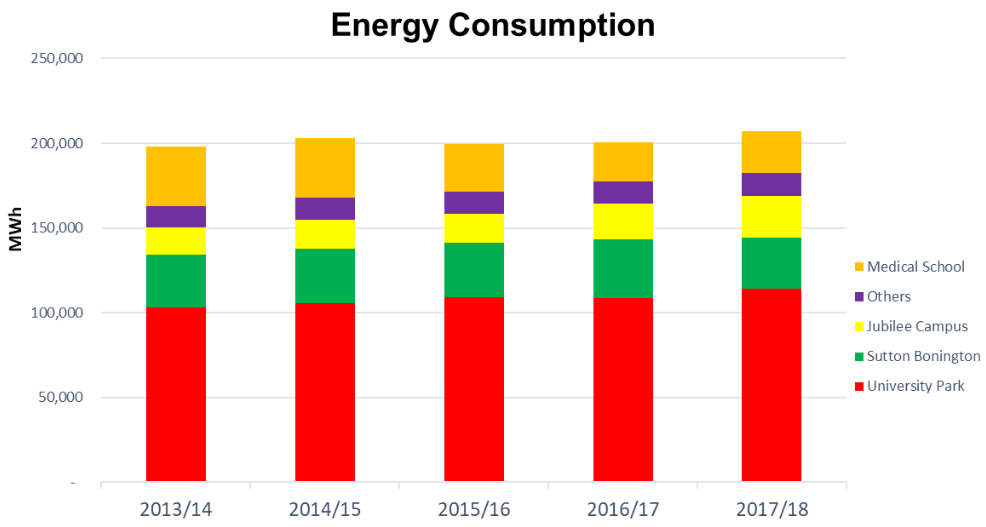

Figure 1. Energy Consumption in the 2013/2014 to 2017/18 period

2.2. Carbon dioxide emissions (Scope 1 and 2)

We have seen a steady reduction in our emissions following 8 years of investment in energy saving projects and external factors that are out of our control. The National Grid has continued to reduce its CO_2 emissions associated with power generation through the increasing proportion of renewable energy and gas-fired power stations supplying the grid with a corresponding reduction in the use of the coal-fired plant.

[1] The Russell Group represents 24 leading UK universities which are committed to maintaining the very best research, an outstanding teaching and learning experience and unrivalled links with business and the public sector

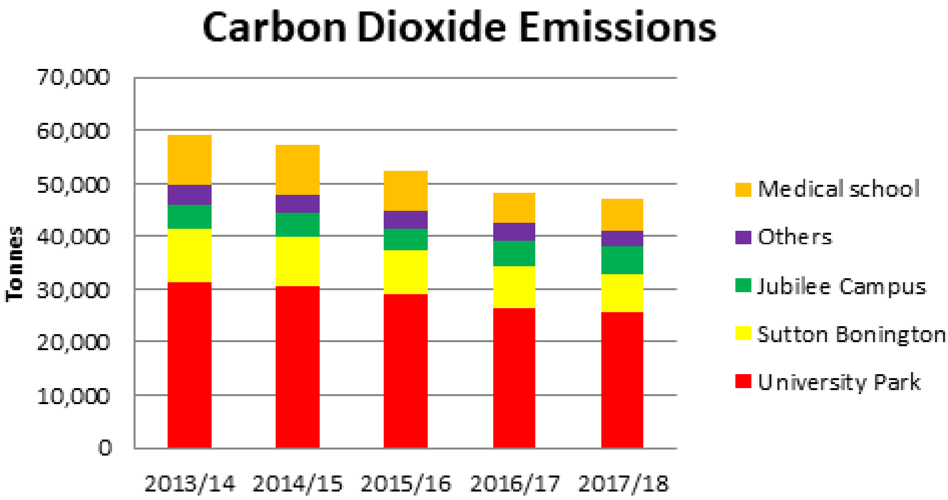

Figure 2. Carbon Dioxide Emissions in the 2013/2014 to 2017/18 period

Table 2. Carbon Dioxide Emissions Factor in the 2013/2014 to 2017/18 period

CO_2 Emission factor	**2013/14**	**2014/15**	**2015/16**	**2016/17**	**2017/18**
Electricity Kg/kWh	0.494	0.462	0.412	0.352	0.311
Natural Gas Kg/kWh	0.185	0.184	0.184	0.184	0.184

Table 3. Carbon Dioxide Emissions Factor in several areas in the 2013/2014 to 2017/18 period

CO_2 (T) Emissions	**2013/14**	**2014/15**	**2015/16**	**2016/17**	**2017/18**	% Change **2016/17 to 2017/18**
University Park	31,424	30,490	28,898	26,573	25,780	-3.0
Sutton Bonington	9,876	9,637	8,244	7,791	6,999	-10.2
Jubilee Campus	4,855	4,295	4,247	4,877	5,294	8.6
Others	3,731	3,612	3,425	3,199	3,114	-2.7
Medical School	9,446	9,285	7,470	5,930	5,760	-2.9
Total	**59,332**	**57,319**	**52,284**	**48,370**	**46,947**	-2.9

Our emission factor for grid consumed electricity includes Scope 1 and 2 emissions associated with power generation but does not include scope 3, i.e. those associated with transmission and distribution losses and are obtained from DEFRA / BEI

2.3. Electricity

Although there was a large increase in our Estate of almost 108,000m² (20%) since 2009/10, overall 'Grid' imported electricity consumption only increased by 7%, this is due to on-site generation from the installation of the 800kW CHP plant at our Sutton Bonington campus and other new plant and equipment installed.

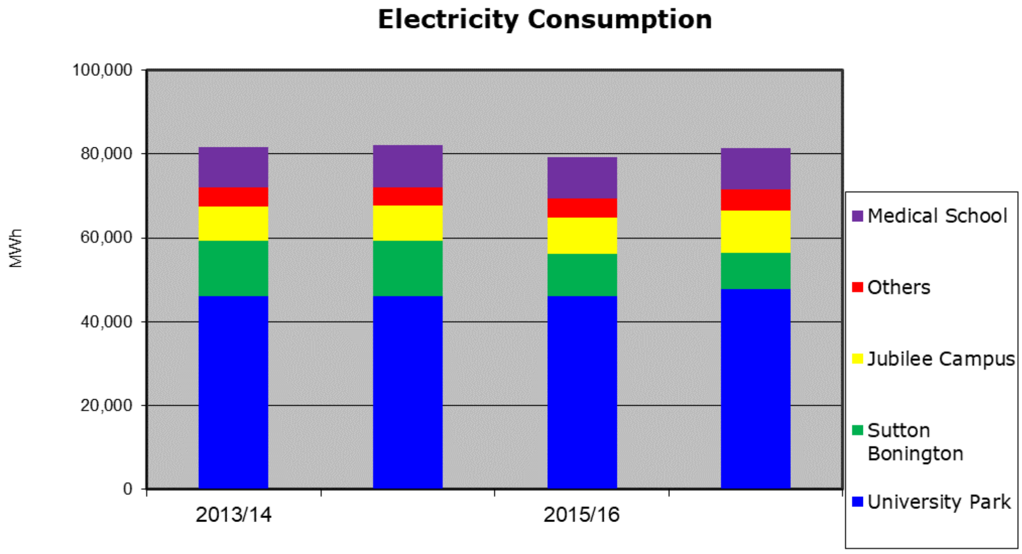

Figure 3. Electricity Consumption in the 2013/2014 to 2017/18 period

2.4. Natural gas

Despite the increase in the floor area of the University estate and additional gas required for the new CHP plant, overall consumption of natural gas actually reduced by 2% since 2009/10 this has been achieved by efficiency gains and new plant and equipment.

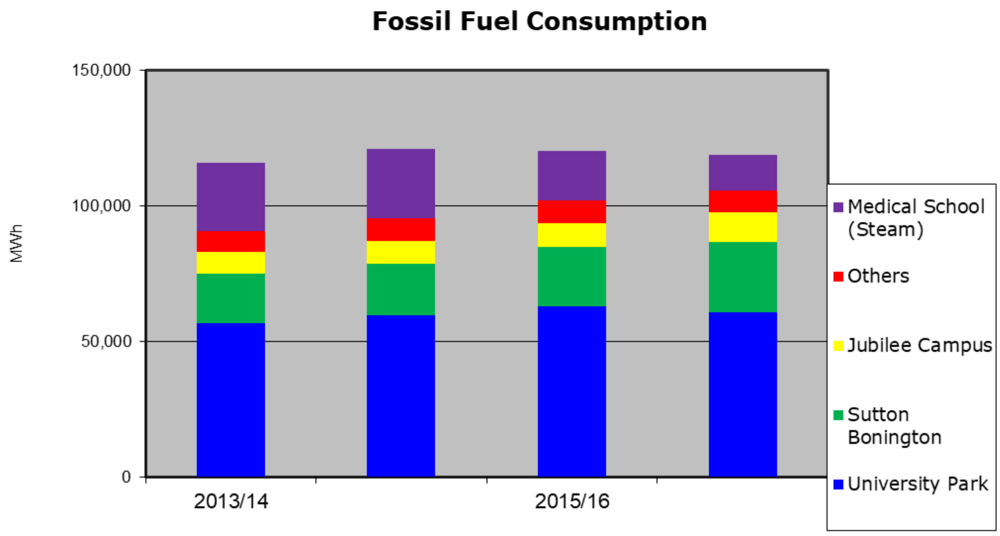

Figure 4. Fossil Fuel Consumption in the 2013/2014 to 2017/18 period

2.5. Targets for scope 1 and 2 emissions

Our 2015 Carbon Management Plan target was 51,000 tons, a reduction of 17,000 tons from our 2009/10 baseline year. Our total programme savings at the end of 2017/18 stood at 14,034t CO_2 per annum from 2009/10. Since the publication of the CMP in 2010 the University has exceeded its planned growth plan, however, carbon emissions have reduced by 21,051t CO_2 with as a result of the considered investments made and the wider de-carbonizing of power generation supplied to the UK's National Grid[2]. This will continue to have a significant influence on our performance and ability to meet carbon targets.

[2] National Grid is the high-voltage electric power transmission network covering Great Britain, connecting power stations and major substations and ensuring that electricity generated anywhere on it can be used to satisfy demand elsewhere.

The challenge over the period to 2025 and beyond will be to continue to identify and implement cost-effective carbon reduction initiatives to achieve:

- absolute reductions in emissions
- offset continued growth in any new buildings
- offset increased intensive energy consumption from research

It is clear that to achieve the long-term targets we need to continue to invest in large- and small-scale carbon reduction projects to de-carbonize our power and heat supplies to our buildings, as there are currently predominately from the combustion of natural gas.

3. Carbon Projects

3.1. Carbon management plan sample of projects

A sample of carbon saving projects installed over the last 5 years is given below. Projects are grouped into the main CMP themes together with their financial and carbon performance and bring the total investment over the last 8 years to £18.8m delivering £2.3m in energy savings and 14,034 t CO_2 each year.

Table 4. A sample of carbon saving projects installed over the last 5 years

Project Theme	Project description	Investment cost £	Estimated annual savings	
			Financial £	CO_2 tonnes
Laboratories: Continuation of Fume Cupboard works	Upgrade of fume cupboard controls, with full VAV with PIR auto sash closure in Chemistry.	525,456	129,575	819
Boiler Replacements, steam controls	Replacement of old inefficient boilers and all sites and steam controls in the Medical school	1,542,767	137,543	595
Controls, heating upgrades, fan and pump motor drives.	Controls to building ventilation/ heating systems upgrades and installation of new inverter drives to fans etc.	1,413,793	393,392	1,216
Double glazing	Replacing single glazed high-performance double glazing in Science and Medical school buildings	5,852,000	82,765	500
Lighting upgrades	Replace T8 fluorescent with LED	364,733	30,385	165
Solar PV	Roof mounted PV system to Vets School	223,000	26,000	69
CHP plant	Sutton Bonington Campus. 800kWe CHP plant	1,320,000	272,000	1,250
High efficiency chilled water plant.	Medical school replacement of steam absorption chiller with 'Tubocor' electric chillers	1,559,000	286,750	1,290

3.2. Project overview and updates

We have continued to deliver investment in the laboratory fume cupboard efficiency programme with further works to reduce fan speeds with full variable speed extracts to reduce electricity use and, as a consequence, reduce gas from space heating. These systems included PIR occupancy sensors that automatically lower the fume cupboard sash window and reduces fan speed if no one is in front of the cupboard. The means savings are achieved as soon as possible with the added safety benefit a lowered sash provides for other lab users.

The replacement of old plant, both chillers and boilers, has resulted in improved efficiency across the estate and this rolling programme will continue over the coming years.

The University's Medical School has had additional projects involving replacement lighting on F Floor, new controls to existing central extract systems and works on the steam main to reduce significant losses. Along with the installation of new chillers replacing dependency on steam-driven cooling systems which have now delivered the total accumulative carbon savings of 8,695t CO_2.

3.3. Renewable energy projects

Small and medium scale renewable energy projects are financially supported by UK legislation through initiatives such as the Feed-in Tariffs (FITs) and Renewable Heat Incentive (RHI). These programmes promote widespread uptake and provide income from generation to accredited technologies including photovoltaics (PV), wind, biomass, solar thermal and ground source heat pumps (GSHP).

Table 5. A summary of the University's renewable energy generation in the 2017/18 period.

Building	Technology	Annual Production (kWh)
Dearing	PV	6,795
Business School North	PV	14,284
Computer Sciences	PV	6,955
Derby Hall	PV	49,403
Lincoln Hall	PV	38,537
Si Yuan Chinese Studies	PV	4,678
Aerospace Technology	PV	11,453
Energy Technologies Building	PV	11,307
Environmental Education Centre	PV	14,342
Sustainable Research Building	PV	5,124
Ingenuity Centre (TEC)	PV	4,553
Riverside Sports Pavilion A	PV	10,017
The Barn	PV	3,376
Sustainable Chemistry	PV	214,388
George Green Library	PV	3,084
Orchard Hotel	PV	7,849
Advanced Manufacturing Building	PV	3,597
Veterinary School	PV	124,295
Total		**564,047**
Si Yuan Chinese Studies	Solar thermal	1,724
Rutland and Sherwood	Solar thermal	10,627
Geospatial	Biomass	41,686
Bio Energy	Biomass	26,891
Total		**80,928**

These installations have saved 191 tonnes of carbon last year by displacing electricity and gas that would have been provided by the National Grid. A number of sizeable low carbon energy generation schemes have been installed on both the David Ross Sports Village (solar PV and combined heat and power) and the Teaching and Learning Building (solar PV) that are awaiting permission from Western Power for connection to the local grid. These should come online in 2019 following works to enhance local grid resilience.

3.4. Future investments

A significant amount of work has been carried out looking at the long term energy strategies of both University Park and Sutton Bonington campuses due to their energy-intensive activities.

Sutton Bonington Ground-based PV Array

At Sutton Bonington, we have invested in a mixed blend of energy generation, including a CHP scheme and photovoltaic (PV) array on the University School of Veterinary and Medical Science. A detailed business case for a 1MWe PV array is being evaluated with calculations showing potential for a 6500m^2 array that would generate an annual yield of 870,000kWh of electricity or about 8% of the campus electricity demand. This has an estimated potential to achieve annual fuel cost savings of £92,000 and a carbon saving of around 205t CO_2. Over the 25 year life of the panels, the system is expected to save in excess of £3m in electricity cost and over 4000 t CO_2.

Combined with the existing CHP plant, on certain days of the year, the campus could be self-sufficient in electrical power. CHP and solar PV have a good output synergy as PV provides power peak around the middle of the day/early afternoon when the sun is highest in the sky (south orientation) and for the longest period of time during the months of May-August and when heating demand reduces and the CHP usually reduces output as heating demands are met, hence maintaining a good electrical generation balance for the site. Consideration of using land underutilized farmland (known as the 'Paddocks') situated on the north side of the campus. The business case for investment will be made in 18/19.

University Park Low Carbon Heat Networks

The University's Energy & Carbon team are undertaking detailed feasibility work for the development of a cluster of low carbon heat networks to replace an aging central boiler house and underground high-pressure hot water heat network totaling 3km to achieve significant fuel cost savings and reductions in CO_2. A business case was submitted for consideration Feb 2019 and approval was given for the next stage detailed feasibility study. It's proposed that this circa £10m scheme will utilize high-efficiency gas-fired boiler plant operating at a much lower temperature than the original system along with CHP plant or other future technologies with aim of reducing energy costs, carbon emissions.

University Park Electrical Loads

We continue with ongoing monitoring to understand where the significant overnight baseloads are located and how these may be reduced. The Science and Engineering faculties account for almost 40% of total electrical use mainly due to research equipment/processes that operate year round. Further understanding is still required and schools and departments have been asked to submit equipment schedules detailing power rating and likely operating profiles. Demand reduction will continue to be an area of focus across all our campuses.

4. Future Carbon Management and Investment Programmes

At this mid-term position, the CMP needs to continue to deliver the depth and range of carbon reduction projects needed to deliver our institutional targets. This includes continuing with plant replacement, glazing and insulation projects and on-site with major investments such as the Sutton Bonington low carbon energy strategy. We will continue to take an evidence-based targeted approach to further investments in energy and carbon-intensive buildings.

An energy strategy to cover the expansion of Jubilee Campus is being developed to look at options for low carbon energy sources to serve a number of buildings at the north end of the campus from a common plant room. Whilst there is likely to be significant further development on acquired sites the appraisal assumed the development of the 'bonded warehouse' site whilst the future plans of that site is considered.

As the University develops its wider strategy and an estate masterplan we will identify where investment is needed over the next 5 years to reduce carbon emissions. These are likely to include large scale building fabric upgrades as part of major general refurbishment works to our halls of residence as well as investment in the underpinning heat and power infrastructure.

The programme continues the focus on investment in the CMP's core activities:

- Large and small scale Plant/ infrastructure replacements
- Laboratory fume cupboard efficiency upgrades
- Campus-wide low carbon generation strategies
- Staff and student engagement

- Continued improvements to existing building fabric to reduce heat losses
- Review renewable energy strategies following imminent removal of
- Government feed-in tariffs.

5. Financial Requirements

CMP projects continue to be assessed for financial and carbon performance and submitted for approval, having initially gone through an energy & carbon working group. Funding for CMP projects is provided from CMP capital, Salix finance and grant contributions and loans.

6. Salix Finance

The University continues to utilize its Salix Finance revolving green fund and has used it to invest more than £983K to date and will continue to invest these ring-fenced savings into further carbon saving projects.

References

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Mission Zero Emission – Managing Energy and Climate Change at the Environmental Campus Birkenfeld

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Abstract. Due to the extensive utilization of sustainable technologies, Environmental Campus Birkenfeld (ECB) is the first Zero-Emission Campus in Germany. Energy – heat and electrical – are supplied by neighboring biomass combined heat and power station, which uses regionally available waste wood and biogas as a primary energy source. Innovative building standards and environmental technologies legitimize the claim of being a real Zero-Emission Campus. One hundred percent of the buildings at the Environmental Campus Birkenfeld (ECB) feature "Smart Building" technologies. All our buildings are networked by a building control system, which is based on standardized network communications protocols for building automation. For example, the 'Communication Centre' building is a non-residential passive house with an excellently insulated building envelope integrated with highly efficient systems technology. The Environmental Campus uses the photovoltaic technology intensively. Not only the roof areas but also the facades of the connecting passageways were incorporated into the photovoltaic system and used to generate electrical energy. The performance of different photovoltaics (PV) modules and mounting systems are continuously monitored, displayed and employed as a subject for teaching and research. The photovoltaic installation on the rooftops generates up to 50% of the total amount of electricity required by the campus. With the help of solar power, traffic-related emissions on the ECB can be significantly reduced by switching from cars powered by combustion engines to electric mobility. A corresponding model project is currently being established in Birkenfeld.

Keywords: climate change, climate neutral university, electric mobility, Environmental Campus Birkenfeld, zero emission campus

1. Introduction

In 2015, the United Nations adopted Agenda 2030 with the 17 Sustainable Development Goals, which provide a guideline for a just and equitable development of the world [1]. Two of the 17 SDGs concern energy and climate protection. SDG 7 demands the provision of clean and affordable energy for all people and attaches importance to the use of renewable energies and the efficient use of energy. Climate protection is the focus of SDG 13, with a direct link to the United Nations climate protection agreements.

Universities have a special responsibility for sustainable development because they shape the decision-makers of tomorrow. It is therefore particularly important for universities to fulfill their social obligations. To this end, a holistic approach must be adopted that integrates all areas of higher education: teaching, research, transfer, governance and operation of the university: The UI GreenMetric Rankings assesses universities in a holistic way and the Environmental Campus Birkenfeld has established itself in recent years in the top ten universities in this ranking [2].

This article describes how the Environmental Campus Birkenfeld implements the aspects of energy and climate protection within the framework of sustainability management. The Environmental Campus is briefly presented in Section 2. The zero-emission concept of the university and examples of established projects in the field of energy and climate protection are explained in Section 3. The fourth section outlines a model project on the use of electric vehicles for the mobility needs of staff and students at the ECB. The last section contains a short summary of the findings, an outlook regarding the next steps at Environmental Campus Birkenfeld and their transferability to other universities.

2. The Environmental Campus Birkenfeld

In 1993, the state of Rhineland-Palatinate made the forward-looking decision to establish the Environmental Campus in the municipality of Hoppstädten-Weiersbach of the Birkenfeld association as a new location of a

University of Applied Sciences. The decision was also motivated by structural policy, as the loss of military facilities weakened the economy of the already structurally weak and rural Birkenfeld district. Until 1992, the property of the Umwelt-Campus had served as a site for a reserve military hospital of the American armed forces in Germany and was now to be converted to a new use. At the time, the local press had the headline: "Campus spirit in a ghost hospital". Fig. 1 shows the environmental campus in 2018, with the preserved comb-like building structure of the former military hospital clearly visible. From the beginning, the concept of the Environmental Campus Birkenfeld included an interdisciplinary education under the framework of circular economy in the sense of sustainable development. The campus model was to be based on the "residential campus" known from American universities, which combines living, learning and working in one place. For this purpose, student dormitories, as well as generous areas for applied research at the university and in the neighboring property an eco-industrial park for environment-related company settlements, were planned.

The Environmental Campus Birkenfeld is a site of the Trier University of Applied Sciences and began teaching in the winter semester of 1996/97. In the first year, approximately 175 students were expected. In fact, however, more than 550 students enrolled in one of the five diploma courses on offer. The Environmental Campus was originally designed for 1,100 students. This target number was already exceeded by almost 50% in 2004 with over 1,600 registered students. Currently, in 2018, approximately 2,500 students from over 60 countries are being taught in 12 Bachelor's, four dual Bachelor's and 12 Master's degree programmes by a total of 56 full professors in the two faculties of Environmental Planning/Environmental Technology and Environmental Economics/Environmental Law.

Figure 1. Aerial view of the Environmental Campus Birkenfeld [3]

Sustainability is implemented and lived holistically at the Environmental Campus Birkenfeld. Starting with the anchoring in the mission statement and in the management structures, all areas from operations, teaching and research to the transfer towards sustainability are developed. How successfully this is implemented in Birkenfeld is demonstrated not least by a series of prizes and awards that the Environmental Campus has received [4]

3. Zero Emission Concept of the Environmental Campus Birkenfeld and Selected Projects

In the category "Energy and Climate", the Environmental Campus in Germany continues to be one of the best universities worldwide in the UI GreenMetric Rankings. This category has the highest individual weight in the ranking and evaluates aspects such as energy efficiency, electricity consumption, energy standards of buildings, use of renewable energy and reduction of CO_2 emissions [5].

The Environmental Campus Birkenfeld is the first "Zero Emission University" in Germany and in Europe, as the property is completely supplied with renewable energies in terms of heat and electricity. Fig. 2 shows the heat supply of the environmental campus. In a nearby wood chip cogeneration plant, heat and electricity are produced from regional waste wood in a climate-neutral and efficient way with the aid of combined heat and power generation. In 1997, the wood-chip power station was inaugurated with an installed thermal capacity of 28 MW utilizing 65,000 tonnes of low and high contaminated waste wood annually from forestry, agriculture, landscape gardening and industry to produce up to 8 MW heat, 37.5 tonnes per hour of steam and up to 8.3 MW electricity for the Environmental Campus, the neighbouring industry facilities and the national electricity grid. Clean Biomass (waste wood) is a very important renewable energy source for ECB with an amount of 1,790,200 kWh in 2017. Furthermore, a cogeneration unit utilizes the biogas output of the nearby anaerobic digestion plant treating 40,000 tonnes of organic municipal solid waste annually and collected in the rural districts of Birkenfeld (and thus also of the environmental campus) and Bad Kreuznach.

The environmental campus obtains "green electricity" and additionally generates around 50% of its electricity requirements from large-scale solar systems on the roofs and facades. However, due to the feed-in tariff for renewable electricity, most of the solar electricity generated on the roofs is fed into the grid.

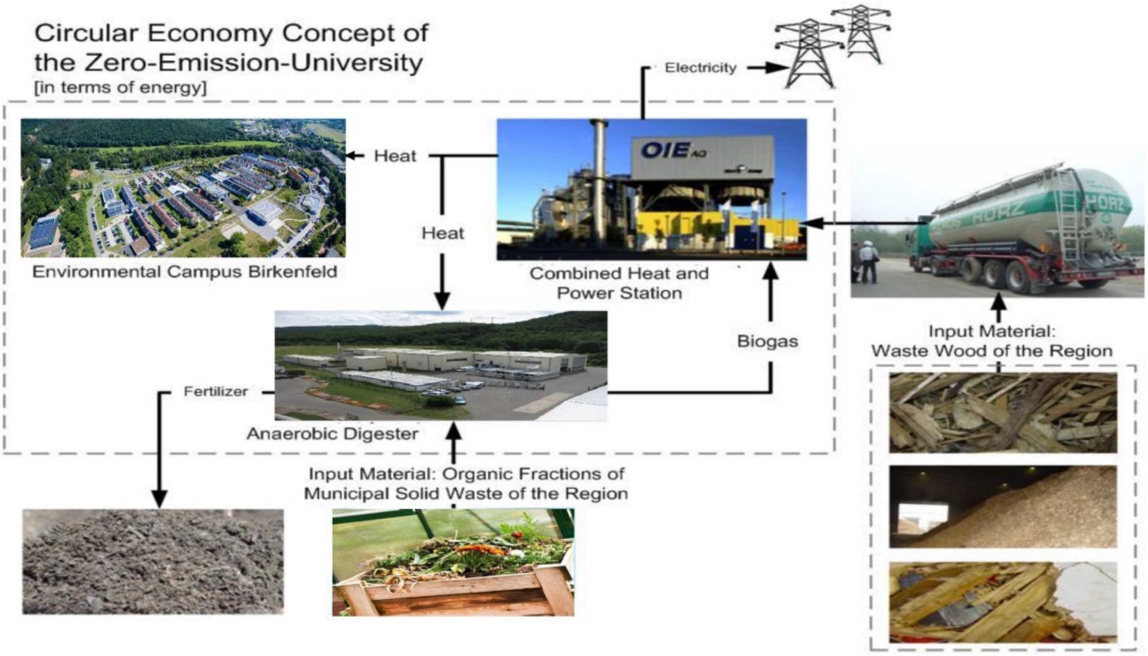

Figure 2. The circular Economy concept of the zero-emission campus

An ecological construction concept and CO_2-neutral energy, heating and cooling supply, as well as the latest building and plant technologies, offer a unique place to "live, learn and work". Living on the Environmental Campus is also energy-efficient. The dormitories were built to low-energy and passive house standards. The ‘Communication Centre’ on the Environmental Campus, which is used for conferences and many other events, is an energy-plus building. This building is basically designed as a passive house. The excellent insulation of the building envelope and highly efficient building technology reduce the need for heating energy to a minimum. The remaining primary energy requirement is overcompensated by an installed photovoltaic system so that mathematically even more energy is generated than consumed. Further information on building services engineering and the operation of the university can be found in the technology brochure [6] and regularly in the sustainability reports of the Environmental Campus [7].

All buildings at the Environmental Campus Birkenfeld are fitted with the latest energy-efficient and energy-saving appliances such as motion light sensors in every room, daylight distribution system, automated daylight management blinds, efficient lighting systems, indoor and outdoor LED-based illumination, high-efficiency ventilation technology, individual room climate-control (HVAC) combined with central monitoring and use of rainwater-storage-collection-flush systems coupled with low-flow and waterless urinals. Fig. 3 provides an overview of ECB´s green building technologies.

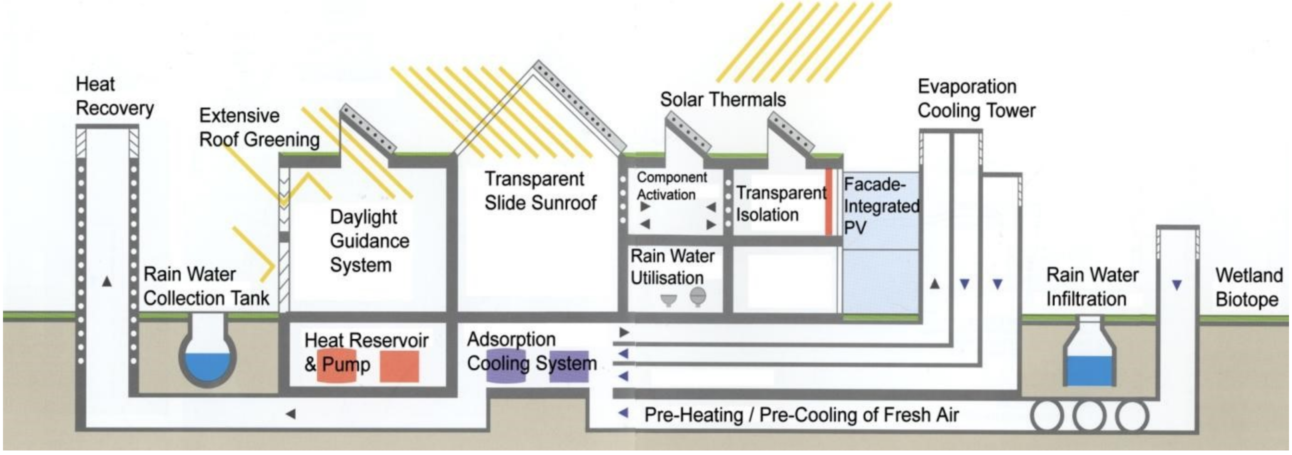

Figure 3. Overview of green building technologies at ECB

Besides the above-mentioned utilities, ECB features many more eco-friendly solutions in all buildings such as disconnectable sockets and connector strips to avoid 'standby mode' power losses in the offices and laboratories. Through the feedback of the energy monitoring systems, ECB continuously improves the energy efficiency of appliances and respective processes [8]

The procurement and the operation of our IT devices are focused on GreenIT solutions as well and include Thin Clients and, most importantly, virtual server technology. Furthermore, ECB includes certified and commonly known energy-efficiency labels like Blue Angel (the German Label "Blauer Engel") and Energy Star in all relevant procurement decisions for energy-consuming appliances.

4. The Role of Electric Mobility Towards Zero Emission

At the Environmental Campus Birkenfeld, some of the traffic-related emissions are significantly reduced by using the railway, as the university has a direct rail connection. From the University railway station Neubrücke/Nahe it is only 200 meters to the lecture hall. As a university located in a rural region, however, not all employees and students can reach the university by train or bus, so that a large part of the journeys is still made by car. Likewise, for a large part of business trips, the use of cars is unavoidable due to the lack of public transport connections.

In Germany, for example, about 20 percent of direct CO_2 emissions are caused by traffic, and about 95 percent of these are generated by road traffic. The switch from fossil-fuel engines to electric mobility can make a major contribution to reducing traffic-related emissions [8]. This is where a model project at the ECB comes in, funded by the national climate protection initiative of the Federal Republic of Germany, which aims to significantly improve the existing infrastructure for the use of electric mobility by 2021.

The Environmental Campus has already implemented an 'e-car strategy' with several e-cars and charging stations which has been further developed in 2018 by the research project "NEMO" which strives to implement zero-emissions mobility solutions for the ECB. The construction of a zero-emission mobility station, solar carports for ten carshare electric vehicles and the expansion of the charging infrastructure belong to the climate protection concept of the ECB. Furthermore, it is possible to extend "Zero Emission" to Scope 3 by 2050 by switching from fossil-fuelled combustion engines to electric mobility. Mobility thus plays a fundamental role in supporting and further developing the goal of the "Highly Efficient Zero-Emission University".

Students and employees can use electric vehicles via a car-sharing concept to travel to the university and for other individual mobility needs. Another objective is to organize the business trips of ECB staff and professors in a sustainable and climate-neutral manner and, in combination with the expansion of the charging infrastructure, to implement a landmark project on campus. Three conventional vehicles, which are currently used for employee business trips, will be replaced by purely electrically powered vehicles, and the necessary charging infrastructure, consisting of two fast-charging columns, two normal charging points and a battery storage unit, will be expanded so that the electric vehicles can be charged on the existing network. With regard to the expansion of the charging infrastructure, a battery storage facility, as well as two fast-charging columns and two normal charging points, are to be installed.

Battery storage with a capacity of 200 kWh and a (charging & discharging) capacity of 100 kVA is planned. The battery storage is indispensable for the electrical charging infrastructure on the environmental campus, as these load peaks intercept the electric cars during simultaneous charging processes, which cannot compensate for the grid load on the campus and is, therefore, an essential component of the measure. The battery storage is designed in such a way that the three new electric cars can be fully charged once a day on campus in the existing network without increasing the network load on campus.

This project is intended to stimulate the rapid establishment of electric mobility at the ECB and in the region through the exemplary function of the ECB as a public institution. Thus, the ECB can act as a multiplier in the region and for other universities implementing electric mobility solutions.

Furthermore, to encourage ‘cycling to work’, the relevant infrastructure such as parking places, shades, re-charging stations are provided. Additionally, electric bicycles are rented by the university and ECB has the free-of-charge charging stations for the e-bikes which can be used by students and staff alike. Student initiatives are also in place at ECB for repairing and servicing of bicycles and the university provides workshop facilities. As Birkenfeld and the surrounding region is very attractive for cycling and mountain biking ECB has extended its cycling infrastructure through bicycle paths and has connected the campus to the neighboring villages, cities, and to the Hunsrück-Hochwald national park.

5. Summary and Concluding Remarks

Universities have the responsibility to educate the future leaders of the world for a more sustainable future. They should implement a systematic approach towards sustainability including education, research, operations, transfer and governance. This is the reason why universities are often considered as living labs for sustainability [9]. According to the "Living Lab" model, the Environmental Campus is a practical laboratory for sustainability in which students analyze and optimize the installed technologies within the framework of teaching and research projects. The ECB's established zero-emission concept is continuously being further developed. Together with professors and research institutes, facility management develops and establishes new energy-saving solutions to optimize the operation of the university. Students are also involved in this improvement process through interdisciplinary projects.

The Travelling University (TU) is a specific type of the living lab at the ECB in which students from different disciplines can participate. This transdisciplinary seminar is organized in the form of a project and develops solutions for practical problems. The TU started in 1999, and since then this seminar has become a regular part of an interdisciplinary curriculum at the ECB. Owing to its reference and cross-linking to other projects held at the ECB with similar sustainable aims, the TU project was among others a part of the University of Applied Sciences’ contribution to the EXPO-2000 in Hannover, Germany. Since then this program was integrated into projects in Sweden, China, Poland, Turkey, Brazil, Canada, Serbia, Cap Verde, Mexico, Sri Lanka and Morocco. Together with partners from municipalities, ministries, companies and many other actors students learn how to plan and to implement sustainable solutions for real-world problems. The students have to collect data, discuss with stakeholders, develop technical solutions to solve the problems and last but not least they develop a business plan that should underline the economic feasibility of their idea. The Travelling University represents the best practice of project-based learning and gives students the opportunity to put their acquired knowledge into practice in real time [10]. The TU has already been used in many cooperation projects to establish the idea of the Zero Emission Campus in partner universities of the ECB. Concepts have already been developed with universities in Marocco, Brazil, China and Sri Lanka and in 2019 a TU is planned for the transfer of the Vison Zero Emission in Oman.

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Calculation and Registration of the Carbon Footprint of the Miguel Hernandez of Elche University (Spain)

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Abstract. The Government of Spain approved in 2014 the Royal Decree 163/2014, which creates the Carbon Footprint registry. This system aims to fight against climate change by promoting the calculation and reduction of Carbon Footprint by the Spanish organizations. The main objective of the study is to verify the tool proposed by the Government of Spain and analyze the results obtained and their evolution in a higher education institution such as the Miguel Hernandez University of Elche. In this work, it has been shown the results obtained for 7 years (2011-2017) for the Carbon Footprint of University Miguel Hernandez. The data obtained from the Carbon Footprint per person of an organization allows obtaining an environmental indicator directly correlated with its environmental impact and serves as a frame of reference for making decisions aimed at reducing greenhouse gases emissions.

Keywords: carbon footprint, climate change, greenhouse gases, university

1. Introduction

In 1992 the United Nations Framework Convention on Climate Change (UNFCCC) defined climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" [1].

Afterward, in 2014, the Intergovernmental Panel on Climate Change concluded that the human influence on climate is evident and it is growing due to the increase of greenhouse gas (GHG) emissions [2].

Furthermore, the EU has adopted a directive to reach a decrease of 30% of total CO_2 emissions in the domestic sector until 2030. In this sense, some public organizations as universities, which should be an example to follow, are currently reporting their emission voluntarily in order to contribute to a greater knowledge of global emissions and their effects on climate change.

The Carbon Footprint of an organization is the sum of the GHGs emitted due to its activity. An activity can have several sources of GHG, classified in three scopes (Fig. 1):

- Scope 1: direct emissions.
- Scope 2: indirect emissions for electricity consumption.
- Scope 3: other indirect emissions.

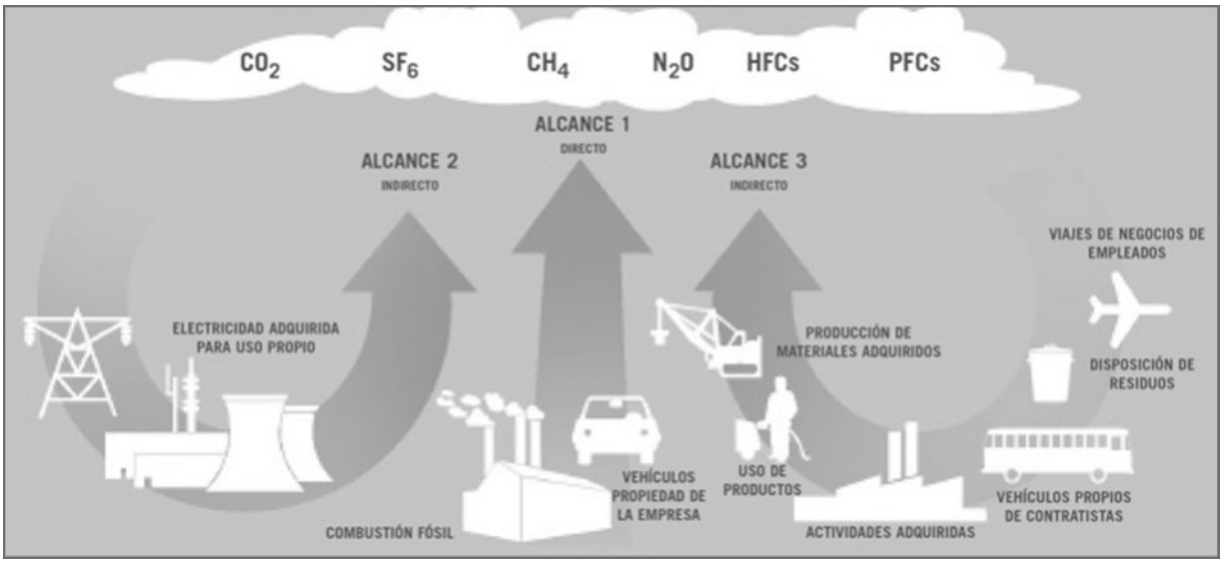

Figure 1. GHG emissions by scope. (*source: GHG Protocol*)

The HC is expressed as the amount of CO_2 equivalent, a universal unit of measurement that indicates the global warming potential (GWP) of each one of the different GHGs (CO2, CH4, N2O, HFCs, etc.).

The Government of Spain, through the Spanish Office of Climate Change, approved in 2014 a Carbon Footprint calculation and registration system [3]. This administrative and public registry has three sections:

a) A section of Carbon Footprint calculation and commitments to reduce GHG emissions.

b) A CO_2 absorption projects section.

c) A Carbon Footprint compensation section.

This study focuses on the first one, which aims to fight against climate change by promoting the calculation and reduction of the Carbon Footprint by organizations.

The entities that voluntarily participate have to calculate their Carbon Footprint and report it. Afterward the Government issues a seal certifying their inclusion in the registry and the level of commitment reached (calculation, reduction and compensation).

2. Methodology

Miguel Hernandez of Elche University, a public university located in the southeastern of Spain, was chosen for the study. It was established in 1996 and operates on four different campuses. Its campuses extend over almost 95 hectares, there are 75 university buildings and has 25,247 students enrolled.

For enrollment in the Carbon Footprint calculation and reduction section, an internationally recognized calculation methodology, like UNE-ISO 14064, GHG Protocol, PAS 2050, etc., is required. So, for the study, the GHG Protocol [4] was chosen. However, the emission factors must be those provided by the Government.

As the base year, 2011 was established, and it was decided to measure the Carbon Footprint associated with scope 1 and scope 2.

Over 7 years, until 2017, consumption data were compiled for each GHG emission source, like natural gas, propane gas, gasoline and gases of the air conditioning system. Also, the electricity consumption data was compiled for scope 2.

Using the calculation tool and the emission factors provided by the Government, the Carbon Footprint of the Miguel Hernández University was calculated for each year, and the results reported to the Spanish Office of Climate Change.

3. Results

As a result, the measures of the Carbon Footprint of the Miguel Hernández of Elche University between 2011 and 2017 have been obtained, with a breakdown by the types of scope or sources of emission (Fig. 2).

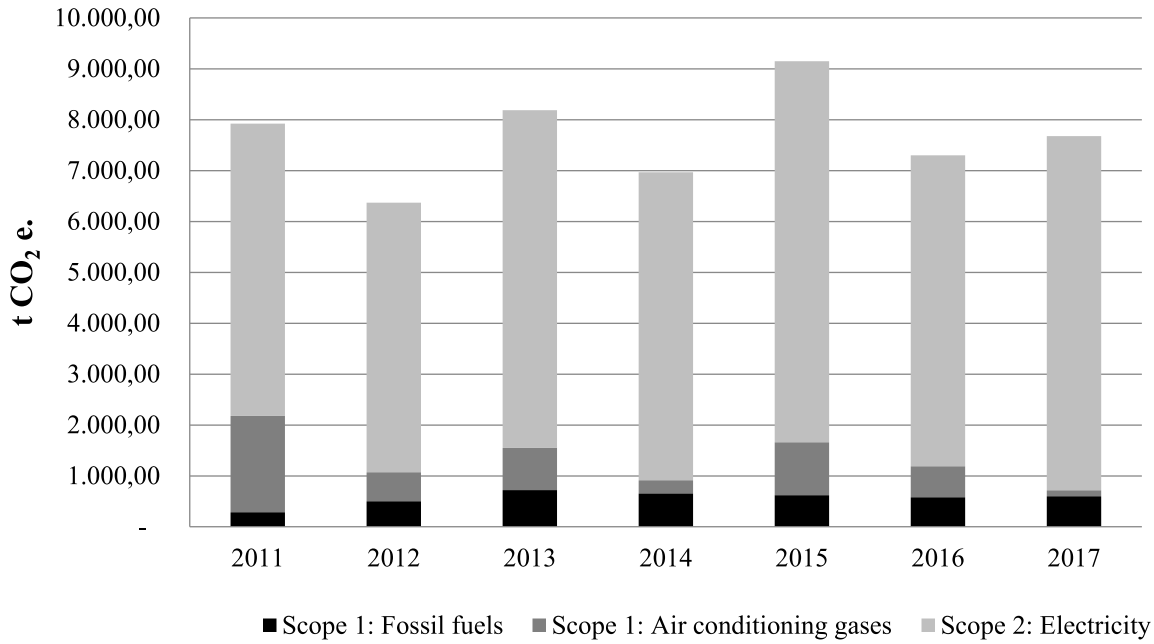

Figure 2. Evolution of the Carbon Footprint of the Miguel Hernández of Elche University by sources of GHG.

We can observe that the GHG emissions data from electricity consumption are not correlated with the amounts of electricity consumed. It is correlated with the emission factor associated with the source of that electricity (Fig. 3). For example, in 2017 the electricity consumption was reduced by 6%, but due to an increase in the emission factor of the energy consumed (kg CO_2 / kWh), the CO_2 equivalent emissions were increased by 14%.

It has been also observed a decrease of Carbon Footprint in the last year studied (2017), especially for the emissions associated with the air conditioning gasses. This is due to the implementation of a hard control of the protocols of air conditions functioning, to avoid gas escape to the atmosphere.

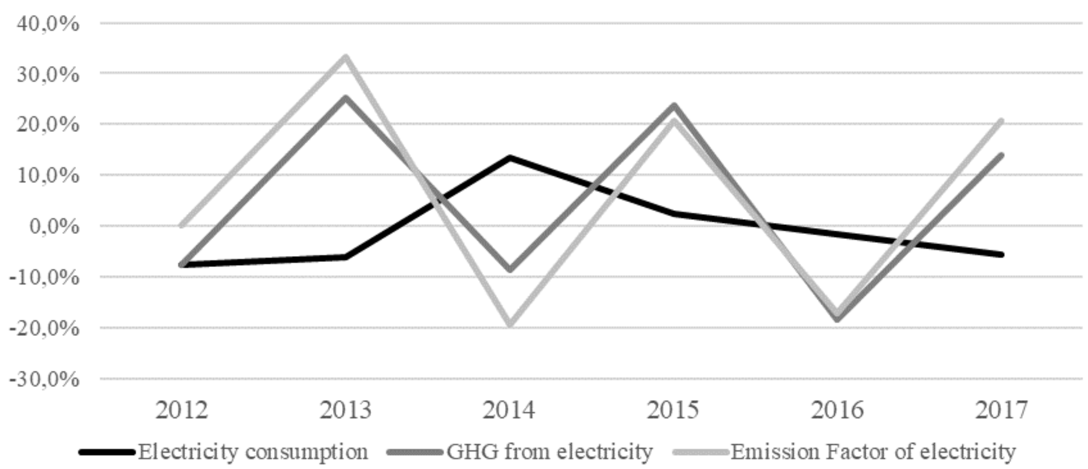

Figure 3. Variation with respect to the previous year of GHG emissions from electricity consumption, electricity consumption and the associated emission factor.

Finally, as a result of the inclusion of the data in the Carbon Footprint Registry of the Ministry, the corresponding certificate is obtained (Fig. 4).

Figure 4. One of the certificates granted to the UMH by the Spanish Government.

4. Conclusions

The major contribution of Carbon Footprint in the UMH are the emissions associated with electrical consumption. This is due to the type of energy used and the emission factor associated.
It is recommended to obtain the electrical energy from sources with a lower emission factor or even from renewable energies (emission factor equal to zero [5]), which would imply a decrease of 84% of the Carbon Footprint.

The data obtained from the Carbon Footprint per person of an organization allows obtaining an environmental indicator directly correlated with its environmental impact. Also, it serves as a frame of reference for making decisions aimed at reducing GHG emissions.

Including an organization in the Government Registry, allows external recognition as an environmentally responsible company.

Carbon Footprint can be used as a tool to raise environmental awareness.

The creation of the registry will contribute to the reduction at the national level of greenhouse gas emissions, and facilitate the fulfillment of the international commitments assumed by Spain in the matter of climate change.

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The 5th International Workshop on UI GreenMetric
Cork, Ireland, 14-16 April 2019

Exceeding the 2020 Target of 33% Energy Efficiency: Dublin City University

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Abstract. Across Dublin City University's five campuses there is over 500,000 square meters of lecture halls, teaching and research laboratories and offices across 75 buildings dating from 1680 – 2018 within a total area of 128 acres. Providing the necessary infrastructure to enable the university to deliver its services while reducing the overall energy consumption and carbon footprint of the organization has significant challenges. DCU has met and exceeded these challenges making a 35.3% energy performance improvement in 2017 against a 2010 baseline. However further campus development increases the challenge to achieve absolute energy and carbon emission reductions.

Keywords: carbon footprint, energy efficiency, sustainable campus

1. Introduction

In 2012, the European Union introduced Energy Efficiency legislation (*Energy Efficiency Directive (EED) 2012/27/EU*) requiring the Member States to intensify the implementation of energy efficiency measures. In addition, the *2030 Climate and Energy Framework*[1] includes EU-wide targets that include at least 40% cuts in greenhouse gas emissions (from 1990 levels) along with at least 32% share for renewable energy and an improvement in energy efficiency of at least 32.5%, all required by 2030. These measures combined with a transparent and dynamic governance process that can revise targets will help the EU to deliver on its objectives to move towards a low-carbon economy and implement its commitments under the Paris Agreement.

As a member of the EU Ireland has transposed this into national legislation (SI 426 (2014)) and as part of this established the *National Energy Efficiency Action Plan (NEEAP)*[2]. Under the NEEAP, public bodies, including universities, are required to lead the way, with the plan stating that '*The public sector will improve its energy efficiency by 33% and will be seen to lead by example – showing all sectors what is possible through strong, committed action'*. In addition, the Irish Government implemented a *Public Sector Energy Efficiency Strategy (2017)* to support the intensification of efforts needed to meet the required targets. There is increased investment in the capital allocation for energy efficient support through the Department of Communications, Climate Action and Environment (DCCAE) and the Sustainable Energy Authority of Ireland (SEAI). Fig. 1 below demonstrates the level of engagement across the public sector following the initial call to four hundred public sector bodies in 2014 to report on their energy efficiency measures.

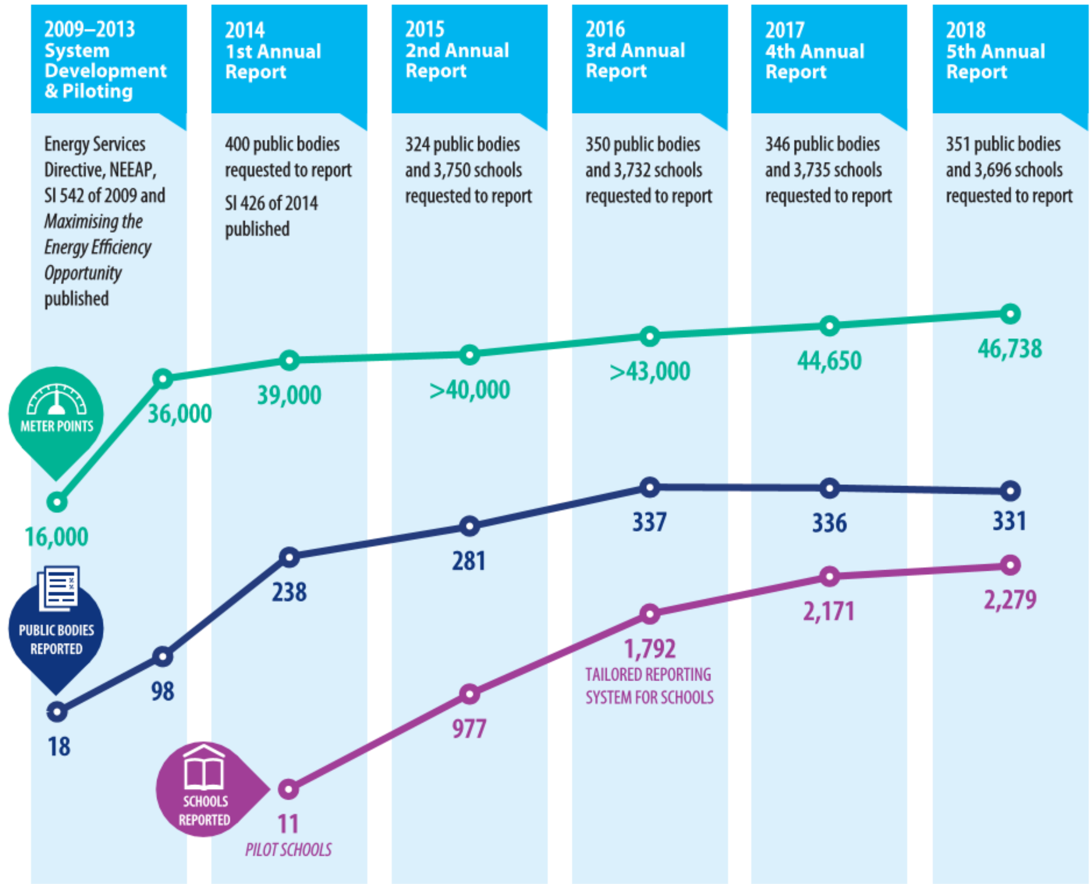

Figure 1. Engagement levels by Public Bodies and Schools in the Public Sector Energy Efficiency monitoring and reporting programme (SEAI, Annual Report 2018 on Public Sector Energy Efficiency Performance)

Dublin City University, along with 92% of the education sector has engaged in this monitoring and reporting activities with the education sector (excluding schools and ETB's) accounting for 8% of the total energy consumption. The impact of the *Public Sector Energy Efficiency Strategy (2017)* has been significant. As reported in the SEAI's Annual Report 2018 on Public Sector Energy Efficiency Performance there has been a 24% improvement in energy efficiency across the entire public sector with a target of 33% by 2020. The education sector significantly exceeded the overall average with an improved level of 31%. DCU has in 2017 exceeded the 2020 target achieving 35.3% improvement in energy efficiency.

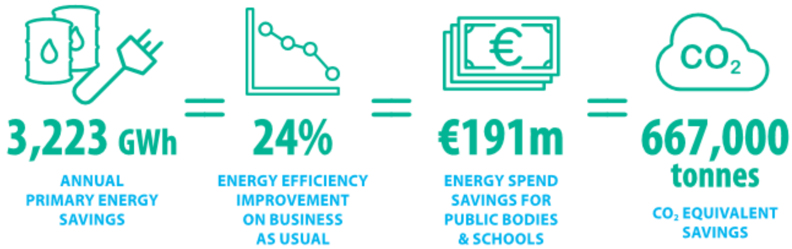

Figure 2. Demonstrated savings in 2017 across public sector bodies (SEAI, Annual Report 2018 on Public Sector Energy Efficiency Performance)

2. Energy Efficient Measures at DCU

Dublin City University (DCU) is a young, dynamic and ambitious university with a distinctive mission to transform lives and societies through education, research and innovation. Since admitting its first students in 1980, DCU has grown in both student numbers and size and is now a multi-campus environment located just north of Dublin city. With over 17,000 students and 2,500 staff, DCU delivers a comprehensive range of over 200 programmes across its five faculties– Humanities and Social Sciences, Science and Health, Engineering and Computing, DCU Business School and the DCU Institute of Education

DCUs vision is to be a globally significant *University of Transformation and Enterprise* that is renowned for among other things its commitment to sustainability. This is clearly articulated in one of the nine strategic goals for the University in its 2017 – 2022 Strategic Plan – Strategic Goal 8: Place sustainability at the core of the university[3].

2.1. Operational

In 2018 the overall DCU footprint is 518,000 m^2 across five campus locations all within a 2 km radius. There are over 80 individual buildings ranging in construction date from the 1600s to 2018 providing approx 250,000m^2 of office, lecture, research, accommodation and social spaces.

The five DCU campuses are shown in the figure below and include:

- Glasnevin Campus, Collins Avenue, 170,000m2 on 50 acres
- St Patricks Campus, Drumcondra, 40,000m2 on 22 acres
- All Hallows Campus, Drumcondra, 12,000m2 on 16 acres
- DCU Sports Campus, Glasnevin, 1,500m2 on 30 acres
- DCU Alpha - Innovation Campus, Glasnevin, 18,000m2 on 9 acres
- Elmhurst lands, Griffith Avenue, 10 acres undeveloped

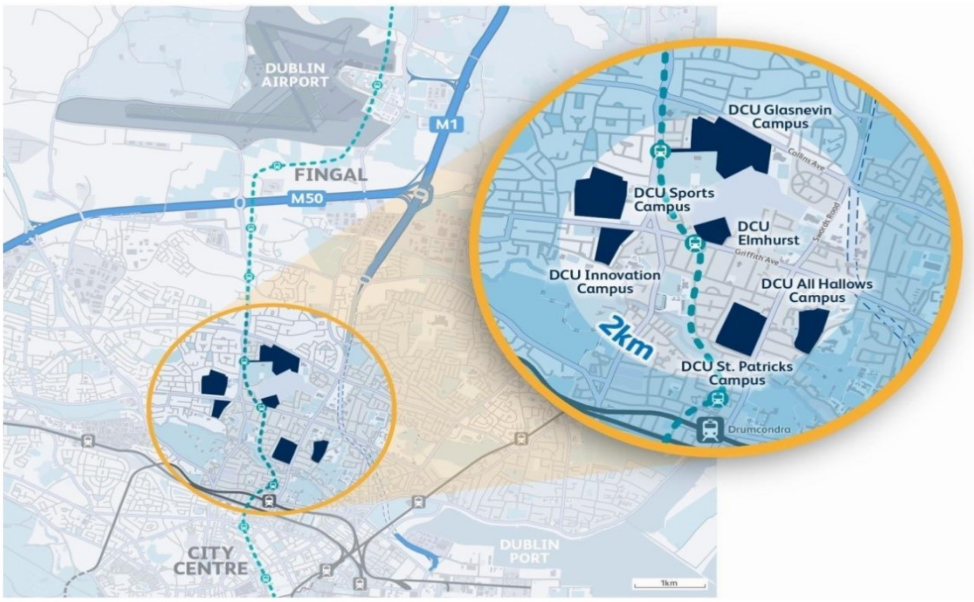

Figure 3. Dublin City University Campuses

Over the past 15 years, DCU has aimed to demonstrate on all campuses leading practice in the energy efficient operations and reduced consumption through technology implementation and behavioral change. In addition, we aim to translate this knowledge and understanding to our campus users as well as our local community to enable and support broader impact. Fig. 4 below identified some of the highlights on DCU's path to an energy efficient university.

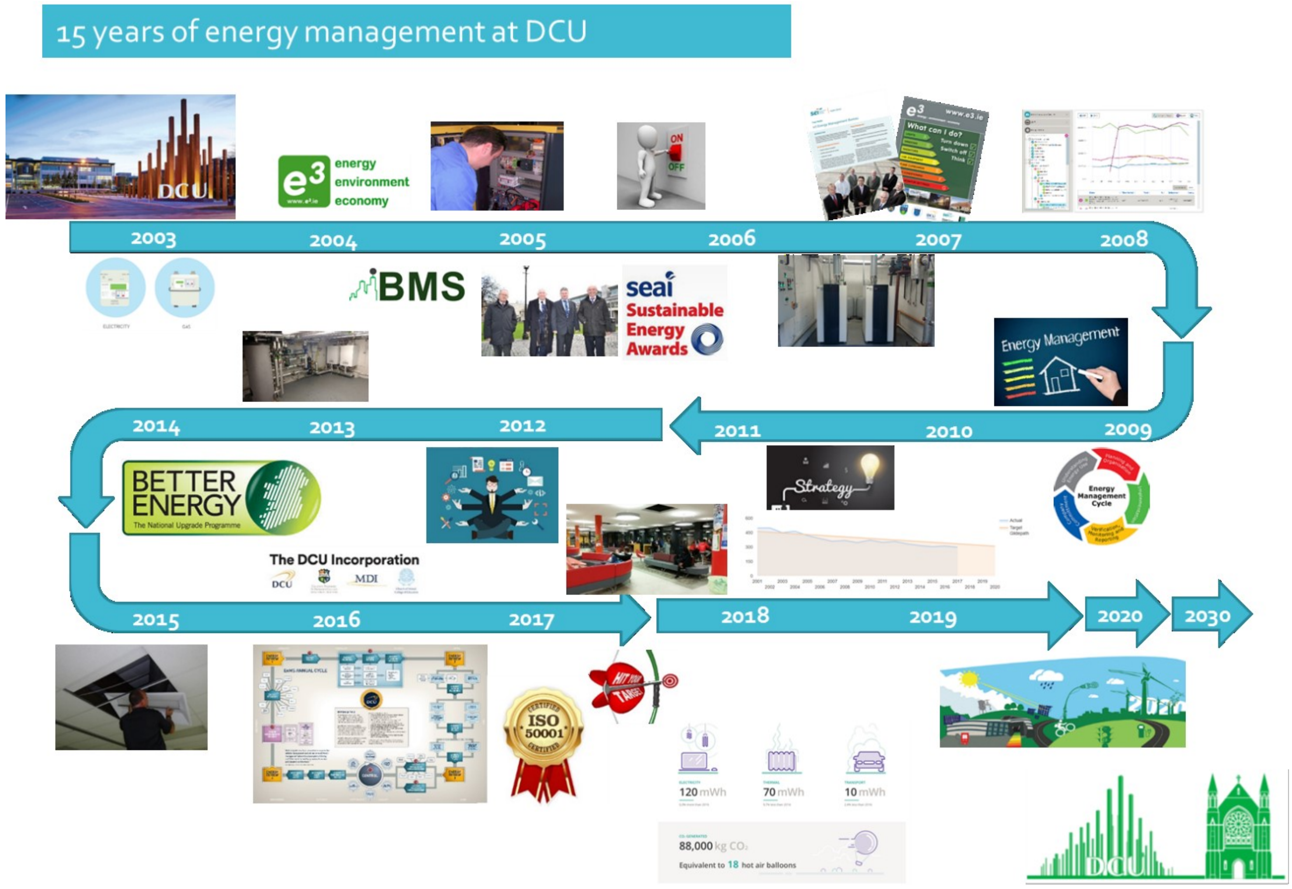

Figure 4. Energy management actions at DCU over the past 15 years

Over the years the DCU Estates team has undertaken annual reviews, identifying potential infrastructural replacements and upgrades to existing systems across all campuses. Working with several stakeholders including the Sustainable Energy Authority of Ireland (under their *Better Energy Communities Programme*) and local authorities, specific projects are prioritized on potential impact and availability of funding. Initially many of these projects targeted the *low hanging fruit* i.e. high impact and lower cost. As can be seen from Fig. 5 significant progress has been made with DCU exceeding the 2020 target of 33% in 2017.

However, this is but an interim target and DCU's ultimate ambition is to be a low carbon or even possibly a net positive campus with less absolute CO2 emitted than sequestered. DCU, therefore, continued to review all activities on campus and seeks to identify practices and technologies that can be implemented within the living lab environment of the university demonstrating the potential impact for broader deployment.

Figure 5. DCU's energy performance indicator 2017 under the SEAI monitoring and reporting scheme

3. DCU Sustainability Office

Established in 2012, the DCU Sustainability Office aims to embed an ethos of sustainability across the institution. It is a cross-campus initiative working with internal and external stakeholder to develop an understanding of sustainability and demonstrate a commitment to reducing the environmental impact through action projects. Working with DCU Estates Office, lecturing and research staff and students the office provides support in the development and implementation of these projects. Below are two examples of open engagement actions that educate and support behavioral change practices both within the university and the local societal and business communities.

3.1. Green campus

In March 2012 DCU joined the Green Campus Programme under the Federation of Environmental Education (FEE) Green Campus Programme [4] operated by An Taisce in Ireland.

Over two year the DCU Sustainability Office along with the cross-campus Green Committee developed and implemented numerous action projects across the themes – Energy, Water, Waste, Biodiversity, Transport and Communications. Some examples of energy projects include *Last Out Light Out*, *Students Achieving Valuable Energy Savings,* and *Smarter Energy Use in Student Hub.* In 2014 DCU was awarded its first Green Campus Certification (Fig. 6). The Green Campus programme at DCU had undertaken many engaging and compelling projects working with a broad range of stakeholders that have focused on developing an understanding of the limited resources available and identification of sustainable solutions.

A primary focus of the Green Campus programme is educating and informing all members of the DCU Community, all staff (academic, research, administrative and technical), all students (undergraduate and postgraduate) along with societal groups and enterprise partners who are linked to DCU. The operational projects have of course a very significant impact on the consumption levels within the university however to translate this impact to a global scale behavioral change is needed across the board. DCU Sustainability Office continues its ongoing engagement under the Green Campus Programme and has maintained Green Campus Status for DCU.

Figure 6. DCU Green Campus Certificate re-awarded 2017/2018

3.2. Sustainable energy communities

In 2018/2019 the DCU Sustainability Office established, with support from the Sustainable Energy Authority of Ireland, a *Sustainable Energy Community* at DCU. The focus of the initiative in phase one is on staff at DCU and associated companies on our campuses such as Siemens (DCU Alpha). Using *Home Energy Kits,* an energy map of individuals' homes will be generated, collated and grouped into categories. Support programmes will then be implemented to enable individuals to access the broad range of energy efficiency grants available to improve the energy efficiency of their homes. Phase two includes the rolling out of this scheme to the local communities surrounding the DCU campuses.

4. Conclusions

Dublin City University has made significant progress in the implementation of energy efficiency actions across all campuses. The combined efforts of the DCU Estates team and the DCU Sustainability office enables a broader more holistic approach directly addressing the technological solutions as well as supporting and enabling behavioral change. The investment in time and resources in formalizing the energy management system and attaining the ISO 500001 accreditation for this system will support the future efforts that are required to continue on a path to a low carbon/net positive campus. There are many challenges still to be addressed both technical and behavioral but with DCU Estates and DCU Sustainability working together the objective of a new positive campus is achievable.

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Improving Energy Efficiency in Government Agencies' Project: Srinakharinwirot University Ongkharak

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Abstract. Srinakharinwirot University Ongkharak in Nakhon Nayok, Thailand, had received financial support from The Energy Conservation Promotion Fund (ENCON Fund) from the Department of Alternative Energy Development and Efficiency (DEDE) under the Ministry of Energy for the fiscal year 2017 to carry out an energy efficiency improvement project intended for government agencies. The project aimed to reduce energy consumption in the university as well as to increase awareness of energy efficiency and sustainability to the public. In this study, the lighting and air-conditioning systems were selected for replacement and retrofitting as they are considered as high-impact areas. LEDs, and split-type inverter and VRF air-conditioning systems in several buildings of Srinakharinwirot University Ongkharak were replaced. The results show that the estimated saving of electrical energy is 5,112,920 kWh per year, which in turn is equal to an annual saving of 20,451,680 baht per year (657,900 USD per year) from the investment funding of 46,060,455 baht (1,481,696 USD). This study is one of a few ongoing projects via cooperation between government agencies to create a sustainable society.

Keywords: Air-conditioning, electrical energy saving, energy efficiency,LEDs, sustainability,

1. Introduction

the Srinakharinwirot University has participated in the UI GreenMetric Campaign for the first time in October 2018 submission. This sustainability development is a key part of a long-term development plan of the university to involve itself into the new era of education and align well with the university's vision. The working team of the Green University Project consists of staffs and faculties from various disciplines such as the Dean Office, the Academic Affairs office, Faculty of Engineering, Faculty of Environmental Culture and Ecotourism, and etc. to address sustainability issues in five different categories [1].

This project is a showcase of the synergy between the government agency and educational institution of an effort to develop more sustainable campus. The execution of this project can be a benchmark for similar sustainability projects in the future.

2. Background

2.1. Energy conservation promotion fund

In response to agreement reached by Asia-Pacific Economic Cooperation (APEC) leaders in 2007, Thailand has developed a national policy framework and guidelines called 'The 20-Year Energy Efficiency Development Plan (2011-2030)', EEDP, with a goal to reduce energy intensity by 25% in 2030, compared with that in 2005 [2]. This is equivalent to a reduction of energy consumption by approximately 20% in 2030, or about 30,000 thousand tons of crude oil equivalent (ktoe). Both mandatory measures, via rules and regulations, and supportive/promotional measures have been implemented.

A way to achieve 'Energy Conservation' in EEDP is through energy efficiency improvement, i.e. doing the same activities using lower energy consumption for, such as lighting, hot water production, air-conditioning systems, transportation, or manufacturing. EEDP reported electricity consumption of different commercial building types in Table 1, and indicated education institutions as 'high-potential' in terms of energy saving.

Table 1. Electricity consumption in large commercial buildings (data from 2007)

Type of Building	Electricity Consumption (GWh)
Office	7,139
Hotel	2,339
Educational institution	1,102
Medical center	1,172
Retail & wholesale business facility	2,351

As a part of this effort, in 2017, Srinakharinwirot University received financial support from the Department of Alternative Energy Development and Efficiency (DEDE) under the Ministry of Energy to improve energy efficiency of its Ongkharak campus. Since this is one of the first large-scale sustainability and energy conservation projects in the organization, the working committee selected to work on parts that will give the most impact. That is to reducing energy consumption from air-conditioning and lighting systems which are heavily used in the institution as well as typical educational buildings [3].

2.2. Srinakharinwirot University Ongkharak

Srinakharinwirot University (SWU) has nineteen faculties spread across two campuses. The older social science, science, and educational faculties are at the Prasarnmit Campus in downtown Bangkok. The newer health science faculties, including a medical school, plus the Faculty of Engineering, are at the Ongkharak Campus, 70 km NE of Bangkok.

The energy efficiency improvement campaign started in August 2017 and completed in September 2018. The project composes of four main tasks in sequence.

1) Desktop study of potential high-impact areas of improvement
2) Site survey and technical preparation (including measurement of baseline energy consumption)
3) Installation of new equipment for lighting and air-conditioning
4) Test run and measurement of energy consumption after improvement

The desktop study took several factors into consideration, such as load histories, time and duration of use, efficiency of current equipment, and number of occupancies, in order to select appropriate sites for energy efficiency improvement. Following by a site survey to evaluate any potential issues regarding removal and installation of equipment, and safety, selected sites are as shown in Table 2.

Figure 1. Srinakharinwirot University (SWU): Ongkharak Campus

Table 2. Selected sites for energy efficiency improvement

Administration Building	Main library	Faculty of Pharmacy
Faculty of Nursing	Students Dormitory	Faculty of Engineering
Student Activities and Service Building	Fundamental Education Building	Faculty of Health Science

3. Detail of Activities

3.1. Technical specifications

LED Lighting

Lighting accounts for about 18 percent of energy usage in large commercial buildings, seconded to the energy use for the air-conditioning system. New lighting technologies, such as light emitting diodes (LEDs) are many times more efficient than traditional technologies such as fluorescent lamps or incandescent bulbs which are typically used in Thailand. Not only that switching to LEDs can result in direct energy consumption reduction, it can also indirectly decrease cooling loads of the air-conditioning system as LEDs dissipate lower amount of heat waste through convection and radiation to the room.

Table 3 shows original lightning equipment and the proposed LEDs lighting system that were designed to meet the requirements of usage, such as illuminance and visual ergonomics.

Air-Conditioning System

Traditional (non-inverter) split-type air conditioning unit is the most commonly used for residential and some commercial buildings in Thailand. Due to technical reasons and rules, legacy air-conditioning systems used in the buildings of most public educational institutions are split-type, which is known for flexibility of use but not in terms of energy efficiency. In the non-inverter split-type air conditioning unit, the compressor works in on/off mode, i.e. compressor starts working at full power when room temperature goes above the set value and turns off when the temperature has come down below the desired level. This start/stop intermittent process requires greater power than running the compressor continuously.

In contrast, the compressor in the inverter system runs continuously with its speed adjusted to the required cooling load. This provides higher energy efficiency and more precise temperature control (typically within 0.5 deg C of the desired level) which increase thermal comfort of occupants. Similarly, the variable refrigerant flow (VRF) system uses an inverter to control speed of the compressor. The VRF system typically consists of an air-cooled outdoor condenser unit and a group of refrigerant-based indoor fan coil units, with a control system that can adjust the amount of refrigerant flowing to each of these fan coil units depending on required cooling load in each zone. This type of system provides good energy efficiency and installation flexibility for tight spaces, making it suitable for this project as modifications to structures of the building is not desirable. Table 4 shows the proposed air-conditioning systems that were designed to meet the requirements of usage, such as cooling loads and thermal comfort of occupants.

Table 3. LED replacement specifications

Before improvement		After improvement		Quantity
Type	Total watt	Type	Total watt	(Unit)
Compact Fluorescent	28	LED Tube (60 cm.)	8	2,545
Compact Fluorescent	11	LED A60 E27 Bulb	5	682
Fluorescent lamps T8	28, 46	LED Tube (120 cm.)	8, 14	26,698
Circular Fluorescent Lamp	42	LED Circular Tube	15	511

Table 4. Air-conditioning system specifications

Type	Cooling Capacity	Quantity (Unit)
Split type (inverter)	12,000 (Btu/hr)	14
Split type (inverter)	18,000 (Btu/hr)	40
Split type (inverter)	24,000 (Btu/hr)	85
Split type (inverter)	30,000 (Btu/hr)	4
Split type (inverter)	36,000 (Btu/hr)	115
Split type (inverter)	40,000 (Btu/hr)	22
Variable Refrigerant Flow (VRF)	251 (ton)	100

3.2. System tests and assessment of energy consumption reduction

Illuminance measurement of LEDs system

It is important that the illuminance measurement of the newly installed LEDs System remains within the standard [4] and also within ±10% when compared to before the replacement. LX-50 digital illuminance meter with an accuracy of ±5% rdg + 2 dgt was used and placed at the same level with the desk (75 cm from the floor). The measurement was set to take place in actual daily use setting and the readings from the meter must exclude impact from outdoor light. Fig. 2 and 3 show a schematic of the illuminance measurement and the field test, respectively. Test results show that all measurement was within the standard and the allowable deviation from before the replacement.

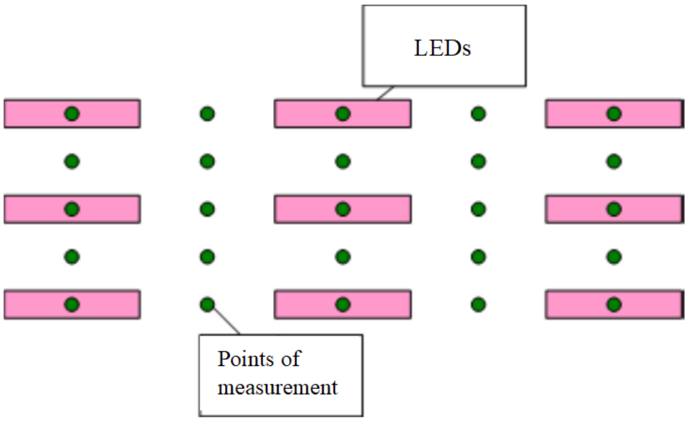

Figure 2. Layout of illuminance measurement

Figure 3. Field illuminance measurement

Energy conservation from the retrofit of LEDs

Energy consumption before and after the retrofitting campaign was measured using Hioki 3286-20 clamp-on power meter, with an accuracy of ±5%. It was used to measure current, voltage, power factor, and power. The measurement took place at the control switch or directly at the LEDs every two hours throughout the day. The total number of operating hours per year was calculated from actual office hours (8 hours/day) and days of operation (330 days/year). The measured energy usage in kWh before and after the retrofit was used to calculate total energy saving per year, as shown in Equation 1.

$$\text{Energy Saving} = (\text{kWh/yr})_{\text{baseline}} - (\text{kWh/yr})_{\text{retrofit}} \tag{1}$$

Energy conservation from the retrofit of air-conditioning system

A similar method used for LEDs was also applied to the energy consumption measurement of the air-conditioning system. Various parameters used to determine *Energy Efficiency Ratio (EER)*, given in Equation 2, of the split-type and VRF systems was recorded for both before and after the retrofitting campaign.

$$\text{EER} = \text{Cooling Capacity (Btu/hr)} / \text{Input Power (kW)} \quad (2)$$

Field cooling capacity is given by:

$$\text{Cooling Capacity} = 4.5 \times \text{Flowrate (CFM)} \times (h_i - h_o) \quad (3)$$

where h_i : enthalpy at the inlet (Btu/lb)

h_o : enthalpy at the outlet (Btu/lb)

Flowrate can be determined from the air velocity and area of the outlet, while the change of enthalpy can be determined from temperature and humidity of cool air at the inlet and outlet of the fan coil unit. In turn, energy usage can be calculated using EER from Equation 2, estimated cooling loads, and a total number of hours of use per year, as shown in Equation 4.

$$\text{Energy usage (kWh/yr)} = (1/\text{EER}) \times \text{Estimated load (Btu)} \times \text{Hours of usage (hr/year)} \quad (4)$$

Figure 4. Air flow rate measurement and VRF condensing unit installation

Summary of results

Table 5 presents a summary of the estimated energy saving per year as a result of retrofitting activities of selected LEDs and air-conditioning systems. Given the typical price of electricity in Thailand at around 4 baht/kWh (0.13 USD/kWh), the annual saving from this campaign will be approximately 20,451,680 baht/year (657,900 USD/yr) from the investment funding of 46,060,455 baht (1,481,696 USD).

Table 5. Comparison of energy consumption

Equipment	Energy Consumption (kWh/yr)		
	Before retrofit	After retrofit	Saving
LEDs (All)	3,394,170	1,047,640	2,346,530
Air-con (All)	3,588,510	822,120	2,766,390
Total	6,982,680	1,869,760	5,112,920

4. Concluding Remarks

Srinakharinwirot University has started 'SWU Green University' initiative in late 2017. Since then various activities and projects have been implemented around its Prasarnmit and Ongkharak campuses [5]. Examples are reducing usage of plastic bags and straws, electric-powered public transportation, increasing the use of solar-rooftop and renewable energy. The energy efficiency improvement project is the first large-scale attempt to decrease energy consumption and greenhouse gas emission of the Ongkharak campus with cooperation from the Department of Alternative Energy Development and Efficiency (DEDE) under Thailand's Ministry of Energy. Knowledge and technical expertise shared between the university and other government agencies have led to successful planning and execution of the project, which results in significant saving in energy consumption, paving a way to long-term sustainability of the campus.

The next phase of the project is to achieve further reduction of energy consumption by using 'Building Energy Management' techniques such as occupancy sensors, timers, scheduling, and machine learning. These sensors and control network will lead to building automation that allows more refined temperature and lighting control to the level of individual comfort and maximum energy saving.

Acknowledgments

The authors would like to acknowledge support from the Department of Alternative Energy Development and Efficiency (DEDE) under Thailand's Ministry of Energy. Additionally, staffs and faculties on the SWU Green University project at Srinakharinwirot University are greatly appreciated.

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The 5th International Workshop on UI GreenMetric
Cork, Ireland, 14-16 April 2019

Buying Green at Universities: A Handbook on Green Public Procurement at the University of Valladolid (Spain)

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Abstract. Green Public Procurement (GPP) is a process where public authorities seek to source goods, services or works with a reduced environmental impact. Public universities, as a part of the Public Sector, have a responsibility to promote green procurement, in order to support the UN Sustainable Development Goals. To strengthen the response to the threat of climate change, the University of Valladolid (UVa) developed in 2007 a *Handbook on Green Public Procurement*. By producing and disseminating this Handbook, we sought to encourage the purchase and contracting of products or services that are more respectful with the environment, as well as promoting good consumer practices. It is a document addressed to the university community that includes practical tips for responsible consumption, and also contains information on suppliers of ecological products that could supply the University. In recent years there have been advances in this area, as well as important legislative changes. The Public Procurement Law, approved 2017, transposes 2014 European Public Procurement Directives into Spanish legislation including new environmental obligations. This paper explains how the UVa is updating its 2007 Handbook and outlines the possibilities to pursue GPP under the 2014 Procurement Directives. Buying green is our main objective.

Keywords: Environmental criteria, green public procurement, public universities, tendering

1. Introduction

Green Public Procurement (GPP) is a process where public authorities seek to source goods, services or works with a reduced environmental impact. Our public universities, as a part of the Public Sector, have a responsibility to promote green procurement, in order to support the UN Sustainable Development Goals.

To strengthen the global response to the threat of climate change, the University of Valladolid (UVa) developed in 2007 a *Handbook on Green Public Procurement*. By producing and disseminating this Handbook, we sought to encourage the purchase and contracting of products or services that are more respectful of the environment at university level, as well as promoting good consumer practices. It is a document addressed to the university community that includes practical tips for responsible consumption, and also contains information on suppliers of ecological products that could supply the University.

In recent years there have been advances in this area, as well as important legislative changes. The Public Procurement Law (PPL), approved on 8 November 2017, transposes European public procurement directives into Spanish legislation, in particular Directive 2014/24/EU, on public procurement; as well as Directive 2014/23/EU, on the award of concession contracts. The main novelties of the new law evolve around the incorporation of the criteria for best price-quality value, social and environmental obligations.

This paper explains how the UVa is updating its *2007 Handbook* and outlines the possibilities to pursue GPP under the 2014 Procurement Directives and better develop the use of environmental criteria.

2. Buying Green at Universities: The Legal Framework

2.1. The European union's environmental policy: boosting energy efficiency through public procurement

European law has been encouraging public procurement as a means of environmental protection in response to the principle of integration of the environment into other European policies, laid down in Article 35 of the EU Charter of Fundamental Rights: "A high level of environmental protection and the improvement of the quality of the environment must be integrated into the policies of the Union and ensured in accordance with the principle of sustainable development".

One of the objectives of EU environmental policy is to encourage all types of organizations to use environmental management systems and reduce their environmental impacts with the aim of meeting climate change and energy commitments [1]. With a time horizon of 2020, these commitments are structured around three targets ("20-20-20" objective): (i) to reduce global greenhouse gas emissions by at least 20% in comparison to 1990 levels; (ii) to increase energy efficiency by 20%; and (iii) to achieve a 20% share of renewable energies in final energy consumption [2]. To implement these targets the EU introduced a set of policies in 2009, known as the "Climate and Energy Package", which included four main parts: a reviewed Directive on emissions trading (ETS Directive), the Effort-Sharing Decision (ESD), the Renewable Energy Directive (RED), and a Directive on carbon capture and storage (CCS Directive) [3].

In this sense, public procurement can be a powerful instrument for achieving energy efficiency and energy saving objectives in relation to environmental protection policy, as long as it directs public expenditure towards energy-efficient products, modes of transport, buildings, works and services. This has also been understood in EU sector-specific legislation, since public bodies subject to the Public Procurement Directives are already obliged, for example, to take energy efficiency criteria into account when purchasing their vehicles [4] or office equipment [5]. This obligation will also apply in the near future to new buildings occupied or owned by public authorities, as from 2019 they will have to achieve "almost zero energy consumption" [6]. In addition, Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency refers to the exemplary role to be played by the public sector as regards the purchase of certain products and services and the purchase and rental of buildings [7].

In line with these recommendations and mandates, the 2014 Procurement Directives [8] enable public authorities to take environmental considerations into account. The Directives incorporate into the rules the possibility for contracting authorities to include the energy and environmental costs of the products, services and works to be procured among the award criteria for a contract. In this way, the cost-effectiveness ratio of a service or product can be taken into account from a life-cycle approach [9] that economically quantifies these impacts in its purchasing decision. It is also envisaged to obtain environmental information based on the use of eco-labels that facilitate an informed choice regarding the environmental performance of the product to be purchased.

2.2. The Spanish public procurement law and environmental clauses

The Public Procurement Law (PPL), approved on 8 November 2017, transposes European public procurement directives into Spanish legislation, in particular Directive 2014/24/EU, on public procurement; as well as Directive 2014/23/EU, on the award of concession contracts.

The new law regulates public sector contracts with the aim of ensuring an efficient use of public funds in connection with the sought budget stability and expenditure control, according to the principles of integrity, freedom of access to tenders, publicity and transparency, and non-discrimination and equal treatment among tenderers. It also aims to safeguard free competition and to make sure that the financially most beneficial bid is ultimately chosen. The main novelties of the PPL evolve around the incorporation of the criteria for best price-quality value, social and environmental obligations, publicity and electronic means, and the general simplification of procurement proceedings [10].

The law contemplates public procurement as a strategic instrument for the achievement of objectives of general interest and the development of public policies such as environmental protection, energy efficiency and savings, promotion of SMEs, fight against unemployment, integration of people with disabilities, fair trade, gender equality, innovation, competitiveness or technological development. In short, it is based on the conviction that public procurement, given the high volume of resources it mobilizes [11], in addition to being oriented towards the search for greater economic efficiency, must become an important tool for achieving a more innovative, sustainable and inclusive economy [12].

In accordance with the new Spanish Law, the Administration will use purchasing power with public funds as an instrument of environmental policies, to order private action towards the general interest by means of incentives for "green" production and by controlling the environmental legality of the actions of contractor companies [13].

The key to understand the new system is Article 1 paragraph 3, which clearly prescribes that "social and environmental criteria shall be incorporated in all public procurement in a transversal and mandatory manner, provided that they relate to the object of the contract, in the conviction that their inclusion provides better value for money in the contractual service, as well as greater and better efficiency in the use of public funds (...)". Therefore, in an unequivocal way, a new obligation is introduced for the strategic vision to permeate all tendering procedures. Moreover, according to Article 28 paragraph 2 PPL, public sector entities "shall value the incorporation of social, environmental and innovation considerations as positive aspects in public procurement procedures".

Price will not be the only criterion to be taken into account by the contracting body when awarding a contract. The criterion of "the most advantageous economic offer" has been replaced by that of "best value for money". In this respect, Articles 131.2 and 145.1 state that "the award shall ordinarily be made using a plurality of award criteria based on the principle of best value for money...". The importance of social and environmental considerations in public contracts is reinforced. Contracting authorities may establish these considerations as qualitative award criteria in order to assess the best value for money and, as hitherto, in the special contract performance clauses. The novelty here is that it is mandatory to include at least one social, environmental or innovative clause for the execution of the contract. Non-compliance with the special execution conditions is subject to a penalty (article 202.3).

2.3. Public universities and public procurement law

Universities obligation to comply with EU public procurement rules when they purchase derives from their status as ‘contracting authorities’ under Directive 2014/24. Universities are bound by EU public procurement rules, either because they are state authorities or because they receive more than 50% of their funding from the State, either on a structural basis (making them bodies governed by public law) or regarding specific projects [14].

In Spain, the new PPL expressly mentions public Universities in its article 3 paragraph 1, indicating that they are part of the public sector, within which they are considered public administrations. As public administrations, Universities play an important role in public procurement because by using their purchasing power to choose goods, services and works with a reduced environmental impact, they can make an important contribution towards local, regional, national and international sustainability goals. They contribute to sustainable development through education, research, and daily operations [15]. Recent studies about GPP practices at Spanish universities show that 21.5% universities have put into practice different initiatives related to green procurement (having a public procurement manual), and 72.5% of them have a department in charge of environmental subjects. Universities regularly organize awareness and media campaigns [16]. They generally include environmental criteria in the public procurement contract specifications, but the use of environmental criteria in the works tendered by Spanish public universities is low (19.2%) in comparison with the results of other studies in local, regional, and national administrations in Spain and other European countries [17]. So, it is necessary to encourage sustainable public procurement in public universities and greening our contracting processes.

3. Green Public Procurement at the University of Valladolid (Spain)

3.1. The University of Valladolid as a public university concerned about sustainability

The origins of the UVa date back to the thirteenth century. Since then, this academic institution has grown and has adapted to changing times to become one of the leading universities in Spain. The university is spread over four campuses: Palencia, Segovia, Soria and Valladolid, located in the region of Castilla y León. It offers a range of graduate degrees, official master’s degrees, and doctoral degrees, with programmes in the areas of Science, Humanities, Engineering and Architecture, Health Sciences, Social Sciences, and Law. Its commitment to ongoing education, its extensive network of international relationships, its prestigious research centres, its enormous cultural and sporting potential together with its commitment to society and the environment form an exceptional academic setting that is comparable to the oldest and most prestigious universities in Europe.

Spain has a total of 83 universities, 50 of them public and 33 private. Last UI GreenMetric report benchmarked 28 of them, with UVa occupying the 16th position [18]. The results of UVa are just shy of the average of the analysed Spanish universities (5575 points against 5916, -5,76%). They are higher in the Setting and Infrastructure (800 pp. against 776, +3,09%), Energy and Climate Change (1550 pp. against 1205, +28,63%) and Transportation (1075 pp. against 979, +9,81%) areas, and lower in the Waste (825 pp. against 1200, -

31,25%), Water (425 pp. against 515, -19,05%) and Education and Research (900 pp. against 1240, -27,42%) areas. This helps in the individuation of the measures to be taken to improve the overall results in the following years. UVa ranks 80th out of 230 in the European ranking and 199th out of 719 in the World ranking, with Table 1 showing the World, European and Spanish average results for each criteria compared to the results obtained by UVa, and the gap between UVa and the Spanish average in the last column.

Table 1. World, European, Spanish averages compared to UVa points, and UVa-Spain gap

	World (avg.)	Europe (avg.)	Spain (avg.)	UVa (pp.)	UVa-Spain gap
Setting & Infrastructure	802	776	776	800	3,09%
Energy & Climate Change	915	996	1205	1550	28,63%
Waste	876	987	1200	825	-31,25%
Water	419	397	525	425	-19,05%
Transportation	848	913	979	1075	9,81%
Education & Research	942	1031	1240	900	-27,42%
Total	4802	5100	5916	5575	-5,76%

Source: Own elaboration based on UI GreenMetric report (2018) [18]

Spanish results are ahead of the European average and, at the same time, European results are ahead of World average, which could reveal the solid commitment of Spanish Higher Education institutions with sustainability. It could also reveal the high competition those institutions need to address in order to further improve their respective positions in the UI GreenMetric ranking. As Fig. 1 shows, the priorities for UVa to be at least on par with the national average have to do with Waste and Education & Research indicators in the first place, and with Water indicators in second place. This would also solve the imbalances obtained in performance in different criteria.

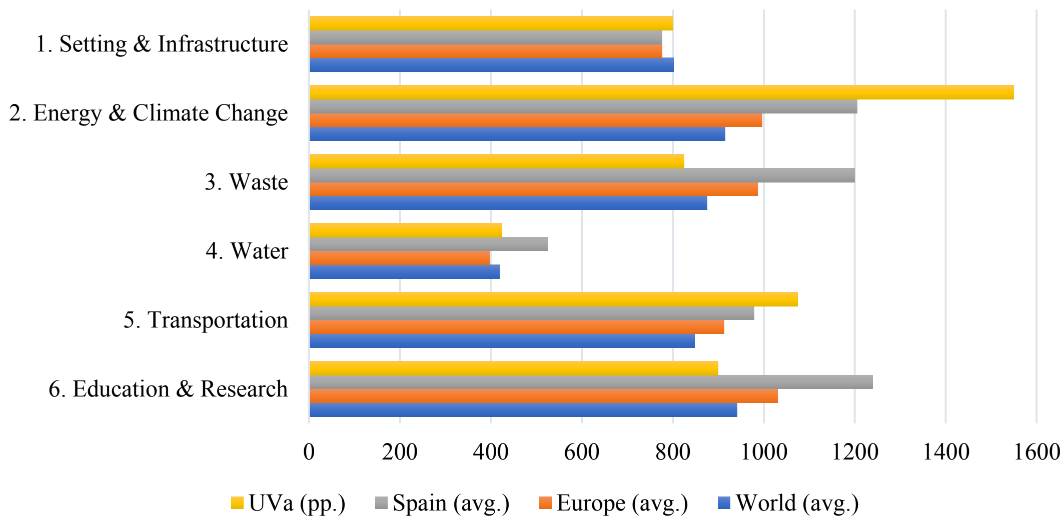

Figure 1. World, European and Spanish averages values against UVa UI GreenMetric results

The Statues of UVa approved in 2003 include amongst the core aims of the university, “to collaborate in the conservation of the environment, encouraging, in the exercise of its functions, the rational use of energy and the priority usage of ecological and recyclable materials, as well as the promotion of research and teaching aimed at sustainable development” [19]. Within the plans of the current Rector's team to further improve this goal is to create an Area of University Social Responsibility with a threefold objective: to increase the commitment to society, to align with the institutionalization of Social Responsibility, and to develop more capacities and organize more efficiently some existing university services related to Social Responsibility [20].

The commitment to environmental sustainability (use of clean energy, waste treatment, sustainable mobility, etc.) involves various university Offices: The Social Services area, the Environment and Environmental Quality area, the International Cooperation for Development area, as well as the Health and Occupational Risk Prevention Service. One way to this goal is to develop a culture of commitment to energy saving, sustainable development and the preservation of the environment, by preparing guides and giving open talks to the entire university community and the general public. In this line, UVa has publish a Sustainable Development Goals (SDGs) web guide with clear explanations of what the goals are, the metrics that help make each SDG more understandable, the partial goals for each SDG, and what UVa and other public institutions are doing for every single SDG [21].

Some efforts to promote the awareness-raising work where already set up in 2007 with the creation of the Office of Environmental Quality and Sustainability. The Office quickly developed and published a *"Practical Guide to Environmental Quality and Sustainability"* [22] to highlight how to make progress towards sustainable development with simple individual and collective actions taken in our daily environment.

3.2. Handbook on green public procurement (2007)

The UVa's Office of Environmental Quality and Sustainability also published in 2007 a "*Handbook on Green Public Procurement*" [23], intended to the university community. The guide included practical tips for responsible consumption, as well as information on providers of green products that could supply the University. It also encourages the purchase and contracting of products and/or services that are more respectful of the environment at university level, while promoting good consumer practices. The guide was structured after analyzing the main UVa provider categories: stationery, office supplies, IT equipment, furniture, vehicles, water and energy consumption, contracting of works and services, works, gardening, cafeterias, vending machines and cleaning services.

Figure 1. Handbook on green public procurement (2007) [23]

3.3. New proposals for updating the handbook

There are many examples of green contracts: energy efficient computers, office furniture from sustainable timber, low energy buildings, recycled paper, cleaning services using ecologically sound products, electricity from renewable energy sources, etc. By choosing goods, services and works with a reduced environmental impact, UVa can make an important contribution towards local, regional, national and international sustainability goals. Moreover, UVa must lead innovation and GPP can be a major driver for innovation, providing real incentives for developing green products and services. GPP may also provide financial savings for our University – especially considering the full life-cycle costs of a contract and not just the purchase price.

It is necessary to increase green practices through the adoption of measures that actually contribute to sustainable consumption. Regarding the role of environmental criteria within the contracting process, more importance should be given by public administration managers and technicians. As part of the encouragement of GPP practices, plans for environmental training of the administration's technical staff in public universities should be included [17].

4. Conclusions

GPP is a relatively new activity in Spain. Universities are really important to the promotion of sustainable consumption through their positive effects on students and other stakeholders.

Universities must incorporate sustainability in the avenues of education, research and daily operations. The most obvious barriers to sustainability are financial and that leadership, incentive and demand are required to move forward with improving sustainability at universities.

In public procurement, the achievement of a positive social and environmental impact must go beyond the functional satisfaction of the needs to be covered by the contracting body. Public universities as buyers and consumers can contribute to the sustainable development that makes it possible to guarantee "the needs of the present without compromising the possibilities of future generations". With its new Handbook on GPP the UVa wants to show its clear intention to use procurement as an instrument for the fulfillment of other public purposes, taking into account an approach that goes beyond the sole consideration of price in the award of public contracts.

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Sustainable University in a Changing World for Managing Energy Usage and Mitigating Climate Change

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Abstract. The objective of this study is to analyze the opportunities and challenges of sustainable energy and climate change and to determine the measures to overcome environmental issues. For this study, we have reviewed the literature for prevailing stimulation and upcoming stimulations. Different methods have been compared from various studies such as Dietz and Stern (2015), Revesz, Howard, Arrow and Glouder (2014) and few recent approaches. Moreover, we looked at which method are easily attainable using popular software. From the outcomes, it has been estimated that economic models: knowledge, industrial and feudal based models along with booming the growth of the economy has been playing a major part in damaging environment and causing threats to lives. The 21st century has seen colossal changes in technologies and its input. The world is also moving from feudal farming towards vertical farming from conveyer build production processes to customized consumer waste industrial production, as well as knowledge-based highly innovative service sector. The world today has been fragmented into three: knowledge base economies, industrial-based economies, and feudal based economies, each having a different rate of growth as well as the volume of energy usage. There by contributing mitigating or polluting the environment in such as way, which has contributed to the rapid phenomena of climate change. Universities create new knowledge that should become a link between the three trends of economic participation suggested above. It is the task of the universities to create modern, economic and scientific ways that should not only provide understanding, but measure and suggest ways of sustainable energy usage in order to stop, mitigate and help reverse the effects of climate change.

Keywords: Climate change, economic models, mitigation, sustainable energy

1. Introduction

The 21st century has seen colossal changes in technologies and its input. The world is also moving from feudal farming towards vertical farming from conveyer build production processes to customized consumer waste industrial production, as well as knowledge-based highly innovative service sector. The world today have been fragmented into three: knowledge base economies, industrial-based economies, and feudal based economies, each having a different rate of growth as well as the volume of energy usage. There by contributing mitigating or polluting the environment in such as way, which has contributed to the rapid phenomena of climate change.

According to (International Energy Agency , 2019) because of increasing industrialization, increasing world population, and urbanization, the global energy needs are increasing by 30% between 1917 and 1940. Apart from the traditional users of energy (North America and Europe), Southeast Asia (China, India & Pakistan) as well as other developing nations are fast becoming a heavyweight in energy consumption. Today, thanks to the decreasing costs the share of renewables are fast catching up to nonrenewable energy sources and would contribute 40% of world's energy mix by 2040. The share of gas in the global energy mix is fast increasing while the share of coal and oil (high polluter) is fast decreasing in the global energy mix.

According to (Ministry of Finance, 2018), in Pakistan in 2000-2001 total oil consumption was 17.65 billion tons that increased to 25.56 billion tons in 2016-2017. Total gas consumption in 2000-2001 was 0.77 billion mm cft that increased to 1.38 billion mm cft in 2016-2017. While total consumption of coal in the country in 2000-2001 was 4.0 million metric tons that increased to 11.2 million metric tons in 2016-2017. As the use of oil, gas and coal in the energy mix is rising in Pakistan, so is climate change, which is fast impacting on livelihoods of the people, especially in the agricultural sector of the country. Biodiversity in the country is also being adversely affected by climate change.

Huge downpours of rain, flash floods, frequent droughts and shift of weather patterns in Pakistan are changing the rural and agricultural landscape. Large part of illiterate and uneducated people live, work and try to survive with traditional techniques of farming and related vocations and therefore seldom understand the sudden change in climatic patterns as well as its adverse effects on their lives and livelihoods. According to (Ministry of Finance, 2018) “Pakistan is assessed to be one of the vulnerable countries to climate change. This vulnerability is mainly due to its geographic location, demographic and diverse climatic conditions. Building resilience and adaptation to climate change is becoming indispensable for Pakistan”

1.1. Problem statement

The problem is how to educate the people in usages of more renewables and environmentally friendly energy sources. How to increase the research in methods to mitigate the adverse results of climate usage. Moreover, the role of sustainable Universities, especially University of Central Punjab (UCP), Lahore, Pakistan in help manage energy usages in the country and the university for mitigating climate change.

Universities create new knowledge that should become a link between the three trends of economic participation suggested above, i.e. knowledge base economies, industrial-based economies, and feudal based economies. It is the task of the universities to create modern, economic and scientific ways that should not only provide understanding, but measure and suggest ways of sustainable energy usage in order to stop, mitigate and help reverse the effects of climate change.

1.2. Objectives of the study

The objectives of the study is to analysis the role of University of Central Punjab (UCP), Lahore, Pakistan in order to manage energy usages for mitigating climate change.

1.3. Methods

For this study, we have reviewed the literature for prevailing situation and upcoming situations. Different methods have been compared from various studies such as Dietz and Stern (2015), Revesz, Howard, Arrow and Glouder (2014) and few recent approaches. Moreover, we looked at which method are easily attainable using popular software.

Furthermore, we will only look into the work already done by University of Central Punjab (UCP), Lahore, Pakistan for a sustainable university environment in order to enhance the University’s role in mitigating Climate change.

2. Literature review

According to (Richard L. Revesz, 2014)“It is true that future technological developments might better equip society to cope with climate change. And of course overall bias cannot be determined simply by adding biases in each direction. But the bulk of the literature and arguments indicates that social-cost models are underestimating climate-change harms. “Modelers, scientists and environmental economists must continue to step outside their silos and work together to identify research gaps and modelling limitations”.

According to (Dietz & Stern, 2015), “it is important to stress that the science of climate change was running years ahead of the economics (something that arguably remains the case today in understanding the impacts of climate change”. They conclude, “If the analysis is extended to take more strongly into account three essential elements of the climate problem – the endogeneity of growth, the convexity of damage and climate risk – optimal policy comprises strong controls”.

According to (Celikdemir, Gunay, Katrinli, & Alpbaz, 2016)“The universities are the major actors which should pursue sustainability, as they affect society”. “Universities being the major cornerstones of higher education play a vital role in regional development of countries; therefore, their sustainable development should be well handled to enable regional development”.

According to (Napolitano & Johnson, 2018), “Time is running out. If the world is going to prevent a climate catastrophe, colleges and universities must lead. We owe it to our university communities, our states, nation, and world — and to generations to come”.

According to (Harward University, 2019), “Climate change poses an immediate and long-term threat to people and our planet. Universities like Harvard are uniquely equipped to shape the ideas and innovations that will lead the transition to a low-carbon future”.

According to (Copernicus Institute of Sustainable Development, 2019), "Research on climate change adaptation at the Copernicus Institute focusses on anticipating the impacts of climate change in three ways: moderating potential damage, coping with the consequences or taking advantage of opportunities. From that perspective, a major task lies ahead to make certain parts of the world climate proof. Most research relates to the integration of adaptation measures into urban planning, water management and biodiversity conservation".

3. Discussion

(University of Central Punjab, Lahore, Pakistan, 2019), also called UCP is a private sector university, established in 1999 and currently is working with 10 Faculties with a vision to "become an internationally acclaimed University in teaching and research". With a mission, "To provide quality education to the youth of our nation in a stimulating and conducive learning environment by equipping them with the intellectual and technological tools necessary to meet the challenges of the future".

The partner organizations of UCP are World Wildlife Fund (WWF) and **Sunrise Green Pak Welfare Organization.**

The Department of Environment Sustainability (DSE) at UCP "is established to perform various activities related to sustainable environment and to coordinate work done by the teaching departments in their areas". DSE is to:

- Suggest policy guidelines regarding protecting our environment
- Create awareness among the students, teachers, and staff about the importance of preserving our environment and the harmful effects of polluting our world
- Organize events and activities related to the sustainable environment
- Coordinate various environment-related activities at UCP and other universities and colleges in the group.
- Participate in national and international events to enhance the effectiveness of the efforts towards environment

3.1. Energy Conservation

Keeping sustainable development and energy conservation issues in mind, UCP has already in collaboration with M/S Premier Energy embarked upon the renewable solar energy solutions and 1/4th of the total energy consumption of UCP is being produced through state of the art grid-tired solar system.

3.2. Paperless Environment

UCP is moving towards a paperless environment and the following actions are expected from faculty, staff, and students. In this regards instructions have been issued to Prefer emails for correspondence avoiding the use of paper. While printing, use both sides of the paper wherever possible. Review and proofread the documents before printing to avoid any wastage of paper. If selected portions of a report or document are needed limit your printing to that. Use the back side of the papers with one side printing. Use the UCP web portal or Moodle for providing documents to students, including assignments, projects, articles, books etc.. Accept students' work online wherever possible. Use multimedia projector instead of paper handouts for classroom discussions. Try to share copies wherever possible to reduce paper printing. Make exact number of copies for examinations and meetings to avoid wastage of paper. Use WhatsApp and other such applications of communication to reduce printing. Eliminate duplication of documents i.e. online and printed copies. Reuse paper envelopes. Keep smaller paper chits for writing short messages or other material. Promote electronic backups as compared paper files. Use and promote recycled paper wherever possible. Minimize use of disposable paper products.

Paper Conservation Initiatives in UCP Library include: the library is not receiving thesis from students in hard form since January 2018 to avoid paper consumption. We receive soft copies of the thesis and upload on our institutional repository. This does not only save paper but also for library space. To avoid photocopies of book chapters or library resources, the library has provided the scanning facility to the UCP community. For internal communication, we circulate the instructions through email instead of papers, we also reuse the paper if it is printed on one side. I hope that this will add somewhere in the contribution. I hope and pray for a success in this regard.

3.3. Water conservation policy

Water is life it should neither be wasted nor be misused. There are many parts of the world and in our country where people do not get clean drinking water and are forced to drink unclean and unhealthy water. To many people, even this polluted water is not available. Signals of a future shortage of water are evident such as lower water levels, increasing salinity, and drying rivers.

It is extremely important that we start understanding the seriousness of this issue and adopt measures to conserve water. UCP also promotes the sagacious use of water. Some of the salient features of the water conservation policy of UCP are given here: Reuse water for inferior purposes. Use rainwater. Use Altered Nozzles reducing water consumption by 98%. Use Low-flush or Dual-flush flush systems in bathrooms. Try not to use running water directly. Never keep water running when not used. Regularly check leakages in the water supply and places of water use. Processor treat sewage water. Promote the use of filtered water instead of bottled water. Use reusable glasses or cups for drinking water. Use any other device that will reduce water use. Do not use drinking water for plants and washing. Create awareness about water conservation.

3.4. Recycling and waste reduction program of UCP

A lot of waste is regularly produced in our offices and at other places. Efforts are made to reduce the production of this waste and its proper disposal. We promote a waste hierarchy of Three3 *R's* i.e. Reduce, Reuse and Recycle. UCP promotes waste minimization and adoption of such measures that reduce wastage. We advocate energy production from waste, which gives duel advantage. Minimize or eliminate the use of disposable items and promote the use of utensils made of natural materials. Segregation of waste materials for recycling, reuse, and disposal. UCP is also initiating a recycling program of the waste produced. We are shifting towards minimum consumption of paper by increasing the use of online communication, double side printing, reusing envelopes, employing UCP academic portal and Moodle for academic activities etc. Further, in order to properly recycle the waste three different waste bins are placed in the university. We are looking forward to taking more steps to reduce waste by eliminating plastic bags and disposable items.

Our waste reduction and recycling program will consider the following steps are. Conducting a waste audit. Identify what is recyclable (already done). Decide what to recycle (already done). Setting up recycling bins for selected items (already done). Creating Awareness (several ways of creating awareness are used such as social media, UCP official website, electronic notice boards, general campaigns etc.). Monitor the recycling. Evaluate results (we plan to evaluate the results of our efforts on regular basis).

The steps taken or will be taken to control waste or to recycle it as it will help to protect and save our environment include going paperless (to whatever extent possible we are working on it). Keeping a paper recycling bin within arm's reach in offices and keeping enough number of bins at various places in the university. Printing smarter (by printing only the most important documents). Providing real dishes and silverware (by reducing disposable plates, glasses, bottles etc.). Buying in bulk. Reusing binders, file folders, and envelops. Creating a recycling center (working on the project and it will start soon). Providing Filtered Water and eliminating bottled water. Giving Employees Reusable Water Bottles.

3.5. Air pollution policy

Air pollution is perhaps the most dangerous form of pollution as it directly affects everyone and there is no escape if one has to be at a polluted place. Industrialization and an increase in the number of vehicles are the two major causes of air pollution and on the other side, trees are cut, which provide oxygen and help to reduce air pollution. We want to control air pollution and reduce it to a minimum at the UCP campus and at the same time send this message to all the students, faculty, and staff members to support this cause and promote it wherever they live. The following are some of the key elements of our policy that includes, making strict rules regarding creating air pollution at UCP campus. Imposing fines and penalties in case of violation of rules. No smoking in the campus. No burning of any waste at any time in the campus or near the campus. Proposal for proper disposal of waste without creating any air or water pollution. Fines and penalties for any violations of pollution-related rules. Carbon emissions are calculated and we work towards gradually reducing these emissions. Minimum emission air conditions and other devices. Not allowing vehicles creating smoke or unusual emissions. Keeping power generators in best conditions with clean filters keeping the emissions to the minimum. Regular tree plantation campaigns at UCP campus and in the nearby areas.

3.6. Initiative to decrease vehicle parking at university

UCP campuses have international standard parking facilities. This does not only make parking easy but also reduces the time to park thus controlling carbon emissions at the campus. Nevertheless, campus traffic and parking issues are serious concerns for the universities due to which faculty, staff, and students face problems. UCP's management is keen to reduce the carbon emissions from vehicles by better management of parking facility and Pick & Drop facility. To deal with these issues following steps are taken or are in process and include. Providing shuttle bus service to the students, faculty, and staff members (already provided). In addition to the shuttle bus service, UCP provides Pick and Drop bus service to students to reduce the flow of personal vehicles. Planning to reduce unnecessary parking at the UCP campus. Encouraging and facilitating carpooling for students, faculty, and staff. Reducing the distance traveled by vehicles in the parking area by using empty space indicators and electronic boards. Planning to subsidize the bus rates to encourage students to use this service. Improving management of parking areas to minimize traveling of vehicles in these areas. UCP management is working on improving the Pick and Drop lane to reduce the time per pick and drop.

3.7. Environment related activities with students and faculty of UCP

Plantation Drive and Environment Protection Walk: Department of Sustainable Environment and Environment Protection Society of UCP conducted Plantation Drive inside the campus and inaugurated this ceremony by unleashing balloons in the air.

Save Earth There is No Planet B: Department of Sustainable Environment (DSE) of University of Central Punjab (UCP) organized an event with the theme "Save Earth There is No Planet B". Minister of States for Climate Change Ms. Zartaj Gul was the chief guest of the event.

Sustainability Week 2018: Department of Sustainable Environment and Environment Protection Society of University of Central Punjab inaugurated Prime Minister's Clean and Green Pakistan movement and conducted an opening ceremony of Sustainability week 2018.

Plantation Awareness through Wall of Awareness: UCP-VIS has arranged some walls around Lahore to spread social messages to masses. 6 of these were about plantation, its benefits and damage done by not having plants and trees around us. Wall of Awareness Campaign was covered by Volunteer 2030 on their website as main page story for more than a week.

Plantation Drives: UCP-VIS Department has organized various plantation drives every year with Sunrise Green Pak Welfare Organization. This includes plantation by volunteers at different places around Lahore.

Cleanliness Campaigns: UCP-VIS has organized cleanliness campaign various times in last 7 years. These include cleanliness campaign at Jail Road, Ghalib Market and Green Town etc. It's a symbolic activity and our volunteer collect wrappers, shopping bags and other trash lying without trash bins. This activity is aimed at making people realize that it is their duty to put the trash in bins rather than throwing it here and there.

Flower Arrangement Competitions: UCP-VIS organizes flower arrangement competition every year to emphasize on the importance of flowers and plants in our environment.

Plantation Drive by MAJU-VIS: MAJU-VIS Department has organized a plantation drive in August 2018. Free plants were also provided to masses to encourage them to plant trees.

Earth Day Celebrations: DSE-UCP and VIS Department is organizing walk and sessions on earth day on annual basis.

Water Day Celebration: UCP-VIS Department is organizing walk and sessions on Water Day on annual basis.

3.8. Monitoring and reporting

The University of Central Punjab Sustainability Report 2017-2018 has already been produced and can be seen on the UCP's website in DES section.

4. Results

From the outcomes, it has been estimated that economic models: knowledge, industrial and feudal based models along with booming the growth of the economy has been playing a major part in damaging environment and causing threats to live.

Therefore, Universities have to be the spearhead of both futuristic knowledge, as well as futuristic activities and research to change behaviors and of the public for mitigating the harmful effects of environmental pollution and Climate Change. They have to think out of the box solutions through research and discussions on, create a learning environment for all and outreach to local communities with new thought processes, more practical models and ways of living and working. So that the modern energy usages would be limited and diverted towards reusable and eco-friendly technologies that in turn should result in reduction of emission of harmful to the environment gasses for greater reversal of climate change.

5. Conclusion

Universities create new knowledge that should become a link between the three trends of economic participation suggested above. It is the task of the universities to create modern, economic and scientific ways that should not only provide understanding, but measure and suggest ways of sustainable energy usage in order to stop, mitigate and help reverse the effects of climate change.

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Issues and Innovation in Managing Waste

Excellence in Higher Education and Research Establishments: Digital Transformation & Waste Management as Twin Vectors for the Transition towards Sustainability

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Abstract. This paper seeks to demonstrate the salience of 'twinning' Waste Management and Digital Transformation, as didactic interfacing of key 'virtual' and 'material' dimensions of societal transitions. The first part of the paper sketches an overview of excellence in higher education and research establishments (HERE) as a multi-criteria multi-stakeholder problem, with particular reference to sustainability. The second part of the paper looks at Waste Management as a component of the INSEEC U Group's corporate social responsibility (CSR) strategy, situating this with reference to French, European and international frameworks for transition (e.g., circular economy) and excellence (e.g., the AASHE 'STARS' programme). The third part of the paper looks through the lens of INSEEC U experience, at the interface between Digital Transformation (DT) and the hypothesis of improved waste management through 'smart systems' and 'dematerialization'. The final part of the paper concludes with some suggested next steps for exploiting TICE for HERE capacity-building. In particular, we identify opportunities for intensive and extensive Stakeholder Engagement in INSEEC U Waste Management Strategy, explaining this as an alliance of 'Bottom-up' and 'Top-down' initiatives for Digital Transformation and Transition towards Sustainability. Overall, we try to show how the new digital networking technologies offer radically new opportunities for collaborative *learning* about sustainability challenges, for *monitoring* performance, for sharing suggestions for *action*, for materially *improving energy, material flows and environmental performance*, and for *evaluating* the quality of institutional strategies — action by action — in a multi-stakeholder vision relative to multiple excellence considerations.

Keywords: circular economy, digital transformation, excellence, higher education, stakeholders, transition, waste.

1. UI GreenMetric: The Challenge of HERE Quality & Sustainability

1.1. A Multi-stakeholder multi-criteria framework for HERE quality appraisal

In an industrial economics or business management perspective, the "life cycle" of higher education and research establishments (henceforth, HERE) is characterised, on the one hand, by activities taking place "*inside*" the knowledge sector (such as teaching and the preparation of teaching materials; or the proposing, performing, reviewing and reporting of research); and, on the other hand, by activities "outside" the knowledge sector itself. These "outside" activities can be split into two sub-categories:

- The decision-making and resource allocation activities "*upstream*" that provide for the material, human, and financial resources that feed into research activities; and,
- The domains of activity "*downstream*" including innovation, decision support and educational uses of knowledge.

Who, then, are the stakeholders in higher education and research activity? The short answer is, of course, everybody. There are, in a general sense, the teachers, the researchers and the students (even though, ideally, we are all together in a knowledge/learning community). There is also the technical and administrative support staff of any HERE. These are "internal" stakeholders. As for those "around" the knowledge sector, here also it would seem relevant to distinguish two sub-categories of "external" stakeholders:

- Those entities or institutions having a well-defined *"contractual" engagement* with the higher education or research activity — e.g., as public funding agencies, private sector investors, partners in the exploitation of R&D, or other sorts of a client of the knowledge, products and derivative services;

- Those persons within *civil society "at large"* who are not directly engaged with the knowledge production process but perceive their interests "at stake" along with any dimension of the economic, environmental, health or societal implications of the HERE activity.

What are the quality and performance considerations for stakeholders across these domains of action? HERE activities in both private and public sectors are subjected to multiple expectations:

- The "*intrinsic*" quality considerations of pedagogical and scientific integrity.
- The "*extrinsic*" quality considerations that are expressed across multiple institutions, as for example: (a) legislative frameworks that require research entities to address the "ethical" status of research and potential impacts in terms of environmental protection, employment, and health; (b) funding conditionality that, in public as well as in private sector domains, incites researchers to focus on fields and forms of analysis that correspond not only to curiosity and novelty but also to politically determined priorities such as environmental, employment, health, and technology domains; and (c) the pressures, codified for example in business reporting and performance rating procedures, of demonstrable commercial value and market success.
- The value statements expressed, individually and collectively, by people as participants in "*civil society*" — for example about the *acceptability* of a project, product or innovation. Such value statements may have their roots in moral, religious, cultural, political or existential concerns.

In this way, we establish a schematic 3×3×3 typology (along with the three axes of domains of action, stakeholder classes, and quality considerations) for structuring CSR strategies and evaluation procedures for higher education and research establishments [1, 2, 3].

1.2. Situating waste management in the wider HERE quality context

Numerous frameworks for HERE quality assessment and self-evaluation have been promulgated since the 1990s, many (but not all) of which give attention to wider societal and environmental 'sustainability' [4, 5]. We do not scrutinize all programmes around the world; rather we highlight some features of structure that are common to HERE ranking and self-evaluation frameworks. First, there is an identification of a small number of distinct performance domains, one or more of which addresses environmental sustainability concerns. Then, within each of these domains, sub-categories of action and/or specific ecological transition topics will be identified. These will include direct environmental performance topics such as air quality, greenhouse gases and climate change, energy use, water, and waste, addressed either in operational terms (e.g., purchasing policy, waste recycling, mobility solutions) or in terms of environmental effects. For example:

- The AASHE 'STARS' programme [https://stars.aashe.org/] specifies four major domains: *Academics, Engagement, Operations, Planning & Administration*, and has recently added *'Innovation'* as a separate 5th domain. The specific topic of waste management is then addressed, within the Operations domain, through sub-categories of 'Waste' and 'Purchasing'.
- The French 'EVADDES' framework (the acronym coming from '*Outil d'auto-EValuation du Développement Durable dans l'Enseignement Supérieur'),* developed during 2009-2013 in the context of the national "green plan" for higher education in France, specifies 5 focus areas: *strategy and governance; training; research; social policy and regional presence; environmental management.* The environmental management domain then includes *'Non-hazardous waste'; 'Hazardous waste';* and *'Waste Electrical and Electronic Equipment'* amongst its sub-domains.
- The 'GREENMETRIC' evaluation process, which is focussed particularly on environmental sustainability [see: http://greenmetric.ui.ac.id/criterian-indicator/] defines 6 major performance categories: *Setting and Infrastructure; Energy and Climate Change, Waste, Water, Transportation, Education and Research*. So in this case, 'Waste' is set as a top-level domain.

Sustainability concerns may also, importantly, be addressed through teaching and research and through institutional management and governance processes — that is, contributions to capacity building for sustainability at societal and institutional levels.

2. The INSEEC U Waste Management Strategy: Key Performance Concepts & Categories

In this section, we look at Waste Management as a key component of the INSEEC U Group's corporate social responsibility (CSR) strategy and situate it relative to national and international frameworks.

2.1. Waste management as a facet of INSEEC U 'RSE' strategy

INSEEC U has, since 2014, put in place a collaborative approach for continuous improvement in sustainability performance, as a core feature of its CSR (coRPorate societal responsibility) strategy. This strategy defines Actions, Indicators and Results around 5 commitments:

- Implement Exemplary Participatory Governance in SD;
- Train up internal and external stakeholders and improve their awareness;
- Participating in advancing knowledge of CSR and promote responsible research and innovation;
- Implement effective and coordinated environmental management;
- Develop a social and societal policy.

There has been specific governance and budget since 2014 (SD Commission, President, Director, SD representatives of staff and student in each campus, etc..). Internal and external communication actions include a dedicated web site, CSR annual report, internal newsletter, workshops and conferences. Waste management relates, in operational terms, to the 4th of these CSR strategic goals. But, achieving operational goals depends also on effectiveness in the 1st, 2nd and 3rd themes.

2.2. Categories of waste and of waste management strategy

The INSEEC U Waste Management strategy has focussed on a relatively small number of categories of waste materials with high visibility to staff and students and with high "returns on investment":

- Collection & recycling of bottles; used plastic cups, paper cups; and aluminum cans;
- Attention to the consumption of paper in teaching and administration (including 'dematerialization'), and to the recycling of used paper;
- Pro-active strategy for the purchase and use of digital technology equipment, with consideration for 'life cycle' disposal as well as energy efficiency in use.

The current INSEEC U strategy illustrates a well-known tension between pragmatic and "bottom-up" considerations of priority actions, (that is, the "low hanging fruit" at institutional, campus or building scales), and systematic attention to the full spectrum of the classification schemes permitting synthetic views at territorial, national or international scales. This tension can be exploited as a basis for monitoring and for continuous improvement. In this regard, we situate the INSEEC U Waste Management strategy first with reference to EU and French national monitoring frameworks for movement towards a "circular economy", and then with reference to representative HERE sustainability excellence frameworks as already mentioned (AASHE 'STARS' and 'UI GreenMetric').

2.3. The EU framework for observing the circular economy

The EUROSTAT monitoring framework on the circular economy was set up during 2017-2018 by the European Commission. It consists currently of 10 indicators, some of which are broken down into sub-indicators. [See: https://ec.europa.eu/eurostat/web/circular-economy/indicators]. This set of indicators is selected in order to capture the main elements of a circular economy, taking account of statistical measurement and aggregation quality issues. The four domains are:

- Production and consumption;
- Waste Management
- Secondary raw materials
- Competitiveness and Innovation.

In each domain, the chosen indicators exploit available data, while issues are flagged where new indicators being developed (e.g., for green public procurement and food waste). Of course, in the overall vision of transition towards a circular economy, these four domains overlap. Eco-conception in production and consumption can facilitate longer product life, re-use and recycling; and for many classes of material, there is a continuum between secondary raw materials and waste recycling.

The EU Waste Management domain focuses on measures of the volume of wastes in various categories (kg or tonnes), and then on the share (%) of waste which is recycled and actually returned into the economic cycle to continue creating value.

An aggregate estimation is made for the recycling rate averaged over all waste streams except major mineral wastes, and then for specific waste streams (municipal wastes including food and other vegetal material; packaging waste (with a separate estimation for plastic); electronic or E-waste; and wastes from construction and demolition. The graphic on the right provides a schematic overview of the recycling rates for the main categories of waste streams addressed by the sub-indicators. Current INSEEC U Waste Management strategy engages action and estimation of volumes recycled for several of the Eurostat categories, whereas other sub-domains are yet to be addressed.

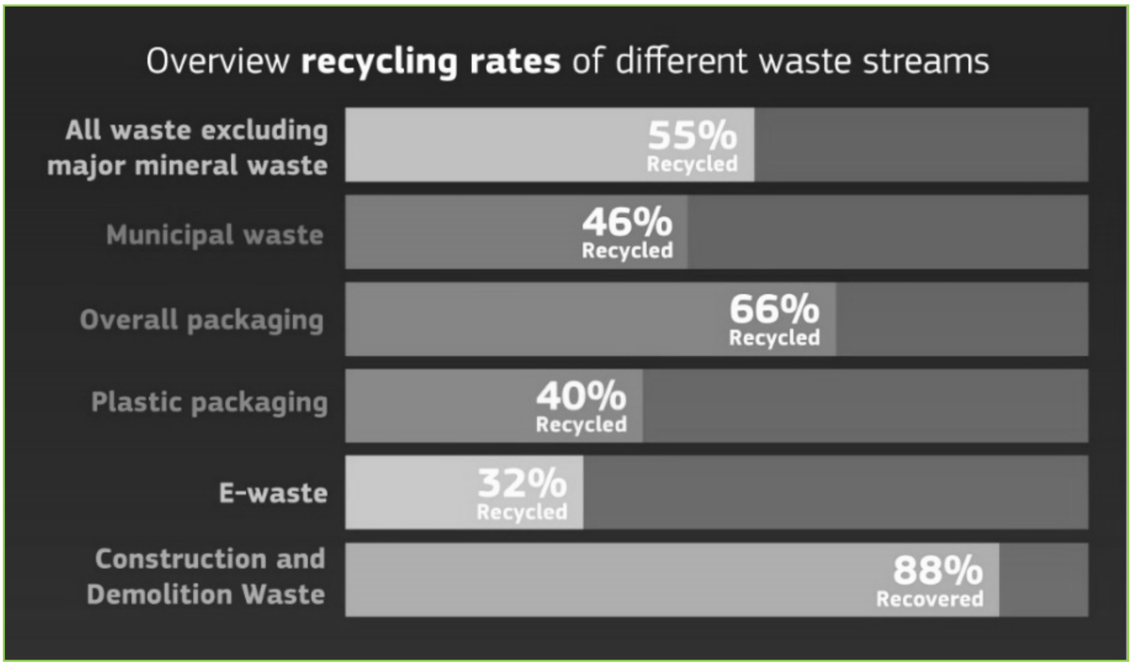

Figure 1. EU Recycling rates of different Waste Streams (Eurostat 2018)

2.4. Positioning INSEEC U relative to the French plan for transition to a circular economy

In May 2018 the French government published its *Roadmap for the Circular Economy* [see: https://www.ecologique-solidaire.gouv.fr/sites/default/files/FREC%20anglais.pdf], setting out "50 Measures for a 100% Circular Economy". These measures are divided into four domains: *Better Production (*7 measures); *Better Consumption* (9); *Better Managing Our Waste* (24); and *Mobilising All Actors* (10). Amongst these 50 measures, we mention the following as pertinent to INSEEC U.

Table 1. Measures in the French Circular Economy Roadmap most pertinent for INSEEC U

No.	*Measures for Better Consumption*
8	Strengthen the range of services offered by actors involved in reuse, repair and the economy of functionality (product-service systems)
10	Mandatory simple information logo on reparability from 1 Jan 2020 for electrical and electronic products
13	Improve consumer information
14	Step up the fight against food waste
No.	*Measures for Better Managing Our Waste*
17	Launch a "general mobilization" drive to accelerate the collection of recyclable packaging, plastic bottles and cans through returns for charitable purposes.
18	Extend the scope of the EPR "packaging" scheme to professional packaging and aim to increase the percentage of bottles and cans collected in the cafe, hotel and restaurant sector.
31	By 2019, study the deployment of a financial mechanism to promote the recovery of old mobile phones.
No.	*Measures for Mobilizing all Actors*
42	Raise awareness and educate
47	Mobilize the scientific and technical community with a multidisciplinary approach

2.5. Positioning INSEEC U relative to international HERE Frameworks

As already signaled, the UI GreenMetric framework as of 2019, establishes *6 major sustainability performance categories, including Waste* (WS), weighted as 18% of the overall UI GreenMetric score. Within the '*WASTE'* category, indicators address:

- *Recycling program for university waste; Program to reduce the use of paper and plastic in campus; Organic waste treatment; Inorganic waste treatment; Toxic waste handled; Sewerage disposal.*

The UI GreenMetric framework also highlights the pertinence of *'Education and Research'* activities in support of sustainability. Since 2012, the evaluation system defines indicators that address:

- *The ratio of sustainability courses towards total courses/subjects; The ratio of sustainability Research funding towards total research funding; the number of Scholarly publications on environment and sustainability published; Scholarly events related to environment and sustainability; Student organizations related to environment and sustainability; Existence of a university-run sustainability website; Existence of a published sustainability report*.

Waste management can be addressed within all of these sub-domains. The AASHE 'STARS' framework covers broadly similar categories to UI GreenMetric. It also gives emphasis to operational considerations, notably under Purchasing, where sub-categories include:

- *OP 12: Electronics Purchasing; OP 13: Cleaning Product Purchasing; OP 14: Office Paper Purchasing; OP 15: Inclusive and Local Purchasing; OP 16: Life Cycle Cost Analysis.*

At its present time, the INSEEC U Waste Management strategy has operational components addressing: (1) the recycling of wastes on campus; (2) the reduction of waste streams through purchasing a policy; and also (3) the building of capacity through teaching and research programmes.

3. Exploiting TICE for HERE Capacity-building in Managing Waste

3.2. The INSEEC U strategy of Digital Transformation (DT)

We will now look at some of the technological and educational components of our strategy, in particular, the exploitation of digital innovations. An innovative ecosystem of digital learning has been developed at INSEEC U since 2012, with studio and server capacities for the production and management of an increasing variety of digital teaching resources, digital delivery and dialoguing systems for on-campus and off-campus learning communities and networked administrative services to staff and students. During 2018 a strategic reorganization of these activities has been implemented, with the creation of a *Digital Learning Department* whose cross-cutting mission is *"… to conceive, develop and integrate digital learning services dedicated to our students on campus and to new markets."* In parallel with this pedagogic DT strategy, we are experimenting with the use of "smart systems" and other digital technologies in order to improve the performance of the group in Waste Management as well as other sustainability challenges.

3.2. Smart systems for the circular economy – The initial INSEEC U experience

Since 2015, INSEEC U. has been firmly committed in a circular economy policy. We work in partnership with specialized service providers such as ELISE and LEMON TRI. In 2017, some 22 tonnes of paper, bottles, cans and cups were collected by ELISE on the 19 sites of INSEEC U. Group. Paris sites account for 67% of this, followed by Bordeaux (20%), Lyon (9%) and Chambery (4%). The importance of the quantities recycled can be expressed not just in mass terms, but also with various "equivalences". The 12 250 metal cans collected, corresponding to the metal needed for 18 bicycles. The 7618 plastic goblets recycled are enough to fabricate 63 composite coat-hangers.

With our partner LEMON TRI, we use smart machines appealing to students where several materials are collected in the same place in a fun way. Incentives in the form of tokens convertible into coffee are offered to encourage participation in recycling activities. Our students are therefore ambassadors for good practices in eco-gestures. The recycling performance for each category (bottles; plastic cups; paper cups; metal cans) is certified by independent partners (e.g., SAM Montereau SAS for metal recycling; Papeterie Emin Leydier for paper cups and cardboard materials; Atlan for plastic goblets ground up for the fabrication of plastic composite products; and Plastipack for plastic bottles recycled).

3.3. IT and 'dematerialisation' – Issues of direct and indirect material and energy needs

We can follow directly our recycling results as well as the associated environmental and societal impacts, thanks to a smart system using sensors and other digital means. But this is only the tip of the iceberg in our attempts to ally systematically Transition to Sustainability with Digital Transformation.

Much has been written since the 1990s, of the potential of IT for the "dematerialization" of the economy, that is, reduction in the quantities of materials used per unit of output goods and services. It is useful in this regard to make the distinction between "Green IT" and "IT for Green" [6, 7]. "Green IT" signals a low or decreasing environmental impact profile of IT production and activities themselves (e.g., laptops or portable telephones). "IT for Green" signals the application of IT in order to improve environmental performance in other sectors. Some actions of the INSEEC U group fall into the category "Green IT" category, e.g., the down-sizing and upgrading of the group's servers. But most are instances of "IT for Green". Via digital networking and other "smart systems", currently we estimate the following benefits of "dematerialization":

- Elimination of paper registration forms = Savings equivalent of 4400 tonnes of CO_2 per year;
- Dematerialized internship agreements = Savings of eq. 6200 tonnes of CO_2 per year;
- Digitalization of contracts and pay slips = Avoid 68,000 printed pages a year;
- Generalization of a video-conference system for all campus = Drop in transportation for general meetings in France and abroad or for courses, etc.
- Drops in water and energy consumption with the generalization of smart buildings;
- Drops in waste production thanks to general smart recycling and re-use policy.

Water resources, primary energy use and climate change have a high current profile on the "ecological transition agenda". For example, one of the indicators retained by UI GreenMetric is the per student 'Carbon Footprint' for a university. The estimation "ecological efficiency" indicators (such as energy use, water use and GHG emissions per student per year) requires a careful distinction to be made between "direct" and "indirect" requirements [8]. So-called "footprints' of indirect (sometimes called "embodied" or "induced") environmental pressures can be defined and estimated on the "input" side (e.g., energy, water, copper or other raw materials) or on the "output" side (e.g., GHG emissions, or any other category of pollutant emissions into the atmosphere and water bodies, or of solid waste requiring disposal. An important next step for INSEEC U is the systematic estimation and communication of indirect as well as direct waste management performance.

3.4. Suggestions for action: Integrating bottom-up and top-down initiatives

INSEEC U is actively growing its expertise at the interface Sustainability and Digitalization, in the academic domains of teaching, research and innovation as well as in operational domains such as site management, purchasing and procurement policy. Examples of new teaching programmes are: (i) a certificate online on "Sustainable Development and CSR Management"; and (ii) a Masters level programme in Strategic Management for the Ecological Transition (including the circular economy and RSE themes). The specific academic and operational programmes are to be seen as components in a wider programme of continuous improvement.

In a collaborative learning perspective, we consider all HERE stakeholders as members of a knowledge-innovation community: a *Sustainable Campus Social Network (SCSN*). A corporate or campus-level sustainability strategy — existing or hypothetical — is made up of many bricks, or *Actions*. Participating members of the community can be invited to contribute suggested Actions and to give their opinion on the pros and cons of existing or proposed Actions. In schematic terms [5],

- Each of these Actions (and therefore, in a composite way, a Strategy as a whole), can be situated in one or more domains (or sub-domains) in the HERE life cycle.
- An Action is to be judged — *ex-post* (for an existing or past situation) or *ex-ante* (for any scenario) — for its Qualities relative to an agreed spectrum of Sustainability Performance Considerations.
- This evaluation can be undertaken by people linked in social networks. With current social networking technologies, we can easily envisage *nested judgments* (a) moving upwards from individual Indicators to Actions, to an overall vision of a HERE sustainability strategy; and (b) moving from Individual participants to Stakeholder Classes, and to an overall judgment about a HERE's sustainability performance.

The reference to social networks gives us a simple concept of evaluation: "*Like*" or "*Don't Like*". But we can apply conventions of evaluation that are more sophisticated while remaining intuitive for the contributors and for the observers. For example, each Action could be scored for its quality, with reference to a given Performance Issue, along with the 5-point EVADDES scale as follows:

Level 1 AWARENESS	Level 2 INITIATION	Level 3 CONFORMITY	Level 4 Pro-ACTIVE	Level 5 LEADERSHIP

3. Conclusions and Outlook

New knowledge contributes to new risks. The current wave of "digital revolution" is not always creating "responsible value" in the sense of results in compliance with declared societal considerations of security, justice, or environmental sustainability [7]. In this respect, the challenge of reducing material wastes and, in particular, reducing the toxicity of solid, dissolved and suspended waste flows into our environment, is certainly one of the most urgent problems of our times [9].

Our paper opened with a heuristic framework for the identification of the full spectrum of actors, quality issues and impacts associated with HERE activities. In this way, we advocate the development, in an experimental way, of innovative approaches to the appraisal of HERE performance across the full spectrum of quality criteria and the full spectrum of stakeholders. This will necessitate but also contribute to, continuous improvement in HERE competences. Our suggestion is that, as a part of a proactive strategy of digital transformation, new HERE practices and capacities in support of sustainability can be developed in highly collaborative ways — including the initiation of academic and administrative staff, as well as students in contributions to HERE sustainability strategies and to the use of auto-evaluation and auditing tools. We have tried, through our examples of innovative approaches to on-campus material recycling, to show how environmental awareness and engagement in "good practices" can be relayed through social networking tools allowing students to share their waste management suggestions, evaluate the pros and cons of different proposed actions, and thus contribute in a "bottom-up" way to HERE sustainability strategy development, monitoring and auto-evaluation. The collaborative tools and practices are vehicles of collaborative learning, and, as such, their design and use become themselves an object of teaching and research [10, 11].

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The 5th International Workshop on UI GreenMetric
Cork, Ireland, 14-16 April 2019

Sustainability Culture at USP –São Carlos Campus

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Abstract. The University of São Paulo launched its Environmental Policy in January 2018, based on several years of experience in projects aimed at improving its socio-environmental performance. So, This paper aims at presenting some of the results of the USP's project Culture of Sustainability, that seeks to create a baseline of the level of sustainability culture in the USP community, a project to monitor the impact of its environmental policy. To measure the university's sustainability culture, two components must be integrated - the behavioral aspect, and the eco-efficiency of the system. A questionnaire was applied for students, staff and teaching staff of the campus of USP-São Carlos to map behavioral aspects related to transportation, food, solid waste, energy, green areas, and engagement in outreach activities for sustainability. Indicators used in the UI GreenMetric platform will provide performance information about the eco-efficiency of the system.

Keywords: Culture, Sustainability, University, Community, Environment.

1. Introduction

University campuses management should be presented as good practices laboratories for innovation in diagnostic systems and monitoring of pressure on natural resources and socioeconomic aspects [1] [2] [3]. This discussion falls on university's role of being a best practices model of sustainability. Actions must be inserted in: purchasing processes, focusing on products with social responsibility certification and opting for organic products with local production; waste prevention of paper and disposable products; water and electric energy saving; building facilities focusing on thermal comfort, having technologies such as green roofs and larger windows for lighting optimization; outreach programs focused on dialogue and social actors empowering regard the sustainability theme, so that they also become agents of change and leadership committed to the theme; courses and disciplines with teaching processes focused on sustainability; and encourage, through events, academic media and other vehicles, a culture focused on actions towards a sustainable conduct, among several other initiatives [4].

The University of São Paulo (USP) launched its Environmental Policy in January 2018, based on several years of experience in projects aimed at improving its socio-environmental performance. This process consisted in a long participatory process that involved students, staff and faculty. The policy is structured around eleven thematic axes: I - administration; II - water and effluents; III - green areas and ecological reserves; IV - sustainable buildings; V - environmental education; VI - greenhouse gas emissions and gaseous pollutants; VII - energy; VIII - fauna management; IX - mobility; X - waste; XI - territorial use and occupation.

In this context, it is important to insert the concept of Sustainability Culture, which can be understood as values, behaviors and levels of understanding and commitment, degrees of integration and dispositions within a community aligned with the concept of sustainable development. Marans defines the culture of sustainability as "the culture in which individuals are aware of major environmental (and social / economic) challenges, behave in sustainable ways, and are committed to a sustainable lifestyle for both present and future" [5].

To create a baseline on the level of sustainability culture in the USP community, the University of São Paulo, through the Research and Outreach Nucleus in Sustainability and Sanitation, in partnership with the Graham Sustainability Institute of the University of Michigan, and the Environmental Management Superintendence of USP initiated a project to monitor the impact of its environmental policy. To measure the university's sustainability culture, two components will be integrated. The first deals with the behavioral aspect, which refers to monitoring how people are changing their attitudes related to themes such as mobility, shopping, food, etc., to better align with the concept of sustainability. The second component is eco-efficiency, concerning to more efficient productions practices, goods and services, whilst continuously reducing natural resources consumption and pollution emission. By way of explanation, measuring eco-efficiency on the university campus is to calculate the academic impacts and services produced at its facilities concerning to the level of pressure it exerts on natural resources. Part of the indicators used in the UI GreenMetric platform provides performance information.

2. Results

The first questionnaire applied in 2016 was structured around six themes: transportation, food, solid waste, energy, green areas, and engagement in outreach activities for sustainability. The questionnaire was applied to students, faculty and staff of the campus of USP-São Carlos, and had 1287 answers, out of a total of 9279 university students, according to Table 1. For the application of the questionnaires, the Survey Monkey Software was used.

Table 1. Number of people that answered the Sustainability Questionnaire at USP-São Carlos in 2016

Category	Respondents	Total
Graduation Students	571	4752
Postgraduate Students	167	3142
Faculty	199	586
Staff	350	799
Total	1287	9279

In the respondent's opinion, the completion time of the questionnaires applied in 2016 was the main negative point, since it was very long. In 2018 the questionnaire was reapplied on the São Carlos campus. The main change was the reduction of the questionnaire with the withdrawal of several questions, reducing the conclusion time in half.

Table 2. Number of people that answered the Sustainability Questionnaire at USP-São Carlos in 2018

Category	Respondents	Total
Graduation Students	703	4752
Postgraduate Students	496	3142
Faculty	126	586
Staff	645	799
Total	1970	9279

A much more significant number of responses can be observed in 2018, with the exception of faculty respondents.

The following topics present results of the 2016 survey, for transportation, waste and green areas.

2.1. Sustainability culture research at USP: Theme – transportation

According to the Ministry of the Environment [6], increasing urbanization rates and the limitations of collective transportation policies lead to a significant increase in cars and motorcycles that circulate in cities. This pattern is unsustainable, causing negative environmental impacts, such as air quality degradation and global warming; and it compromises life quality, as it increases noise levels, can cause accidents and stress.

The project "USP's Culture of Sustainability" evaluated (concerning to 2016 answers) how much USP's students, faculty and staff are sensitized on this issue and if they promote effective actions for behavior changes. In relation to the use of public transport, 49.31% of faculty and 42.91% of staff agreed that people should use it even if it is less convenient (Fig. 1) and 62.5% of faculty and 58.20% of staff agreed that people should ride a bike or walk even if it is less convenient (Fig. 2). Nonetheless, when questioned about which means of transport, they use most to go to university and elsewhere, most faculty and staff responded that they use car (Fig. 3 and Fig. 4). For undergraduates and graduate students, it is more common to walk to university and other places (Fig. 3 and Fig. 4).

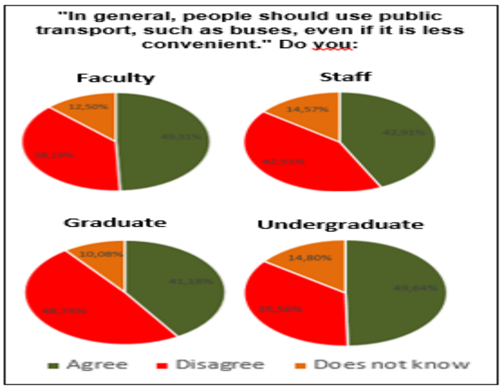

Figure 1. Responses from Faculty, students and Staff to the Sustainability Questionnaire

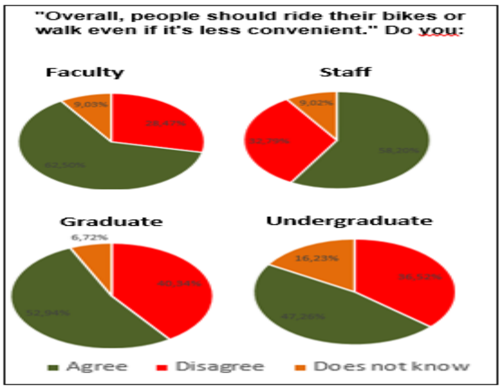

Figure 2. Faculty, Student and Staff Responses to the Sustainability Questionnaire

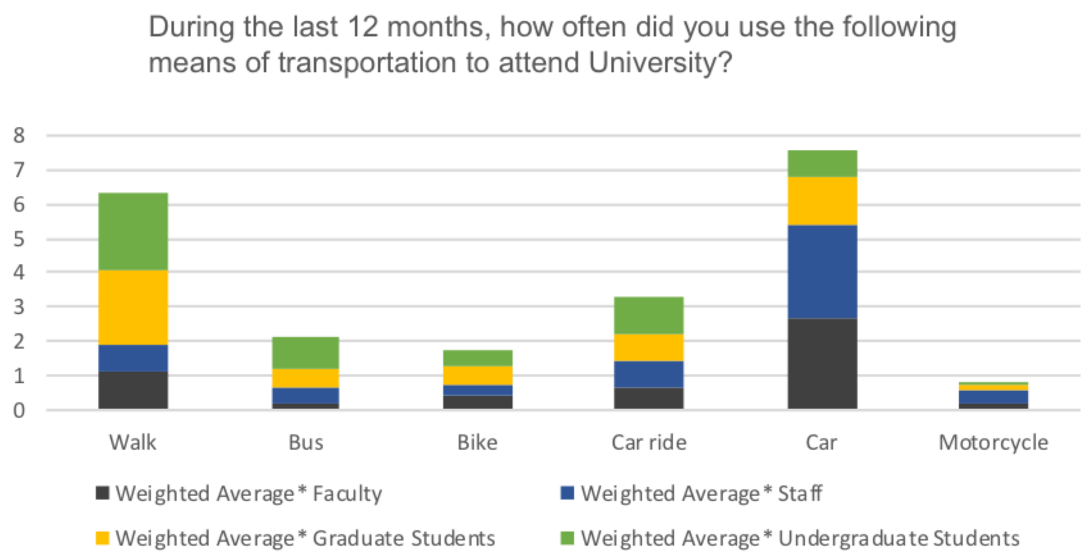

Figure 3. Responses from faculty, students and staff to the question "During the last 12 months, how often did you use the following means of transportation to go to the University?" Of the Sustainability Questionnaire

* Values obtained by means of the weighted average, that is, the assignment of values from different amounts (Never = weight 0; Rarely = weight 1; Sometimes = weight 2; Almost Always / Always = 3)

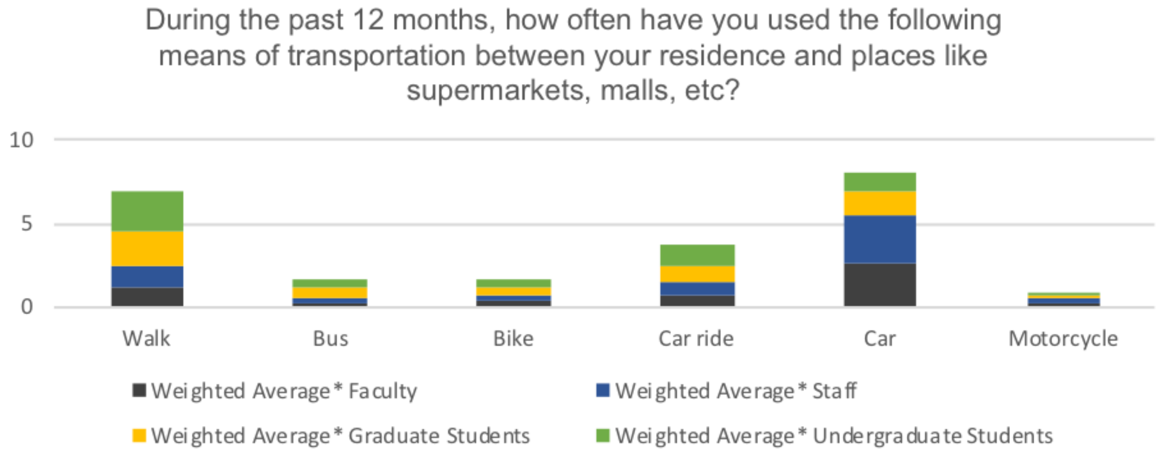

Figure 4. Responses from faculty, students and staff to the question "During the past 12 months, how often did you use the following means of transportation between your residence and places like supermarkets, malls, etc.?" Of the Sustainability Questionnaire

* Values obtained by means of the weighted average, that is, the assignment of values from different amounts (Never = weight 0; Rarely = weight 1; Sometimes = weight 2; Almost Always / Always = 3)

The presented results display that there is still a mismatch between the discourse and the practice. The university tackles to address associated factors with this issue and that education, awareness and management actions can contribute to greater alignment with Sustainable Development.

2.2. Sustainability culture research at USP: Theme – waste prevention

Energy saving is a relevant and very important effort for environmental protection. In Brazil, for example, most of the electricity is generated by means of hydroelectric plants. Thus, reducing energy consumption also reduces the pressure on water resources, the main basis for energy generation. In addition, the more energy is used, the greater the need to build infrastructures for its generation, which leads to increased money spending and the risk of social and environmental impacts.

The project "USP's Culture of Sustainability" evaluated the efforts that students, faculty and staff of the USP-São Carlos campus promote to save energy at home and university. Most faculty, staff and students reported that they do the following energy-saving actions at the university: they close windows and doors when air conditioner is on, followed by turning off the lights, using natural lighting and ventilation; and turning off electronics when not in use. However, informing and sensitizing others is the activity performed less frequently by all categories.

It is also noted that the weighted average number of people closing windows when the air conditioner is turned on, is higher than the weighted average of people using natural lighting and ventilation. This indicates that sustainability related to air conditioning is more frequent among people (Fig. 5).

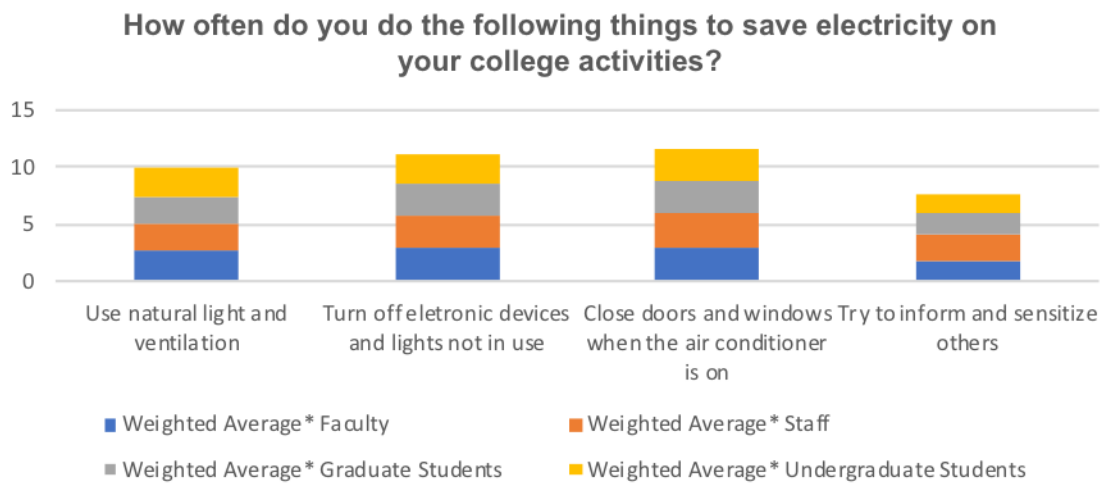

Figure 5. Faculty, Student, and Staff Responses to the Question "How often do you do the following things to save electricity on your college activities? of the Sustainability Questionnaire

* Values obtained by means of the weighted average, that is, the assignment of values from different amounts (Never = weight 0; Rarely = weight 1; Sometimes = weight 2; Almost Always / Always = 3)

Concerning sustainable actions promotion at home, the most frequent response for faculty, staff and students was "to turn off the lights when leaving the room". It is observed that it was more frequent for faculty and staff to report that they buy food with environmental certification and compost food than undergraduate and postgraduate students (Fig. 6), probably given the cost for certified food; concerning composting, it is required large spaces such as gardens, for example. Students usually live in apartments and small houses, the bigger the garden, more expensive it is the rent.

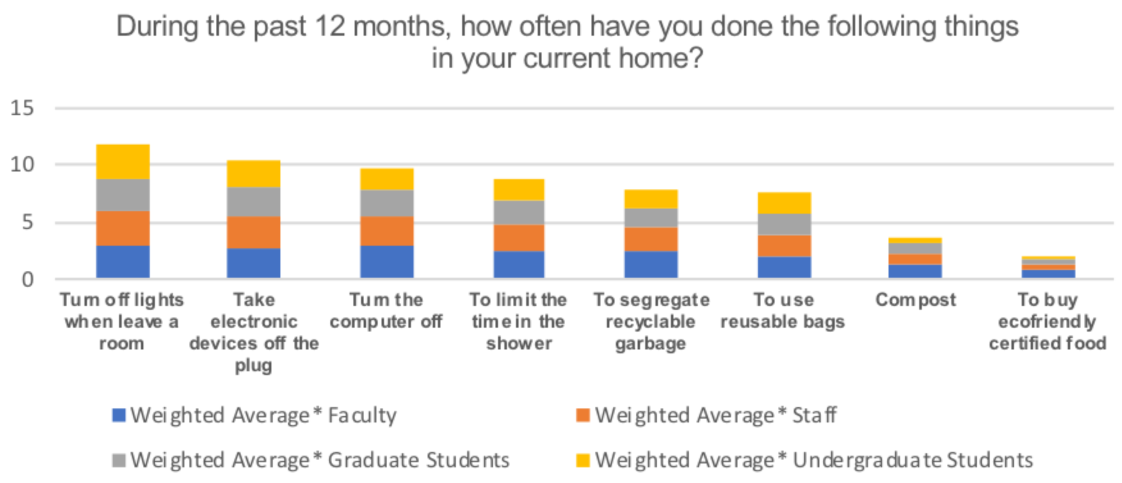

Figure 6. Responses from faculty, students and staff to the question "During the past 12 months, how often did you do the following things in your current home?" Of the Sustainability Questionnaire

* Values obtained by means of the weighted average, that is, the assignment of values from different amounts (Never = weight 0; Rarely = weight 1; Sometimes = weight 2; Almost Always / Always = 3)

Most of São Carlos's USP waste, according to what faculty, staff and students observe, comes from excess of lights, followed by unnecessarily air conditioning and ventilator usage, deregulated faucets and discharged toilet flushing (Fig. 7).

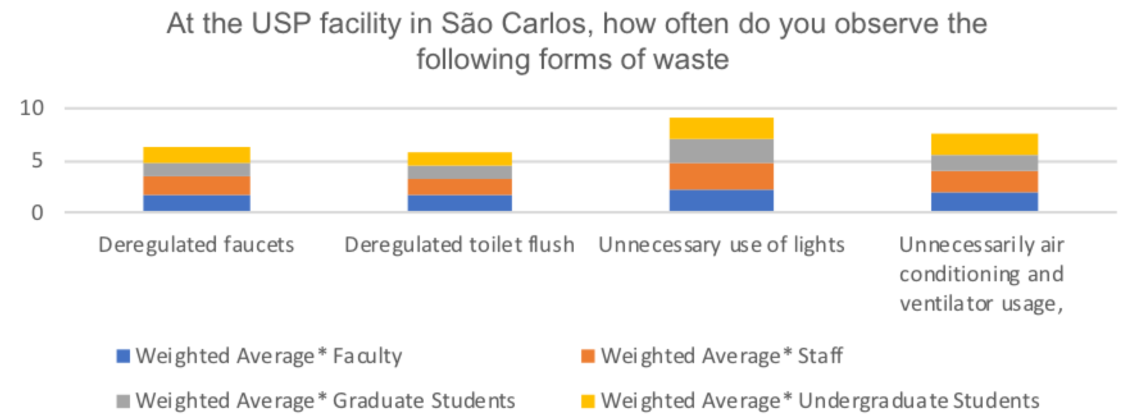

Figure 7. Responses from faculty, students and staff to the question "At the facilities of São Carlos USP, how often do you observe the following forms of waste" of the Sustainability Questionnaire.

2.3. Sustainability culture research at USP: Theme – green areas

Green areas have many environmental benefits in life quality. They are important for environmental balance, climate regulation, leisure and recreation, etc. The project "USP's Culture of Sustainability" evaluated whether students, faculty and staff of USP are aware of its importance. Most faculty, staff and students responded that they believe that the USP-São Carlos campus green areas provide external thermal comfort and make the university environment more pleasant (Fig. 8). However, most of the respondents do not promote or participate in activities carried out in the campus green and native vegetation areas (Fig. 9 to 12).

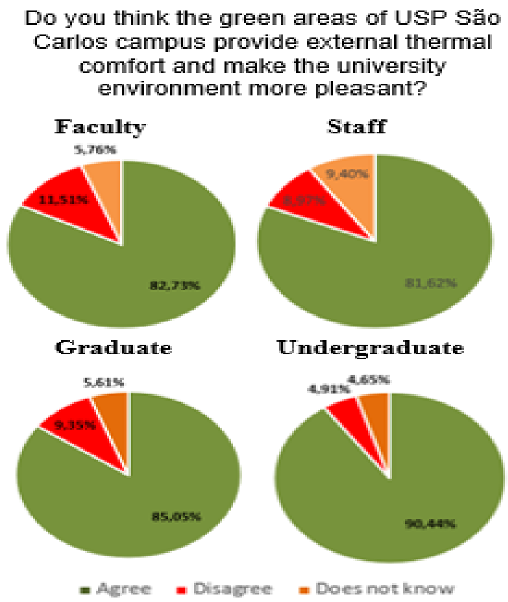

Figure 8. Responses from faculty, students and staff to the Sustainability Questionnaire

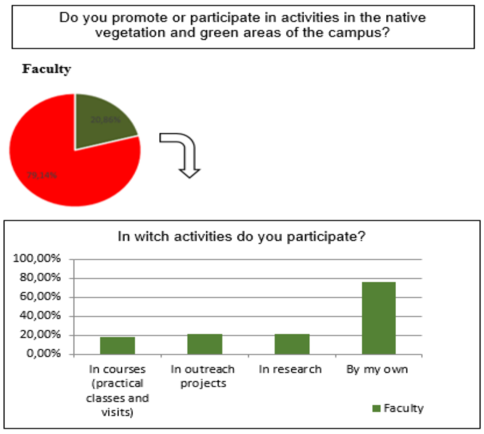

Figure 9. Responses from faculty to the Sustainability Questionnaire

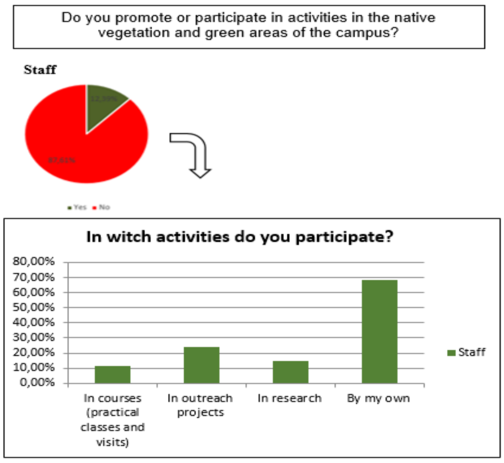

Figure 10. Responses from staff to the Sustainability Questionnaire

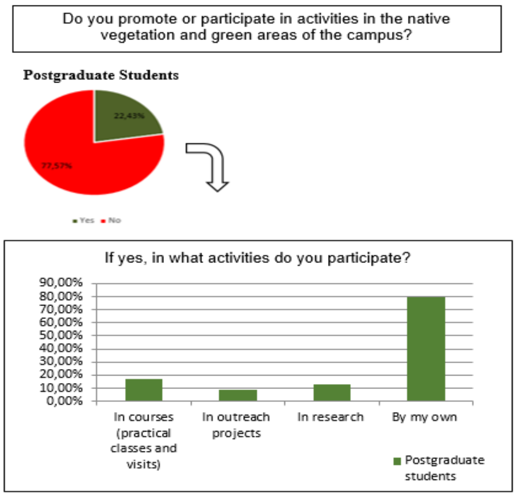

Figure 11. Postgraduate students' responses to the Sustainability Questionnaire

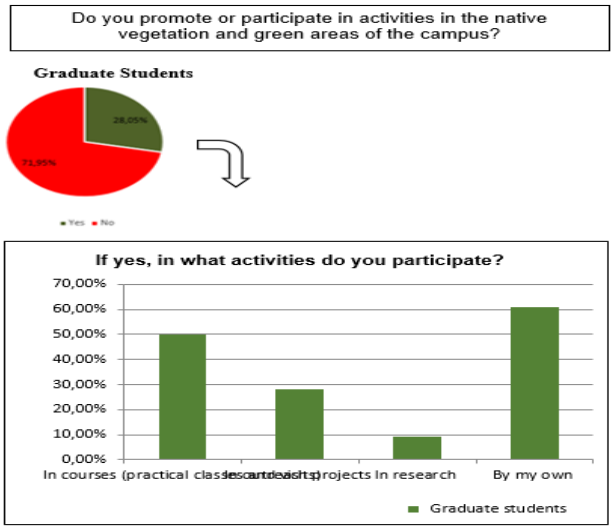

Figure 12. Graduates' responses to the question "Do you promote or participate in activities carried out in the green and native vegetation of the campus?" Of the Sustainability Questionnaire

It can be observed that there are no actions that encourage the green areas usage aiming at an improvement in the quality of life.

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Engagement of Students toward Single Use Plastics Reduction in KMUTT Thailand

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Abstract. King Mongkut's University of Technology Thonburi (KMUTT) committed to be Sustainable University for SDGs 2030 since 2017 which comply the global and national sustainable agenda and to promote the development of sustainability leadership "Green Heart" on our campus. KMUTT Green Heart Student Team are students who interested in sustainable environment which make the university community more green and better quality of life. In 2018 the Green heart team launch "KMUTT Say no to single use plastics" project which comply to National Agenda, University Policy and SDG 2030 Goal 12 and Goal 13. The objective of this project is no BIG 4 (Plastic Bags / Plastic Bottles / Plastic Straws / Plastic spoon and fork) single use plastics usage within KMUTT by the year 2020. KMUTTOneLess campaign has been started on August 2018 with the commitment from everyone in KMUTT to reduce one from the BIG 4 single use plastics on their starting. The results in the 5 months' operation (August – December 2018) showed 63% reduction on BIG 4 single used plastics usage within the university. The results achieved along with the decrease of greenhouse gas emissions and waste disposals within university.

Keywords: Single use plastics reduction, student engagement, sustainable development goal, sustainable leadership, waste management

1. Introduction

King Mongkut's University of Technology Thonburi (KMUTT) is one of Science and Technology university in Thailand which committed to be sustainable university which comply the global and national sustainable agenda. Sustainability is one of the major challenges of current and future generation of students & staff. KMUTT plan to educate our students and encourage them to learn outside classroom and transform its campuses to be an ideal environment for developing awareness and innovative solutions to relevant problems that will improve the world for current and future generations. KMUTT has a responsibility to contribute the national sustainability agenda and to promote the development of sustainability leadership on our campus. To promote the development of sustainability leadership, KMUTT provides a sustainable activities platform to educate /encourage/ promote the development of sustainability leadership "Green heart "within our university and communities by using SEP for SDG concept. The student engagement is a key role to make campus sustainability and help communities surrounded have a better quality of life. The purpose of this study is to share one of our experience of student engagement on KMUTT Waste management by using 'KMUTT Say no to Single use plastics "project with KMUTTOneless campaign."

2. Methodology

2.1. Municipal solid waste management system in KMUTT

Waste management play a key role in SDG 2030 Agenda, especially in the Sustainable Development Goals (SDGs) for sustainable cities and communities (SDG 11), responsible consumption and production (SDG 12). Developing fully-functional waste management systems and a circular economy contributes positively to achieving Good health and wellbeing (SDG 3), and climate action (SDG 13). Waste is one of environmental problems of national concern according to the lack of improper management. KMUTT is one of educational institute who has a significant environmental impact including hazardous waste and municipal solid waste and try to reduce this impact with possible save the university resources and money. The Municipal Solid Waste

(MSW) management system within KMUTT has been developed since 2002 and revised in 2012 which comply for the new standard. The system consists of three main parts: waste segregation, waste collection and waste utilization. In this system, the MSW were separated into 5 difference types including organic waste (Green), recycled waste (Yellow), non-recycled waste (Blue), toxic waste (Red) and workshop waste (Grey) according to KMUTT activities and standard practices. The waste collection has been kept by proper waste containers, waste transportation and waste collection center as shown in Fig. 1.

Figure 1. Municipal solid waste management system in KMUTT

The KMUTT Municipal Solid Waste showed the high percentage of Non-Recycle Waste which most of them are Single use plastics as shown in Fig. 2.

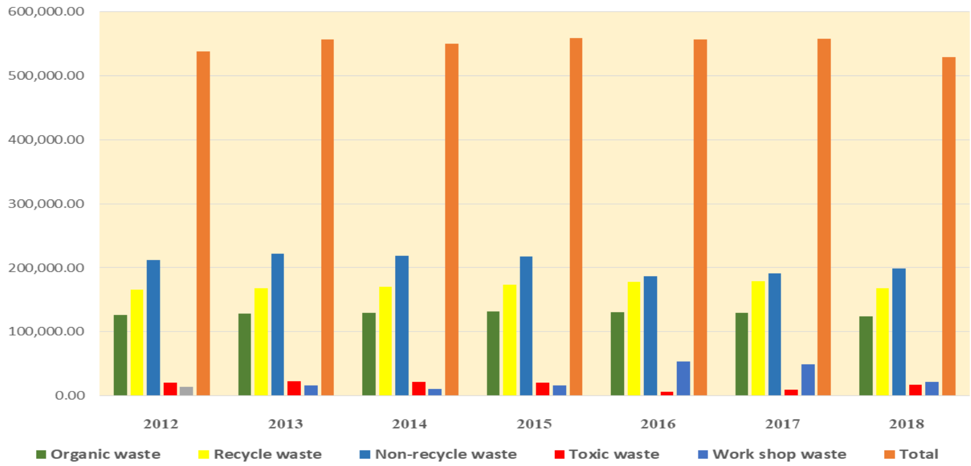

Figure 2. Data collection of KMUTT Municipal Solid Waste (2012-2018) showed the high percentage of Non-Recycle Waste which most of them are Single use plastics

2.2. ‘KMUTT say no to single use plastics “project

In 2018 the Green heart team launch “KMUTT Say no to single use plastics” project since August 2018, which comply to National Agenda, University Policy and SDG 2030 Goal12 and Goal13. The objective of this project is no **BIG 4 (Plastic Bags / Plastic Bottles / Plastic Straws / Plastic spoon and fork)** single use plastics usage within KMUTT by the year 2020. KMUTTOneLess campaign has been started on August 2018 with the commitment from everyone in KMUTT to reduce one from the BIG 4 single use plastics on their starting.

2.2.1. Green Heart Team brainstorming and set up their goal

To find the way to reduce single use plastics within the university, the Green Heart Team from KMUTT Petchra Pra Jom Klao Scholarship Students set up the brainstorming section and focus on goals and targets by using design thinking concept as shown in Fig. 3. The results from this brainstorming are the ultimate goal “No BIG 4 plastics within KMUTT by 2020 “with goals, targets and implementation plan for each year from 2018-2020.Fifty members of the Green Heart Team have been joined from the starting.

Figure 3. Green Heart Team brainstorming section on June 2018

2.2.2. Posters and medias

On the 2018 implementation plan, the Green Heart Team start their campaign from June 2018 by using posters and various media /channels including social media for communications to target groups as shown in Fig. 4. These have been done on roadshows, counting down activities to Say no to Single use plastics for all in KMUTT and expansion for new Green Heart members to join the activities.

Figure 4. Posters and media "KMUTT Say No to single use plastics"

2.2.3. Roadshow for D-Day "Say No to single use plastics in KMUTT"

The Green Heart Team make their plan to walk around KMUTT and announce their campaign for all in KMUTT to know July 25, 2018 is Our D-Day for **"Say No to Single Use Plastics in KMUTT"**: Moreover, all food services, convenient store and Coffee shops in KMUTT join this campaign as network to implement. "They launched the new campaign "No plastic bag usage and use cotton bag for shopping "in KMUTT . They added more activities which all in KMUTT can join in the games playing on **"Say No to Single Use Plastics in KMUTT"**and get rewards such as water mugs, lunch boxes and cotton bags. For these activities ,more than 10,000 students joined the campaign.

Figure 5. D-Day announcement "KMUTT say no to single use plastics"

2.2.4. Expansion to get new Green Heart members

KMUTT provided the Green Heart Camp for the First Year Students on August 2018. The Green Heart Camp is the 2 nights /3 days camping with provide the learning spaces on sustainaility and Green activities by using Play and Learn concept. More than 500 of the first-year students join this camp and some join to be the new member on "KMUTT say no to SingleUse plastics"

2.2.5. #KMUTTONELESS: Initiative model for no single use plastics at KMUTT

KMUTTOneLess campaign has been started on August 2018 with the commitment from everyone in KMUTT to reduce one from the BIG 4 single use plastics on their starting. This initiative model make all in KMUTT accept this campaign and willing to join.

Figure 6. #KMUTTONELESS by Green Heart Team on Freshman Orientation

3. Summary/ Concluding Remarks

According to the objective of this project is no BIG 4 (Plastic Bags / Plastic Bottles / Plastic Straws / Plastic spoon and fork) single use plastics usage within KMUTT by the year 2020. KMUTTOneLess campaign has been started on August 2018 with the commitment from everyone in KMUTT to reduce one from the BIG 4 single use plastics on their starting. The results in the 5 months' operation (August – December 2018) showed 63% reduction on BIG 4 single used plastics usage within the university compare to 2017 as shown in Table1.

Table 1. 63% reduction of Big 4 single use plastics usage at KMUTT (August – December 2018)

Plastic Big 4	2017 (Piece)	2018 (Piece)	Compare
Plastic Bags	890,000	300,100	-66%
Plastic Glasses	470,000	197,000	-58%
Plastic Straws	550,000	193,000	-64%
Plastic spoon and fork	50,000	27,000	-46%
Total	**1,960,000**	**717,100**	**-63%**

The purpose of this study is to share one of our experience of student engagement in KMUTT Waste management by using 'KMUTT Say no to Single use plastics "project with KMUTTOneless campaign". The results achieved along with the decrease of greenhouse gas emissions and waste disposals within university according to the student engagement.

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Waste Management System at Chaoyang University of Technology

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Abstract. Chaoyang University of Technology (CYUT) was established in 1994 and located in the southeastern suburb of Taichung City, Taiwan. In order to demonstrate the determination about promotion of the Green University, CYUT has signed the "Talloires Declaration" in 2009. To actively implement the ”Talloires Declaration” and achieve the social responsibility and tasks of the university, CYUT and several universities in Taiwan co-sponsored the establishment of the "Green University Union of Taiwan" to promote the concept of environmental sustainability in 2012. CYUT promotes the Green University's four perspectives in the campus, namely, "Energy and Resource Management", "Disaster Prevention and Management", "Occupational Safety and Health Management" and "Environmental Management". The perspectives have been realized by four projects including ”Introduction of Management System", "Planning and Management of Sustainable Curriculum", "Promotion of Sustainable Events" and " Development of Sustainable Environment". In terms of waste management, the ISO 14001 environmental management system has been induced to manage the campus waste completely. The practical activities enhancing the environmental awareness of teachers and students consist of waste reduction, resource recovery, waste recycling and reusing.

Keywords: Green university, ISO 14001, talloires declaration, waste management

1. Introduction

Waste is generated more or less in our daily activities. According to the 2017 annual report of the Taiwan Environmental Protection Agency (EPA), the annual waste produced in Taiwan includes general waste, resource waste and kitchen waste. The total amount of waste is more than 7 million metric tons estimated by 330 kilograms of waste per year per person [1]. Each Taiwanese produces about half of the waste in comparsion with the United States people, that is equivalent to Japan and the European Union [2]. In order to reduce the burden of waste disposal, the Taiwan EPA promoted the "Recycling Four-in-One Project" in 1997, mainly is conducted by the "community people" to classify and recover resource waste at various households. In addition, "Local Government Cleaning Team", "Recyclers" and "Recycling Funds" are also conected with community to execute this project. Through the integration of four groups, a complete recycling network will be established to ensure that resource items are actually recycled or properly disposed of. The participating people, cleaning teams and recyclers can receive reasonable profits or rewards to stablize this recycling system [3]. Moreover, the entire Taiwanese implementation of waste compulsory classification has been developed since 2006; the national resource recovery rate greatly increased from 38.7% in 2007 to 59.5% in 2017.

Although Taiwan’s resource recovery rate has exceeded 50%, more efforts should be made. To the consideration of marine litter issue, there were 8 million tons of plastic waste thrown into the sea in 2010 according to the National Geographic magazine. Even worse, ten times of 8 million tons of plastic waste will be dump in the ocean the next decade unless people find a new way to improve the garbage collection and treatment [4]. The wild fish in the ocean will probably be extinct by 2048 if such situation does not improve according to Taiwan TVBS News [5]. Of course, this situation is resulted from human overfishing and the deterioration of the marine environment as well.

CYUT have established a comprehensive system of waste classification and storage facility to promote the concept of garbage separation among teachers and students to implement waste reduction. Being a green university is one of the most important goal of CYUT. Therefore, it is our mission and social responsibility to cultivate students with environmentally literacy.

2. Strategy of Green University Promotion

2.1. Brief introduction of CYUT

Founded in 1994, CYUT is an emerging university with 5 colleges including management, science and engineering, design, humanities and social sciences, informatics, 22 departments, 22 master classes, and 5 doctoral programs. There are about 16,000 students and more than 600 full-time faculty members at CYUT. The univdersity is located in the hilly southeast of Taichung City, Taiwan (Fig. 1) and covers an area of 66.4 hectares to build up #1, #2 campuses based on the development schedule (Fig. 2). The first campus is the main campus that provides classrooms, laboratories and space for teachers and students. The 2nd campus is located 3 kilometers southeast of the 1st campus and covers an area of 39 hectares. It is currently fully planted that can fix around 290 CO_2e metric tons per year.

Figure1. Location of CYUT

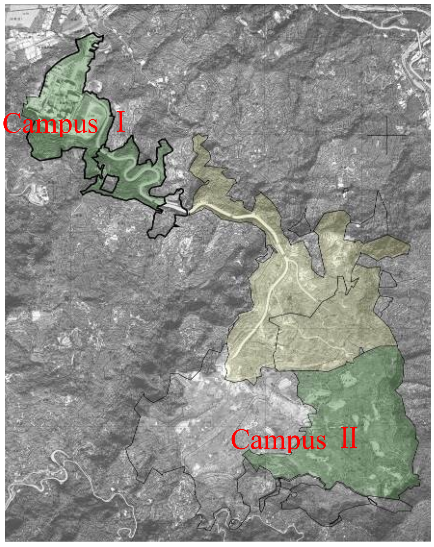

Figure 2. CYUT campus

2.2. Policy of Green University Promotion

With reference to the United Nations Sustainable Development Goals and the environmental characteristics of Taiwan, CYUT promotes green university policy with four perspectives of "Energy and Resource Management", "Disaster Prevention and Management", "Occupational Safety and Health Management" and "Environmental Management". The perspectives have been realized by four projects shown in Fig. 3 including ”Introduction of Management System", "Planning and Management of Sustainable Curriculum", "Promotion of Sustainable Events" and " Development of Sustainable Environment". In order to achieve the goal of sustainable and low-carbon campus, teachers and students integrate the concept of green and sustainable ideas into daily life through learning, living and experience outside world [6].

Figue 3. Policy of green university promotion

2.3. Signature of Environmental Policy

In order to demonstrate the determination of sustainable development and low-carbon campus, the "Environmental Policy" had been signed by the president of CYUT in 2007 (Fig. 4). In addition, the determination to implement disaster prevention and management had been declared. An annual environmental policy review is conducted and amended. The environmental policy content of CYUT is shown as the following:

Chaoyang University of Technology adheres to the vision of "Cultivating in Taiwan, Striding to world, and Sustaining Growth" and is implementing the ISO 14001 Environmental Management System based on the understanding of environmental protection, the concept of improving environmental quality and the responsibility of higher education to society. With regards to this, we make commitments:

1) to reduce energy, save resources and continuously maintain the improvment to become a sustainable campus.
2) to implement pollution prevention and comply with relevant laws and regulations.
3) to promote waste classification and reduction, and create a high-quality campus environment.
4) to strengthen education and enhance the environmental awareness of all employees.

Figure 4. CYUT environmental policy signed by the president

3. Waste Management

According to the Taiwan Waste Management Law and the "Waste Management Procedures"of CYUT" based on ISO14001 Environmental Management System, all waste generated in the campus is divided into two categories: general business waste and hazardous business waste. The general business waste includes non-hazardous waste such as domestic waste, in-situ factory waste wood, and sludge generated from waste water plants. The hazardous business waste include biomedical waste from the health center and that from the chemical laboratory (Fig. 5). The waste management process of CYUT is shown in Fig. 6.

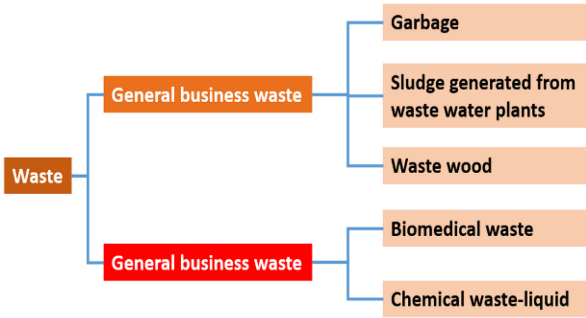

Figure 5. Campus waste classification

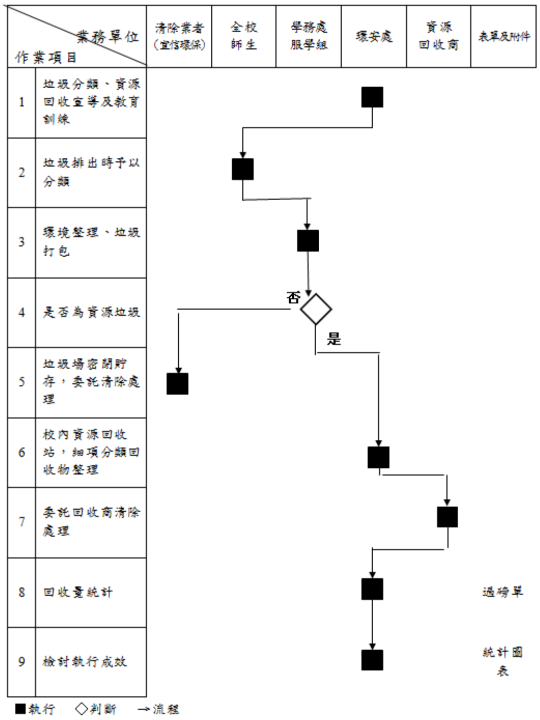

Figure 6.The management flow chart of general waste at CYUT

3.1. General business waste

A. Domestic garbage (general waste): In order to maintain the clean environment around the garbage storage site, garbage is stored in a closed compression mode, and is requested to be sent to the municipal waste incinerator for daily disposal. In addition, defoliation, kitchen waste, waste oil, and waste wood are reused.

B. Sludge (general business waste): It is the waste generated by the wastewater treatment plant. Such sludge can be attributed to genetal waste based on the result of the toxicity characteristic leaching procedure (TCLP). The school irregularly request the removal of the clearing process.

3.2. Hazardous business waste

The school's hazardous waste is mainly laboratory chemical waste-liquid and biomedical waste. The biomedical waste is wound-dressing waste produced by the health center. The school's waste-liquid classification is divided into six categories according to its chemical characteristics: cyanide, inorganic acid, alkaline, heavy metal, non-halogen solvent, halogen solvent.

3.3. Resources reusage

a. The defoliation is concentrated and stacked: the falling leaves of the school district are concentrated and piled up. After the pile is completed, it can be used for soil improvement. Not only to reduce the garbage disposal fee, but also to improve the soil quality of the campus.

b. In cooperation with the "Innovative Center of Sludge Recovery" of CYUT, the treated sludge has been used for campus soil improvement. Fig. 7 shows the soil improvement test of the harmless sludge.

Figure 7. Soil improvement test of treated sludge (left: experimental test, right: control test)

c. The tree branches are crushed and used for paving and laying garden, which reduces weed growth and soil conservation to avoid soil loss. Fig. 8 shows the crushing process and application of tree branches.

Figure 8. The crushing process and application of tree branches (left: crushing process, rihgt: paving and laying garden)

d. Environmental education courses for the recycling of design resources. CYUT is an environmental education facility approved by the EPA of the Executive Yuan. The environmental education courses include reuse knowledge such as waste wood, waste optical discs and waste bottles. Fig. 9 shows course to teach how to use tree branches and waste wood to make an owl refrigerator sticker and a pen holder.

Figure 9. The course to teach how to use tree branches and waste wood

e. Food waste: the kitchen waste produced by the school's restaurant is sent to the resource recycling yard that is managed by an assigned person. The raw kitchen waste (Fig. 10) is sent to manufacture compost and organic fertilizer those are incorporated into the defoliated compost as the soil improvement for hillside and campus soil. The cooked kitchen waste provides pig farmers for pig use.

Figure 10. Compost of raw kitchen waste

f. The "Second-hand Book Zone" was set up to co-operate with the school's bookstore. Used books of teachers and students can be sent to bookstore to get discount coupon. The used books are sold through the bookstore selling system, so that the "all books are used to the best of their ability" can be fulfilled. The second-hand book area of CYUT is shown in Fig. 11.

Figure 11. Second-hand Book Zone

g. CYUT established an honest shop to promote the education of cherished materials and moral acknowledge in 2015. Teachers and students can submit items that are still available on the honest store shelves. People who needs these items can pay by listed price and retrieve them (Fig. 12). The proceeds from the sale are used as a student's emergency aid.

Figure 12. Honest shop

h. The establishment of the "CYUT Second-hand Auction Platform": Due to the conduct of environmental education in campus, students set up a second-hand auction website as an exchange platform for teachers and students. Currently, there are more than 9,000 registered members on the website, namely, accounting for 56% of the total number of students (Fig. 13).

Figure 13. CYUT Second-hand Auction Platform

4. Performance of Waste Management

4.1. Effectiveness of waste reduction

CYUT has achieved satisfactory results by the establishment of comprehensive waste storage facilities, promotion of waste sorting and recycling, and development of resource recycling and reuse. Waste has been reduced from more than 400 metric tons per year to 200 metric tons per year. The average amount of garbage produced per person in the past three years was 12.75 kg/year, 12.32 kg/year and 12.18 kg/year, respectively, showing a steady state. If compared with Taiwan's per capita waste of 330 kg / year, it is obviously low. Table 1 lists data of the amount of garbage produced per capita at CYUT from 2016 to 2018.

Table 1. Data of the amount of garbage produced per capita at CYUT

	year		
	2016	2017	2018
General waste(metric ton)	214	201	198
Staffs and students(number)	16,788	16,313	16,254
Garbage produced per person(kg/year)	12.75	12.32	12.18

4.2. Effectiveness of resource recovery

In order to promote the recycling, CYUT formulated the " Implementation Plan of Resources Recycling " in 1997. The classificaiton of resources is based on the characteristics of recycling garbage (waste paper, waste plastics, scrap metal, etc.), fallen leaves and kitchen waste (including waste cooking oil). The amount of various types of resources is monthly computed. A review will be conducted if there is an abnormality. The average recovery rate in the past three years was 30.5%, 36.6% and 36.2%, respectively. Table 2 lists data of resource recovery at CYUT.

Table 2. Data of resource recovery at CYUT

		Year		
		2016	2017	2018
General Waste (metric ton)		214	201	198
Recovery rate (%)		30.5	36.6	36.2
Amount of resources (metric ton)	recycling garbage	54.92	55.7	57.18
	Kitchen waste, cooking oil	19.36	33.1	30.4
	Fallen leaves	21.0	26	25
	Summary	95.28	114.8	112.58

5. Conclusions

Although there have been waste problems caused by the human civilization, the problem of waste has become more and more serious due to the impact of economic growth and industrialization. In addition to the large amount of money to be consumed to treat waste, more seriously, environmental problems have not been properly handled such as marine pollution issue. Because the school life is one of primary socialized process [7], universities should be in charge of social responsibility to lead the public to face environmental problems.

CYUT started to promote ”waste sorting, resource recovery and waste reduction” from the beginning of its founding in 1994. By implementing the ”labor education system” and ”learning by doing”, students can enhance their environmental literacy and the concept of waste sorting and resource recovery. The statistics data from recent years present that the average amount of waste produced by teachers and students in campus is far below that of household in Taiwan. Consequently, the waste management system of CYUT demonstrated its satisfactory effectiveness.

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The Unique Treatment Facility achieving Zero-Laboratory Wastes Discharge at National Cheng Kung University in Taiwan

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Abstract. The National Cheng Kung University (NCKU) Environmental Resource and Management Research Center (ERMRC) was funded by the Taiwan Ministry of Education in 2003 and has been responsible for the treatment of laboratory wastes collected from schools and universities in Taiwan since 2005. Currently, there are 25 full-time staffs working in the laboratory wastes treatment plant, with a capacity of 1000 tons/yr treating organic/inorganic liquid wastes and combustible/incombustible solid wastes. The three treatment systems for laboratory wastes include Incineration system for organic liquid wastes and combustible solid wastes treatment, Physical-chemical system for inorganic liquid wastes treatment, and Plasma Melting system for incombustible solid wastes. With the Eco-chain treatment processes, treated water from the Physical-chemical system can be recycled as cooling water in the incineration system, and the sludge from the physical-chemical system and fly ash/bottom ash from the incineration system can be further stabilized by the Plasma Melting system, achieving zero-laboratory wastes discharge design concept. The waste heat from the Incineration system was recycled for sludge drying and the synthetic gas from the Plasma Melting system was used as fuel, increasing the energy utilization efficiency in the whole treatment plant.

Keywords: eco-chain treatment, laboratory wastes, plasma melting system, zero-laboratory wastes discharge

1. Introduction

The wastes from laboratories of schools and research institutes are quite different from manufacturing factories. Laboratory waste characteristics include small quantity, multifarious types, toxic, inflammable, corrosiveness, and corrosion. Most schools commissioned the publicly or privately-owned waste management organizations for disposal in the past. However, the Taiwan EPA Waste Disposal Act changed and restrained the privately-owned waste management organizations. As the results, it increases the cost of waste disposal and some wastes from schools' laboratories cannot be managed well and forced to store that inside the schools, increasing the safety risks for students and staffs.

The National Cheng Kung University (NCKU) Environmental Resource and Management Research Center (ERMRC, Fig.1) was funded by the Taiwan Ministry of Education in 2003 and has been responsible for the treatment of laboratory wastes collected from schools and universities in Taiwan since 2005. The NCKU ERMRC not only manages the wastes from school effectively but also develops different technologies for demands. The ERMRC is the first and the only academic research institute with laboratory wastes treatment technology and facilities in Taiwan. The goals and functions of ERMRC are proper storage, collection, and treatment of laboratory wastes generated in universities and schools in Taiwan. The design concepts for the three treatment facilities, as shown in Fig. 2, include high efficiency and low emission operation, wastewater recycling and reuse, energy recovery. The three major waste treatment facilities in the ERMRC include incineration process, physical-chemical process and plasma melting process to approach stabilization, zero hazards and resource recycling. In the treatment processes, we expect to produce nonhazardous solid residues, liquids or gases, so we can maintain a clean and safe environment.

Figure 1. The NCKU ERMRC for laboratory waste treatment

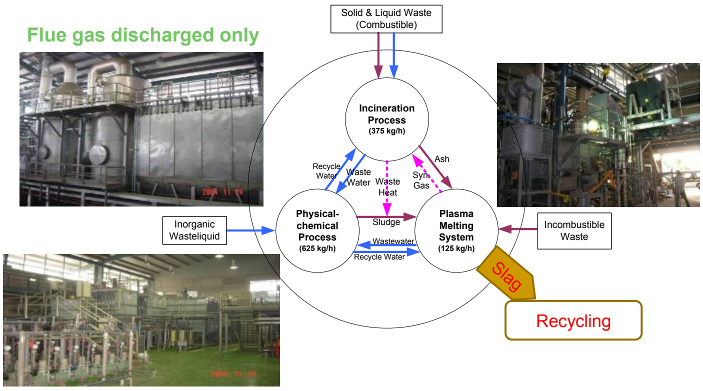

Figure 2. Design concept of ERMRC treatment facilities for Eco-chain treatment processes

2. Characteristics and Classification of Laboratory Wastes

Unlike a large number of industrial wastes produced, laboratory wastes produced form schools and universities are usually with characteristics of small quantity but complicated and high chance of hazardous. In Taiwan, every year about 750 tons of laboratory wastes are generated from schools and universities in Taiwan, and those laboratory wastes are collected using 20 L tanks and then transported to treatment facilities at the NCKU by legal hazardous waste handling and transportation companies. Laboratory wastes are generated by different laboratories, so the waste composition and properties are very different depending on research topics conducted and chemical reagents used in different laboratories. In addition, laboratory wastes are usually identified as hazardous wastes according to the Taiwan EPA regulation for hazardous wastes because heavy metals and toxic solvents are commonly used and found in the laboratory wastes (Table 1). Another property of laboratory waste is mis-labeling frequently found during waste classification procedure in the laboratory and this may increase safety risk during the storage period. In order to minimize mis-labeling issue concerned, the ERMRC of NCKU, based on previous experiences accumulated, develops a waste classification procedure for laboratories as shown in Fig. 3 The laboratory waste stabilization, storage, and safety protection procedure include the followings:

- Uncertain organic wastes are classified as organic wastes with halogen.
- For cyanide wasted liquids, the pH of wasted liquid should be maintained above 11 to avoid toxic HCN gas yield and decrease safety risks during handling and shipping.
- For fluorine and phosphorous containing wasted liquid, calcium salt, like CaO, $Ca(OH)_2$, $CaSO_4$ and $CaCl_2$, should be added to adjust the pH > 7.0 or as the ratio of 1:1.
- Compatibility of various wastes should be concerned during handling and shipping.

Table 1. Typical laboratory waste contents

Analytic items	Organic waste liquids		Inorganic waste liquids	
	Mean	Standard deviation	Mean	Standard deviation
Samples #	500	—	500	—
Heat value (cal/g)	4073	3302	—	—
Water content (%)	27.16	32.47	—	—
Specific gravity	0.91	0.11	—	—
COD (mg/L)	—	—	67933	111544
CN (mg/L)	—	—	90.39	1444
Cl (%)	10.55	17.11	0.93	2.78
S (mg/kg)	1650	10954	8782	36753
Cu (mg/ kg)	43.05	569	1979	12894
Cr (mg/ kg)	26.09	133	241	2077
Cd (mg/ kg)	14.58	8.17	11.26	12.07
Ni (mg/ kg)	4.06	15.07	756	4056
Pb (mg/ kg)	2.77	10.62	88.18	1487
Zn (mg/ kg)	17.58	180	119	749
As (mg/ kg)	1.43	6.74	5.18	36.61
Hg (mg/ kg)	5.98	73.37	122	581

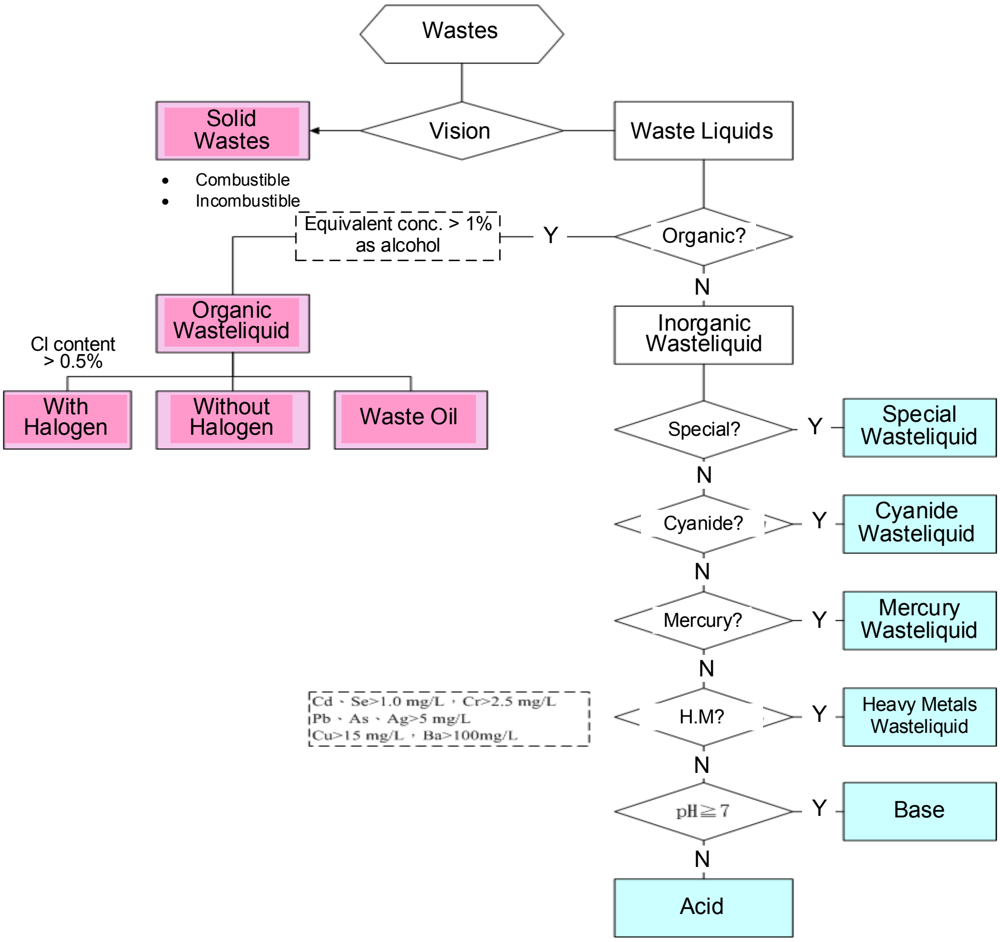

Figure 3. Classification procedure for laboratory waste stabilization, storage, and safety protection

Following the laboratory waste stabilization, storage, and safety protection procedure, laboratory wastes can be classified into the categories of wasted liquids and solid wastes. Wasted liquids are further classified as wasted organic liquids (with or without chloride), wasted inorganic liquids (cyanide, mercury, acid, base, metals), and wasted Oils. Solid wastes category includes combustible and incombustible solid wastes. Based on the waste classification procedure, the laboratory wastes are transported to the NCKU ERMRC for further treatment.

3. Wastes Treatment Facilities

3.1. Incineration process

Incineration process (Fig. 4) included feeder, combustion chamber, quench tower, baghouse, and stack. Operation processes of these facilities are as follows:

1) Feeder: organic waste liquid is transported by pipelines and sprayed by nozzles, and injected into the combustion chamber for thermal treatment. Using oil pressure push rod feed the solid waste into the combustor chamber.
2) Combustion chamber: included primary combustion chamber (operated at 850-950°C) and secondary combustion chamber (operated at 1050°C). Secondary combustion chamber also supplied waste heat to dried dewatered sludge and recycled energy from syn-gas of plasma melting process.
3) Quench tower: decreased flue gas temperature from 1050 to 180°C.
4) Bad house: particulates collection by 200 bags.
5) Packing tower: flue gas de-acid process
6) Stack: flue gas emission; also installed a heater to increase temperature and online monitoring devices.

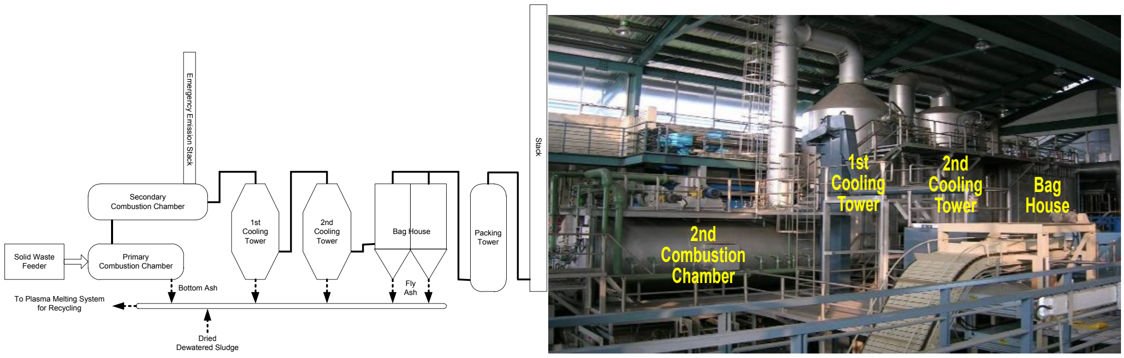

Figure 4. Incineration process for wasted organic liquids and combustible solid wastes

3.2. Physical-chemical process

Physical-Chemical Process (Fig. 6) included pretreatment, CSTR chemical precipitation process, and advanced wastewater treatment facilities. Operation processes of these facilities are shown as followed:

1) Pretreatment: included cyanide, mercury, acid, base and heavy metals batch reactors to treat inorganic wastes with high concentration-variation.
2) CSTR chemical precipitation: treated pretreated solution, and process wastewater from incineration and plasma melting processes by using chemical precipitation process, including pH adjustment, flocculation, and sedimentation.
3) Sludge condenser and dewatering facilities: sediment from pretreatment and CSTR processes are condensed and dewatered by 3 condensed tanks and chamber-plate dewatering facility, respectively.
4) Advanced wastewater treatment facilities: included microfiltration, activated carbon adsorption tank, resin adsorption tank, reverse osmosis, and ultraviolet disinfection.
5) Capacity: 625 kg/h.

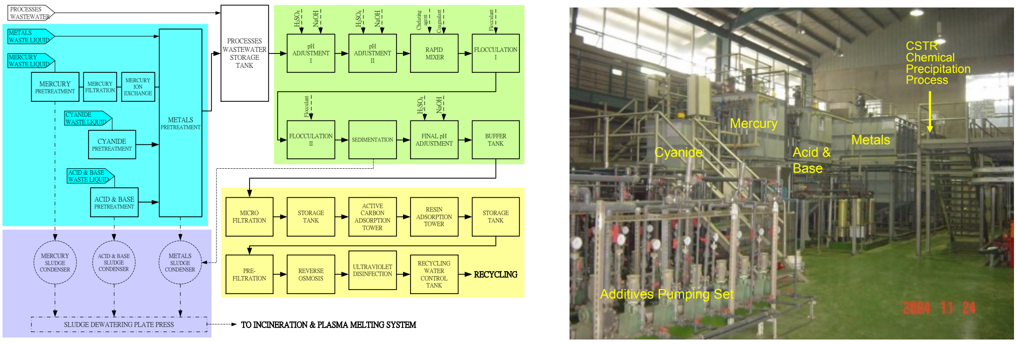

Figure 5. Physical-chemical process for wasted inorganic liquids

3.3. Plasma melting process

Plasma melting process (Fig. 5) included feeder, reaction chamber, air pollution control devices (APCDs), and stack. Operation processes of these facilities are shown as followed:

1) Feeder: Composed by solid waste conveyor, incineration ashes and dried sludge feeder. There are two gates with nitrogen-sealed to maintain reduction environment.
2) Reaction chamber: treated wastes at 1500ºC. Two slag outlets are set to collect various densities of slags or metal mixtures.
3) APCDs: included venturi scrubber quencher, packing tower, and mercury adsorption tank.
4) Stack: flue gas emission with an oxidizer.
5) Capacity: 125 kg/h.

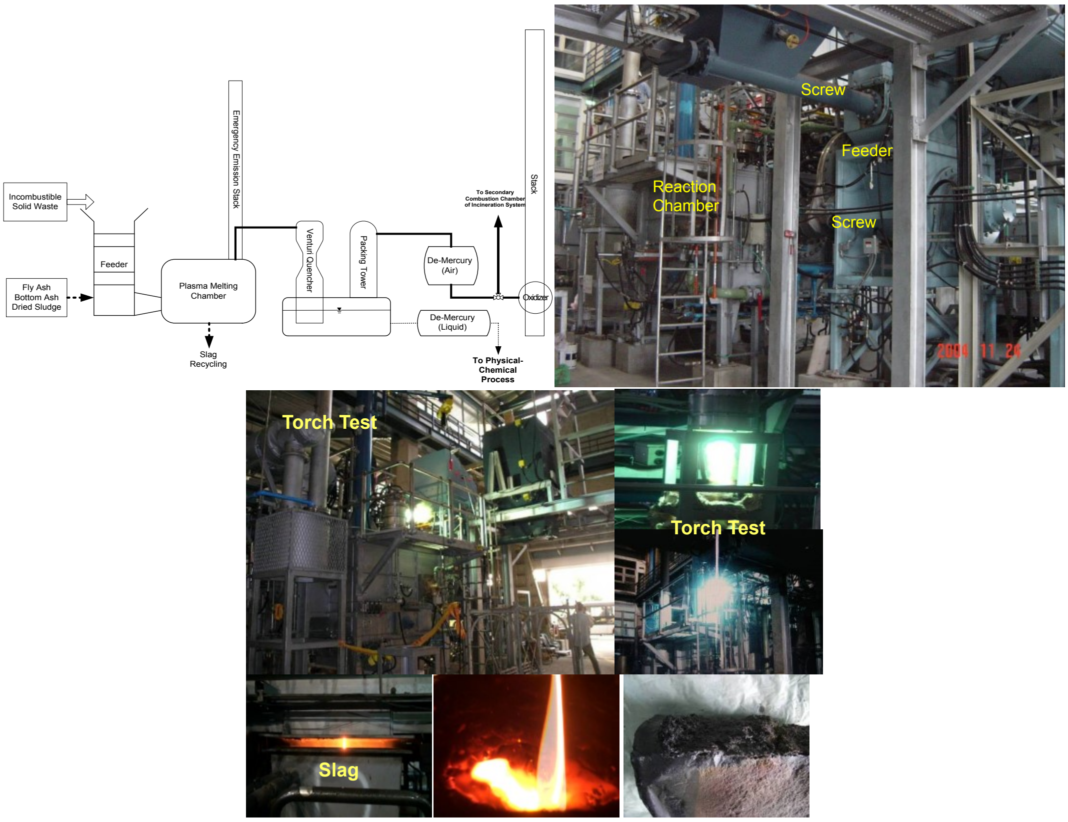

Figure 6. Plasma melting process for incombustible solid wastes, sludge from physical-chemical process and ashes from incineration

4. Summary/ Concluding Remarks

The NCKU ERMRC has been responsible for the treatment of laboratory wastes collected from schools and universities in Taiwan since 2005. Currently, the treatment capacity is 1000 tons/yr for organic and inorganic liquid wastes and combustible and incombustible solid wastes. The three treatment systems for laboratory wastes include Incineration system for organic liquid wastes and combustible solid wastes treatment, a physical-chemical system for inorganic liquid wastes treatment, and plasma melting system for incombustible solid wastes. With the Eco-chain treatment processes, treated water from the Physical-chemical system can be recycled as cooling water in the Incineration system, and the sludge from the physical-chemical system and fly ash/bottom ash from the incineration system can be further stabilized by the plasma melting system, achieving zero-laboratory wastes discharge design concept. The waste heat from the Incineration system was recycled for sludge drying and the synthetic gas from the Plasma Melting system was used as fuel, increasing the energy utilization efficiency in the whole treatment plant.

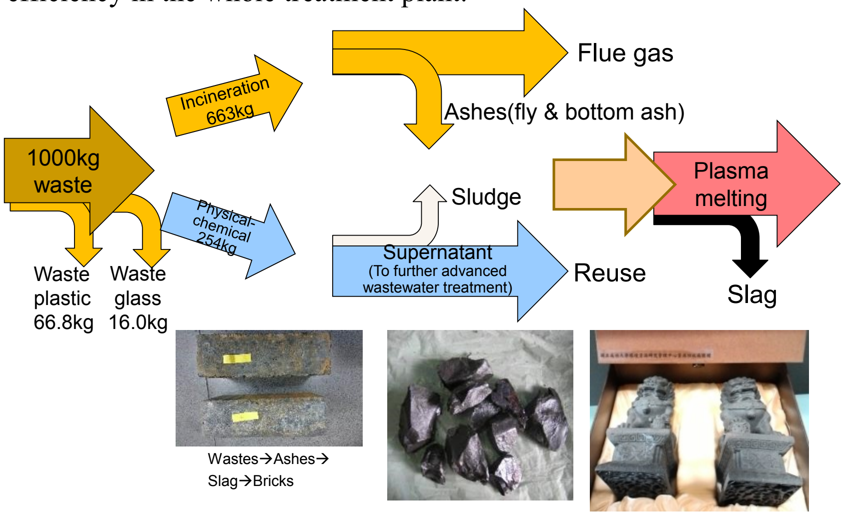

Figure 7. Mass balance of NCKU ERMRC treatment facilities for Eco-chain treatment processes

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Issues and Innovation in Managing Water

The 5th International Workshop on UI GreenMetric
Cork, Ireland, 14-16 April 2019

The Sustainable Agenda of the University of Groningen

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Abstract. As a socially responsible institution, the University of Groningen has set itself the goal of promoting sustainable development in every aspect of University operations. This includes sustainable development in teaching and research, as well as excelling in sustainable business operations. This will be achieved by establishing an inspiring, healthy, sustainable environment in which staff and students can work, study and live.

In 2015 a Roadmap 2015 -2020, with goals in the area of People, Planet end performance was validated by the board of the University. During the last 4 years these goals within the Roadmap have become the leading agenda for the UG where it comes to sustainability. To reach this a Green Office was established in 2015 and a taskforce was set up with attendees from the Faculties, staff and students of the UG as an advisory group. 4 years later the UG belongs to the top 7 of sustainable Universities in the world according to the UI GreenMetric World University Rankings.

Keywords: CO_2 neutral, energy, UI GreenMetric, rainwater, water

1. Introduction

As a socially responsible institution, the University of Groningen has set itself the goal of promoting sustainable development in every aspect of University operations. This includes sustainable development in teaching and research, as well as excelling in sustainable business operations. In addition, the University hopes to set an inspiring example, promoting sustainability in a transparent way and actively involving and facilitating students in sustainable activities.

2. Ambition

University of Groningen healthy and strives to be CO_2 neutral by 2020. This will be achieved by working to establish an inspiring, healthy, sustainable environment in which staff and students can work, study and live. The path towards a CO_2-neutral university in 2020 will require huge efforts in terms of efficient energy consumption and increased energy production from renewable sources. To realize this goal, we have established the following sub-goals in the area of People, Planet and Performance:

People: University of Groningen will be healthy and dynamic by 2020

- promote the long-term employability of staff
- promote inclusiveness
- focus on vitality and empowerment of students and staff
- promote long-term mobility

Planet: University of Groningen strives to be CO_2-neutral by 2020

- at least 30% improvement in energy efficiency by 2020 compared with 2005
- at least 25% of energy produced by our own renewable sources by 2020
- water consumption ≤ 2008 by 2020
- 15% reduction in total waste production by 2020 compared with 2005
- at least 70% of waste separated by 2020
- BREEAM excellent will be the norm for new building and renovation work wherever possible
- ecological management of university premises, with consideration for users

Performance: University of Groningen will be aware of and responsible for from profits to value by 2020

- integrate sustainability into the teaching curricula and research projects
- aim for 100% sustainable purchasing, with consideration for working conditions and human rights
- improve communication with staff and students about sustainability, by promoting and supporting events, symposia, lectures and courses relating to sustainability

3. Review of the Current Situation

3.1. Commuter traffic

In 2018, the Green Office (GO), in collaboration with the department of Human Resource (HR) and an external party started a project for a new mobility plan for the entire UG. The aim of the update is to come to an overview of measures that with possible changes in mobility policy, specifically aimed at at commuting. The measures must be in line with the objectives of the UG in terms of accessibility, sustainability and vitality. The new plan will be presented to the Executive Board in 2019 and implemented after approval. In 2018 the smart campus bike was introduced at the UG. Smart campus bikes are bicycles, equipped with a "smart" lock that can be opened via an app on the mobile phone.

3.2. Business trips

In 2018 a start was made with the new tender for business trips within the UG. The steering group on procurement of travel proposes, among other things, that traveling by train over a distance of up to 500 km will, in line with market conditions as applied by the Dutch government, be made mandatory from under certain conditions.

In 2018, the share of CO_2 emissions from business trips on the total CO_2 footprint of the UG was approximately 16%. One of the ambitions in the UG 2015–2020 Roadmap is to strive for a CO_2 neutral UG in 2020. To achieve this, the GO, in collaboration with employees from the UG, started a research to find a for the RUG suitable local CO_2 compensation project so that employees of the RUG can fly fully CO_2 compensated (integrated) in the future.

3.3. Planet

The RUG Roadmap includes the ambition to achieve a CO_2 neutral university by 2020. Definition CO_2 neutral: the aim of organizations and companies to avoid or compensate for the amount of greenhouse gasses emitted. The term CO_2 neutral "is used to visualize the performance of an organization. The calculation tool for determining the CO_2 footprint, developed by the Green Office in 2017, was finally put into use in 2018 following extensive testing by both internal RUG researchers and participants in the local, Groningen Energy Neutral Platform. It has been agreed with the participants in this platform to start publishing the CO_2 footprint per participant on the Groningen energy-neutral website.

3.4. CO_2 footprint in 2018

In 2018, the total CO_2 production of the RUG was 69 ktonnes. The graphs below represent the CO_2 emissions per category for the years 2015 and 2018, such as electricity, gas, commuter traffic, but also business flight kilometers from the RUG. The results show that in 2015 44% of CO_2 production comes from electricity consumption. Ca. 35% of CO_2 production is the result of travel (commuting and business trips). In 2018, CO_2 production was 34 ktonnes. This is a decrease of 51% compared to 2015. The decrease is almost entirely caused by the fact that in 2018 the purchased electricity will be 100% compensated with GVO Certificates for electricity produced in the Netherlands and in the EU from wind energy.

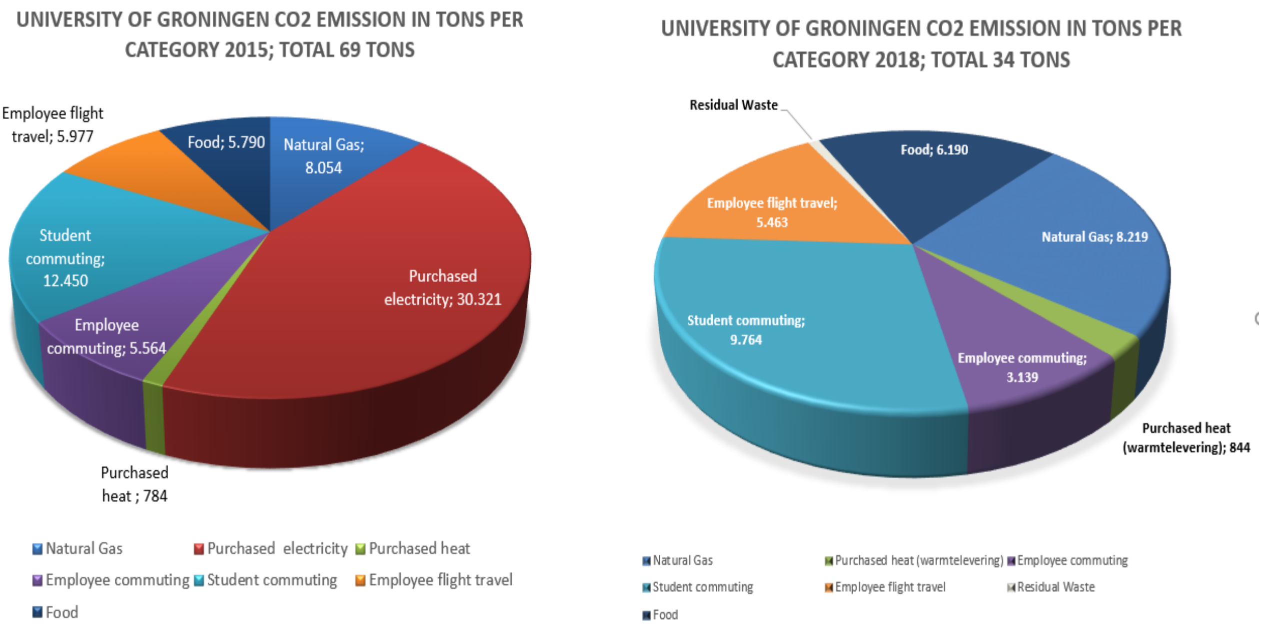

Figure 1. University of Groningen CO_2 emission in tons per categori 2015 and 2018

3.5. Energy

Energy targets have been included in the Roadmap 2015-2020. About 30% improvement in energy efficiency in 2020 compared to 2005.

The following projects started in 2018:

- Mandatory energy label C (or better) for offices. According to information from the Netherlands Enterprise Agency, it is expected that every office larger than 100 m^2 must have at least energy label C in 2023. In response to this, it was decided to update the existing long-term housing plans of the UG for both the new construction and the existing construction with a sustainability section.
- Implementation of energy management system: In 2019, the energy management system set up in previous years will be implemented throughout the UG.

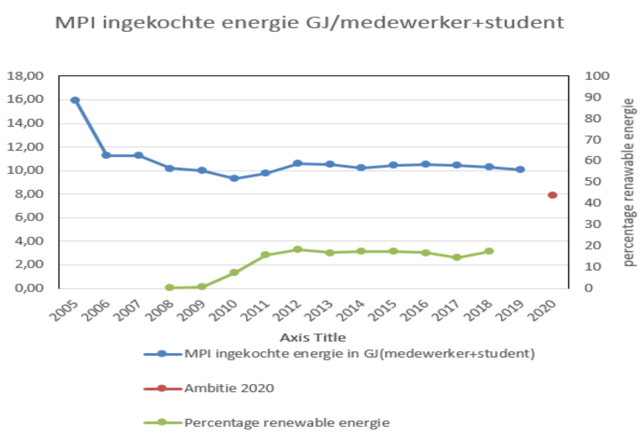

Figure 2. Energy use UG 2018

The Environmental Performance Indicators [1] for energy (MPIs in GJ / employee + student) show that the amount of energy purchased will increase from 2010, but from 2014 the total amount of energy purchased per student + employee seems to decrease slightly.

3.5.1. Renewable energy

The 2015-2020 roadmap includes the following target for sustainable energy: in 2020 at least 25% energy from our own renewable sources.

The graph above also shows the percentage of renewable energy produced by the UG (green line). The percentage is made up of the total energy produced by the sun, wind and heat and cold storage at the UG. The graph shows that the percentage remained around 17% for several years.

In collaboration with the Real Estate and Investments (VGI) and Facility Services (FB) departments, a study was started into the possibility of purchasing sustainable generated regional energy for the UG. The current contract whereby fossil energy is purchased and subsequently compensated with the help of GVO certificates (guarantee of origin) is extended for another 2 years. In 2018, the total electricity purchased was compensated with GVOs for wind energy purchased in the Netherlands and in Europe. With this, the UG directly stimulates the production of green electricity in the Netherlands and Europe. In 2019, a total of 2250 panels with a total capacity of 660 MW/year or a maximum saving of 207 tonnes of CO_2/year will be installed

3.6. Water

Despite a steady increase in the number of students, water use has stabilized in recent years at around 0.39 m^3/employee and student. Water consumption fell in 2013 and subsequently remained stable. The reason for this decrease is a considerable saving of water in the drinking water supply at the animal enclosures in one of the buildings of the UG (Linnaeusborg). Water-saving toilets and taps have also been installed in various buildings and rainwater is being used in a number of buildings to flush the toilets.

3.7. Waste

The UG has ambitions to separate at least 70% of non-hazardous waste by 2020 and to reduce total waste production by 15% in 2020 compared to 2005. The graph below shows that the total amount of waste in recent years increased to around 32 kg per employee/student.

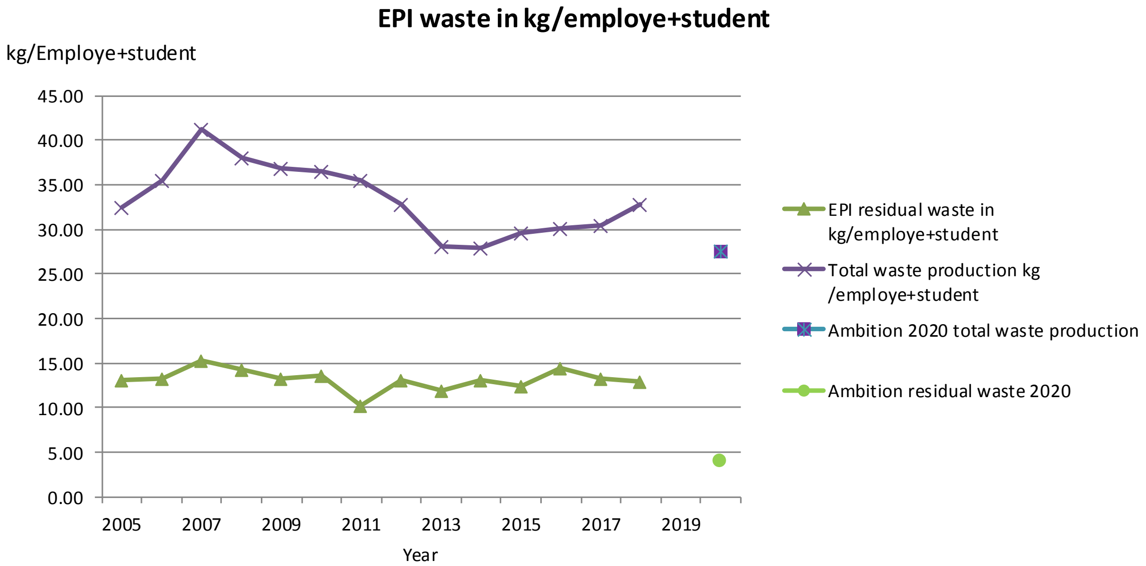

Figure 3. EPI waste in kilogram from 2005 until 2020

Possibilities for a further reduction of the total amount of waste will mainly have to come from better separation of the residual waste. The current separation rate is 53%. In 2017, the composition of the residual waste was examined by an external party. This input is important for drawing up a feasibility plan with regard to the further separation of residual waste (plastic, organic waste, can etc.). In consultation with the purchasing department of the Facility Services department, a process was started at the end of 2018 for a new tender for the collection of waste from the UG. This includes the new plans for better separation of residual waste and the reduction of the total amount of waste.

3.8. Performance

In 2018, the University of Groningen rose four places in the global UI GreenMetric Rankings and is now at position 7. The UI Green Metric Ranking was set up by Universitas Indonesia to draw attention to sustainability in university policy.

Table 1. Position of the RUG

Years	Ranking	Number of Participating Universities
2018	7	719
2017	11	619
2016	15	516
2015	12	407
2014	49	361

3.9. Sustainability in Education

Commissioned by the Sustainability Taskforce, a study was conducted in 2017 into the number of sustainability-related courses at the RUG. The research showed that 40% of the total range of courses could be related to sustainability. The existing methodology was evaluated and renewed at the end of 2018.

3.10. Staff Week

In 2018, the Green Office organized an Erasmus Staff Week on sustainability. During the week, the best practices of the UG in the field of sustainability were shared. The goal of the week was to learn from each other and to inspire each other.

3.11. International Cooperation

The first Summer School on sustainability was organized in 2018. The "Creating a Climate for Change" school handled cases submitted by participating universitys. The Summer School will be organized again in 2019.

3.12 Sustainable Development Goals

A study into publications and how they can be linked to the SDGs was started in 2018. In the meantime, a profile has been drawn up for each faculty and this has also been sent to the faculty for approval. The aim is to set up a website by mid-2019 in which it can be seen per research area and study program to which SDG these are connected.

3.13. Research Sustainability Knowledge

Students from Research and Consultancy started a study into the level of sustainability knowledge among students and employees. This Sulitest (Sustainable Literacy Test) will be rolled out further. It will be investigated how modules can be offered to supplement this knowledge.

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The 5th International Workshop on UI GreenMetric
Cork, Ireland, 14-16 April 2019

Implementation of Integrated Water Resources Management Practices at the Universidad Autónoma de Occidente (UAO)

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Abstract. The UAO implements the Integrated Water Resources Management (IWRM) concept in the university campus operation as a component of the Sustainable Campus Program and following the guidelines established by the environmental university policy. Within the campus, water services are entirely provided and operated by the university, with legal surveillance and control by the environmental authority and without any support by the waterworks municipal company. In order to implement the IWRM concept the university has launched a program oriented towards a more efficient use of water and to increase the reuse of treated wastewater. The IWRM system is composed of: a deep well for groundwater supply, the drinking water plant, hydraulic and sanitary installations, sanitary sewerage, the wastewater treatment plant (includes biosolid treatment and management), pluvial sewerage and a rainwater storage pond. The IWRM system: supplies drinking water for all campus activities (aprox. 10.400 people); treats the total produced wastewater (Q = 1.55 l/s); reuses about 30% of the treated wastewater; and storages and uses rainwater. This work aims at showing the implementation of IWRM at UAO highlighting successful practices, barriers to higher water recycling rates and perspectives and challenges for the next years.

Keywords: Efficient use of water, integrated water resources management, reuse of treated wastewater, sustainable campus, water recycling

1. Introduction

In September 2010, the Universidad Autónoma de Occidente (UAO) developed and implemented a corporate environmental management model, with the aim of reducing the environmental impacts generated by the daily activities carried out on the university campus, as well as, influencing the university community and its influence area towards sociocultural changes which may contribute to regional sustainability.

Giving continuity to this model, in 2015 the University approved the "Sustainable Campus" program articulating actions and projects generated by faculties, research groups and the internal operation and social projection areas of the University, according to their commitment and environmental and social responsibility [3].

In 2016 "Sustainable Campus" consolidated itself as a program addressing the following components: climate change, green campus, sustainable consumption, efficient and rational use of water and energy, production, treatment and disposal of waste, healthy campus, and social, cultural and environmental education.

In a broader sense, "Sustainable Campus" refers to the Campus in which actions and activities are carried out while minimizing negative impacts on the environment that may have effects upon the local economy, social wellbeing and public health. The University actively involves its knowledge, experience and human resources to address, and provide solutions to the ecological and social challenges faced by current and future society, aiming to establish a balance between the needs of human beings and those of other beings with which we share the planet, to guarantee its process of evolution and integration in the web of life [2].

"Sustainable Campus" is first of all a matter of institutional coherence; it is, in other words, to carry out in our university campus what we propose from teaching and research as sustainable solutions, that is, to engineer sustainability in our own home.

Thanks to its commitment and good practices of implementation, the UAO of Cali has been ranked during the past two years, as the first most sustainable university in Colombia and the third in Latin America, according to the UI GreenMetric World University Rankings published by the University of Indonesia.

This work looks at implementation of integrated water resources management (IWRM) practices as an important component of the university sustainable campus project. It aims at showing the implementation of IWRM at UAO highlighting successful practices, barriers to higher water recycling rates and perspectives and challenges for the next years.

2. Integrated Water Resources Management at UAO

The Integrated Water Resources Management concept is at the core of the university environmental policy. When the actual university campus was built in the late nineties, its location was beyond the urban perimeter, bringing as a consequence that the UAO had to provide all water services without any support from the municipal water works company, while fulfilling all environmental regulations related to drinking water treatment and supply, and wastewater treatment and reuse. Since then the university has been implementing the IWRM concept and strategies with the aim of guarantying an efficient use of water. The IWRM system is composed of: a deep well for groundwater supply, the drinking water plant, hydraulic and sanitary installations, sanitary sewerage, the wastewater treatment plant (includes biosolid treatment and management), pluvial sewerage and a rainwater storage pond. All university infrastructure and activities are supported by the IWRM system independently from the municipal water works company. Recently the university has launched a program oriented towards a more efficient use of water through the installation of water saving devices in toiles and bathrooms, and to increase the reuse of treated wastewater in gardens irrigation [3].

3. The Drinking Water Supply System

The university drinking water supply system takes raw water from a deep well of 143 meters with a vertical pencil-type pump located 42 meters from the surface. Through a 3-inch diameter pipe and a flow rate of 92 gallons per minute, the water is conducted to the entrance of the potable treatment plant. However, before the raw water enters the plant, it passes through a flow measurement device which is constantly monitored by the operators, in order to fulfill the requirements groundwater concession imposed by the regional environmental authority.

The Potable Water Treatment Plant (PWTP) was designed to work at high load, with a capacity of 480 GPM for a population equivalent to 9,000 people. This plant complies with the legal requirements of the Colombian legislation regarding the water supply services (i.e. Decree 2105 of July 26, 1983 of the Ministry of Public Health, Decree 1575 of 2007 of May 9, 2007 of the Ministry of Social Protection and Resolution 2115 of June 2007 of the Ministry of the Environment, Housing and Territorial Development) [4].

The drinking water treatment is carried out through the following unit operations: sand filtration, storage and chlorination. The first stage is a direct filter built in reinforced concrete of 1.5 m wide by 2.5 m long and 3.90 m in total height. This unit is confirmed by four layers of quartz gravel at different granulometries, a layer of activated carbon and of sand, with a maximum capacity to treat 5.37 l/s. In the upper part of the filter there is a gutter for the collection and evacuation of the water coming from the washing of the filtering bed through ascending water flow coming from the same well.

In the second stage, the storage is carried out in a tank internally coated with a 1.2 mm thick PAVCO PVC membrane, walls, bottom slab and beams for the support of the roof. This tank has a useful volume of 165 m^3. In this stage the chlorination of the water is carried out by means of a direct drip system and distributed to the internal network of the university, by means of two pumps of 7.5 Hp each one, providing drinking water to 100% of the university campus. As imposed by health regulations the university carries out water quality assessments through Hidroambiental LTDA, which is an external water quality laboratory [4].

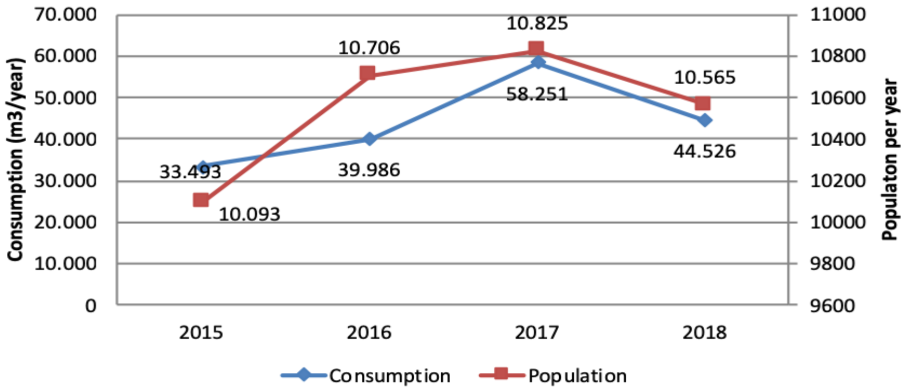

Figure 1. Consumption of drinking water at UAO

Fig. 1 shows the consumption of drinking water in the last four years. In the year 2017, the highest consumption was presented due to a high number of academic events held by the university and to civil works undertaken in that year for infrastructure improvement. Similarly, in 2018 there was an effect on water consumption taking into account the behavior that occurred in the previous years (2015–2016).

4. The Wastewater Treatment Plant

The University has a wastewater treatment plant (WWTP) that treats the wastewater produced by bathrooms and kitchens of the campus and the chemical waters from the laboratories located in the basement of the central building (Q = 1.55 l/s). In the case of chemical waters from laboratories located in the basement and semi-basement of the central building, they are stored, neutralized and then conducted to the WWTP in small doses for treatment [5].

The wastewater is conducted by a sanitary sewer system, which works by gravity, to a stabilization tank. The WWTP is confirmed by the following operation units (Fig. 2):

- Coarse solid removal grids
- Primary sedimentation
- Grease trap
- Aeration tank (i.e. mechanical aeration)
- Secondary sedimentation
- Rapid sand filtration
- Compact ultraviolet light disinfection system
- Treated wastewater storage tank for subsequent use in campus gardens irrigation
- Treated wastewater discharge system
- Four drying beds for the biosolids treatment. Once the biosolids have been dried, they are mixed with organic solid waste produced in the kitchens for a composting process.

Figure 2. Wastewater Treatment Plant (WWTP)

5. Rainwater Management and Recycling Water Program

The rainwater falling on roof and on paved areas the university campus are conducted through a storm sewer system to a storage tank with has a 600 m^3 volume capacity (Fig. 3). With regard to the water recycling program, the university currently establishes formal policies focusing on the use of recycled water for the irrigation of gardens and sports areas exclusively. In addition, 30% of the wastewater treated in the WWTP is also used in the irrigation of gardens and sports areas of the campus [5].

Figure 3. Storage tank of the university

6. Summary/ Concluding Remarks

Since 2010 the UAO has implemented an environmental university management plan in order to have a campus operation which fulfil all environmental legal requirements imposed by the regional environmental authority. As an evolution of this environmental management plan, the university launched in 2015 the Sustainable Campus Program in order to strength the university commitment in relation to sustainability and to sustainable development.

IWRM is a key component in the Sustainable Campus Program. The university is autonomous in all water management aspects, from drinking water supply for all activities to wastewater treatment and reuse, including rainwater.

The main challenges for the next few years in terms of IWRM are: (i) increasing the efficiency in water uses through the reduction of water consumption per capita; and (ii) increasing the reuse of treated wastewater in uses different from gardens irrigation.

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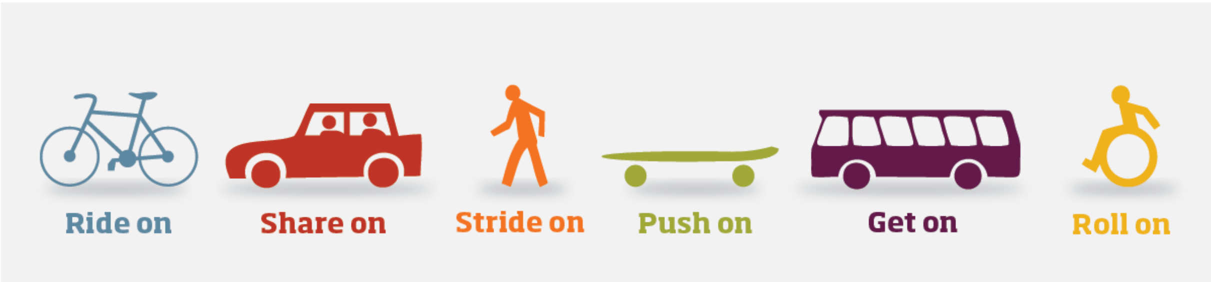
Issues and Innovation in Managing Transportation



The 5th International Workshop on UI GreenMetric
Cork, Ireland, 14-16 April 2019

15 Years of Innovation in Sustainable Mobility

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Abstract. Over the past 40 years, the Université de Sherbrooke has forged its identity as a pioneer in sustainable development in Canada through the implementation of innovative and bold programs, particularly in terms of sustainable mobility. Its free public transit program for students on Sherbrooke campuses, its mobility incentive program for staff and the conversion of parking spaces into large green areas accessible to the community are world-class references in this field. But since the institution wishes to intensify its efforts in the coming years, with a new Sustainable Mobility Strategy 2018–2022 with more than 75 actions carried out over the next few years on the University's 3 campuses.

Keywords: Active transportation, behaviour change, electric vehicles, intermodality, public transit

1. Introduction

Over the last 40 years, the Université de Sherbrooke has forged a more-than-enviable reputation in the area of sustainable development, even earning it the title of Green University. Whether for the excellence of its University Centre for Environmental and Sustainable Development Studies, its sustainable-mobility strategies, or for being the first Quebec university to have a vice-president of sustainable development and a related policy, Sherbrooke stands out as the flagship university in Quebec in this field.

In particular, at the start of the academic year in the fall of 2014, Sherbrooke demonstrated its forward-thinking approach by initiating a bold program of giving its students free access to mass transit, which was a Quebec first in Canada. This initiative literally shaped the institution's identity, changed the landscape of its campuses, and charted the way to a series of inspiring measures related to sustainable mobility.

2. Free Access to Mass Transit for Students

For nearly 15 years now, Sherbrooke full- and part-time students have been riding city buses free upon presenting their student ID. Since being implemented, this program providing free access to mass transit has reduced the number of vehicles, relieved the parking situation on campus and along nearby streets, and reduced greenhouse gases. It has fostered better integration of students into the local community by increasing student mobility in town and decreasing the demand for apartments near campuses, while, obviously, lightening the burden on student budgets.

Other institutions in town—such as the Cégep de Sherbrooke and the Centre hospitalier universitaire de Sherbrooke—have followed suit and developed similar models. The issue of mass transit has therefore become a priority for Sherbrooke. A number of educational institutions and student associations elsewhere in Quebec—such as Université Laval—are trying to set up the same type of program.

In these various projects, as in the Canadian colleges and universities that have implemented free mass-transit programs, the users contribute to funding the programs to varying but always rather substantial degrees. That is the case for the Université de Sherbrooke, whose program is jointly funded by the institution and a modest mandatory contribution from students. Despite the constraints on university budgets, the University's administration made the program one of its priorities in sustainable development.

As a result of this program, a series of former asphalted parking lots in the heart of the main campus have been transformed into a veritable oasis with a stream, ponds, and cascades for the treatment and recovery of rainwater (Fig. 1).

Figure 1. 150 parking spaces replaced in the middle of campus

The University has received many awards for this outstanding initiative, including the 2010 Clean Air Day national award.

3. Mass Transit for Personnel

Based on its success with the mass-transit program for students, the Université de Sherbrooke recently took another step forward to promote alternatives to lone commuting. It has come up an attractive program to incentivize the personnel of its Sherbrooke and Longueuil campuses to opt for mass transit.

The program gives identical financial incentives to employees on all three campuses based on the offerings of the various transportation networks. Regardless of the campus, the University encourages full-time employees to switch to mass transit by awarding them $50 a month, which is nearly 75% of the cost. Obviously, this travel pass is valid at all times and on all routes, not just to go to the campuses.

While the University hopes to free up several hundred parking spaces through this program, more importantly, it wants to foster behavioural changes that will have a genuine impact on greenhouse gases. Indeed, if the program has a real impact on parking at the University, it will reduce the number of vehicles on the road by an equal amount.

4. Intercity-Transportation Program

University life entails a number of activities such as conferences, congresses, training sessions, work meetings, and meetings, all of which can involve intercity transportation, especially towards large urban centres, such as Montréal. University activities related to the Longueuil campus also involve their own share of travel between Sherbrooke and Longueuil. More than three-quarters of Sherbrooke students come from outside of Estrie, which amounts to quite a bit of travel between the University and their homes.

In order to significantly cut down on expenses and to limit travel-related greenhouse-gas emissions, the University has agreements with Transdev Limocar that have significantly facilitated access to intercity transportation.

As a result, the University offers its employees the possibility of travelling by bus to Longueuil or Montréal at no charge, simply by presenting their employee ID. In fiscal 2015–2016, there were 3571 trips under this free-access intercity-transportation program. Such intercity travel is only available for work-related purposes, but University students also benefit from additional savings of up to 40% off the intercity fare.

5. Fuel-Efficient Vehicles

The Université de Sherbrooke made the shift to electricity several years ago. Today, electric vehicles make up more than 40% of its fleet. It should come as no surprise that the Université de Sherbrooke has Canada's largest solar farm dedicated to applied research[1] and stands out as a Canadian reference in validating future production and storage technologies associated with renewable energy, particularly in cold climates.

The University's various sites have 29 charging stations for electric and hybrid vehicles. Electric Circuit stations can be used by any driver, whereas other stations reserved for employee use have been installed under the Quebec government's Branché au travail program (Fig. 2).

Figure 2. Sherbrooke's electrical strategy

6. Active Transportation

Aware as it is of the importance of integrating physical activity into a person's daily routine, the University encourages members of its community to opt for active modes of transportation such as cycling, walking, and jogging. Moreover, Sherbrooke was among the first wave of organizations and communities to receive Vélosympathique certification from Vélo Québec. The Université de Sherbrooke stands out in this sector for the quality and quantity of actions taken on its campuses to encourage biking. Some examples are the availability of showers on its campuses, the fleet of self-service bikes on the main and Longueuil campuses, and secure parking for bicycles, including the latest Vélostation (bicycle park) on the Longueuil campus in cooperation with the Association métropolitaine de transport (AMT).

The Université de Sherbrooke can also count on Coopérative de vélos La Déraille, located on the main campus. La Déraille is a solidarity cooperative that offers its members access to a fully equipped cycle mechanical workshop. Its main mission is to facilitate the practice of utilitarian biking by empowering their members to maintain their own bicycles.

Founded in 2013, the Coopérative de Vélo La Déraille now has nearly 450 members and a crew of about 10 workshop volunteers per session. The cooperative implemented the first self-service repair stations on the main campus in 2015. Since 2018, the cooperative has been working to professionalize its activities, particularly by developing a high-quality, diversified training offering targeting both its members and the general public.

La Déraille, which plays an active role on campus and in the city, advocates for its members, such as on the University's sustainable-mobility committee and through joint actions taken with other organizations in the city (Fig. 3).

Figure 3. Active transportation at the University

One of the characteristics of the University's main campus that significantly promotes mobility is its network of underground tunnels built at the end of the 1960s. Over the years, thousands of students have made their way through this network of more than 3.5 km of tunnels. Some of them have even left their mark in the form of artwork dating from different periods. In addition to providing passageways for pedestrians, the tunnels also house equipment to transport water and electricity as well as to regulate the climate in campus buildings in a country where winter conditions can sometimes be harsh. Moreover, about 30 electric vehicles navigate the system of tunnels in order to reduce the number of gas-powered vehicles on campus.

7. 2018–2022 Sustainable Mobility Plan

The Université de Sherbrooke's 2018–2022 strategic planning includes a promising vision affirming that sustainable development lies at the core of its priorities and its teaching, research, and community-service missions. In keeping with its target to "Continue positioning the University as the Quebec benchmark in sustainable development," the University aims, in particular, to:

- Deploy the strategies required to integrate sustainable development into management mechanisms.
- Transform campuses into open sustainable-development laboratories in the community by banking on training and research innovations.

Given an interest in stimulating a culture of collaboration and synergy, the University created seven working committees and two joint committees with outside organizations in order to design its 2018–2022 Sustainable-Development Plan[2] consisting of 7 strategies and 2 areas of focus. The University also took advantage of this joint-action process to conduct its Sustainable-Development Assessment[3] of the last 40 years, which could serve as a solid foundation on which to base future endeavours.

One of the main components of the Sustainable-Development Plan is the 2018–2022 strategy on sustainable mobility[4]. In particular, the strategy aims at intensifying the University's efforts in this regard, mobilizing the community, and integrating, with the same approach, various mobility-related actions put forward. The strategy targets six fields of action (Fig. 4). Its deployment should promote intermodal means of transportation with a view to achieving beneficial outcomes for the users of the various modes of sustainable transportation. It should also make it possible to quantify the contribution of the sector to the institutional target of carbon neutrality.

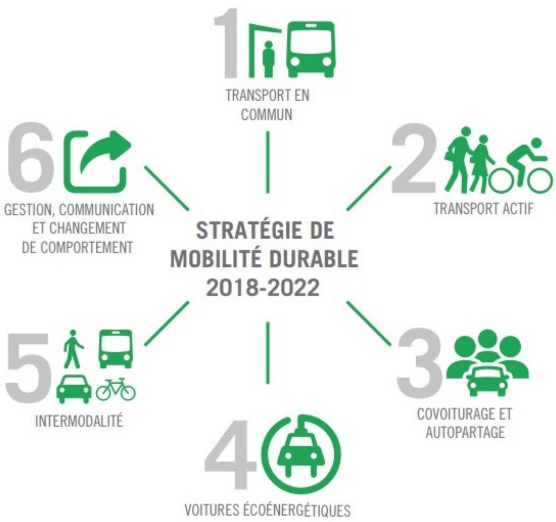

Figure 4. The 6 fields of action of the University's Sustainable Mobility Strategy 2018–2022

The major actions in the strategy include:

- Renewing the agreement for free access to mass transit for Sherbrooke's student community
- New bike paths and construction of 5 bicycle parks
- A new regional ridesharing platform
- New charging stations for electric vehicles
- A shuttle service between the three campuses and implementation of intermodal transfer stations
- Increasing the University committee's awareness of more sustainable mobility

8. Summary and Concluding Remarks

Since nearly 15 years ago, the Université de Sherbrooke made the choice of adopting a sustainable-development approach involving students that would integrate its teaching and research missions to transform its campuses into veritable laboratories of sustainable development.

Canada's leader in the 2018 UI GreenMetric World University Rankings, this community of more than 40,000 individuals has positioned sustainable development a core priority. As a responsible and pioneering institution in the area of mobility, the Université de Sherbrooke wants to remain a model and engine of behavioural change in promoting the use of sustainable modes of transportation, which would lead to a reduction in greenhouse gases generated by the university community.

This determination to transform its sustainable-mobility commitments into concrete actions is also reflected in research because, in 2017, the Société de transport de Sherbrooke (STS) and the Université de Sherbrooke announced the creation of an observatory on sustainable mobility (OMD). This organization aims at facilitating collaboration in teaching and research between the two partners in order to contribute to the development of sustainable mobility in the City of Sherbrooke. This stands out as more indisputable proof that the Université de Sherbrooke is a world model in the area of mobility.

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NPUST Sustainable Operations and the Development of Circular Economies

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Abstract. The National Pingtung University of Science and Technology was established as an agricultural institution in 1924. With a true appreciation for the environment, the university is dedicated to the pursuit of technology and practices that are sustainable, eco-friendly and environmentally sound. The university has already earned a reputation for "being Green" as a result of its approach to sustainable operations and circular economies. The university is actively working to make its campus Greener and healthier through simple measures, such as lending out free bicycles to students, and complex measures, such as developing water treatment and recycling systems designed to conserve water and restore eco-systems. Additionally, the university is working to raise environmental awareness among its students and is actively investing in the research and development of technologies that will be able to help businesses operate more sustainably in the future.

Keywords: Sustainability, water treatment and recycling, waterscape creation, zero emissions

1. Introduction

The National Pingtung University of Science and Technology was established in 1924 as an agricultural institution. For almost a century, this educational institution has been making valuable contributions to the advancement of Taiwan's agricultural sectors through projects funded by various governmental agencies and private sectors. The university is well committed to the development and execution of projects that strengthen its "Green" identity, and it has established related measures involving teaching, research, university development, student welfare and other valued objectives. Such goals serve as the basis for the initiation of new policies and the execution of related projects, which, without proper planning, enforcement, and funding would not be able to reach the point of maturity and recompense. With these underlying considerations in place, the foremost questions that must continuously be raised are directed at the need for sustainability, in all of its various dimensions. In this respect, on-going evaluations continuously provide the feedback necessary for future adjustments. Currently the university has three over-arching approaches dedicated to the themes of sustainability and care for the environment. These approaches involve both the adoption of practices that can have an immediate impact on air quality and water conservation, and the investment in research and education that will allow for much broader-reaching sustainable operations.

2. Approaches

2.1. Water conservation program implementation

NPUST water sources include groundwater, mountain spring water and rainwater. 100% of recycled water is treated at a sewage treatment plant and used for watering plants or flushing.

In addition to the be immediately recognizable practical applications of purified domestic sewage, such as plant watering, flushing and other non-contact purposes, the timely replenishment of groundwater also has a slowing effect on subsidence formations. Water pollution control measures and education campaigns have been adopted by the university to promote environmental care, sustainability and economic objectives; and wastewater management techniques have been used for ecological restoration purposes, including the creation of a waterscape that is home to a variety of plant and aquatic lifeforms. The design not only offers a living space for plant and animal life, but also helps increase biodiversity and provides a very natural setting for ecological research, education and the promotion thereof. The restoration area also gives teachers, students, local residents and visitors a space that can be used for relaxation and recreation.

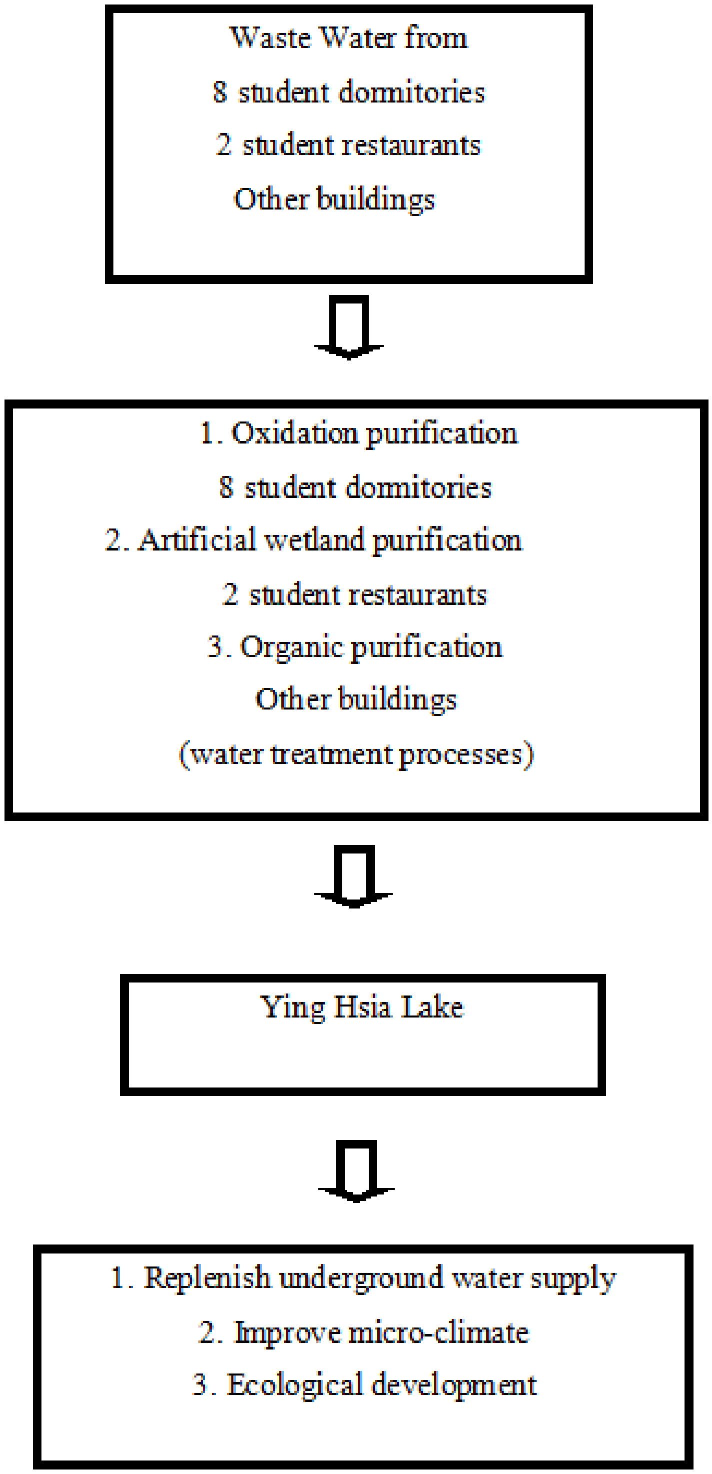

Figure 1. NPUST domestic wastewater treatment and recycling

Figure 2. NPUST wastewater recycle processing areas

2.2. Zero emission vehicles

As part of its efforts to cooperate with the Green Energy Policy and accelerate the reduction of carbon dioxide emissions, the university has established a number of related measures on campus. In the past, NPUST freshmen wholly relied on gas-powered motorcycles to commute both inside and outside the campus area. However, in recent years, the university has set a goal to reduce the use of gasoline motorcycles by providing subsidies for an on-campus/off-campus electric bus system, offering leasing programs for electric motorcycles, and lending out bicycles free of charge.

NPUST and China Motors are jointly promoting means of "green transportation" on campus, including electric vehicles and bicycles which can be rented out or bought through one of three preferential schemes created for students. Electric vehicle charging stands have also been installed at the dorms, Administrative Building, and Comprehensive Building on campus for electric vehicle commuters to charge their batteries free of charge. Service stations have also been set up at the school to provide related consultation and simple maintenance services. Furthermore, battery exchange stations have been installed to provide additional options for users. In August 2017, a total of 39 electric bicycles/vehicles were rented by teaching/administrative units for various official duties. At present, the number of electric bicycles/motorcycles rented by students is about 300; there are also 20 privately owned electric bicycles/motorcycles in use.

In order to reduce the number of motorcyclists and reduce air pollution, NPUST has applied to the Kaohsiung City Government Environmental Protection Bureau for more than 200 C-BIKE bicycles. These are provided to the students for use at no charge and can be borrowed from various stations around campus. Currently, 187 bikes have been lent out and another 450 to 500 private bicycles are in use.

Figure 3. Electric bus

Figure 4. Electric bus charging at the station

Figure 5. Electric bicycle/motorcycle charging station

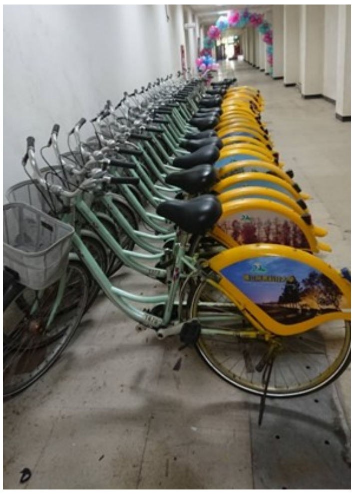

Figure 6. Bicycles

2.3. Education

The two approaches mentioned above are practical in application and have effects which are immediate; however, their contributions are inherently limited to the campus and immediate area. Thus, in an effort to reach further and create positive benefits that can spread far-and-wide, NPUST has also dedicated itself to a third approach, which is oriented towards R&D and education. The university recognizes that by developing Green and sustainable technologies that can be used by industries as economically viable substitutions for those which are more taxing on the environment, it has a chance to make contributions that can be shared by the world. Additionally, by raising awareness and providing education to students and the general public on the nature of relevant environmental and sustainability issues, they will stand in better positions to make their own contributions in ways that can be transmittable and transferable –once they start looking at the world with new perspectives, these members of society will undoubtedly discover new ways of overcoming related challenges in their local communities. Currently, the university is making an effort to encourage faculty members to incorporate topics related to the environment or sustainability into their course materials. The statistical information related to these courses is presented in Table 1 below.

Table 1. Statistics of courses related to environment and sustainability

Year	Number	Percentage
2013	1731	34.46%
2014	1988	39.78%
2015	2727	50.68%
2016	2731	50.82%
2017	2781	51.75%

3. Summary/ Concluding Remarks

National Pingtung University of Science and Technology recognizes the importance of maintaining a vision that is focused on finding real solutions to the problems the world currently faces – and sharing those solutions with others. By adopting practices that are green and sustainable, and demonstrating the right attitude towards the environment, the university aims to have a positive impact on its students and see tangible changes in society. The university has already adopted practices that seriously address questions related to air quality, water conservation, ecosystem restoration and environmental protection; and students are learning more about care for the environment than ever before. On top of this, the general public is being provided with information that will help them make a difference in their own communities and resources are being invested towards the development of technologies that hold the potential to have a much further reach and more resonant impact. With care and concern for future generations, NPUST vows to keep up with its current pace and continue to initiate more projects that support sustainable development goals and help create a better world for tomorrow.

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The 5th International Workshop on UI GreenMetric
Cork, Ireland, 14-16 April 2019

Managing Transportation in Escuela Superior Politécnica de Chimborazo ESPOCH (Ecuador)

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Abstract. Escuela Superior Politécnica de Chimborazo is a comprehensive higher education institution located in Riobamba-Ecuador, with a tropical wet and dry weather. Its main campus is an urban setting with a total area of 1201671 sq.m. There are 19396 students from all around the country currently enrolled, and 1748 professionals work as academic and administrative staff. Several efforts have been made to manage transportation in an efficient way, while promoting sustainability in the campus at the same time. For reducing the need of private transportation, at least 4 shuttles operate in the university campus, with an average number of passengers of 42; the service is regular and free averaging 30 shuttle services each day. There are initiatives to decrease private vehicle use on campus such as: "A la Poli en Bici" (To the polytechnic school in bike), a carpooling initiative, and a user information system showing the routes inside ESPOCH. Pedestrian paths are available, designed for safety, convenient and mostly have disabled-friendly features. The managing transportation indicator in ESPOCH, shows that the policies and initiatives on campus are positive; however, the sustainability efforts must be sustained, grow and spread throughout the community for achieving greater social and environmental benefits.

Keywords: Carpooling initiatives, sustainable transportation, transportation indicator, UI GreenMetric

1. Introduction

University campuses are important points in the urban transportation network because they cause heavy traffic due to the concentration of activities at certain (peak) hours for work or study purposes specially during early morning and late afternoon. There are high vehicular volumes of entry to the campuses, which include private vehicles and collective transport, bicycles, as well as pedestrian activity. The combination of concentrated levels of pedestrian and bicycle traffic with motor vehicles in a campus setting creates several conflict areas causing safety and operational problems[1]. Usually, during peak times there are temporary delays in the main accesses and roads adjacent to the campuses. Because of this, universities must plan their transportation systems to meet the needs of students, while at the same time reducing traffic[2]. Additional derived impacts on the urban environment such as energy consumption from non-renewable sources, increased levels of air pollution, emissions of polluting gases and noise must be avoided by designing a good mobility plan for the university[3].

Zero-emission systems (trams, cable systems, shared bicycles and pedestrians), simultaneously, have more benefits and advantages at the social, environmental and mobility levels, because they are easily accessible for the population in general and especially the ones with fewer economic resources. Since these systems do not need fossil fuels, they do not emit greenhouse gases. There are systems that reduce the use of the private vehicle, collaborating again with the reduction of emissions and improving the mobility of the cities. For example shared bicycle and pedestrian systems provide the improvement of physical and mental health of people; they are of considerable contact and interaction of the users with the vehicular systems, therefore, it is important to take into account the road safety in the areas of circulation and interaction of the two types of systems[3]. People that work and attend university frequently spend a large majority of their lives there; therefore, investing in sustainability initiatives at the grassroots level will have wide reaching an long-lasting benefits to students and staff[4].

Escuela Superior Politécnica de Chimborazo is a comprehensive higher education institution located in Riobamba Ecuador, with a tropical wet and dry weather. Its main campus is an urban setting with a total area of 1201671 sq.m. There are 19396 students from all around the country currently enrolled, and 1748 professionals work as academic and administrative staff. The magnitude of activities that take place daily within this physical space generates a great critical mass of activities developed by people during peak hours, causing a disorderly occupation of the physical space and poor use of the land[5, 6]. In this paper, the initiatives of sustainable mobility at ESPOCH, which allowed it to rank first of Ecuador in UI GreenMetric World University Rankings 2018[7], will be explored and discussed.

2. Mobility at ESPOCH

2.1. Road infrastructure

Road infrastructure at ESPOCH has a total length of about 19.20 km, there are more than 3000 private vehicles circulating through these routes every day. They give access to the seven faculties in the main campus, parking areas, pedestrian, and bike paths. The transport services offered in the ESPOCH are accessible to all citizens regardless of whether they own a vehicle or not, that is, they allow the entry of taxis, their own vehicles and offers a public transport system that runs trough the entire polytechnic campus. The total parking area on campus is 80000 sq.m. representing less than 1% of the total campus area. The Campus offers a road infrastructure that allows adequate accessibility for vulnerable people, including priority parking spots, sidewalks with ramps for people with special capacities[5].

2.2. Bus routes

People moving inside the institution, mainly used private vehicles instead of walking, using bicycle or the internal public transport, which causes congestion, pollution, insecurity and serious problems when traveling, this can be seen in Table 1, which was adapted from Bravo (2015). Actually, there are four shuttles operated continuously at ESPOCH, there are 42 passengers in average in each shuttle with 30 trips of shuttle services each day mostly during peak times; therefore, an alternative to the use of private vehicles has been created inside the campus.

Table 1. Number of vehicles entering ESPOCH

Type of vehicle	Number	Percentage (%)
Taxi	2914	38.9
Particular	4377	58.45
Motorbike	145	1.94
Bus	25	0.33
Truck	28	0.38
Total	**7489**	

3. Sustainable Transportation Initiatives

The sustainable mobility model contemplates access to all public spaces allowed to all members of the polytechnic community, adopting the necessary measures to guarantee this right to everybody. In addition, it guarantees access in the best possible conditions, avoiding the problems that cause accessibility deficit to specific parts of the campus.

3.1. Yellow zones

This is a strategy which restricts circulation of taxis inside the polytechnic campus because 38.9% of vehicles entering ESPOCH everyday are taxis. For this, two parking lots with a capacity of 24 vehicles which will stay no longer than the necessary time for leaving the passengers, allowing a continuous transit, are located close to the two main entrances of the university. Bus stops are in these parking lots, for allowing students to travel freely through the campus. The restriction for taxis to enter ESPOCH reduces heavy traffic during peak hours, making internal transit more efficient, specially for walking or biking.

3.2. "Biking to the Polytechnic" ("A la Poli en Bici")

Since April 2013, a group of students, teachers, employees and workers from ESPOCH joined together to make a dream come true in ESPOCH, by creating a bike path in the campus. Actually, most of the internal roads in the campus have bike paths, with safe parking sports for leaving the bikes[8]. Among the objectives of this campaign are: promoting safety of cyclists in the campus, reducing pollution, increasing activity levels in students, and even helping people to make friends. In addition, since 2016 the Faculty of Sciences, have created a student-managed project by which whoever can have a bike for free for moving inside the campus, by means of showing an identification or prearranging the lean by phone call[9].

Figure 5. Evidences of the program A la Poli en Bici

3.3. Carpooling Campaign for Reducing Private Vehicles

To start this strategy, the institution used the system called "AVENTON", on the website www.aventones.com; it has migrated to BlaBlaCar, which is an online system at no cost. This initiative helps polytechnic students and staff to generate a change in the way of thinking, because the less the vehicles entering the university, the lower the greenhouse emissions produced. Among the benefits that the Polytechnic Community obtains from implementing this system are: to promote the coexistence among students, to decrease traffic in the area, to mitigate CO_2 emissions, to generate sustainable mobility, fuel savings and maintenance of shared vehicles. The information is collected during the registration process for students, in the schools' secretariats for teachers and administrative staff and for workers in ESPOCH´s Workers Association[6].

3.4. Plan of Sustainable Mobility for Ecuador

On January 31st, 2019, the Ministry of Transport and Public Works signed the Interinstitutional Cooperation Agreement for the Execution of the Sustainable Mobility and Academic Research Initiative (MOVIA) with a consortium of universities, which includes ESPOCH. The initiative aims to generate research related to transport and sustainable mobility, and develop public policy based on reliable information to minimize environmental impact and achieve low carbon mobility. MOVIA is a strategy to influence the number of academic publications related to the problem of transport and sustainable mobility, urban and rural, through graduation projects, bonding projects, essays, theses, dissertations or scientific articles. MOVIA will directly benefit more than 3000 students of careers related to transport, who will have easy access to research topics and data, and will also indirectly benefit 58572 students of all races[10].

4. Concluding Remarks

The managing transportation indicator at ESPOCH ranked first in UI GreenMetric World University Rankings for Ecuador; the most remarkable parameters in this category include shuttle service provided by university, regular and free, zero emission vehicles available, provided by the university for free, and available pedestrian paths, designed for safety, and mostly have disabled-friendly features. The university mobility plan is that successful that it was launched at national scale with a consortium of six universities and the Ministry of Transportation of Ecuador.

After last year results ESPOCH is implementing new cleaner transportation modes such as zero emission buses, a revision on the bus routes and itineraries at the main campus, and educational plans for sharing the mobility plan with all the members of the polytechnic community. Biking initiatives are being enforced, and the correct use of parking space is constantly stated. A focal point of the sharing and biking initiatives is not only reducing carbon footprint but also improving personal relations among people at ESPOCH.

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Sustainable Mobility Management at the University of Milano-Bicocca

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Abstract. Since it was founded in 1998, the University of Milano-Bicocca has been working to make its structures environmentally, socially, and economically sustainable. This objective has been pursued by creating BASE (*Bicocca Ambiente Società Economia* – Bicocca Environment Society Economy), a centre that promotes interaction between research and training and that stimulates sustainability within the University and outside it. The university's action on sustainability has been programmed as part of the Bicocca Sustainability Plan, a framework that sets out the objectives and the action to be taken around the core topics of settings, infrastructure, energy and climate change, waste, water, transport, education, and research. This report focuses on the measures that relate to mobility and describes the action that is being taken in favour of more sustainable forms of mobility, specifically on mobility management, study, and research, and on the results that have been obtained in the use of public transport and the adoption of active mobility. The attention Milano-Bicocca is giving to the economic and social aspects of sustainable mobility is documented by describing its agreements with transport operators, and its policies for improving student access to the University.

Keywords: Best practice, carbon footprint, mobility management, sustainability management, transport policies

1. Introduction

Since it was founded in 1998, the University of Milano-Bicocca has been working to make its structures environmentally, socially, and economically sustainable, not only to reduce the costs and environmental impact of its management processes, but also to promote sustainable behaviour on the part of its employees and students. BASE (*Bicocca Ambiente Società Economia* – Bicocca Environment Society Economy) was created for that purpose as an internal centre that promotes interaction between research and training and that stimulates action for sustainability within the University and outside it. Within the university this interaction is exemplified by studies and research on sustainability, by sustainability training for students and staff, and by the coordination between the different university sectors for the implementation of sustainability measures. Outside the university, BASE supports the interest in sustainability by participating in working groups at the local level (the Bicocca District), nationally (the University Network for Sustainable Development), and at the international level (the International Sustainable Campus Network - ISCN). BASE promotes a holistic approach to sustainability that includes a commitment to education on energy, waste, mobility, climate change, water, food, and sustainability. This report focuses on the measures that relate to mobility and describes the action that is being taken in favour of more sustainable forms of mobility, specifically on mobility management, study, and research, and on the results that have been obtained in the use of public transport and the adoption of active mobility. The attention Milano-Bicocca is giving to the economic and social aspects of sustainable mobility is documented by describing its agreements with transport operators, and its policies for improving student access to the University.

2. The Academic Supply, and the National Survey on Commuting at Italian Universities

Education in Italy is extensive and diversified; there are 89 universities, 61 of which are public and 28 are private (ISTAT, 2016). Although the provision of university education is greater in the larger cities and the northern regions (where 36% of the universities are concentrated), it is distributed widely and is spread across no less than 136 university sites. This great dispersion results in a demand for mobility that is equally widely distributed, and in a modal split which in the decentralised parts of the country is dominated by the use of private vehicles, as it also is in the smaller cities where fewer public transport services are available (Colleoni 2019).

Nationally, the provision of university education is also diverse in terms of its size. In the 2014-2015 academic year about 1,700,000 students were enrolled at Italian universities (of which 91% were attending the public universities and 9% at the private universities). About 40% of these students reside in the three most populated regions (Lombardy, Lazio and Campania), whilst the remaining 60% are distributed across the universities in the other 18 regions. Italy's mega-universities represent 13% of the national university offer and have more than 40,000 students between them. The national offer is characterised by a prevalence of universities with 10,000 - 20,000 students, and by a substantial number of universities with fewer than 10,000 students (making up 44% of the total). This means that the universities in many of Italy's university cities and towns are small in size. Another influence on the potential demand for mobility relates to how the university population is distributed, based on the most important socio-demographic variables. According to the results of the 2016 ISTAT study just mentioned, about 56% of university students are female and about 75% of these are under 26 years old. So, this is a young population with a strong female component (most of whom still live with their families in their home towns). Nearly all of the students enrolled at the public universities come from a wide range of economic backgrounds, whilst only one tenth of those who come from more affluent, more highly educated families are enrolled at the private universities. So far as their municipalities of origin are concerned, approximately 8 out of 10 students are enrolled at universities in the region where they reside (79%), whilst more of the students who hold a higher diploma level and are enrolled on master's programmes and/or at private universities reside outside their region of origin. Finally, the 1999 reform led to an increase in the number of universities, decentralised them away from the main urban centres, and increased the variety of degree courses on offer (Demarinis et al., 2011). A large number of Italian municipalities now host small universities, almost all of which are public and where almost all of the students come from a middle-class background and who, as compared to other European countries, have a lower level of residential mobility (OECD, 2014) and a higher level of demand for daily travel to and from their place of study.

In order to comply with the requirements of Interministerial Decree no. 27/03/1998, entitled “Sustainable mobility in urban areas”, all public institutions and private companies with more than 300 employees are required to nominate a mobility manager. In general, each university mobility manager gathers information about the daily mobility of their university population by carrying out specific surveys of the home/work/study journeys taken by staff and students. Although these surveys are normally only carried out by university personnel (tutors and staff), in many instances the whole university population becomes involved. In order to assemble national, up to date, comparable data on home-university journeys and to provide information that can be used to guide mobility management policies, in October 2016 the University Network for Sustainable Development promoted and implemented the first national survey, based on a sample of 37 universities and 70,000 respondents, on commuting at Italian universities. As compared to Italy’s overall daily mobility demand (ISFORT, 2016, ISTAT, 2017, ISPRA, 2017), the level of demand for university mobility revealed at least three positive aspects.

- First: a better modal split, with a low proportion of journeys by private car (22%), greater use of public transport (61%) and a level of active mobility that is in line with national values (17%).
- Second: a good degree of inter-modality and the use of shared vehicles.
- Lastly: the university is a favourable context in which to innovate.

However, three negative aspects of the mobility demand require targeted governance and action by university mobility managers:

- First: the lack of homogeneity in the modal split in relation to the size, location, and type of the university population (a split that is most marked at the smaller universities, particularly in central and southern Italy).
- Second: the low level of active mobility on the part of students, because of the great distances they have to travel between home and university, and the absence, or the poor quality, of cycling and walking infrastructure and services.
- Third: the long travel time and the considerable distance of the journeys that many students take in order to get to their universities; these are significantly greater than those in other western European countries. For the average Italian student, the journey to university is 29 km long and takes 51 minutes (each way). The difference is explained by the dispersion, as we have mentioned, of the places where Italian students reside (mainly in some of the large metropolitan areas) and their tendency to live at home with their parents. This results in the widespread use of private cars by those who live and study

in areas where public transport is poor, and in a tendency to minimise their attendance at university: just two of the most significant negative consequences of such long journeys and the time they take. There are also other negative consequences in terms of the costs of travel, particularly for students who live more than 40 kilometres from the university. This final negative aspect of the mobility profiles of Italian university students suggests that targeted policies should be adopted not only to minimise travel costs but also to improve the quality of the journey. Italian students spend a significant amount of their time on the move, so if we want to improve their quality of life, one goal towards which universities, public administrations, and public transport service providers should contribute to attaining is the enhancement of the quality of those journeys.

3. Strategies and Policies for Academic Mobility Management at the University of Milano-Bicocca

As we have just seen in the previous section, the modal split at Italian universities is generally more virtuous than the national average, with a much greater proportion of travel by public transport and, consequently, a smaller proportion of private vehicle use. Like the other universities, most journeys to and from Milano Bicocca are by public transport (77%) with a reduced percentage of private vehicle use (16%) and active mobility (7%). But we have also highlighted critical elements that require action to manage the daily travel of the university population with the aim of further reducing the use of private cars, increasing the journeys made by public transport and active mobility, improving the quality of university mobility more generally and, as a consequence, also improving the equitability of the study offer.

As was mentioned, policies for university mobility management can be divided into three different strategies whose effectiveness depends on the ability of universities to implement them continuously and in synergy.

3.1. Concession strategies and policies

Policies on concessions should aim to minimise the use of private vehicles by supporting active mobility and the use of public transport. Concessions are the most widespread type of policy in use by Italian universities, partly because public transport concessions are often included in the general benefits offered to employees. Policies that incentivise the use of public transport are normally based on agreements with local (municipal) public transport companies or, at the supra-local (provincial or regional) level, in the form of discounted travel cards issued to employees (financed partly by the transport company and partly by the university). These policies have proven very effective wherever they have been implemented and have succeeded in shifting a significant number of employees from private to public transport, whilst also encouraging them to use public transport for other journeys as well as for their commute to/from university. Milano-Bicocca University has been promoting these concession policies for employees at the municipal, regional, national, and international levels for more than 15 years. In relation to transport at the municipal level, it has an agreement in place with ATM (Azienda Trasporti Milanesi) that enables employees to purchase an annual travel card discounted by approximately 40% thanks to co-financing by the University (about 30%) and by the transport company (about 10%). Approximately 16.50 euros per month is deducted from the employee's monthly salary to cover part of the cost of a city travel card. A similar approach is applied to concessionary travel on regional trains, where the discount (approximately 30%) is fully covered by the University (the railway company for the Lombardy region, Trenord, does not make any co-financing contribution).

For countrywide travel by public transport, Milano-Bicocca has finalised the text of an agreement with Trenitalia, the national carrier, for discounts to university employees on tickets for business travel. This agreement is advantageous not only because it reduces the cost of the frequent train journeys that academic staff make (a saving that can be more usefully reinvested in research), but also because it enables these journeys to be more effectively accounted for, reducing waste and the consequent negative environmental impact. This commercial agreement with Trenitalia offers a discount that varies between 15% and 30% depending on the extent to which Trenitalia's business objectives are achieved in terms of the volume of tickets purchased. A further advantage is that academic staff no longer have to pay for their travel themselves and request reimbursement at a later stage, since Trenitalia now issues an electronic invoice to the university, which the university pays directly. Another agreement with Trenitalia gives both employees and students a 10% discount on the basic fare for train tickets for medium and long-distance journeys. For national and international air travel, Milano Bicocca is also in the process of concluding commercial agreements with Alitalia and Turkish Airlines. The main interest for Alitalia is the domestic market, whilst for Turkish Airlines it is the Middle East.

These concession agreements not only make possible air travel at reduced prices (thereby saving resources that can be used for research) but also improve the conditions for tutors and students when they are travelling for study and work (by entitling them to use comfortable waiting lounges). In particular, these discount policies offer heavily discounted prices to deserving and/or economically disadvantaged students, as well as supporting medium and long-distance return travel for students who are attending international summer schools. In that sense it can be said that these concession policies support the learning experience.

There are also other agreements with an increasing number of companies that provide shared mobility services, and these deserve separate treatment. Having only recently appeared on the transport market, in the space of a few years these services have led to a considerable increase in the number of users who share vehicles, particularly in the cities where these services have the strongest presence (Turin, Milan, and Rome). The academic world has immediately looked with interest at this sector, which by offering shared mobility services (managed using the new communication technologies), finds a privileged target of reference in university students. Shared mobility services also play an important complementary role in supporting public transport, which is still entrusted with managing large travel flows. In particular, the University of Milano-Bicocca has stipulated agreements with car-sharing operators (DriveNow, SharenGo, Ubeeqo, and Genial Move), bike-sharing operators (Ofo) and eCooltra (scooter sharing).

Furthermore, since this concession strategy is aimed at supporting pedestrian mobility whilst at the same time restricting the use of private transport, not only to facilitate home-university mobility but also to support mobility within university campuses and between university buildings, the measures taken also include the activation of university shuttle services, which at Milano-Bicocca are provided free of charge within the campus.

Figure 1. From the left: the Mobility Manager - Prof. Matteo Colleoni and the Rector - Prof. Cristina Messa

3.2. Restriction strategies and policies

Because restriction policies on cars limit the right to private travel, universities in Italy adopt them much less frequently than policies based on concessions for travel by public transport. Moreover, there are continuing debates and exchanges of opinion between widely differing points of view, in relation to restricting the right to use private cars. These are exemplified by the complaints of university employees (teaching and other staff) about the recent proposals by some universities to prohibit private cars from accessing or parking in their public spaces. For that reason, measures to restrict private car access have not been adopted by many Italian universities.

Policies to restrict the use of private cars are leading some universities to replace their car fleets with hybrid or fully electric cars, or to reduce the number of car journeys by encouraging university-based car pooling as a way of reducing environmental impact. The University of Milano-Bicocca has adopted that strategy and has acquired a fleet of hybrid cars; it is also encouraging car-pooling by supporting the digital platforms of various operators who create contacts between those who are seeking a lift and those who are offering one. These platforms were presented as part of the first Bicocca Mobility Day.

3.3. Persuasive strategies and policies

Persuasive strategies and policies are based on the assumption that like other habitual behaviour, restrictive measures will not suffice to change mobility decisions and that it is also necessary to intervene on the values, norms, and attitudes of individuals (Shove, 2010; Bamberg et al., 2011). Moreover, since mobility is a habitual type of behaviour that is difficult to change with rational rules and explanations, changing it requires that people be given sufficient time to experience the effectiveness of changing their travel habits and/or practices. Measures to encourage the use of active mobility and public transport via communication and/or awareness-raising campaigns, particularly by the use of personalised marketing programmes (better known in the English-language literature as Personalised Travel Planning or PTP), form part of that discussion. Such measures have in common three assumptions that underlie all persuasive strategies. Firstly, communication and/or awareness-raising campaigns will only be effective if they are tailored to individual characteristics and expectations. Secondly, they must enable the changed behaviour to be tried out, allowing sufficient time for its benefits to be evaluated; and thirdly, rather than aiming these measures at everyone, they should only be targeted at those who are most likely to change their travel habits. University students clearly fall into the latter category, particularly those in their first year who have not yet acquired a habitual pattern of travel. Moreover, since first-year students are younger they are more willing to experiment with changes in how they habitually use the opportunities offered by the university, and how they travel in order to make use of them. In recent years a small number of universities in Italy have initiated personalised marketing programmes that offer an alternative to using private cars; one of the most successful, which was developed and promoted by the University of Cagliari, is I-Pet (Individual Persuasive Eco-travel Technology), an application that gives the student a personalised travel solution by tracking their home/university routes by GPS and sending them a personalised travel plan. In a similar way as at Cagliari, the University of Milano-Bicocca is preparing its own persuasive policies based on a survey that tracks the journeys taken by students and then suggests alternatives that are more sustainable for their health and the environment, thereby encouraging active mobility and the use of local public transport. These alternatives will be implemented via an application that will provide tailor-made responses to the students who take part in the scheme.

A less focused but more widely disseminated way of supporting persuasive measures is by participating in national and international sustainable mobility campaigns that often use prize-winning competitions to encourage the adoption of virtuous mobility styles; one of the best known is European Mobility Week, which is promoted by the European Union. The University of Milano-Bicocca is also participating in another European project: Bike2Work - Smart choices for commuter. Bike2Work is designed to shift mobility from cars to bicycles via a programme that changes the general (and the corporate) conception of the worker who commutes into that of the worker who travels to work by bicycle every day. Milano-Bicocca is also participating in U-MOB LIFE - European Network for Sustainable Mobility at Universities, a European project funded by the European Commission within the LIFE programme. The aim of U-MOB LIFE is to create a network that facilitates the exchange and transfer of knowledge between European universities on good standards of sustainable mobility. By improving the journeys made by the university community, this network will serve as a tool for reducing CO_2 emissions. Of the recent activities to disseminate and promote sustainable mobility within the Milan-Bicocca campus, Bicocca Mobility Day, which was organised for the first time in May 2018, is worthy of attention. The first edition focused on the importance of shared mobility services, mainly in terms of how they complement the use of traditional public transport.

Figure 2. Sharing mobility services at the Bicocca Mobility Day 2018

3.4. Innovative strategies and policies

The aim of innovative strategies and policies is to promote study and research into the innovations that are the most likely to be widely accepted in settings such as academia. In fact, a number of Italian universities, operating within the work programmes of the Mobility Working Group of the Network of the Mediterranean Universities for Sustainable Development, as well as in other settings, are in the process of developing technological and organisational proposals that improve the mobility of their populations. On the technology front, in addition to the policies previously mentioned for renewing university car fleets and installing electric vehicle charging points, several Italian universities are using their scientific know-how to seek solutions that reduce the energy consumption of vehicles and, more generally, increase the use of urban mobility infrastructure (roads and charging stations). Particular attention is being given to studying and researching electric vehicle power supply technologies, analysing the correct urban locations for charging points, developing new inductive charging systems (e.g. in car parks and at rental stations), and trialling photovoltaic panels integrated into car bodies.

However so far, few studies or trials have been undertaken on innovative organisational measures that could improve the governance of mobility flows. These most commonly fall within the category of so-called immobility measures that aim to discourage unnecessary journeys. They include campaigns to reduce the number of discussions and meetings that require physical travel (to be replaced by online meetings) or, for employees in the technical-administrative sector, by the use of teleworking and "agile work" programmes. These methods have been on the agenda at Milano-Bicocca for a long time, and this University has been piloting various "smart working" possibilities for many years not only as a means of acquiring greater flexibility for a more effective home-work time balance, but also as a way of decongesting traffic flows.

Milano-Bicocca is also piloting measures designed to modify the work and teaching calendars and hours of the university population, in order to de-synchronise entry and exit flows from and to the university buildings. Although in our post-industrial societies journeys have already become less concentrated into rush hours, we still know that daily peaks occur between 7 and 9 a.m. and between 5 and 7 p.m.. The negative consequences of private vehicle traffic congestion at peak times, and the excessive use of public transport, are very obvious (and with the well-known negative repercussions on the quality of the journey itself, as well as on the inefficiency of how the road system is used during periods of light traffic). But although better rationalisation and distribution of the presence on campus of students and university staff would lead to a more efficient use of energy resources and reduced consumption, measures to de-synchronise the academic offer are rare and still run up against rigidities of various kinds that prevent them from being applied and diffused.

4. Conclusions: Four Empirically Based Discussion Topics for the Better Governance of Sustainable University Mobility

The increased attention that is now being given to sustainability, and the improving national coordination between mobility managers, have led to positive outcomes in terms of increasing the number of institutional contacts and of launching policies for mobility governance. These policies are beginning to present a very wide spectrum of intervention that ranges from concession strategies, which are more numerous and traditional, to strategies for restriction, persuasion, and innovation. This report has highlighted their positive elements and the factors that still impede their implementation, and by way of example has discussed some proposals put forward by the University of Milan-Bicocca. But the continuing imbalance between policies based on issuing concessions, and other types of policies, suggests that in a sector like mobility, which as urban policies for sustainable mobility teach us, requires the implementation of integrated and multi-dimensional measures, greater attention should be given to persuasive and innovative measures. The data acquired from the national survey, and the policies presented in the preceding paragraphs, enable us to identify four themes on which universities should be focussing their attention in order to improve their governance of mobility.

1) The first theme is concerned with the role that universities play in the local and supra-local governance of mobility and accessibility. Within the more general system of urban and metropolitan mobility in Italy we are beginning to see, in a number of national experiences, the first signs that universities are becoming involved in the governance of academic mobility, although it is too early to assess how effective these experiences are. Whatever those outcomes may be, university mobility managers must nevertheless commit more and more to joining these governance bodies and playing an active role on them, or if not, must promote the setting up of working groups and other inter-institutional settings in which sustainable mobility is managed.
2) The second theme is concerned with extending the idea of mobility to the idea of accessibility and the right to study, in the sense that how we travel is the means to an end, and the end is our arrival at the workplace. This is particularly the case in the university sector, where people travel to places of learning in order to acquire disciplinary and professional skills. Leaving to one side the traditional divergences between the different skills and interests of the education sector and the transport sector, the entitlement to mobility - a mobility that, moreover, should be of good quality - becomes of value when it is associated with the entitlement to study. In a wider sense therefore, integrated mobility policies are also linked to the right to study and the entitlement of every student to an academic experience of good quality, which includes the ability to get to the university and make use of its resources at the proper times, in the correct way. It also includes ensuring that their ability to access the university is not jeopardised by excessive travel time, distance, or cost.
3) The third theme, which is concerned with the quality of mobility, would merit consideration as an autonomous area in which academic mobility managers should invest. Like many other highly mobile sectors of the population, students spend a considerable part of their time every day in places of mobility (in streets, on board public transport, and at waiting areas). They often spend this time studying and interacting, particularly at waiting areas and when they are on board transport vehicles; the quality of such environments will therefore influence the quality of what they do in the course of their journey. Since university mobility managers possess the best knowledge about the lifestyles and needs of their university population, they must become involved in the planning and construction of those places.
4) Finally, the fourth theme is concerned with organisational changes. Unlike changes to infrastructure, which often require considerable resources and institutionally defined skills, making changes to how times and places of study are organised falls more easily within the sphere of academic management. But in Italy, such changes may often be impeded by laziness and acquired privileges that prevent them from being tried out, and as we emphasised when discussing persuasive policies, such changes very often seem impossible to attain because they are seen as being far removed from the everyday routine of habitual practices. But where they can be trialled in a measured way tailored to the needs of the actors involved, they can lead to innovative results not only in terms of mobility, but also ordinary administration.

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IPB University Green Transportation Policy: The Perspective's Student-Motorcycle Rider

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Abstract. In 2015, IPB University has established a policy of "IPB toward Green Campus 2020". There are three criteria, one of which is Green Transportation. The main target of green transportation policy is to reduce number of motorbike rider whose number increase every year. There are three polices of green transportation, namely registration of all motorbike that enter university area; obligation of all motorbike to be parked in the parking zone; riding bus or Electrical Car (MoLi) that connect all parking zones to final destination. They are charged Rp 1 for parking their motorbike in the parking zone, Rp 2,000 for riding MoLi and Rp 1,000 for riding bus. This research aimed to gain students' perception and expectation on the green transportation policy and its facilities; as well as their willingness to pay for parking, bus and MoLi services. Students' perception and expectations are analyzed using important performance analysis (IPA) while willingness to pay is determined by Contingent Valuation Method (CVM).

Keywords: Green transportation, importance performance analysis, motorcycle riders, willingness to pay

1. Introduction

Every year, the number of IPB students tends to increase in December 2010 from 14,832 people to in 2015 16,080 people. It had increased 1,248 people in five years. Motorbike is a favorite transportation for students. Data from PT. BLST (2016) shows that in September 2016 the average number of motorbikes entering the IPB campus during rush hour (06.00-10.00 hours) was 1,560 motorcycles per hour. This fact become a serious obstacle for implementing green transportation policy that has been established in 2015. Many students disagreed with this policy because of some reasons. A study of Faaruq (2016) that surveyed 100 respondents of students where 34% of them rejected the Green Transportation policy. This becomes a challenge to fully implement this policy in 2020 as targeted. This fact shows that IPB University needs to find information why they disagreed with this program. So, this research was intended to answer that some questions related two intentions, student perspectives and expectation on green transportation facilities; and tariff polices of parking; bus and MoLi riding.

2. Analysis and Alternative Handling Solutions

To reduce the number of motorbike use in campus, IPB has applied a policy that every motorbike entering university must be registered through online or to Green Transportation office. The registered and verified motorcycle are allowed to enter IPB campus. Then, they have to park their motorbike in four determined parking zones. They are not allowed to ride their motor bike inside campus. The four-parking zone is connected by bus, MoLi and bike to every final destination or place inside campus. To use bus, they should pay Rp 1,000 and Rp 2,000 to use MoLi. Using bike is free of charge. The aim of this study is to get motorbikes' perceptions on the policy of parking zone and MoLi as well as bus tariff.

The study uses both primary and secondary data gathered from any kind of sources such as respondents, internet, journals, research center and so on. We use four parameters namely perception, expectation, satisfactions and willingness to pay. The data were analyzed using relevant methods. Tables 1, 2, 3 and 4 as attached each show the evaluated attributes of the expected parking facilities; attributes of bus facility; attributes of MoLi, and attributes of supporting facility. The last-mentioned means facilities supporting the success of green transportation policy such as pedestrian and street lighting.

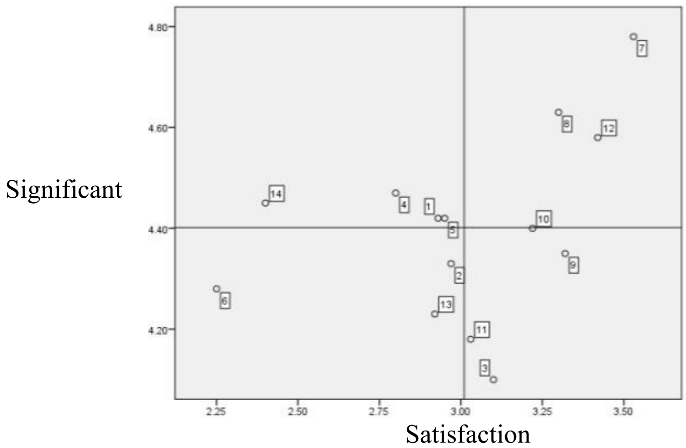
The data gathered from respondents on each facilities' attributes were analyzed and mapped into Cartesian diagram where X shows satisfaction and Y is significant. Fig. 1 is Cartesian diagram of evaluation of parking zone facilities. The diagram is divided into four quadrants based on the average value of the total attribute.

Source: Peliani (2015)

Figure 1. Cartesian diagram of Importance Performance Analysis (IPA)

Followings are analyzed and mapped attributes of each facilities:

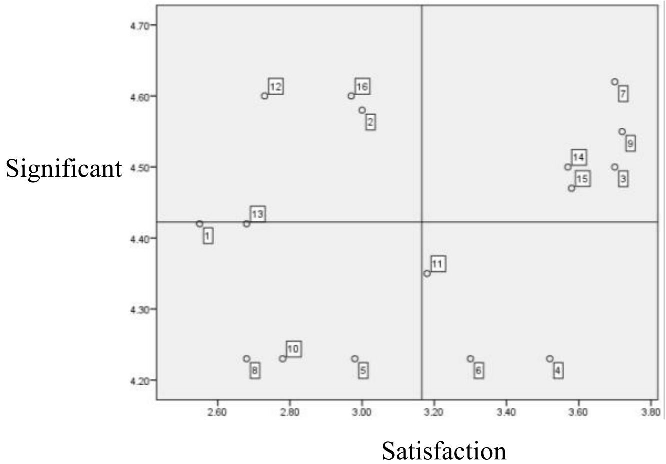
1. Centralized Parking Facility
   Regarding this centralized parking facilities, we focus on attribute that are significant for their improvement. Namely, facilities mapped in the quadrant 4 as shown in Fig. 2.
   - Staff skills in responding to consumer complaints (Attribute 4)
   - Parking lighting at night (Attribute 14)
   - Availability of information on parking hours (Attribute 1)
   - Officers' will to help those who need assistance in parking areas (Attribute 5)



Source: Joshua (2017)

Figure 2 Cartesian diagram of importance *Performance Analysis* centralized parking

2. Bus Facilities
   Similar to the parking facilities, Fig. 3 shows the mapped significant and satisfaction attributes of bus facilities. There are three important attributes needed to improve as shown in quadrant 4 as follows:
   - Operating hours of buses follow the schedule of student class (Attribute 12)
   - Adequate number of buses (Attribute 16)
   - Availability of bus route information (Attribute 2)



Source: Joshua (2017)

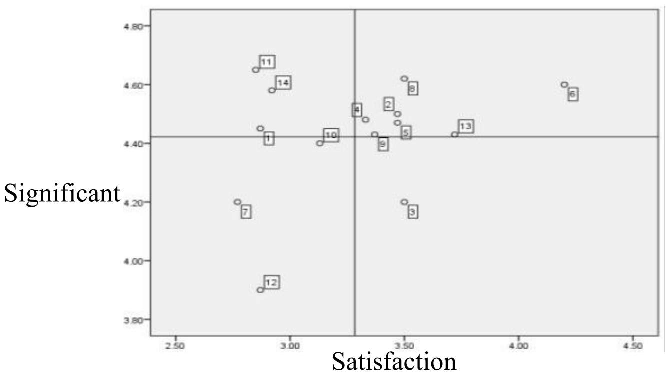
Figure 3. Cartesian diagram of importance *Performance Analysis* bus facility

3. MoLi Facilities

Electrical Car (MoLi) is a favorite transportation. Many both student and other are interested to us this car that is usually in golf field. In order to improve these facilities to support green transportation, there are three important attributes that need to improve as shown in the quadrant 4 of MoLi Cartesian diagram of Fig. 4. These attributes are:

- Operating hours of MoLi follow the schedule of student class (Attribute 11)
- Adequate MoLi number (Attribute 14)
- Availability of MoLi route information (Attribute 1)

These three attributes should be prioritized in order to increase the level of consumer satisfaction.



Source: Joshua (2017)

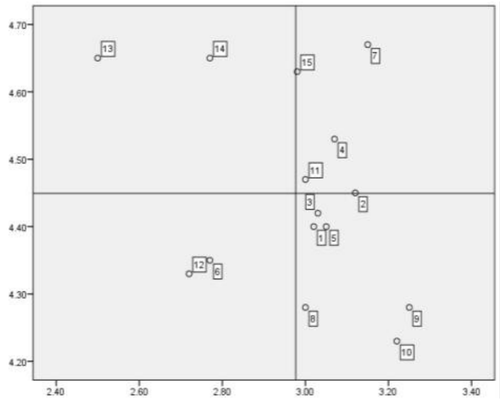
Figure 4. Cartesian diagram of importance *Performance Analysis* MoLi facility

4. Supporting Facilities

The last facilities that have been successfully mapped in this study is attribute of supporting facilities. These facilities are intended to increase convenience and safety in campus. There are two important main facilities as shown in Fig. 5 as follows:

- Availability of street lighting for pedestrians and cyclists (Attribute 13)
- Availability of safe bicycle parking (Attribute 14)

Significant

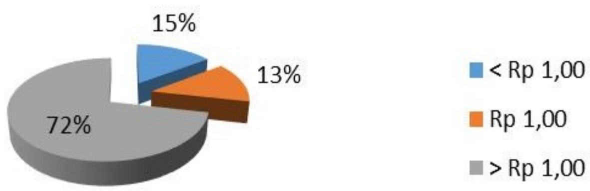


Satisfaction

Source: Joshua (2017)

Figure 5. Cartesian diagram of importance *Performance Analysis* supporting facility

In addition to evaluating the four green transportation facilities, this study also analyzes willingness to pay of respondent (students) for the bus, MoLi and parking tariff. We divided respondents into three groups based on their willingness to pay. The three groups are: (a) respondents who can pay more than the current rate; (b) respondents who want to pay at the same rate (no increase); and (c) respondents who want to pay less than the current rate. The distribution of the respondents' willingness to pay is shown in Fig. 6.



Source: Joshua (2017)

Figure 6. Percentage of respondents' willingness to pay about centralized parking

The IPB University had set a tariff for motorbike is Rp 1 per once parking by tapping tap cash. This tariff is very cheap because its intention is to give incentive for motorbike riders to park their motorbike at parking area. It is possible to increase the tariff if IPB University can improve parking zone facilities as shown in Fig. 6, where 72 % of respondents will to pay more than Rp 1,00. Fig. 7 and 8 shows distribution of respondent's willingness to pay. Most respondents want to pay lower than the current tariff of Rp 1,000.00 for the bus and Rp 2,000.00 for MoLi.

Source: Joshua (2017)

Figure 7. Percentage of respondents against bus willingness to pay

The distribution of the desire to pay respondents to use the MoLi facility can be seen through Fig. 8.

Source: Joshua (2017)

Figure 8 Percentage of respondent's willingness to pay of MoLi

The two results of processing the data show that bus and MoLi rates can be reduced because most respondents want to pay lower than Rp 2,000.

3. Conclusion

The IPB University's students are willing to support the university policy for green transportation implementation. Even, they are possible to be charged more for parking, bus, and MoLi than the current tariff. What they want is that IPB University improve its facilities of parking areas, buses, MoLi, and supporting facilities such as pedestrian, and street lighting. So, the rejection of students on IPB of the university policy for green is not substantially caused by their disagree on the policy but on their unsatisfaction and upreparedness of green transportation facilities.

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Attachments

Table 1. Parking Facility Attributes

No.	Statement
	Reliability
1	Availability of parking hours operational information
2	Parking location close to bus, bicycle and MoLi facilities
3	The skill of the ticketing officer in transactions using Tap Cash
	Responsiveness
4	Staff skills in responding to consumer complaints
5	Officers want to help consumers who have difficulty parking their motorbikes
	Assurance
6	Availability of channels of criticism and suggestions regarding parking facilities
7	Consumers feel safe when parking their vehicles there
8	Consumers feel comfortable when parking their vehicles there
	Empathy
9	Hospitality of parking attendants to all service users
10	Officers are willing to help consumers deal with problems in the parking lot
	Tangible
11	Cleanliness of the parking lot
12	Availability of parking lot guardrails to ensure security
13	Modern centralized ticketing parking system (automatic crossing and parking ticket machine)
14	Parking lighting at night

Source: Joshua (2017)

Table 2. Bus Facility Evaluation Attributes

No.	Statement
	Reliability
1	Availability of bus departure schedule information
2	Availability of bus route information
3	Ability to drive bus drivers
4	The skill of the ticketing officer in transactions using Tap Cash
	Responsiveness
5	Officers quickly respond to consumer complaints and problems
6	Officers want to wait for passengers who want to ride the bus
	Assurance
7	Passengers feel safe using the bus
8	Availability of channels of criticism and suggestions regarding bus facilities
9	Passengers feel comfortable when using the bus
	Empathy
10	Willingness of officers in responding to criticisms and suggestions from bus users
11	Hospitality of officers to all service users
12	Bus operational hours follow the schedule of student activities on campus
	Tangible
13	Cleanliness of the bus stop
14	Bus cleanliness
15	Air circulation on the bus
16	Adequate number of buses

Source: Joshua (2017)

Table 3. MoLi Facility Attributes

No.	Statement
Reliability	
1.	Availability of MoLi route information
2.	The ability to drive a MoLi driver
3.	The staff's skill in making transactions using the Tap Cash machine
	Responsiveness
4.	Officers want to deliver passengers to all destinations on campus
5.	Officers want to help if Tap Cash is carried by a troubled passenger
	Assurance
6.	All passengers feel safe when using MoLi
7.	Availability of channels of criticism and suggestions regarding MoLi facilities
8.	All passengers feel comfortable when using MoLi
	Empathy
9.	Friendliness of drivers to all service users
10.	Willingness of officers to fulfill the route
11.	Molin's operating hours follow the schedule of student activities on campus
	Tangible
12.	Availability of MoLi special stops
13.	Cleanliness of MoLi
14.	Adequate MoLi amount

Source: Joshua (2017)

Table 4. Support Facility Attributes

No.	Statement
	Reliability
1	Availability of information about Green Transportation
2	Gate verification officers' skills in verifying incoming motorbikes
	Responsivenes
3	Speed of officers in responding to consumer complaints
4	Speed of officers in registering motorbikes that have not been registered at Gate Verification
5	Speed of bicycle shelter officers to provide bicycles for consumers
	Assurance
6	Availability of channels of criticism and suggestions regarding Green Transportation
7	Facilities guaranteed safety and comfort when walking and using bicycles on campus
	Empathy
8	The willingness of officers to respond to criticism and suggestions from Green Transportation users (cyclists and pedestrians)
9	Friendliness at Gate Verification
10	Hospitality at the bicycle shelter
11	Willingness to Green Transportation service providers to improve facilities for pedestrians and cyclists
	Tangible
12	Cleanliness of bicycle shelter
13	Availability of street lighting for pedestrians and cyclists
14	Availability of safe bicycle parking
15	Availability of adequate bicycle and sidewalk lanes

Source: Joshua (2017)

Issues and Innovation in Managing Education

The 5th International Workshop on UI GreenMetric
Cork, Ireland, 14-16 April 2019

Student-Centered Environmental Education at Shinshu University

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Abstract. When Shinshu University first acquired ISO 14001 certification in 2001, it was a pioneer among national universities in Japan and has since continued to promote practical environmental education throughout the entire university. The main focus of our activities is to foster an awareness of the need for global environmental conservation through daily practical experience such as the separation of trash, energy conservation, the management of wastewater and chemicals etc. with students at the center of the activities. The aim of this report is to share information with universities around the world who are promoting environmental education by describing our past efforts and our plans for future environmental activities.

Keywords: Eco-mind, environmental education, ISO 14001 certification, practical experience

1. Introduction

The humanity of the 21st century is facing a severe environmental crisis and in the last twenty years Japan has played an important role in the fight to solve these problems. The Kyoto Protocol was a crucial step in establishing the international cooperation needed to combat global warming [1]. And Japan has been quick to adopt other international standards created to build a more sustainable society, such as the RoHS directive, designed to curb the use of hazardous chemical substances in electrical and electronic equipment [2]. It is of the utmost importance to train individuals with an environmental awareness in all areas of life. To contribute to the realization of an eco-friendly society, Shinshu University (SU) has designated all of its five campuses as Eco-Campuses maintained by the students themselves in accordance with an ISO 14001 certification tailored to the needs of the University. The University's students will be the scholars, teachers, scientists, engineers, doctors, legal professionals and economists of the future, and it is the central aim of SU's educational policy that they should graduate with an awareness of the world's environmental problems and a desire to make a contribution to solving them.

SU is located in Nagano Prefecture, renowned in Japan for its commitment to environmental protection. The University consists of five campuses and eight departments (Art, Education, Economics & Law, Science, Engineering, Medicine, Textile Science and Technology, and Agriculture), including graduate schools and a large university hospital. It is a national university with approximately 11,000 undergraduate and graduate students. The University is well known for its promotion of environmental awareness in collaboration with both industry and local communities throughout the region. One important recent example of such collaboration is the Shinshu ESD (Education for Sustainable Development) Consortium, established in 2017. Throughout Nagano Prefecture, the Consortium promotes ESD [3] by setting up UNESCO schools as well as organizing exchanges with schools involved in ESD promotion in Japan and overseas.

Nagano Prefecture is blessed with an inspiring natural environment encompassing the scenic beauty of the Japan Alps, clear mountain water, fertile upland valleys and many natural parks, which occupy over 20% of the prefecture. The prefecture's active promotion of efforts to meet the SDGs (Sustainable Development Goals) [4], is reflected in the "Shiawase Shinshu Creation" business plan, which supports an eco-friendly approach to local development. In addition, the prefecture has achieved the lowest waste volume per person in Japan (3 years in a row).

2. History of Shinshu University Environmental Policy

The modern chapter in the history of the University's environmental policy [5] begins in 1998 when the Faculty of Engineering established the Department of Environmental Function Engineering in order to produce a new generation of engineers and technicians with greater environmental awareness and the expertise needed to solve real environmental problems. Over the course of the next three years, the other departments in the Faculty followed suit and incorporated this educational policy into their curricula. In May of 2001, the Faculty of

Engineering was also the first faculty in a Japanese national university to obtain ISO 14001 certification, which enables an organization to create a framework of standards by which to develop, and monitor the success of, its environmental management systems (EMSs). Throughout the subsequent 10 years, SU worked continuously to maintain and extend the certification. By 2010, ISO 14001 had been adopted by all of the University's eight faculties on all five campuses. An overview of ISO implementation and related activities is given in Table .

In August 2001, SU launched an environmental management internship, and in 2002 established a Department of Environmental Function Engineering within the Graduate School of Science and Technology. In April 2004, a state-of-the-art chemical management system was introduced to enhance chemical substance management and pollution prevention education; and three months later the pioneering "Environmental Mind Program" won recognition and funding from the Ministry of Education, Culture, Sports, Science and Technology (MEXT). (A list of environmental awards received by SU is given in Table). SU established a Promotion Headquarters for this project with the President at its helm.

The "Environmental Mind Promotion Center" was established at the main Matsumoto campus in April 2008 to coordinate environmental management throughout the entire University. Since then, SU has conducted continuous internal audits based on the ISO 14001 certification standards and have repeatedly practiced a PDCA cycle to encourage students to acquire a greater environmental consciousness in their everyday activities.

In March 2011, SU implemented a "Global Warming Prevention Practice Plan" and adopted the target of reducing energy consumption by 10.5% over the period FY2010-2015 (Phase 1), with respect to the baseline year of 2004[3]. The total reduction achieved was actually 18.1% (an average of 1.8% per year). The second phase of implementation, which has adopted the Japanese national standard, aims to reduce greenhouse gas emissions per unit by 7.0% (an average of 1.0% per year) by FY 2020 with fiscal 2013 as the base year.

Table 1. Overview of ISO implementation and related major activities

Date	Implementation
May 2001	Faculty of Engineering obtained ISO 14001 certification (first among national universities/graduate schools)
May 2004	Faculty of Engineering ISO 14001 certification renewed
July 2004	"Eco-mind program" recognized as a Distinctive University Education Support Program by MEXT
Dec. 2005	Faculty of Education obtained ISO 14001 certification (first separate certification for a teacher training faculty in Japan)
June 2006	Organized first ISO 14001 Environmental Management Student Committee national conference
Nov. 2006	Faculty of Agriculture obtained ISO 14001 certification
Dec. 2006	Faculty of Textile Science & Technology obtained ISO 14001 certification
Oct. 2007	Matsumoto campus (excluding School of Medicine and Hospital zone) obtained ISO 14001 certification Eco-Mind Education International Conference held
April 2008	Launched Shinshu University "Eco-Mind Promotion Center"
June 2008	Green Management of Technology (MOT) Education Program Implementation funded by the Ministry of Environment
Dec. 2010	Matsumoto Campus ISO14001 certification extended to the School of Medicine and Shinshu University Hospital. Shinshu University environmental policy revised
March 2011	Shinshu University action plan for the prevention of global warming (Phase 1)
Jan. 2017	New SU Environmental Management System introduced
March 2017	ISO 14001 certification suspended
March 2018	Shinshu University action plan for the prevention of global warming (Phase 2)

[3]Shinshu University became a National University CoRPoration in 2004

The University maintained its ISO 14001 certification for 16 years (2001-2017), accumulating considerable knowledge and experience related to EMSs. In March 2017, SU decided to suspend this certification in order to continue its efforts to further improve the standards of its EMS in a self-sustaining way.

Table 2. Awards list

Date	Award
September 2005	Global 100 Eco-Tech Award at EXPO 2005 Aichi, Japan
September 2005	Ministry of Education, Culture, Sports, Science and Technology Prize for Environmental Education awarded by the Japanese Society for Engineering Education (JSEE)
April 2006	15th Global Environment Excellent College Award
June 2006	4th Japan Environmental Management Award for Environmental Collaboration
March 2008	Excellence Award in Environmental Reporting category at the 11th Environmental Communication Awards[4]
December 2018	UI GreenMetric Ranking #1 University in Japan for Sustainability (48th in the world)

3. Education

3.1. Eco-mind education initiated at the Faculty of Engineering

The most distinctive feature of SU's environmental policy has been the development of an educational initiative which it calls "Eco-Mind" [6]. Eco-Mind is "a level of environmental awareness that leads one to engage in environmental activities on one's own initiative". Since 2000, the Faculty of Engineering has used the campus itself as teaching material, such that the students themselves have became responsible for the creation of an Eco-Campus based on the standards established through the ISO 14001 certification.

The students work together to tackle problems posed by the management of chemical and pharmaceutical materials, laboratory effluent, wastewater from the cafeteria, garbage, as well as studying how to improve energy efficiency and reduce paper consumption. This use of ISO 14001 certification for environmental awareness training is a practice which is unique to SU and different from the way ISO 14001 is employed in the business sector. The internal audit is the most effective educational method for understanding how ISO 14001 is characterized by a PDCA cycle, where continuous improvement is required.

In addition, for students who have gained competence in conducting internal audits, we have started an environmental management internship program which provides training through participation in audits of local government departments, companies, and other organizations in the region where ISO 14001 certification has been obtained. With this type of educational program, knowledge and keywords related to the environment learned in the specialized courses taught in each department become associated with real-world tasks. Students will go on to become technicians with environmental awareness and contribute to the realization of an environmentally-friendly society.

3.2. Enhancement of Eco-mind education by government support

During the period from 2004 to 2007, thanks to the support of the Ministry of Education, Culture, Sports, Science and Technology (MEXT),[5] the activities described in the outline above were upgraded to become regular courses, and two new courses were introduced at the Faculty of Engineering: "Environmental internal audit practice" and "Regional environmental exercise". In the first, students are trained as internal auditors not only through ordinary lectures, but also through a two-day praxis training course and on-site exercises in which they participate in an ISO 14001-based internal audit of the Engineering department. The information gathered in the internal audit provides an opportunity to consider not only the correction of examples of non-compliance (mitigation measures) but also how to eliminate the underlying causes (measures to prevent recurrence), so it

[4]A National Award created by the Ministry of the Environment and the Global Environmental Forum of Japan, sponsored by the *Nihon Keizai Shimbun*, a Japanese financial newspaper. It recognizes a coRPoration's efforts in environmental communication such as environmental reports or advertisements to promote or improve their activities. Shinshu University won an outstanding performance award, in the company of JAXA, Shimane Univ., Chiba Univ., and the Univ. of Tokyo.

[5]A program called MEXT GP (Good Practice).

is extremely useful for understanding the applicability of the PDCA cycle. Students were incentivized by making the content of their audit reports count towards their course assessment.

In the other course, the students learn together with staff from government agencies about environmental problems in the community. Once a task has been identified, the participants formulate a plan and discuss concrete measures, all of which aids in the development of critical-thinking skills and environmental awareness. This learning process also involves a student-centered PDCA cycle in which participants first design and implement their own projects before assessing the results and then making adjustments accordingly. Student performance is assessed using an activity record rather than a standardized one-way evaluation of newly gained competency because: (1) the content of learning is different for each student; and (2) learning from failure is considered to be a valuable experience. In the context of the Japanese education system, this project, based on a self-organized activity, for which the students themselves take responsibility, is a groundbreaking initiative. From 2008, the course was upgraded to become a standard course in the general curriculum of the Faculty of Engineering, managed as one of the objectives of the Engineering department's ISO14001.

3.3. Green MOT program

In 2008, with support from MEXT, SU established a Green Management of Technology (MOT) education program [7] to enable graduate students to acquire expertise in the areas of sustainability, environmental management, technology and corporate social responsibility (CSR). Broadly speaking, SU views its Green MOT program as a kind of Manufacturing Business School. The program aims to produce executives and engineers with the expertise necessary to set up and run EMSs in local small and medium enterprises (SMEs). In their responses to environmental problems, considerable differences can be observed between developed, newly developed and developing countries; and also between large companies and SMEs, reflecting differences in scale and technological resources. In general, the environmental measures instituted by SMEs have been greatly limited, with one of the key reasons being the difficulty of obtaining staff with suitable environmental awareness and knowledge. SU aims to fill this gap by training individuals capable of understanding what steps need to be taken to enhance the competitiveness of local enterprises in EMS and make full use of projects created at the community level. By building an exchange network for green development among universities and local administrations, SU is contributing to the greening of regional industries and business.

3.4. Overseas environmental training program

From 2009, SU started an Overseas Environmental Training program, on which the participating students are accompanied by an environmental expert. The instructor in charge decides on the country and area to visit in cooperation with local stakeholders. Students are required to do research in advance to maximize the learning effect. In cooperation with research laboratories, companies, and administrative agencies, the students learn about local environmental problems, environmental management, environment-related facilities, and get an idea of the daily efforts of the local citizens.

The essential aim of this program is to enable students to grasp environmental problems from the standpoint of several specialized fields, engaging in an interdisciplinary discussion in a mixed team from various faculties. After returning to Japan, students give presentations about their experiences to an audience of students and faculty members from across the University. Through such sessions, the participants learn how to communicate the importance of studying environmental issues to younger students and so keep alive the eco-mind awareness they have acquired.

So far, this training tour has been conducted ten times, with groups of students visiting Asia (Malaysia, Nepal, Thailand), Europe (Austria, France, Germany, Italy, Spain, Switzerland and the UK) and the USA (Hawaii). The participants have learned to think practically and from various perspectives on environmental topics, and because of this have contributed significantly to the promotion of environmental activities on campuses throughout the University.

3.5. Current situation

Currently, all first-year students in SU are required to take courses designed to raise their awareness of environmental issues and equip them with some of the basic scientific and technical knowledge needed to solve environmental problems. At both basic and more advanced levels, the curriculum incorporates environment-related subjects, such as environmental ethics, EMSs, and Life Cycle Assessment (LCA). It is difficult, however, to cultivate such awareness through classroom-based instruction alone, and the basic premise of the University's approach is that students' "Eco-Minds" should be developed through the process of thinking about how the activities of their daily lives can contribute to the maintenance of the ISO 14001 standards. As a part of its implementation of its Eco-Mind policy, SU conducts annual internal ISO audits requiring qualified auditors. Approximately 4% of the students enrolled in the University every year become qualified as ISO internal environmental auditors, as shown in Fig. 1. Every year, faculty and staff also receive ISO internal environmental audit training (Fig. 2). The University's goal is to continuously increase the numbers of qualified auditors and, in general, to improve the environmental awareness of its entire staff.

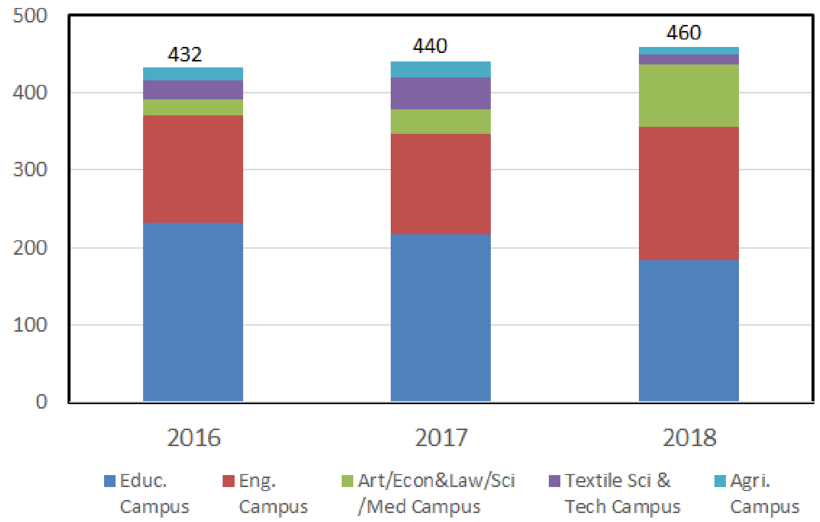

Figure 1. Number of students with internal environmental audit certificate

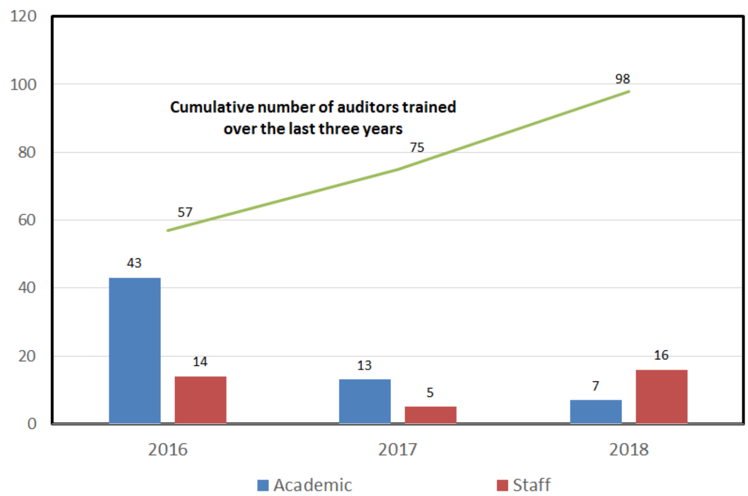

Figure 2. Number of academics and staff with internal environmental audit certificate

4. Student Environmental Committee

Another important way in which students have played a central role in the implementation of the University's environmental policies can be seen in the activities of the Student Environmental Committee (SEC). The more than 100 members of the committee have played an important role in the construction and development of the five Eco-Campuses, especially in implementing the Eco-Mind policies in daily life, taking responsibility for the separation of waste and other recycling activities, carrying out surveys throughout the University, water quality analysis and the organization of awareness-raising events. They have also been involved in the establishment of the University's EMS, participate in regional environmental activities, and conduct independent research by doing fieldwork. Every April, at the beginning of the academic year, members of the

SEC distribute reusable bags (Fig. 3), designed by the members of the Committee, to all new first-year students. Thanks to this activity, the new students use these bags with an increased awareness of environmental issues.

Since 2006, the members of the SEC have participated in the annual National Environmental Management Conference, which in that year was held at Shinshu University, Faculty of Engineering campus. Twelve years later, in 2018, the 12th National Environmental Management conference came back to Shinshu University, this time at the Ueda Textile Science and Technology Campus. On this occasion, the students reviewed the improvements achieved since the first conference and shared their knowledge of the Shinshu University Eco-Mind project with conference attendees from all over Japan. The committee has also taken part in the "Eco-Products Fair" (Fig. 4), another large-scale event, where they set up a booth and exhibited a series of panels that explained the University's environmentally-friendly activities. Students also held a workshop where visitors could experience making chopsticks using scraps from forest thinnings. Shinshu University actively encourages all students to participate in environmental activities and follow the example of the Environmental Student Committee.

Figure 3. Reusable eco-bags designed by SEC members

Figure 4. Participating in the Eco-Products Fair in Tokyo

Figure 5. SEC members checking garbage separation

Figure 6. An example of fieldwork (water quality survey)

SEC Events and Activities:

1) Eco-bag distribution to all new students (April)
2) Campus-wide camp (July)
3) Participation in the National Environmental ISO Student Conference (September)
4) Annual General Meeting (November)
5) Participation in other external environmental events such as the "Eco-Products Fair" (December, Fig. 4)
6) Setting standards for garbage (Fig. 5) / resource sorting, monitoring sorting
7) Water quality surveys (Fig. 6)
8) Picking up local garbage
9) Recycling activities (bazaars, etc.)
10) Environmental education for children
11) Conducting joint surveys and participating in local community study groups

5. Future Plans

The University's future projects include the creation of a new course cluster from April 2019, a continuation of its efforts over the past 20 years: the "Eco-Mind Program: Experience-Based Training Course for Environmental Competence", an educational program to be offered by all faculties. The approach is predominantly practical, at both a local and global level. Students will visit local companies, where they will conduct interviews and engage in joint exercises, learning about nature conservation and how environmental policies are designed and implemented. Many students will find employment with local companies after graduating and such field trips will enable them to see in concrete terms how environmental concerns will be an important component of their working lives. On a global level, overseas training trips will give students detailed knowledge of how EMSs work in cultural contexts very different from those in Japan, and provide an opportunity to think about how such approaches might be applied to environmental problems in their own country. These courses, which are projected to remain a central element of the University's curriculum, will act as a bridge between the compulsory environmental courses for first-year students and the specialized MOT courses for graduate students. With this new program, SU aims to give students in the higher years deeper knowledge and awareness as they develop into capable environmental professionals. By building on its past achievements, Shinshu University will continue to refine its green policies and improve its unique experience- and activity-based approach to environmental education.

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Acknowledgement

We would like especially to express our deep gratitude to Prof. Kimiyoshi Kitazawa, Prof. Yoichi Kabutan, Prof. Kentaro Kanazawa, Prof. David Ruzicka, Prof. Daisuke Tsuda, Mr. Hideaki Nakamura, Ms. Nobuko Imanishi, and my Ph.D student Mr. Jaime Sandoval for their support in the writing of this paper.

Strategic Action to Develop a Sustainable University, Case Study Wageningen University & Research

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Abstract. Sustainability/Corporate Social Responsibility (CSR) is an important pillar of research and education at Wageningen University & Research (WUR). The ambition of WUR in this respect is clearly expressed in its mission - *'To explore the potential of nature to improve the quality of life'*. Within the domain of 'healthy food and living conditions', WUR wants to further expand her leading position. Wageningen University & Research has actively integrated sustainability into the organisation since 2008, first by bringing the facility services (operations) in line with WUR's ambition to lead in sustainability in education and research. Next, by developing ambitious adoptive policies on sustainable operations, necessary action was taken to imprint sustainability into the organisation. Simultaneously, WUR has put considerable effort in informing own staff and students as well as the broader world on these actions in a clear and transparent way (by adopting GRI reporting guidelines). From 2014, WUR has increasingly phased in Corporate Social Responsibility. As a result, WUR was granted the special 'sustainability' quality mark, during the institutional (education) accreditation in 2018.

1. Introduction

Wageningen University & Research (WUR) has sustainable development as a fundamental philosophy, as is expressed in the mission 'To explore the potential of nature to improve the quality of life'[1]. Besides operationalising sustainable development in its education and research, WUR also regards sustainability as an important principle in its operational management. This involves achieving a balance in the complex relationships between today's social, environmental and economic needs, without endangering future needs [2].

Promoting and achieving sustainability is considered as a continuous and on-going process. In this paper we give an insight into the steps taken within WUR to integrate sustainability in its policies and practices in the past ten years. We distinguish three phases: formulating a strategy (section 2), broadening the sustainability strategy towards social responsibility (section 3) and making plans for the near future (section 4). Section 5 will conclude with some remarks on what we see as our achievements and the lessons learned.

2. Strategy for sustainability

Within WUR a broad discussion on sustainability started in 2008. The direct motivation for this debate was a study carried out by PriceWaterhouseCoopers in July 2008 [3], which showed that sustainability at WUR is certainly present, but further developed in the primary processes of research and education than in operational management. Taking into account the diversity within WUR -as WUR is a collaboration of Wageningen University and the specialized institutes of Wageningen Research [4-5]- a new sustainability policy was formulated and approved in 2009.

2.1. Ambition: be a frontrunner in sustainability

The ambition of the new sustainability policy was to become a frontrunner in sustainability. Elements of this policy were:

- On all levels sustainability should be a self-evident aspect of decision-making.
- WUR aims at closer cooperation between primary processes (education and research) and operations.
- Proven technology is applied, but not against all costs, in order not to unnecessarily endanger on-going processes in teaching/research and operational management. However, this does not mean there is no room for innovative pilot projects and trials [6].

The next step was to organize a broad debate with staff and students to offer an opportunity to contribute their ideas about sustainable operational management. Meetings were held, focusing on seven sustainability themes: construction & energy, catering, procurement, waste, mobility, education & research and the sustainable employee. This resulted in the action plan entitled ‘Accelerating towards more sustainable operational management’. This plan described what was required in the short and long term in order to reach the desired ambition level. The short term (2010-2012) focus was to realise a number of actions linked to the 7 themes. The emphasis in the long term was to ‘consolidate’ these actions through changing the organisation itself and the attitude of the employees [7].

2.2. Show it: increasing visibility

The period 2010-2012 was dominated by the implementation of the sustainability action plan. At the end of 2012 all actions were evaluated and a critical look was cast at sustainability within WUR to determine how to maintain and demonstrate its sustainable quality. The main conclusion was that WUR made important steps in sustainable operations, but that these efforts were not commonly known by internal and external stakeholders. More emphasis was put on communicating about the sustainability efforts, by giving more insights in actions and results, i.e. by showing what we are doing. Sustainability reporting and participation in benchmarks were part of this process.

During the 2013-2014 period, the 'frontrunner' ambition specifically for operations was developed in more detail. In addition, results were achieved in terms of combining education, research and operational management and in terms of creating awareness of sustainability [8].

2.3. Involving students: Green Office

Part of the new strategy was to involve employees and students in the sustainability plans. ‘Green Office Wageningen’ plays a central role in this by supporting and connecting initiatives by students and employees. Green Office started in 2012 as a student initiative and is now a platform for students and employees with sustainable ideas and initiatives. Projects of Green Office focus on making operations of WUR more sustainable, in cooperation with WUR’s Facilities and Services.

Examples of projects and activities are the ‘Student Cooking Corner’, ‘Warm Sweater Week’, ‘Seriously Sustainable Week’, ‘Meatless Mondays and Reuse Revolution’. Green Office projects linked to education are Green Match (where students can find a vacancy for a thesis, internship or course project on a sustainable topic) and the Green Teacher Award [12].

Green Office Wageningen: *»We are the green heart of Wageningen University & Research. We make it an inspiring and 100% sustainable place to work and study. Our goal is to give all students and employees access to sustainable options in their workplace»*

2.4. Reporting based on monitoring

Because of Dutch environmental legislation, WUR is obliged to report about its impact on the environment. Based on data gathered from monitoring processes, WUR reports on environmental aspects such as energy, water use and waste in its annual environmental report [9]. Since 2013 more and more sustainability themes were added to these reports, including biodiversity, procurement and transportation. In the next paragraphs an insight is given in the aspects energy, waste and CO_2-emissions.

2.4.1. Energy

The goal of the WUR energy vision is to reach energy neutrality in 2030: a sustainable energy provision with no CO_2 emissions. Policy is to reach 30% energy efficiency in 2005-2030. WUR generates renewable energy with wind turbines in Lelystad, bio-CHP’s, thermal storage on campus and solar panels. Results are shown in Fig. 1 [9, 10].

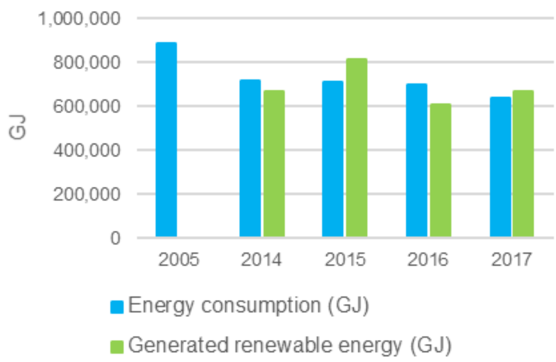

Figure 1. Energy consumption and generated renewable energy of WUR in 2014-2017 compared to 2005

2.4.2. Waste

WUR's approach to waste management follows a waste hierarchy. This means that waste management aims to give priority to the most environmentally friendly methods of processing [11]. WUR reports the three main waste streams: paper, hazardous, and residual. In addition waste is separated in 15 different waste streams, including plastics, organic waste and metals. In 2017 a separation percentage of 54% was reached. A processing method that is classified as a 'useful application' exists for 95% of WUR's waste. 40% of the waste is recycled, 55% is used for a variety of other useful applications. Fig. 2 presents the waste separation percentages in 2012-2017 [9].

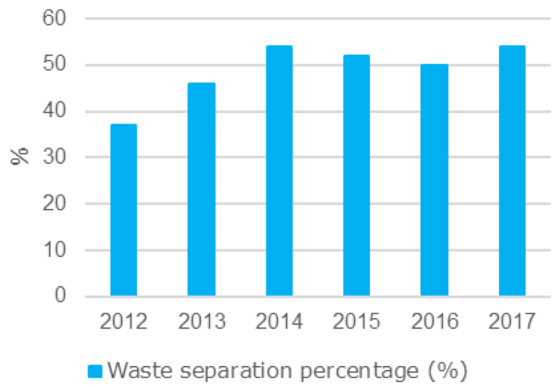

Figure 2. Waste separation percentages of WUR in 2012-2017

2.4.3. CO_2 emissions

To measure the impact of its activities on the climate, WUR started (as part of the sustainability action plan) to calculate a CO_2 footprint in 2010 to gain insight into its total greenhouse gas emissions. This created opportunities to formulate reduction targets as well as compensation measures. Comparison of the footprints in the period 2010-2017 enables WUR to specify effective measures for the reduction and compensation of emissions and to control the implementation of these measures. See Fig. 3 for the CO_2 emissions in 2010-2017 [9].

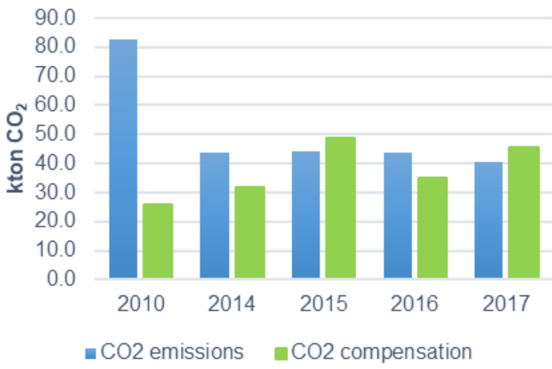

Figure 3. WUR's calculated CO_2 emissions and CO_2 compensation in kilotons, 2014-2017 compared to the reference year 2010

2.5. Transparency: GRI and benchmarks

In 2014, WUR started reporting according to the Global Reporting Initiative (GRI) in the WUR Annual report [13]. This means that reporting is aimed at being transparent about sustainability issues, human rights, governance and social well-being. The main reason to put such emphasis on transparency is to learn and reflect on how to further improve our performance.

Another aspect of being transparent about what WUR is doing on sustainability is participating in benchmarks. Currently WUR participates in the Transparency Benchmark of the Dutch Ministry of Economic Affairs, 'SustainaBul' (a ranking of Dutch universities, organised by the student organisation 'Studenten voor Morgen') and in the UI GreenMetric.

3. From Sustainability to Corporate Social Responsibility (CSR)

Since 2015 WUR started to include more social aspects in the sustainability strategy, in line with the ambition of the Strategic Plan 2015-2018: WUR acts as a socially responsible organisation and "We account for social aspects and ecological boundaries in our performance." [14]

Three pillars are important in WUR's approach on social responsibility:

1) do what you say and show what you do,
2) create awareness within and outside the organisation,
3) search for connections between research, education, value creation and operational management [15].

In the next two subsections we will explain the shift from sustainability towards corporate social responsibility and show the importance of CSR in research and education.

3.1. Setting the agenda for CSR

With a CSR agenda WUR highlights the social themes that will receive extra attention. The CSR agenda, which was first approved by the Executive Board in 2016, consists of 21 topics that were identified as important inside and outside WUR. By following the framework of the ISO 26000 self-declaration and the Global Reporting Initiative (GRI), WUR intends to work on relevant social and sustainable areas where it can make a difference. Every year WUR reports about the activities, achievements and changes of the CSR agenda. Fig. 4 shows the top 10 prioritized themes of the CSR agenda of WUR [13].

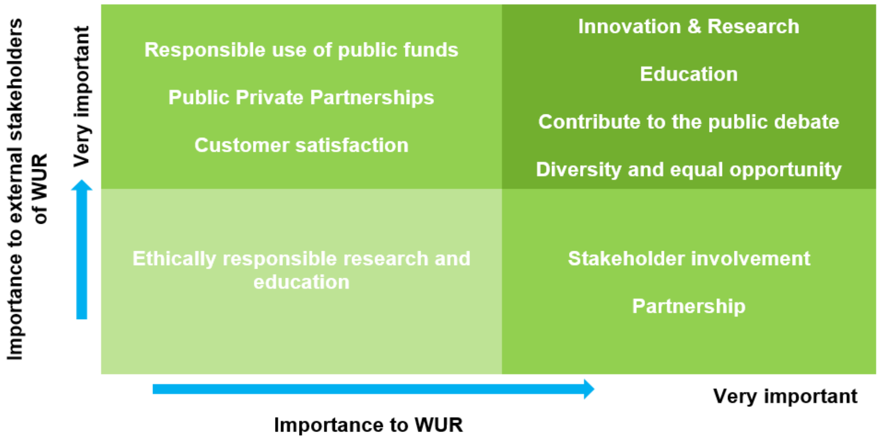

Figure 4. Top 10 prioritized themes of the CSR agenda of WUR

3.2. Sustainability in research and education

'Innovation & research' and 'Education' are ranked at the top of WUR's CSR agenda by internal and external stakeholders. Through research WUR contributes to the global challenges in the fields of ecology, sustainability, health and food safety. As WUR combines Wageningen University and the institutes of Wageningen Research, scientific breakthroughs can be quickly translated into practical applications. Knowledge is shared with society, science and business, and integrated into our education. WUR research contributes to the (Dutch) National Science Agenda, the Grand Societal Challenges of the EU and the Sustainable Development Goals of the UN.

CSR in the WUR Strategic Plan 2019-2022:
«As an organisation, we continue to be a front-runner in sustainability and CoRPorate Social Responsibility (CSR). In this Strategic Plan period we give priority to promoting the vitality of staff and students, to offer healthier and more sustainably produced food in our canteens, and to reduce our food waste.
In transforming our organisation's sustainability, we apply a Living Lab concept – an approach to provide opportunities for research and education experiments. In our procurement policies and practices, we push supply chains to be transparent, sustainable, circular and free from modern slavery.»

A central ambition is to provide excellent education: newest insights from research are applied in the education programs of Wageningen University. Next to the focus on personal learning needs of students, the university aims to offer every student a solid foundation in scientific knowledge and academic skills [13].

Over the past years, WUR has developed a vision for sustainability in education. Wageningen University's mission states "We educate students to become academic professionals, who can contribute to sustainable solutions for existing and future complex issues in the domain of 'healthy food and living environment' all over the world, and who take their social, personal and ethical responsibilities seriously." Working on sustainable solutions and social, ethical, and personal responsibility have been explicitly included as goals. [16]. This approach led to recognition by the Accreditation Organisation of the Netherlands and Flanders (NVAO). In an institutional audit in 2018 Wageningen University received a positive advice on sustainability as a valuable and distinctive specific aspect [17].

4. Towards a 'One Wageningen' Approach

As pointed out in section 3, WUR started to move from environmental (green) sustainability to social responsibility since 2015. In 2018 a new strategic plan for WUR has been formulated, which presented a perfect opportunity to examine how WUR can take CSR to the next level.

A central notion in the new CSR strategy is that everything we do, we want to do in a 'One Wageningen' way to take full advantage of all available WUR knowledge. In order to achieve this, staff and student engagement in CSR policy and actions will be essential.

The next level CSR strategy includes the following elements:

- developing a vision on CSR in operations specifically for human resources, mobility, (food)waste management, catering, energy and procurement.
- involving students and employees, connecting research, education and operations in an integral approach, for example a 'Living Lab' approach.
- increasing the visibility of WUR CSR achievements to staff, students and other stakeholders [18].

These elements are further elaborated upon in the next sections.

4.1. Momentum for change and living labs

For WUR's operational management the integral approach on social responsibility will be continued for existing and new policies. The approach will be most effective if CSR policies and actions are built upon the concept of 'momentum for change'. For example, food provision on Wageningen Campus has environmental and social impacts throughout the food chain. New procurement contracts for food catering and waste management services give us the opportunity to scan the market for innovative CSR-proof solutions, thus generating momentum for change. Outcomes of research about food, for instance themes as health, food security and prevention of food waste, will be used in WUR's CSR approach to food and vitality.

Innovative ideas originating from research and education may encourage change in how WUR operates. Input from research and education is particularly valuable in operations, including procurement processes. Focus will be on projects that combine education, research and operations and on the involvement of students, staff and local stakeholders. This provides opportunities for research pilots and student theses in a living lab approach [18].

4.2. Next level CSR: themes

For the next steps in our CSR policy seven themes [18] are formulated:

- *Human resources*: WUR aims to be an inclusive organisation for employees, where diversity -in terms of gender, ethnic and cultural background, nationality, sexual orientation, and age- is highly valued. Focus is on employability, talent development and vitality.
- *Procurement*: WUR uses a growth model to determine the progress in social responsibility and sustainability in procurement from year to year. For each procurement process this model will encourage the use of specific sets of criteria and measures.
- *Modern slavery*: WUR will develop a policy - within WUR's broader ethical framework - which provides clear guidance on how to prevent, detect and report modern slavery in WUR supply chains or any other part of the organisation.
- *Circularity*: a new strategy on material flows and waste management is being developed, based on an extensive Campus-based Material Flow Analysis (MFA) that maps all WUR material goods and their flows, from procurement through disposal. First results of the MFA is shown in Fig. 5.
- *Catering*: food waste is an important theme in the education and research programmes as well as in the operational management at WUR. The Green Office has an active portfolio on catering (Meatless Monday, Student Cooking Corner and Reuse Revolution).
- *Energy*: WUR aims at a leading role in the energy transition, by setting an example for a balanced system for energy provision, which is sustainable, affordable, reliable and compliant. Optimisation of energy use in buildings is one of the main challenges [10].
- *Mobility*: WUR vision on sustainable mobility [19] identifies measures to increase sustainability: decrease the number and distance of work-related trips, to promote alternative transport and cleaner means of transport and to increase efficiency of existing transport options.

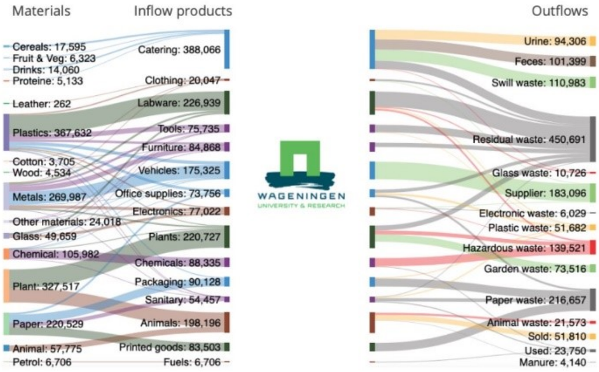

Figure 5. A campus-based Material Flow Analysis (MFA) [20]

5. Concluding Remarks

5.1. Achievements

Working on sustainable development is a continuous and on-going process: a ‘work in progress’. Since 2009 WUR has followed an integral approach to sustainability in research, education and operations. At first, emphasis was put on the ‘green’ sustainability in operational management and on being transparent about WUR’s impact on the environment. Step by step the strategy shifted from sustainability to corporate social responsibility (CSR). This involves achieving a balance in the complex relationships between today’s social, environmental and economic needs, without endangering future needs. Fig. 6 gives an overview the achievements in the past 10 years.

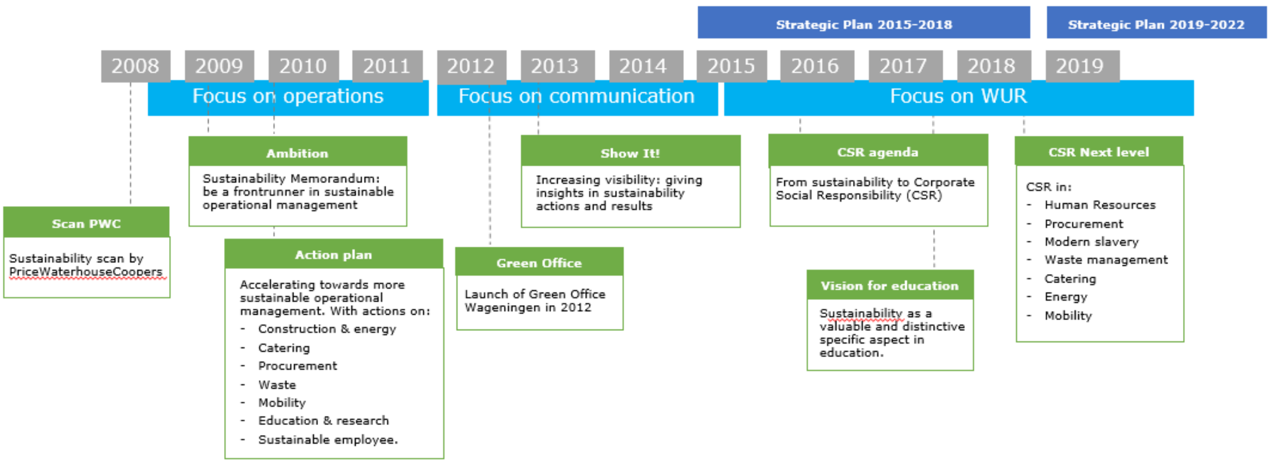

Figure 6. A timeline of the WUR’s strategy towards sustainability and social responsibility

For the coming period WUR will work on further broadening strategy on social responsibility. The CSR agenda will be brought in line with the Strategic Plan 2019-2022. More focus will be put on the involvement of students and staff for example via a Living Lab approach and increasing the visibility of CSR achievements to all (internal and external) stakeholders.

5.2. Lessons learned

For WUR, we learned the following lessons:

- Mapping out strategies and formulating policies is easily done, but sustainable development does not happen by itself. A driving force is needed, responsible persons need to be appointed.
- Be patient and work step by step: you simply cannot do all at the same time. Start with the ‘low hanging fruits’, and continue with more complicated topics that are appropriate for and can be influenced by your organisation.
- Sometimes it is better to wait for the right moment to start (or continue) working on an issue. Use ‘momentum of change’ when an opportunity or a sense of urgency occurs. Examples for WUR are the

interest within the organisation for the UN Sustainable Development Goals and for social responsibility and circularity in procurement and supply chains.

As sustainability is more and more intertwined in all activities of the organisation –as part of the day to day practices and routines- it becomes difficult to value the effort (in time and money) of the strategies, measures and activities linked to sustainability and social responsibility.

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The 5th International Workshop on UI GreenMetric
Cork, Ireland, 14-16 April 2019

King Abdulaziz University Initiatives in Establishment of Climate Change Research Center

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Abstract. The climate and climate change research become an important and urgent need regionally and globally. In the Kingdom of Saudi Arabia there was no full pledges research center or institution to work on climate and climate change. In 2010, the King Abdulaziz University (KAU) took the initiatives to establish a full pledges research center to work on climate and climate change which emerge as "Center of Excellence for Climate Change Research (CECCR)". In a decade, the CECCR developed well. Currently it has a wealth of expertise, diversified skilled manpower, conducting basic scientific research into the earth's climate system, and in particular the climate and climate change over the Kingdom of Saudi Arabia. To date, the CECCR has published more than 200 papers in refereed scientific journals and also contributed to the World Meteorological Organization (WMO) Report "WMO-No. 1103". Of particular note is the development of the Saudi-KAU Coupled Global Climate Model (CGCM), which is now available as a primary tool for research into future climate change for the Kingdom of Saudi Arabia. The adaptation of a number of Regional Climate Models (RCMs) by the Center demonstrates the great progress made in understanding and interpreting the climate and climate change phenomena, especially the climate extremes and their changes in the future. CECCR capabilities include hosting a wide range of climate datasets which are accessible by national researchers working in the fields of climate change impacts and adaptations. CECCR also runs a variety of weather and climate models (both global and regional). It also has the ability to conduct a broad set of climate simulations on the Super Computer "Aziz" of KAU, using its own Saudi-KAU CGCM which is now one of the world-wide collections of seasonal forecasting models. The recent training programs, successfully completed by the CECCR, demonstrated the Center's ability to contribute to national development projects in the fields of climate and climate change. Keeping the current momentum, the CECCR can be considered as the unique and leader in its kind of activities in the country as well as in the region. In the future, CECCR expects to run enhanced climate simulations that will provide climate-change projections with more accuracy and detail. These projections should be of practical utility to planners and policymakers and help the Kingdom of Saudi Arabia to meet its commitments under the international dialogues.

Keywords: Climate change, Jeddah, King Abdulaziz University, Saudi Arabia, sustainability

1. Introduction

1.1. Section head establishment of CECCR

The Center of Excellence for Climate Change Research (CECCR) [1] is a unique research institute in the Arab World and the Middle East, conducting not only research in the field of weather and climate but also building capacity in climate modeling. Established in March 2010 at King Abdulaziz University (KAU), Jeddah, Saudi Arabia, CECCR is playing a major role in climate and climate change research with its broader objectives (Fig. 1).

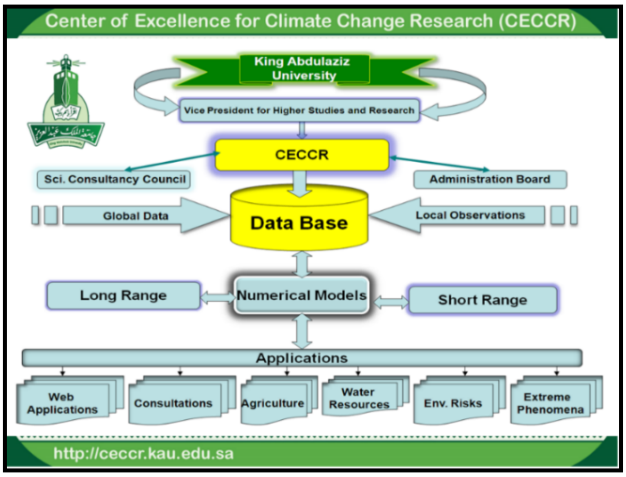

Figure 1. Master plan of CECCR

1.2. Evaluation of CECCR

The Center of Excellence for Climate Change Research (CECCR) is the effort of KAU for its visibility in international research community, and to support planners and policymakers, and help the Kingdom of Saudi Arabia to meet its commitments under the Paris Climate Change accord. The CECCR has its vision and mission along with specific objectives Fig. 2. To fulfill the objectives, the center developed its computational facilities including Aziz Supercomputer of KAU with large data storage, cluster machines and analyses tools. It has diversified and experienced working force including climate scientists, climate modellers, programmers and system analysts. Some of its major activities are documented in this brief article.

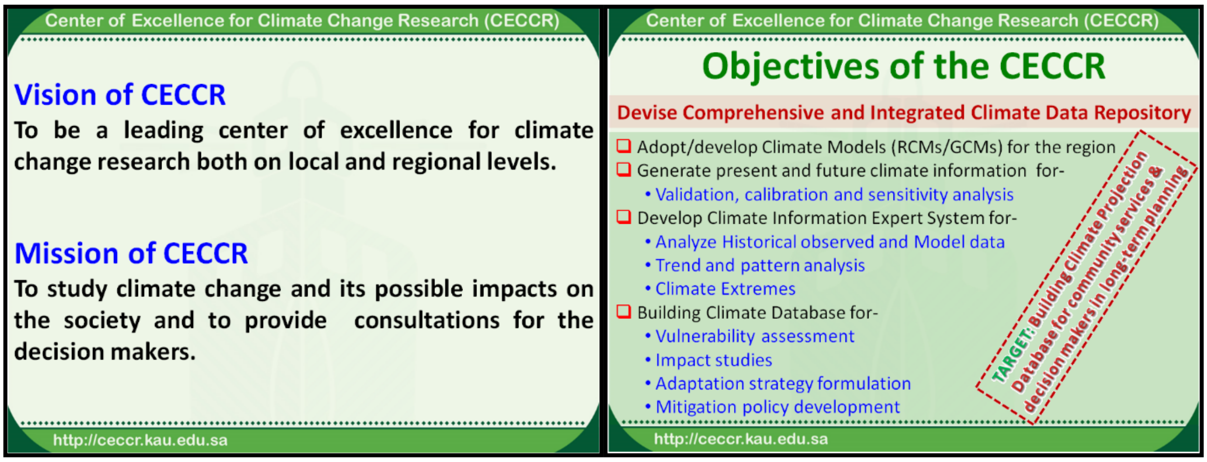

Figure 2. Vision, mission and objectives of CECCR

2. CECCR Activities

2.1. Numerical Weather Prediction (NWP)

CECCR utilizes NWP models for weather forecasting of the Arabian region focusing on Saudi Arabia. Global climate models (GCMs) are installed and running at CECCR and are complemented by regional forecast models to fill in data gaps over the region. Using NWP models, CECCR has the capacity to forecast extreme weather events such as heavy rainfall events causing flash floods, dust storms, etc., over the region. Currently, GCMs outputs are being used in the simulation of recent extreme weather events in the Arabian Peninsula. A single model, as well as multi-model, ensembles are being used

2.2. Intra-seasonal to seasonal forecasts

Starting in 2012, CECCR has developed its own seasonal prediction system based on the Seoul National University (SNU) Coupled Global Climate Model. CECCR is currently providing regular Intra-seasonal to seasonal forecasts. The Center has validated its seasonal forecasts by conducting a 35-year (1981-2015) hindcast.

2.3. Development of the KAU global climate model

CECCR developed the Saudi-KAU Coupled Global Climate Model (CGCM). A description of this model and its performance is available at the link https://link.springer.com/content/pdf/10.1007%2Fs41748-017-0009-7.pdf. The Saudi-KAU CGCM is the first CGCM developed in the Arab world and the Middle East region. Currently, CECCR is improving the model physics to enhance the mean climatic features of the model. The Saudi-KAU CGCM is considered as the backbone to improve seasonal forecasts over the Middle East and the Arabian region in particular Arabian Peninsula. The Saudi-KAU CGCM is coupled with two ocean models. CECCR seasonal forecasts based on the Saudi-KAU CGCM, can be used as an indicator for climate monitoring and inputs for Regional Climate Outlook Forums (RCOFs). The seasonal forecast will soon be available for decision makers and other society stakeholders through a special web portal, which is now under development by CECCR.

2.4. Regional climate modeling (present and future climate)

CECCR is utilizing regional climate models (RCM) including, REGional Climate Model (RegCM) (Version: 4.5.7), ICTP, Italy; Providing REgional Climates for Impacts Studies (PRECIS) (Version: 2.0), Hadley Centre, UK; COSMO-CLM, DWD, Germany. These models are used to understand present regional climatic features and to downscale different future Coupled Model Inter-comparison Projects (CMIP3/CMIP5) scenarios such as Representative Concentration Pathways (RCP 4.5 & 8.5) to understand the potential/expected changes in future climate over the Middle East North Africa (MENA) region including the Arabian Peninsula. CECCR is also investigating weather and climate extremes using high-resolution RCMs outputs. It is worth mentioning that CECCR has a great contribution in the selection of CORDEX-MENA/Arab domain to be utilized in downscaling multi-model database to a finer grid resolution using RCMs.

2.5. Climatic prediction over the Arabian Peninsula for the 21st century

The CECCR has made tremendous advances in climate change research including research on climate projection for the 21st century using CMIP3/CMIP5 multimodel datasets. The downscaling of a CMIP5 dataset by a regional climate model provides details on the temperature projection over the region. The HadGEM data downscaled by RegCM4 shows an indication of maximum temperature to reach 60ºC at some locations in the southeast Arabian Peninsula (Fig. 3). The summer temperature (JJA) in some years after 2070 may exceed 60ºC at the Holy city Makkah (Fig. 4). These results need verification with more research, which is ongoing at the center.

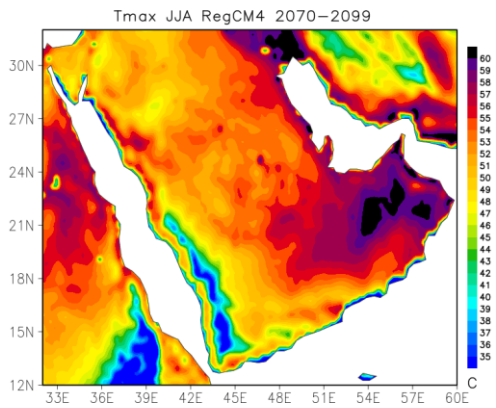

Figure 3 Summer season maximum temperature with RCP8.5 for 2070-2099

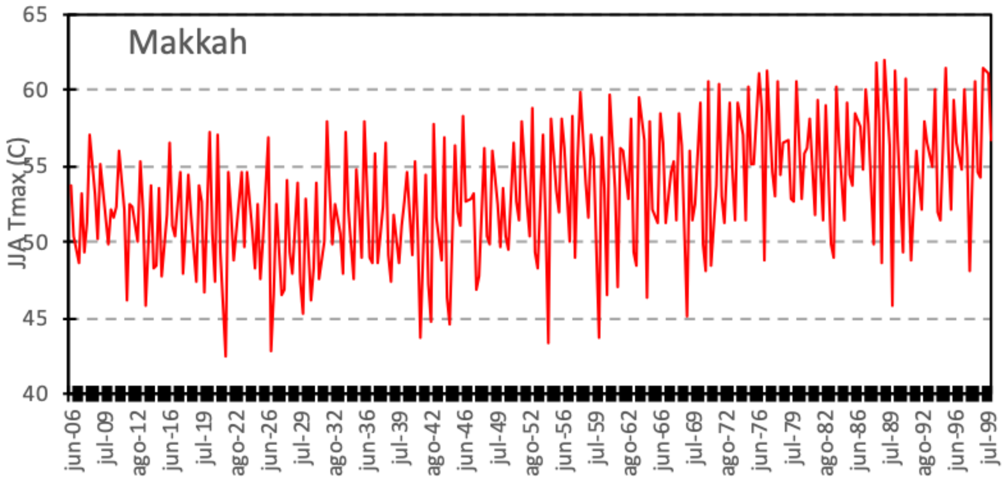

Figure 4 Makkah summer season maximum temperature with RCP8.5 for 2070-2099

2.6. Climate extremes over the Arabian Peninsula in the 21st century

The climate extremes research for the Kingdom of Saudi Arabia is performed using both surface observations and climate model output. Importantly, the utility of climate model data in understanding the climate indices for the present climate is valuable for the projection of extremes in the future climate. The consecutive dry days index (cddi) calculated from a regional climate model data indicates that over the eastern areas of the Peninsula, the number of cddi is highest and it is lowest in the southwest areas, which are in line with the climatology of the region (Fig. 5). Note that the change in the number of warm days (Tmax ≥ 50ºC) is not at the same region where maximum temperature is highest (Fig. 5).

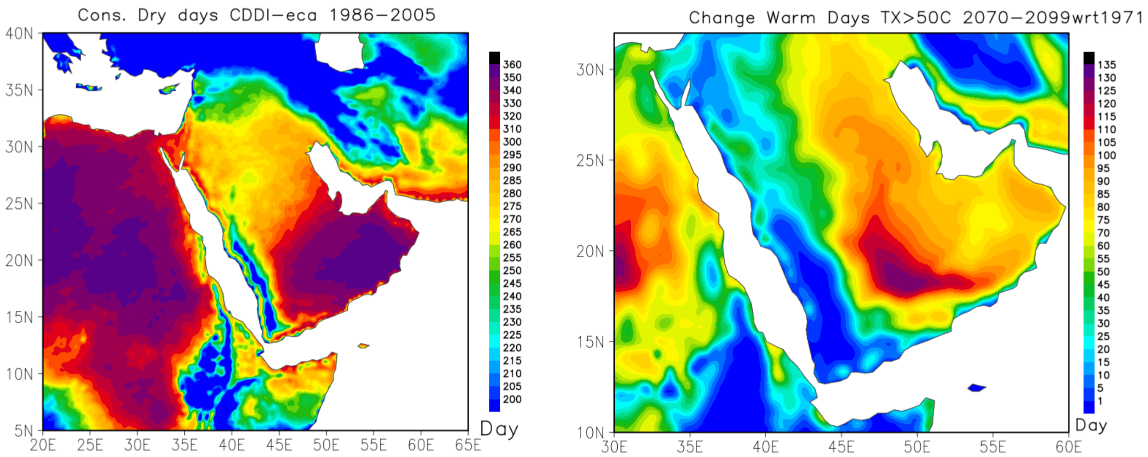

Figure 5 Consecutive dry days with RCP8.5 for 1986-2005 wrt 1971-2000 & change of the number of warm days with RCP8.5 for 2070-2099 wrt 1971-2000

2.7. Establishment of knowledge hub: the KAU climate data library

An important aspect of the Center's societal responsibility is the dissemination of its research, both in the form of scientific publications and in the form of media reports that inform the general public. In support of these efforts, an important initiative is the development of a "Climate Data Base," known as the King Abdulaziz University Climate Data Library (KCDL, Fig. 6). The KCDL is to be a climate and weather data web portal hosted in CECCR, KAU, containing both reanalysis (observed) and KAU model output datasets freely available for the user visualization and download through the following link http://kcdl.kau.edu.sa/. The complete documentation of the KCDL is available for users and covers a wide spectrum of mathematical and statistical functions, including how to use, manipulate data, draw figures and compute different statistics such as mean, variance, standard deviations, as well as other statistical computations like trends, Empirical Orthogonal Functions (EOF), etc. Besides English, an Arabic version of the KCDL is available to serve the Arab scientific community.

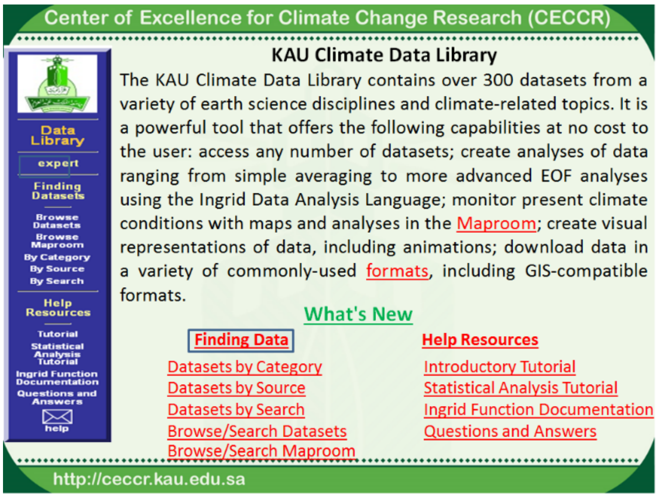

Figure 6. KAU climate data library (KCDL)

2.8. Saudi-KAU CGCM in prediction of ENSO plume

Recently the Saudi-KAU CGCM seasonal forecast was included for the first time in the Columbia University IRI/CPC web portal. The Saudi-KAU CGCM prediction of the ENSO Plume can be reached through the following link: http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso-sst_table. It is worth mentioning that the ENSO Plume of Saudi-KAU CGCM is among the world leading 15 dynamical and 6 statistical seasonal prediction models hosted at IRI/CPC (Fig. 7). This is an evidence of KAU international visibility among the top universities and research institutions worldwide.

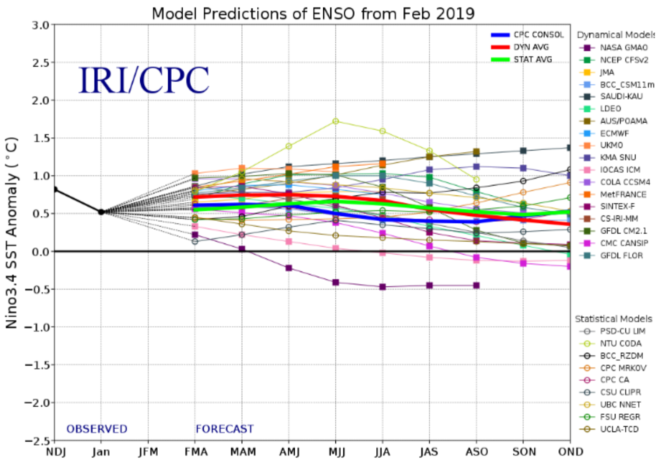

Figure 7. Saudi-KAU CGCM in IRI/CPC ENSO plume

3. CECCR Resources

3.1. CECCR computational and human resources

CECCR is working in different branches of climate research including climate change and weather/climate modeling (Fig. 8). It has an experienced team which includes senior researchers, Postdocs, PhD and MSc students (Fig. 8). The Center also has eminent adjunct professors from renowned international institutions. CECCR is the top user of KAU high performance computing (HPC) facility, the Aziz Supercomputer, which boasts a computational capacity of 12,000 cores and storage of 7.5 Peta-Byte (7500 TB). Using Aziz, CECCR conducts state-of-the-art weather and climate research. In addition to Aziz (Fig. 9), CECCR also has other computational facilities including server clusters and remote sensing data receivers. CECCR has collaborative programs with international institutes/organizations including University of East Anglia, UK; Seoul National University, South Korea; The Abdus Salam International Centre for Theoretical Physics, Italy; Deutscher Wetterdienst (DWD), Germany and Columbia University, USA.

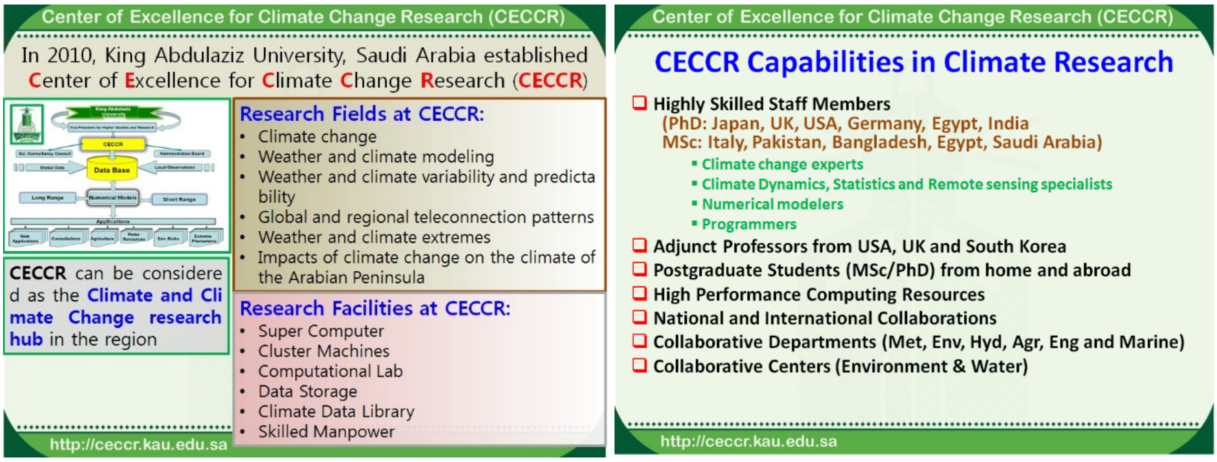

Figure 8. Research fields, facilities and human resourcesat CECCR

Figure 9. Aziz supercomputer

3.2. CECCR research outcomes

The Center has published more than 200 peer-reviewed papers in the field of climate and climate change research since March 2010. It is aiming to fill gaps in understanding the climate of the Arabian Peninsula in the context of the global climate system. These research findings help CECCR to provide government agencies and policy makers with important and relevant information related to weather and climate. The research activities of the Center are already increasing public awareness about the climate change and its expected impacts on severe weather events (e.g., flash floods, heat waves, dust events) and also on the long-term climate of the Arabian region. The CECCR is working on a number of KACST projects. The CECCR contributed in the World Meteorological Organization (WMO) Report (WMO-No. 1103) entitled "THE GLOBAL CLIMATE 2001-2010: a decade of climate extremes", which is available at http://library.wmo.int/pmb_ged/wmo_1103_en.pdf. The CECCR organized a number of training programs.

3.3. Capacity building training

CECCR hosted a first training workshop on seasonal predictability, named "First Seasonal Climatic Prediction Workshop (29 December 2014 – 01 January 2015)" in King Abdulaziz University, aimed at building the capacity of researchers within the Arab world. A total of 35 researchers from 10 Arab countries participated in the training workshop, including 8 Permanent Representatives (PRs) to WMO (World Meteorological Organization) from the National Meteorological Services of the Arab League. These PRs were from Bahrain, Egypt, Jordan, Kuwait, Oman, Saudi Arabia, Sudan, and Yemen. The workshop was also attended by some regional and international organizations; these are Arab League (AL), Economic and Social Commission for Western Asia (ESCWA) and United Nations Environment Programme (UNEP). The aim of the workshop was to provide targeted training to the researchers for knowledge development in the field of seasonal prediction with some laboratory exercises. There were two sessions in the workshop: the morning session with the keynote lectures from the distinguished professors, and the afternoon session with training for the participants (hands-on model dataset with laboratory practices and tutorials) conducted by the CECCR representatives. Participants also enjoyed a poster session based on the CECCR research activities. The below Fig. 10 shows example of the workshop activities.

Figure 10. Morning keynote lectures session

CECCR conducted a training program for the General Authority for Meteorology and Environment Protection (GAMEP) (08 October – 28 December 2017) in King Abdulaziz University, aiming to provide basic knowledge in Meteorology to the fresh employees. A total of 10 trainees from GAMEP participated in the three months training program where Theory and Practical sessions covered about 17 courses in different branches of Meteorology. Among 14 Theory courses, emphasis was given to Numerical Weather Prediction and Climate Change. In the practical sessions, the weather prediction model WRF (Weather Research and Forecasting) and the climate prediction model PRECIS (Providing Regional Climates for Impacts Studies) were taught with hands-on techniques from installation to model output analysis.

3.4. Establishment of scientific journal

CECCR contributed in establishing two international scientific journals where KAU is the partner with Nature and Springer publishing groups. One of the KAU partner journal with Nature is npj Climate and Atmospheric Science (https://www.nature.com/npjclimatsci/) publishes 46 articles since 2017. npj Climate and Atmospheric Science is an online-only and open access journal dedicated to publishing high-quality papers on topics such as climate dynamics, climate variability, weather and climate prediction, climate change, weather extremes, air pollution, atmospheric chemistry including aerosols, the hydrological cycle and atmosphere–ocean and atmosphere–land interactions. A particular area of focus for the journal is studies of regional systems. Another KAU partner journal with Springer is Earth Systems and Environment (ESEV). The journal can be found in the following link: https://www.springer.com/earth+sciences+and+geography/earth+system+sciences/journal/ 41748). The ESEV publishes 84 articles out of 475 since 2017, which bring about 60 citations. Researchers from 41 countries all over the world submitted their articles to ESEV during those two years. The accepted articles originate from 16 countries. This high number of submissions from different countries reflects the international visibility and reputation of KAU.

Both journals are in pipeline of obtaining citation indexing and impact factors. These forms an important factor in ranking universities worldwide by reputable ranking magazines and databases such as ARWU, THE, QS, and US-News. To this ranking, the ESEV also contributes to promoting the KAU publication output in the Environmental disciplines for which citations weigh twice as much as those published in Engineering and Medicine. ESEV can also be considered as a key platform to improve the number of visitors from outside the university (e.g. WeboMetric Ranking) and show KAU's commitment to sustainability, following the 2017 United Nations 17 Goals to promote sustainability through research and publications (e.g. UI GreenMetric Ranking [2]).

4. Future Plans

Looking ahead, CECCR plans to continue its mission to conduct scientific research into climate change, especially as it applies to the region around the Kingdom of Saudi Arabia. With the help of state-of-the-art numerical climate models and the latest observations, CECCR will:

1) Run global and regional climate simulations that will be more precise and accurate than is currently possible, since they will have higher resolution, run for longer times, run more in "ensemble" mode, and include more advanced physical parameterizations.
2) These simulations will require continued (and even extended) access to high-performance computing (HPC) facilities.
3) Provide NWP-based weather-forecasts as required to local authorities, especially in situations where extreme weather events appear to be possible or likely.
4) Provide documentation to national authorities on climate change projections for the Kingdom, with special reference to areas of special interest, including:
   a. Power generation (both conventional and renewable)
   b. Water supply
   c. Aviation
   d. Agriculture
   e. Tourism
5) All the above should help the Kingdom of Saudi Arabia to meet the targets that it has set for Vision 2030 as well as it has set for itself under the Paris Climate Change accord.
6) Continue to provide training and further education to meteorologists and climate researchers.

5. Summary/ Concluding Remarks

The CECCR is a unique research center established by KAU to work in the field of climate and climate change. Since its establishment in 2010, CECCR activities are well accepted in the Kingdom and in the international research community. The CECCR team members are working hard in its reputation and quality research along with publishing papers in international journals. The center is taking part in capacity building which in turn support the socio-economic sustainable development of the Kingdom.

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Publications and Course Units for the Sustainable Goals

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Abstract. Since 2016, the University of Bologna yearly reports its contribution generated by institutional activities carried out to reach the 17 Sustainable Goals set by the United Nations. The report can be downloaded in English at https://www.unibo.it/en/university/who-we-are/report-on-un-sdg. The entire range of activities of the university is reclassified according to UN objectives using a variety of evidences. Both the university publications and course units have been classified in the light of the UN's objectives and have been chosen as evidence for the university's approach for sustainability. The *Zero Poverty* no 1 objective aggregates 1046 publications, followed by 502 for *Quality Education* no 4. The area in which UniBo publications have been less focused is that of *Zero Hunger*.

UniBO offers 4405 courses/modules related to sustainability. In comparison with scientific production, the Education program offered prioritize other aspects and other objectives. For example, Objective 3. *Good Health And Well-Being* with 791 modules is the most representative. This is confirmed by the high number of students enrolled in courses in Medicine, Pharmacy and related subjects.

Keywords: International benchmark, per capita publication, sustainable development goals, unit courses

1. Introduction

The University of Bologna is one of the largest Italian universities with a multicampus setting active in 5 cities and 17 districts in the Emilia-Romagna region, one of the most advanced Italian region both in terms of services offered to the citizens, and of innovation results according to the National Institute for Statistics (ISTAT).

Table 1. Innovation and health services in Emilia Romagna

ISTAT	ISTAT
Emilia-R. Innovative* industries in 2016	Emilia-R. Health Service Satisfaction**
6952	30%
Italy Innovative* industries in 2016	Italia. Health Service Satisfaction**
45257	20%

*product/process innovations introduced in the three-year reference period
**People 18 years of age and more highly satisfied with the public health service (score 8-10) by region - Year 2013

2. Course Units for SDGs

As reported in the UI GreenMetric questionnaire 2018, 87,774 UniBo students attend 4405 course units related to the 17 UN Sustainable goals over a total of 4644. These data came from a survey investigating the link between the single course unit of a study programme and the U.N. Sustainable Development Goals. The survey was conducted asking to all faculty members the link for each their course unit using a web procedure. More than 95% of course units of the A.Y 2017/2018 has a link with at least one SDG.

In Table 2 the course units are divided in five macro categories offering a panorama of the educational areas; there is a substantial balance between the Engineering and Technical and Social and Humanistic areas, in turn counterbalanced by the Medical and Natural Sciences areas.

Table 2 UniBo sustainability related course unit

Clinical Health	Natural & Life Sciences	Technology & Engineering	Management & Social Sciences	Arts & Humanities
603	654	1,150	1,023	975

At the 4th International Workshop on UI GreenMetric Mirko Degli Esposti presented a paper [4] describing the UniBo report on U.N. sustainable development goals. Consistent with the perspectives adopted in the Strategic Plan 2016-2018, the University has an innovative way to report on the contributions generated by its institutional activities, aimed at the achievement of the 17 SDGs. The report presents 17 sections, each one dedicated to a UN goal, reporting the impact generated by the university of Bologna through its diverse activities. Each goal is reported in relation to the four academic dimensions of training, research, third mission and the institution.

In the 2017 edition of the Report on U.N.S Sustainable Development Goals the 4,405 course units appears reclassified by the 17 goals, as shown in Fig. 1.

Figure 1. UniBo course units classified bySDGs

SDG 3, *Good Health and Well-Being*, with 791 courses, guides the ranking; it should be noted that these course units are attended by 13,451 students, most of whom study medicine and surgery.

37,366 students have chosen to attend the 606 courses related to SDG 9, *Industry Innovation and Infrastructure.* This high level of interest is directly linked to the large amount of SMEs in the Emilia Romagna region which host some leader industries for example in the packaging sector and automotive (Emilia Romagna is also known as the *Motor Valley* home of Ducati, Ferrari, Lamborghini). The University fosters entrepreneurship education in many ways, for example through ad-hoc courses for undergraduate and postgraduate curricula in all of the disciplines/fields offering the basic notions of entrepreneurship (feasibility analysis, business planning, etc.).

3. Per Capita Publications and International Benchmark

At the speed of > 30 paper per day, the Alma Mater reaches on average 11,000 publications per year by its 4011 faculty members. For the purpose of the UN report, we have considered all paper from 2007-2017 with at least an Alma Mater author which contain a specific sequence of keywords. These keywords were chosen for each UN SD goal by considering the general declaration of the goals and all targets of each goal.

The selected papers were also analyzed through an international benchmark including universities within the top 10 European Universities in QS World Universities Ranking 2017/2018. They should be comparable to the University of Bologna in terms of: Size (XL - more than 30,000 students), Focus (FC - all 5 QS faculty areas, including the school of medicine), Research Intensity (Very High - more than 13,000 publications in the last 5 years) Status (Public). Using the above mentioned parameters, the field was narrowed to 10 universities listed in Table 3.

Table 3. Unibo international benchmark

University	Country
UCL	UK
The University Of Manchester	UK
Ludwig-Maximilians-Universität München	DE
Sorbonne University	FR
University of Copenhagen	DK
Katholieke Universiteit Leuven	BE
University of Leeds	UK
Utrecht University	NL
University of Ghent	BE
Rheinisch-Westfälische Technische Hochschule Aachen	DE

To eliminate distortions due to simple considering the total number of publications, the articles for each university and each goal was scaled against the number of academic staff as listed by QS for the World University Ranking 2016/2017 and published on www.topunivesities.com. Finally, for each goal we compared the University of Bologna's ratio with the average of the ratios for the 10 universities in the benchmark group. The result is the index number "benchmark = 100"; an index number higher than 100 means that "per capita publications" by UNIBO academics is higher than the average of the universities in the international benchmark group. If the index is lower than 100, UNIBO academic productivity is lower than the benchmark.

The Alma Mater gets and index number above or equal to the international benchmark in six sustainable goals over 17, with the highest score – 149 –in the "*Life below water*" no 14 objective, and the lowest – 24 – in the "*Climate actions"* one. These low performance in terms of number of publications is balanced by the presence of 160 courses attended by 6,681 students.

Table 4 Unibo & SDGs aligned to UI GreenMetric criteria

#6	#7	#11	#12	#13
water	**energy**	**sustainable city**	**Resp. consumption**	**climate**
264 papers in Scopus	195 papers in Scopus	136 papers in Scopus	157 papers in Scopus	303 papers in Scopus
97 Internl. Bench.	122 Internl. Bench.	118 Internl. Bench	124 Internl. Bench.	24 Internl. Bench.
72 c. units	168 c. units	369 c. units	312 c. units	160 c. units
4,968 students	8,086 students	21,280 students	19.509 students	6,681 students

If we consider a selection of sustainable goals more closely related to the general criteria of UI GreenMetric (Table 4), we observe that the objectives 11 and 12, respectively dedicated to the sustainable development of cities and the containment of consumptions, are those in which the University in above the international benchmark. In these areas are also concentrated 700 courses and nearly 41,000 students out of 87,774, almost half of the total student population.

The topic *End of poverty*, Objective 1, is the bibliographic area that attracts the highest number of citations validated in Scopus: 16.888 generated from 1046 papers with at least an author from the University. In this context, the University is also involved in social responsibility initiatives at the educational level. The doors of the University of Bologna are now open to refugee students with the *Unibo4Refugees project.* Even before obtaining refugee status and without having to pay any fees, students can enroll at course units and take Italian language lessons. Enrolment in degree programs is made easier thanks to special procedures for checking academic qualifications and admission requirements, obtaining study grants, getting exemption from fees and access to microcredit. Through this action 19 asylum seekers from 10 different countries registered for the Academic year 2017/2018 and 9 refugees enrolled in degree programs for the Academic year 2017/2018.

4. Summary/ Concluding Remarks

In the *Education* category the University gained a score of 1,575 over a maximum of 1,800, being 25th in the UI GreenMetric ranking over 719 universities and second in Italy. Both indicators ED1 (The ratio of sustainability courses towards total courses/modules) and ED3 (Sustainability publications) received the maximum points available.

These results are linked to a tangible attention to all themes of sustainability from both the research component and the educational dimension, even though these dimensions are not always tuned. For example, whenever the UniBo research appears stronger both in terms of the average publications per capita and in comparison, with a sample of non-Italian universities, the related Teaching & Learning activities does not always follow closely.

An explanation for this could be that a physiological lap of time is needed for the Research results to be transferred to students. But also, that reducing this gap would lead to a mutual improvement.

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Integrated Character Building Coursework B as a Base for SDGs and Environmental Concern of Undergraduate Students at Universitas Indonesia

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Abstract. Sustainability related courses are favorable when evaluating a green university. This paper presents an evaluation of The Integrated Character-Building Coursework B, abbreviated as MPKT B at Universitas Indonesia (UI). MPKT B is a set of compulsory courses given to all new students at UI in the first semester. The MPKT B course is delivered through the Student Centered (Active) Learning blended e-Learning (SCeLE) approach. Courses are held with face-to face classes combined with e-Learning using the Computer Mediated Learning (CML) method. Two main topics of MPKT B is the operating system of nature where we live and our responsibilities as the manager of nature. MPKT B course is aligned with Sustainable Development Goals (SDGs) framework. UI also started the sustainability literacy test (Sulitest) in 2014 to evaluate the sustainability science understanding by the undergraduate students. The results of the examination do not show any trend of the comprehensive understanding of subject, due to the fact that the exams were only pilot projects. However, the exam had shown significant impact on how the students feel as global citizens.

Keywords: Education; integrated character-building coursework; MPKT B; Sulitest; university student

1. Introduction

Nowadays many young people are interested in natural and environmental sciences, but unfortunately many of them do not have sufficient knowledge about sciences. By learning sciences and having critical thinking ability they will be able to understand the nature around them, as well as environmental issues, and be responsible to global environment. In order to set the student with the right knowledge and skills to work well with the nature, Universitas Indonesia runs a course named MPKT as a solution.

The materials of MPKT covered subjects such as logic, philosophy of science, Pancasila (State Philosophy); humanities, ethics, character development, civic; nation building, culture, and environment in Indonesia; in addition to Indonesian language as an introduction to scientific writing. The MPKT in UI is an example of adjusted form of liberal arts education that has been applied by world universities such as Harvard University, Massachusetts Institute of Technology, California Institute of Technology and University of Tokyo. Liberal art education in world universities is part of the characteristics of universities. MPKT is an efficiently packaged set of courses that can be compared to liberal arts education in other world universities. In general, liberal art education materials at UI includes language and literature, arts and humanities, sports, natural and social sciences, and quantitative reasoning [1].

Furthermore, MPKT is a part of compulsory subjects for UI new students in the first semester. This compulsory subjects cover English, arts or sports, religion, MPKT A and MPKT B. MPKT A studies about social sciences and humanities, meanwhile MPKT B studies about science-technology-health [1]. Associating with SDGs framework and environmental issues, we present MPKT B as the focus of discussion. Section 2 consists of the explanation of the content of MPKT B course. Section 3 consists of SDG Modul in Integrated Course for Character Building, section 4 presents the random test conducted by university named Sulitest and section 5 concludes the paper.

2. Content of MPKT B Course

The MPKT B courses employ the Student Centered (Active) Learning blended e-Learning (SCeLE). SCeLe embraces Collaborative Learning (CL) and Program Based Learning (PBL) methods. Courses are offered in the form of face-to-face classes by embracing e-Learning using the Computer Mediated Learning (CML) method. The language of instruction is Bahasa Indonesia. The lecturers of MPKT B courses act as facilitators, role models, and coaches [2]. The students will be actively directed, explained, asked, criticized, proposed, summarized, recorded, and mediated. They would have formed the foundation for live-long learning habit. The values that will be obtained by students are based on UI's 9 values, which include honesty, justice, trust, dignity and/or respect, responsibility and accountability, togetherness, transparency, academic freedom and scientific autonomy, and compliance to the rules.

MPKT B has two main topics, namely the natural (operating) system in which we live and our responsibility as nature managers. Table 1 shows the content of both topics [3].

Table 1. Topics covered in the MPKT B

Topics	Contents
Subject I: The operating system of nature where we live	1. The earth system 2. The atmosphere system 3. Structure and characteristics of the earth 4. Biodiversity and ecosystems 5. Biogeography 6. Natural balance system
Subject II: Our responsibilities as the manager of nature	1. We as managers of the nature 2. We as managers of technology development 3. We as managers of our own health and the environment 4. We as development managers 5. We as managers in facing global issues 6. We are managers in natural disaster management

The basic goal of this course is to prepare students as future generations who care about nature and the environment by developing a balance between hard skills and soft skills [4]. The competencies to be achieved by students are as follows:

1) Acting ethically with strong and sound character in completing or carrying out the tasks;
2) Acting as a citizen who is proud of and loves the country and supports the continuity of life;
3) Able to work together and have high sensitivity and concern for the community and environment;
4) Able to think logically, critically, and creatively;
5) Able to use mathematics to solve problems quantitatively;
6) Able to use information and communication technology (ICT) for development;
7) Able to analyze the natural operating system integrally and comprehensively;
8) Being able to act as a wise manager for the nature to build and support natural conservation for a better and sustainable life.

3. SDGs Modul in Integrated Course for Character Building

As a course in UI, MPKT B is aligned with Sustainable Development Goals (SDGs) framework. According to the 17 goals in SDGs, the following table shows the linkage between MPKT B and SDGs framework.

Tabel 2. Linkage between MPKT B course and SDGs framework

Contents of MPKT B	SDGs Framework
Subject I: The operating system of nature where we live	
1. The earth system	Goal 13: Climate action Goal 15: Life on land
2. The atmosphere system	Goal 13: Climate action
3. Structure and characteristics of the earth	Goal 13: Climate action Goal 15: Life on land
4. Biodiversity and ecosystems	Goal 14: Life below water Goal 15: Life on land
5. Biogeography	Goal 14: Life below water Goal 15: Life on land
6. Natural balance system	Goal 14: Life below water Goal 15: Life on land

Contents of MPKT B	SDGs Framework
Subject II: Our responsibilities as the manager of nature	
1. We as managers of the nature	Goal 7 : Affordable and clean energy Goal 15: Life on land
2. We as managers of technology development	Goal 9 : Industry, innovation and infrastructure Goal 13: Climate action
3. We as managers of our own health and the environment	Goal 3 : Good health and well-being Goal 6 : Clean water and sanitation Goal 11: Sustainable cities and communities
4. We as development managers	Goal 4 : Quality education Goal 8 : Decent work and economic growth Goal 9 : Industry, innovation and infrastructure Goal 13: Climate action
5. We as managers in facing global issues	Goal 7 : Affordable and clean energy Goal 12: Responsible production and consumption Goal 13: Climate action
6. We are managers in natural disaster management	Goal 15: Life on land

This course credit is 6 credits which is conducted in two meetings per week. The course has gained a good credentials as the students found different way of studying and learning from others. As an example task in MPKT B course is the students assigned to visit the faculties in Universitas Indonesia. A group of students will see the condition of the infrastructure and environment of the faculty. The students discuss the state of faculty and give constructive suggestions for sustainability efforts in the faculty.

The following is the testimony from a student of Political Science Program year 2014/2015 term 2 regarding MPKT B courses, “I like the active environment of the class. The lecturer can create a conducive environment in the learning process. The learning method is also good, and especially helpful to be implemented in other courses” [5].

4. Sustainability Literacy Test (Sulitest) Attempt for Student Assessment

Based on definition from The United Nations SDGs Partnership Platform, the sustainability literacy test (Sulitest) is an online multiple choice question assessment [6]. It assesses the minimum level of knowledge in economic, social and environmental responsibility. The test is applicable all over the world, in any kind of higher education institution (HEI), in any country, for students from any kind of tertiary-level course (bachelors, masters, MBAs, PhD).

The person in charge of organizing a session, the examiner, has the flexibility to prepare and schedule the sessions before inviting candidates. The core module of the Sulitest proposes 30 questions randomly selected from the question bank. This core module is common to every country, covering global issues and allowing organizations and candidates to compare scores at a worldwide level [7].

Sustainability Literacy Test (Sulitest) was launched by the United Nations on 2016 and organised by The United Nations Environment Assembly in Nairobi [8]. In 2019 there are 821 universities from 66 countries have trialed this test as the TOEFL of Sustainability Related Knowledge. In UI, started from 2014, particularly at the first year students of some of the classes at the Faculty of Engineering, this test has been used by some lectures to a selected number of students in order to learn the state of the art evaluation on sustainability science understanding by the undergraduate students. Selected students with good result of the MPKT B course and adequate English test results have done the exams in particular selected time. The results are satisfactory, taking into account that they have to learnt some global issues independently. The implementation of this global program for all students of University of Indonesia will require a big shift for learning content comprehension.

The result of the examination from time to time do not show any trend of the comprehensive understanding of the subjects, due to the fact that the exam were only at the pilot project stage in which the participants are only randomly selected students who would like to learn the subjects enforced by the Sulitest. However the exam shows the great impact on the students for feeling of being a global citizen.

5. Concluding Remarks

Many courses at Universitas Indonesia covers different areas of environment and sustainability subjects. UI also attempted to introduce SDGs through a set of compulsory courses known as MPKT for all new students. MPKT B has particularly covered various environmental knowledge with Sulitest as a control mechanism. Yet to substantiate the fundamental knowledge of SDGs, it needs some capstone projects which integrates multidisciplinary courses in an interdisciplinary way of offering. As a result, we encourage the collaboration of two or more study programs within a faculty or among faculties. In this way the students would have sound awareness of SDGs framework.

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NCNU's Collaboration with the Neighborhood to Create a Green Economy

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Abstract. In recent years, National Chi Nan University (NCNU) has performed excellently in terms of the ranking of UI GreenMetric. The university's teachers and students maintain its social responsibility by promoting environmental sustainability in local communities through the implementation of various educational programs and the development of a green economy. NCNU's teachers and students have been helping the residents of Wu Gong Community to perform an ecological investigation in the community. Currently, 25 trained docents are involved in local ecotourism, working with hoteliers to provide hotel guests with eco-tour guidance services. The aim is to allow the community to achieve economic prosperity. NCNU also assists farmers in growing water bamboo using LED lamps as an energy-saving solution, as these lamps make the production of water bamboo more environmentally friendly. Extensive adoption of LED lamps for this purpose in the future is expected to foster related businesses, such as the selling and repair of LED lamps, thereby creating a green economy. The future use of LED lamps in the production of other croppers also appears promising. NCNU will continue to support the cultivation of a green economy in the neighborhood with the goal of achieving regional economic development and environmental sustainability.

1. National Chi Nan University's Image as a Green University

The term "green university" is internationally recognized to mean a university that conducts its affairs according to its vision of sustainable development and asserts the responsibility of promoting the development of human society as a provider of higher education [1]. To achieve the vision of becoming a "green university," National Chi Nan University (NCNU) has integrated ecological principles and environmental protection initiatives into the university's operation and administration through a comprehensive planning approach. The aim is to create a campus with biodiversity and a living environment that supports sustainability. Reliant on the cooperation between its academic and administrative sections, the university encourages researches, club activities, and campaigns concerning sustainable development while widening and deepening the sustainable development curriculum by introducing major university-run projects (such as Civic Literacy Project, Engaged University Project, and University Social Responsibility Project), thereby promoting environmental education holistically [2]. Focusing on the potential issues and demands within the community, the university engages all community inhabitants to participate in production, living, and ecological concerns and learn the value of sustainable development. In summary, NCNU plans and promotes sustainable development as a social care provider, an environmentally friendly activist, an educator of sustainable development, a leader in community building, and a practitioner of corporate social responsibility [3], as showcased in Fig. 1.

Figure 1. Diagram showcasing NCNU's vision for sustainable development

2. Development of NCNU as the Driver of Both Regional Development and Regional Revitalization

In its Higher Education Sprout Project, NCNU aims to develop its school administration through two ways: “Sprout Shui Sha Lian, Welcome Southeast Asia.” In particular, the university plans to “Sprout Shui Sha Lian” by fulfilling the social responsibility of building “Shui Sha Lian University City” (Fig. 2). In recent years, all faculties at NCNU have conducted their operations with this social responsibility in mind, thereby working actively with local organizations and individuals to contribute to the flourishing of the Shui Sha Lian area. For this purpose, the College of Science and Technology is oriented towards the goal of “clean water and sanitation, sustainable cities and communities, and life on land.” The College plans to execute NCNU’s Social Responsibility Project (Class C) – Creating a Green Shui Sha Lian: Intelligence × Pollution Reduction × Circulation, with the aim of “achieving compatibility between the values of environmental protection education and of industry development in the green county.” This aim will be fulfilled through consistent attention to and participation in local affairs to facilitate a sustainable environment, and gradual transformation of individual acts by means of class learning, thereby establishing “a development model for the green county that realizes Intelligence, Pollution Reduction, and Circulation.” The College of Management is oriented towards the goal of “responsible consumption and production” and plans to execute NCNU’s Social Responsibility Project (Class B) – Shui Sha Lian Industry/Academy Cooperative Learning: Development of Links between Local Industries and Rural Tourism. This project aims to connect rural tourism and industries in Shui Sha Lian by coaching farmers to provide tourist services that embody the central idea of “Tourism + Agriculture,” thereby diversifying and refining the local characteristic industries, such as agricultural recreation, private lodging, and coffee production, and ultimately upgrading the rural tourism competitiveness of the Shui Sha Lian area. The College of the Humanities is oriented towards the goal of “reduced inequalities, peace, justice, and strong institution” and plans to execute NCNU’s Social Responsibility Project (Class B) – Building Shui Sha Lian’s Network of Collaborative Governance of Long-Term Care for the Aged. This project aims to work with the local public community groups that share senior care concerns following the strategies of civic engagement and social design. This will stimulate more local actors to join the work on facilitating aging in place and transform individual acts through instruction, thereby building “a town development process from education and co-assistance to sustainable development.” The College of Education is oriented towards the goal of "quality education" and plans to execute NCNU's Social Responsibility Project (Class A) – Improving the Learning Path of Underprivileged Children in Rural Areas: from "Boosting the Confidence to Learn" to "Elevating the Learning Mind." This project aims to investigate new learning paths for underprivileged children in the Shui Sha Lian area through cross-border cooperation, to redefine the teaching innovations of NCNU's College of Education, and to provide underprivileged children in rural areas in Nantou with improved learning environments, thereby contributing to rural education [4].

An in-house multidisciplinary team has been organized by NCNU's teachers to aspire toward the UN's Sustainable Development Goals, with the hope of eventually being able to offer "university-led local collaborative governance" and "local-led university ecological innovations" as the distinguishing features of NCNU. In recent years, the team has not only initiated various cross-boundary cooperative programs, but also cultivated more groups of faculty and students that actively work on local actions and more innovative parties in the pursuit of a "green economy," thereby opening up a new horizon for addressing issues about regional development [5]. Currently, there are 60 teachers from NCNU (about one fifth of the total teachers in the university) engaging in local practice and 1,222 students (about one fifth of the total students in the university) taking the social practice curriculum every school year. To date, 44 research topics about social practice have been developed, seven governmental agencies have been involved, and 39 school clubs have initiated local actions.

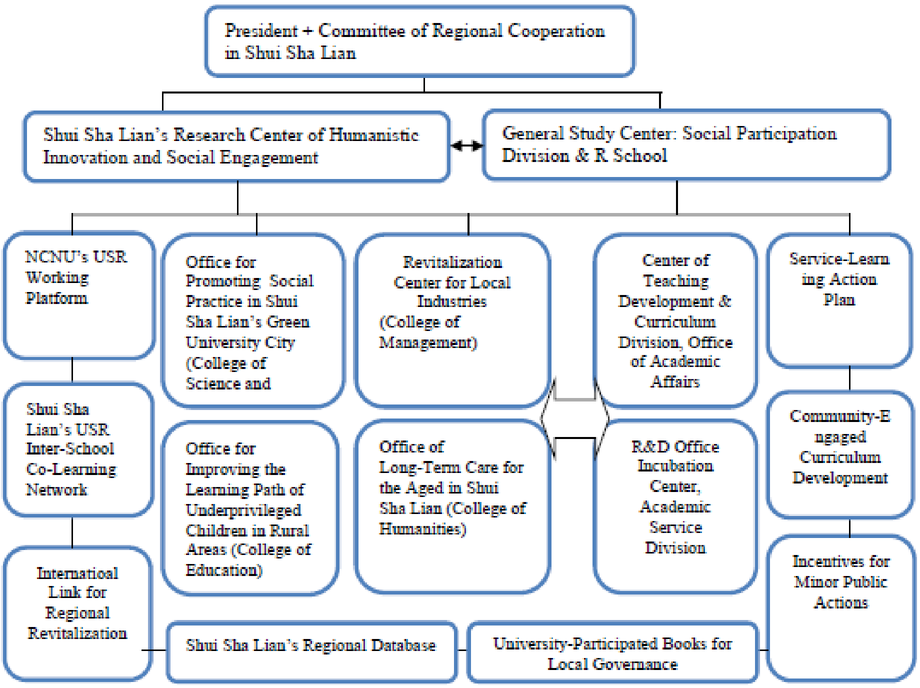

Figure 2. Framework of NCNU's offices pursuing social responsibility

3. Development of Community-fostering Green Curricula

NCNU pays extra efforts to raise students' citizenship consciousness and to establish partnership between the university and local residents. Relying on its knowledge and discipline, NCNU extensively supports local governance in terms of ecology, production, living, and culture. It also promotes the prosperity of both the university and the town while developing green curricula that benefit the communities. In terms of teaching, NCNU provides theoretical and practical courses [6]. In terms of the theoretical courses, professional courses are provided to the Wugong Community, and case studies on the residents taking these courses are conducted, thereby identifying community resources and prioritizing various topics. For example, students working on their graduation projects are guided to begin working with theories and to identify how feasible it is to promote certain industries in the community based on the circular economy. In the practical, hands-on classes, students perceive the community through physical labor and draw maps. Meanwhile, NCNU promotes eco-friendly farming and ecotourism in the community and links NCNU's USR to businesses' CSR, thereby allowing the university, the community, and local businesses to join forces to facilitate local development. After two years of hard work, NCNU has built an initial framework for implementing its USR in the community through local curricula, as shown in Fig. 3.

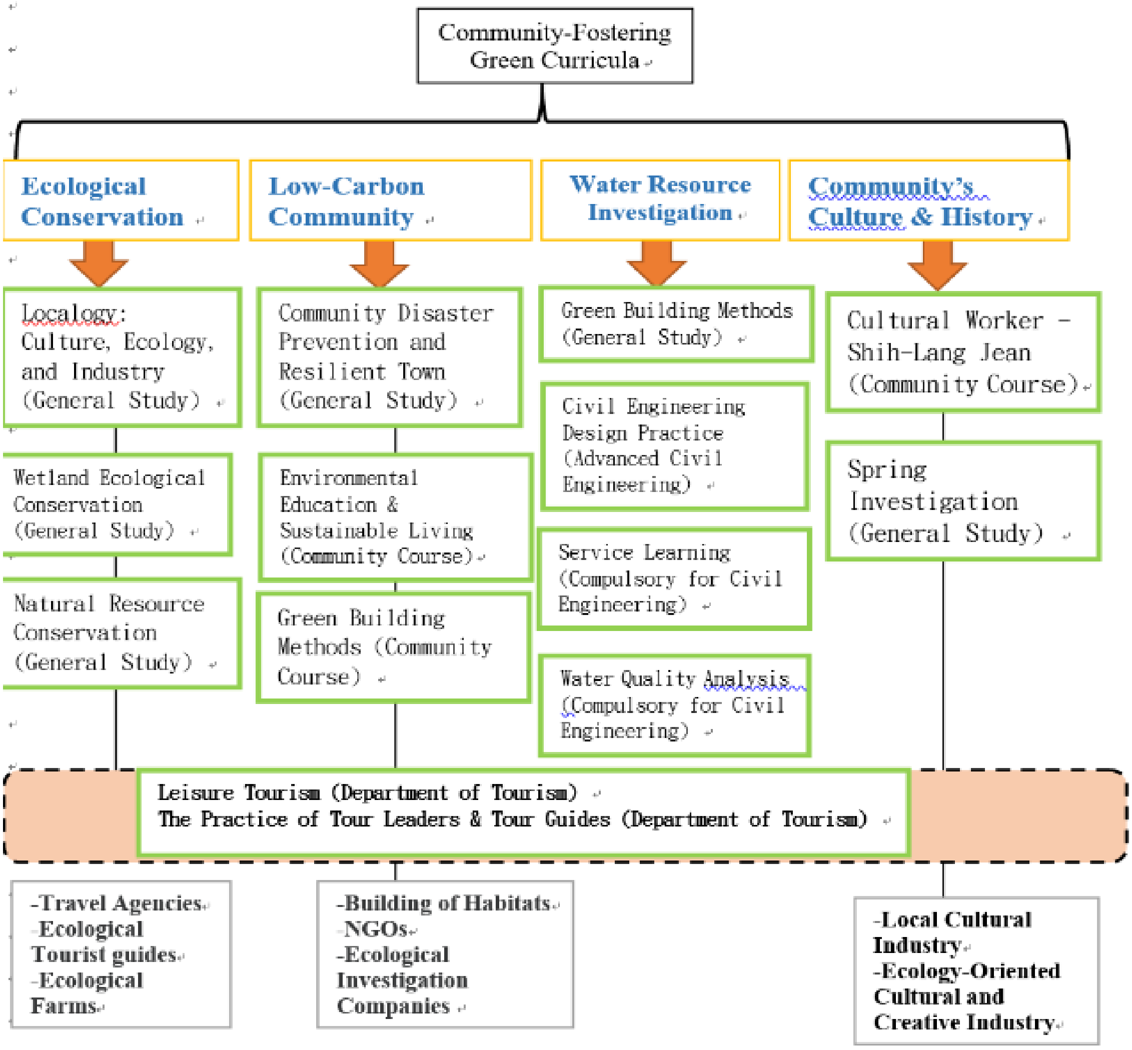

Figure 3. NCNU's community-fostering green curricula

3.1. Subject I: Building in-community organic vegetable gardens - aquaponics systems

In simple terms, aquaponics refers to a practice where aquaculture and hydroponics are combined such that the water for culturing fish can be used to grow the vegetables suitable for hydroponics, thereby forming a cycle in the closed system of a pool and creating an organic vegetable farm in which every substance is used to its maximum usage (Fig. 4). NCNU is now working with Wugong Community in functionally improving and structurally simplifying the community's existing aquaponics system to employ siphon and gravitation. It is expected that the students can, through a school-year-long course, learn basic knowledge about water quality and the operation of the system (Fig. 5 and 6). This class will urge students to reflect on the power source of the water cycle and in turn develop a green production model with local characteristics that maintains sustainable ecological development. Students will thus respond to the worldwide trend of saving the earth's ecology and contribute to conservation and the passing down of the beautiful ecology of Taiwan.

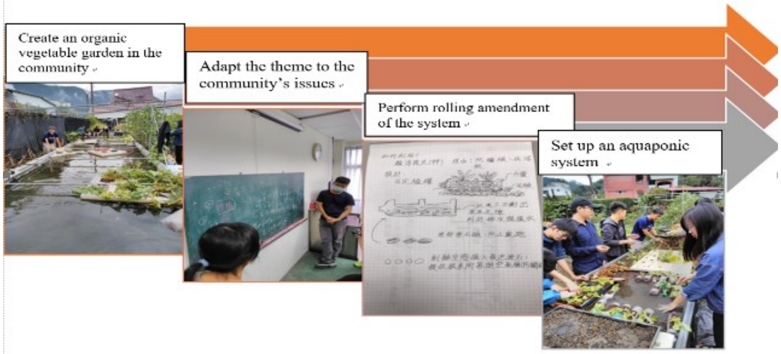

Figure 4. Learning modules of community courses

Figure 5. Learning aquaponics (I)

Figure 6. Learning aquaponics (II)

3.2. Subject II: Generation of the community map

In one of the courses, a map of Wugong Community is made with more attention put on local attractions or "characteristics" than on esthetics. The objective of the course is to generate a map that speaks for the community (Fig. 7) by showing the context of local living to the largest possible extent. To this end, the faculty and students have to comprehend the context before they make the map. From this perspective, the community map has two objectives. The first is to understand the community, and the second is to let the map tell stories about the culture, history, and life of the community, thereby increasing the inhabitants' sense of unity and honor. Thus, simply marking a temple on the community map is rather insignificant if there no links are made between the temple and the inhabitants' daily life. In the old days, the Pingpu peoples established the Apu Tadawan Temple to celebrate Kaxabu culture. How has this formed the faith of the whole village? What does the Apu Tadawan Temple mean to the villagers? When a story responding to these questions is added to the map, the map has a voice. Similarly, a grocery store, a stream, and even a banyan have their distinctive ways of being connected to the community. In the process of investigating these stories, students can inventory community resources and familiarize themselves with the community. The result is a map that tells stories. Students then make the map into postcards as a pledge of the partnership between the community and the university and as a tool for the students and residents to introduce the community that they live in to others (Fig. 8 and 9).

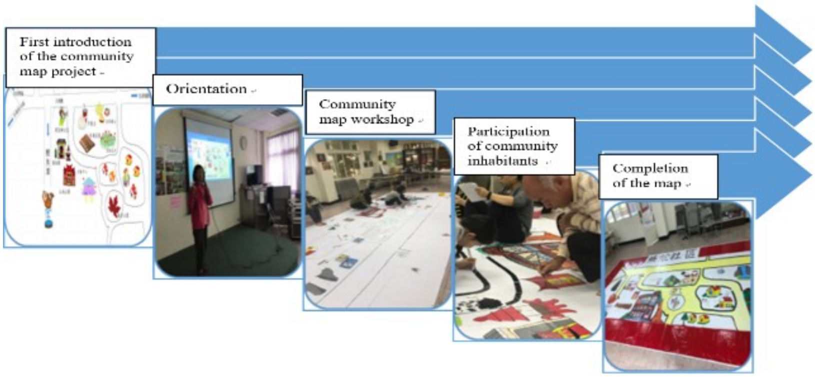

Figure 7. Learning modules of the community course

Figure 8. Drawing the community map

Figure 9. Community map postcard

4. Promoting Ecotourism and Creating a Green Economy

NCNU hopes to build regional connections that are interactive and sustainable, to create a co-learning environment for the local communities and inhabitants, and to strengthen the two-way communication between the university and the neighborhood, thereby effectively integrating regional resources and driving the development of ecotourism in the region. Focusing on ecology, NCNU has launched courses on wetland ecology conservation, natural resources conservation, and localogy (Fig.10 and 11), and provided training for ecological investigation and narration in Wugong Community, Guanyin Waterfall, Liyutan Wetland, and May River Watershed, which have abundant water environment resources, butterfly resources, and a rich Pingpu culture. To date, 25 pre-intermediate ecological narrators/investigators have completed their training courses, and the work of expanding the database of wildling resources in the Liyutan area is ongoing (currently, the database includes 135 species of butterflies, 30 species of damselflies, 30 species of wild birds, and 370 species of plants). NCNU develops environmental teaching plans using these ecological data to help the neighborhood to manage ecotourism. NCNU also engages hotel operators to co-organize ecotours for their guests, thereby integrating USR and CSR and fostering a green economy in the neighborhood (Fig. 12 and 13). The work includes developing environmental education to highlight ecological experiences, receiving visitors' comments and feedback, and helping the administration of the Liyutan Scenic Area and local residents to identify improvements and potential benefits to optimize sustainable ecotourism. To fulfill its social responsibility, NCNU encourages its faculty and students to team up and explore the neighborhood and establish long-term collaboration with the communities. In the past, the faculty and students from NCNU held the "Environmental Education Workshop: Community & Water Resources" in the Greater Puli Area and provided the residents with courses for professional and general study, identified the issues to be addressed in these communities (including Taomi, Wugong, Nanchun, Fangli, Pipa, Wudeng, and Toushe), and determined how to work with the communities to solve problems. As a result, the students and the neighborhood made progresses together. Mr. Yuh-Long Su, NCNU's President, is now leading the project team to work with Taomi Eco-Village to construct wetlands as a solution to private lodging sewage and the negative environmental impact of tourists on Taomikeng River during ecotourism, thereby protecting the habitats of iconic ecological resources, such as frogs and the larvae of fireflies. The pollution generated during ecotourism can be effectively addressed with the construction of wetlands, making ecotourism environmentally friendly. Reducing pollution and protecting habitats allow the community to operate ecotourism sustainably. The constructed wetlands contribute to not only decontamination but also increased habitats, providing a domain for local residents to spend leisure time and for tourists to gain environmental education. NCNU has also assembled local residents to act as volunteer patrols for water protection, thereby sharing the value of protecting ecological commons and channeling the university's energy into the sustainable operation of the eco-village.

Figure 10. Learning in an ecological course

Figure 11. Right: Introduction of ecological courses and their connection to the community

Figure 12. USR & CSR (I) – Hotel guests experience an ecotour

Figure 13. USR & CSR (II) – NCNU faculty and students participate in an ecological guide activity

5. A Green Economy based on Environmentally Friendly Cultivation

In addition to in-school education, NCNU also performs social practices outside the campus and devotes itself to the prosperity of the neighborhood. To fulfill the university's social responsibility, NCNU's team, composed of members of the College of Science and Technology, under the leadership of President Yuh-Long Su (Fig. 14), has developed a crop model that is environmentally friendly. In Puli, the town that is also known as "the Kingdom of Water Bamboo," most of the farmers use high-pressure sodium (HPS) lamps to regulate the production time of water bamboo, making the plant harvestable all year round. However, high-pressure sodium lamps consume much energy, and more disadvantageously, their excessive brightness can cause light pollution that is harmful to the ecology and threatens traffic safety. It is thus desirable to use modern technology, such as LED lamps, to lower energy consumption and reduce production costs, allowing the production of Puli's famous product, the water bamboo, to be more industrious and friendlier for the environment and road users. A special team consisting of 10 teachers and students from the Department of Civil Engineering, Department of Applied Chemistry, and Department of Applied Materials and Optoelectronic first established eight LED lamps in a water bamboo field measuring 1,000 m^2. A year later, the team found that the water bamboo growing under the LED lamps were as good as those growing under high-pressure sodium lamps in terms of quantity and quality. The only problem was that the illumination in the center of the field was slightly lower than in the other parts, which led to a relatively low plant height. To eliminate the difference, the team conducted LED luminance simulation in a vacant lot with no light pollution and tested different lens' focal lengths and different lamp angles. The results are now used in the second year of the experiment to modify the arrangement of LED lamps in the water bamboo field, in an attempt to correct the partially insufficient illumination and optimize water bamboo growth. The field investigation is ongoing (Fig. 15 and 16), and the participating students have said that this is their first time doing farm work and that it is very interesting and meaningful to experience the farmers' joys and sorrows, making them eager to participate in field investigations in the future. In the modified experiment, water bamboo grew well under both high-pressure sodium lamps and LED lamps, demonstrating that LED lamps are an energy-saving and environmentally friendly alternative to high-pressure sodium lamps for water bamboo cultivation. Regarding the downward-lighting arrangement used in the experiment, while the setup cost for LED lamps is twice as much as that for high-pressure sodium lamps, the power consumption from LED lamps is only 1/3-1/4 of that from high-pressure sodium lamps (as shown in Table 1). This means that there will be no difference in terms of setup cost between the two kinds of lamps after two years of use. From the third year on, power saving up to 70% is expected. Technically, LED technology is suitable for the production of water bamboo. Economically, the money spent for setting up lamps in the water bamboo field can be recovered after three to five years. Assuming that eight LED lamps have to be used in a water bamboo field measuring 1,000 m^2, as the cultivation area of water bamboo in Puli is about 1,800 ha, 148,000 LED lamps will be required for overall replacement. If each LED lamp costs USD $80, the overall replacement generates revenue of USD $12M for the LED industry. Following the large-scale adoption of LED lamps in farming areas, related businesses like the selling, maintaining, and repairing of LED lamps will flourish. By driving value creation in a business model using "green" and "innovation," NCNU has set up an innovative green business model and will popularize its use in other regions for agricultural production.

Table 1. LED vs. HPS

	Service Life	Wait	Power Rate	Voltage	Installation	Hg	Price (USD)
High-Pressure Sodium Lamp	2-3 years	400W	1	Non-adjustable	Heavy	Hg-containing	64.76
LED Lamp	Up to 10 years	68W	1/3	Adjustable	Light	Hg-free	77.72

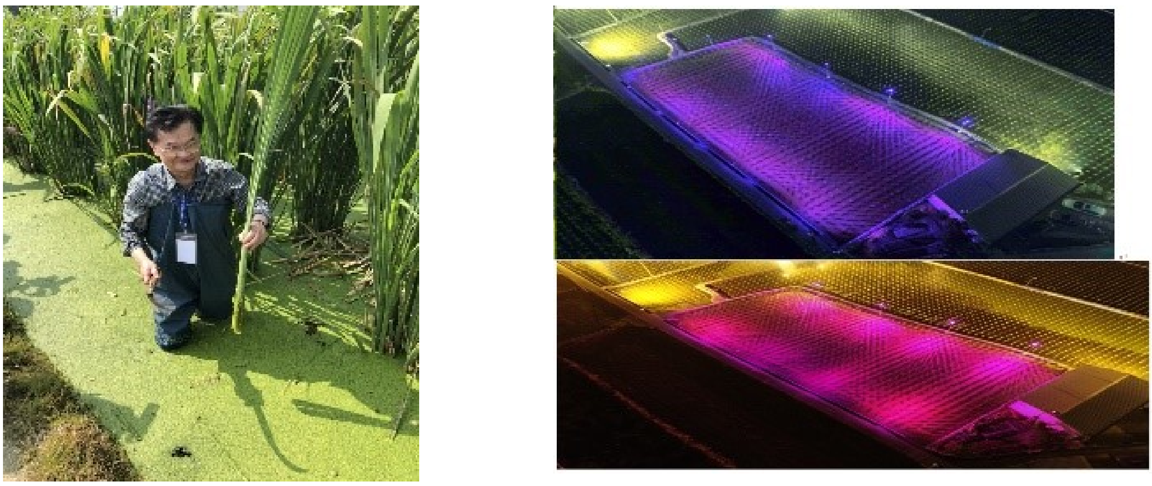

Figure 14. NCNU working with local cultural industries to create a green economy (left: President Yuh-Long Su; upper right: LED lighting at night (before improvement); lower right: LED lighting at night (post-improvement)

Figure 15. Luminance measurement in a simulated water bamboo field and an actual water bamboo field

Figure 16. NCNU's students during a field investigation

6. Conclusion

People form the core of sustainable development; human quality is critical to sustainable development. Therefore, NCNU, in the course of upholding the spirit of higher education and fulfilling its social responsibility, will continue to provide education that interests students and is adaptive; fosters students' (1) ability to think from a comprehensive perspective, (2) problem-solving ability, and (3) creativity matches with individuals' learning ability; and encourages faculty and students to value people and contribute to social solidarity. In terms of curricula, courses have been developed for the Wugong Community, including those on green building methods, global environmental change and sustainable development, community disaster prevention and resilient towns, natural ecological conservation, ecological industry and case studies, and water quality analysis. NCNU also provides environmental education curricula for the Nanchun Community. The 14 courses offered recruit 476 students per year to work with the communities to address local issues. The courses are expected to evolve into standing curricula that promote local, green, sustainable learning. In the Wugong Community, NCNU inventories the ecological resources of the community through ecological investigation and helps the communities to manage ecotourism, by guiding hotel operators in co-organizing ecotours for their guests, thereby integrating USR and CSR, and advance the green economy in the community. In the area implementing the model of LED-lit water bamboo fields, courses about service learning organized by the Department of Civil Engineering are offered to promote eco-friendly farming. The use of LED lamps in water bamboo cultivation has been proven effective in saving energy and making water bamboo production more environmentally friendly. Following the large-scale adoption of LED lamps in farming areas, related businesses like the selling, maintaining, and repairing of LED lamps will flourish, thereby creating a green economy. NCNU looks forward to working with the neighborhood to develop a green economic system for the future, thereby realizing its vision of environmental sustainability and providing a model for other towns pursuing sustainable development.

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Creating a Sustainable Well-Being Through UGM's Multi-discipline Courses

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Abstract. During its first year in participating in the UI GreenMetric World University Rankings in 2018, Universitas Gadjah Mada (UGM) seized the sixth rank in Indonesia and 91st in the world. These ranks were successfully achieved through the high points of two criteria which are waste management and sustainable education. This paper describes the education programs in UGM that support the campus sustainable program. Known as one of the largest universities in Indonesia, UGM consists of 18 faculties and two schools, 263 study programs of various degrees. From all the study programs, there is a ratio of 23% for courses related to the environment and sustainability to the total courses offered. Scheme of courses conducted through collaboration between different study programs is the main key. A field study where students of multidisciplinary study program are sent in groups to empower local communities is held as a mandatory undergraduate course in UGM. Several study program of difference decipline have been developing collaborative sustainable courses under the most relevant study programs such as the Sustainable Energy System course in the Engineering Physics program, where the development process is reported here. The idea is problem-solving learning that elaborates sustainable concept in many disciplines to cover environmental, economics, and social aspects for well-being improvement.

Keywords: Collaborative study, sustainable education, sustainable course

1. Introduction

In the year of 2018, Universitas Gadjah Mada (UGM) participated for the first time in the UI GreenMetric World University Rankings. The details of the scores that were achieved within the six categories of the UI GreenMetric are shown in Tabel 1. In overall, UGM is ranked six in Indonesia and ranked 91st in the world.

Table 1. UGM's UI GreenMetric point

Category	Point	Maximum Point	Percentage
Setting and Infrastructure (SI)	825	1,500	55.00%
Energy and Climate Change (EC)	1,075	2,100	51.19%
Waste (WS)	1,425	1,800	79.17%
Water (WR)	725	1,000	72.50%
Transportation (TR)	1,275	1,800	70.83%
Education (ED)	1,525	1,800	84.72%
Total Score	6,850	10,000	68.50%

It is shown that the Education category obtained the highest point, with a score of 1525 from a maximum available score of 1800 or 84.72%. There are seven indicators for Education. Among them, four indicators succeeded in obtaining the maximum score. One of the indicators discussed in this paper is related to the ratio of sustainability courses towards the total courses/modules. In total, there are 3,360 sustainable courses from a total of 14,566 courses offered in UGM, equal to a ratio of 23%. The keywords that were used to categorize the courses as sustainable courses are; environment, sustain, building, land, water, waste, air, safety, and management. The Directorate of Education and Learning office was the main source of the related information obtained by the UGM UI GreenMetric Team.

The Student Community Services - Community Empowerment Learning (SCS-CEL) is an undergraduate compulsory course offered in UGM since 1971. Detail discussion of the course and how the program has been carrying out the sustainable concepts during its years of being implemented is provided and an example of an SCL program held in one of the regencies in Indonesia is provided. Sustainability is a topic found in almost all of the 18 faculties as course titles, but merely as course materials. The richness of these topics related to sustainability from all these multi-disciplinary study programs is a valuable potential that can be developed into courses that specifically address sustainability concepts. Therefore, cross-faculty collaborative courses are being developed to become compulsory and optional courses through a comprehensive academic study, and thorough discussion among the lecturers with approval from the University's academic senate. However, several of the courses discussed in this paper remain in the development stage at the level of the departments and schools.

2. Student Community Services - Community Empowerment Learning (SCS-CEL)

Universitas Gadjah Mada (UGM) was established on December 19, 1949 as a national university. Today, the university consists of 18 faculties, one postgraduate school, one vocational school, 263 study programs, 108 joint degrees/double degrees, and 21 research centers. The academic activities of Universitas Gadjah Mada are expressed in the form of the cornerstones of *Tri Dharma* higher educational values, which are Education and Teaching, Research, and Community Service.

As one of the oldest universities in Indonesia, UGM is known as a *populist university* due to its commitment in serving the society [1]. Since 1951, UGM has deployed its students on the basis of conducting a Community Service Program. Within a decade, no less than 1218 students had been commissioned, resulting in 109 newly established high schools in areas outside Java Island (the most populated island of Indonesia). In 1971, based on the recommendation of UGM's law expert, Prof. Koesnadi Hardjasoemantri, the program became a compulsory course for UGM undergraduate students. As a populist university, UGM has a moral obligation to maintain the sustainability of SCS program. In 1999, a thematic SCS program emerged as an alternative solution towards Indonesian monetary crisis of the preceding year. Since 2006, UGM shifted the program's paradigm from community development into research-empowerment as a response towards the continuous globalization pressure on the Indonesian community. Thus, the program's name changed into Student Community Services - Community Empowerment Learning (SCS-CEL) [2].

Since then, UGM has deployed its students to nearly all the 34 provinces of Indonesia. The program now includes both Indonesian and international students, with a total of 32 universities from 15 countries also participating, including Norway, South Korea, Japan, Australia, Austria, France, Germany, etc. In 2016, SCS-CEL program was implemented in 33 provinces, 108 districts, 179 sub-districts, and 276 villages. Since its inception, UGM has dispatched more than 200,000 students to all provinces in Indonesia [2].

SCS-CEL program was developed to solve real problems faced by the community (thematic) through an interdisciplinary or multidisciplinary approach and local community empowerment. Therefore, this program sees the students working together with the local community and government. In a program created for problem solving, the students act as motivators, innovators, and facilitators for the assisted community. SCS-CEL program has to be developed based on the alignment of three pillars of sustainability, which comprises of economic, social, and environmental sustainability, and it will have a strategical meaning for the actualization of sustainable development by an academic community [3].

2.1. Scope of SCS-CEL program

Based on UGM's priority and research areas, the scope of SCS-CEL program is divided into several themes as follows:

1) Socio-cultural development based on local wisdom and nationalism
2) Community empowerment through education
3) Women and vulnerable community empowerment
4) Rural governance and administration
5) Enhancement of law and political awareness
6) Small and medium enterprises development
7) Sustainable agricultural, fisheries, farming, and forestry production
8) Natural resources development
9) Environmental management
10) Enhancement of community's health
11) Regional infrastructure development
12) Renewable energy

13) Information technology for sustainable development
14) Disaster early warning system and mitigation
15) Enhancement of national defense and security
16) Eradication of illiteracy

SCS-CEL Program is held twice a year, one term held in between semesters and another term during the semester. The students are divided into teams consisting of a minimum of 20 people and a maximum of 30 people with one field lecturer assigned to each team. In order to solve real problems, each team has to consist of students from four clusters, which are Science-Technology, Social-Humanitarian, Medicine, and Agriculture. Those clusters cover all 18 faculties in UGM. During the implementation, the students are required to attend 72 hours of preparation courses, stay in the implemented location for two months, and fulfill 288 effective hours in order to complete their programs. For funding, SCS-CEL program is suported by involving stakeholders coming from communites, the government, industries, enterprises, and so forth. The partnership can be in the form of funding, service, and providing facilities. Before being deployed, UGM holds preparation courses regarding the history and philosophy of SCS-CEL, educating the students in sustainable development, administration, ethics, community empowerment, as well as occupational health and safety. Then, their comprehension is evaluated through a General Test (GT) that takes place after the course.

2.2. SCS-CEL program in Banyuyoso Village

In 2017, one of the student teams conducted the SCS-CEL program in Banyuyoso Village, Grabag Sub-district, Purworejo Regency, Indonesia. It is an example of how education for sustainable development is implemented through a practical course in real life. The students conoducted their programs from June 10, 2017 until August 4, 2017. Most of the local people in Banyuyoso Village work as farmers and animal breeders. The vision of the student team was to encourage the local community to live independently by solving health, environmental, and social issues that happened in the village. Banyuyoso was proclaimed as the goat breeder village by the regional government. The high number of goat breeders in the village raised environmental issues concerning it excess of excrements, thus the student team was required to provide an alternative utilization of the goat excrement. Another issue was the poor health of the animals due to the local people's lack of knowledge regarding nutrition and cage hygiene. In order to solve those issues, 9 students from the Science-Technology cluster, 3 students from the Medicine cluster, 10 students from the Social-Humanity cluster, and 2 students from the Agricultural cluster were teamed up. The programs which were implemented by each cluster can be seen in Table 1.

Table 1. Programs implemented by each cluster

Cluster	Program	Pillar of Sustainability
Science-Technology	Feasibility study of biogas Design of biogas reactor Installment of biogas reactor Reactor testing	Environment and economics
Agriculture	Manure production	Environment and economics
Medicine	Animal health counseling Animal nutrition counseling Cage disinfection	Environment and social
Social-Humanitarian	Farming census Manure and biogas counseling	Social

Science-Technology Cluster

In the student team in Banyuyoso Village, the Science-Technology cluster consisted of students from the faculty of engineering, the faculty of mathematics and natural science, as well as the faculty of biology. In order to solve the environmental issue, the team, particularly students from Science-Technology cluster, initiated to utilize the excrement for producing biogas. A simple biogas reactor will be installed in each house. Before building the biogas reactor, they conducted feasibility study to obtain the quality and potency of cattle and goat excrement in Banyuyoso Village. The result of the feasibility study showed that the cattle and goat excrement was feasible to produce biogas. Thus, the team continued by creating a design of a biogas reactor which can be seen in Fig. 1.

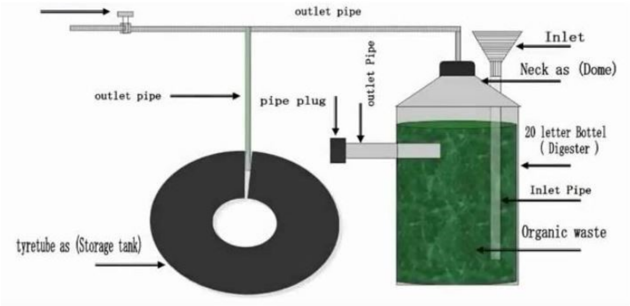

Figure 1. Design of biogas reactor [4]

The student team decided to make a simple design of a biogas reactor due to the limited materials available in the village. It was expected to replace LPG (Liquified Petroleum Gas) which was what was usually used by the local community as their stove fuel. Aside from addressing the environmental issue, by using biogas, the local community could also save money since they no longer have to buy LPG. Therefore, they showed high enthusiasm during this program. Homogeneous excrement enters the biogas reactor which was made from a water tank through an inlet pipe, then an outlet pipe was attached to transport the biogas towards a storage tank (gas holder) which was made of reusable tyre. A valve was installed in the outlet pipe to control biogas output to the connected stove. The installment process of the biogas reactor can be seen in Fig. 2.

Figure 2. Installment of biogas reactor [4]

After making the biogas reactor, the cattle and goat excrement was mixed with water, starter and microbes, and molasses. Biogas was produced after the excrement went through two weeks of an anaerobic process inside the biogas reactor. Before being used, a test was conducted to check the reactor's specification. This was to ensure the reactor was ready to be used, to demonstrate how to operate it properly, as well as to make sure there was no error in the system, and to evaluate the installed system. The local community was excited and actively involved during the biogas installment and testing as seen in Fig. 4. The involvement of the local community from the beginning of all the processes is the key to achieve the sustainability of the system.

Figure 3. Testing biogas system [4]

Agricultural Cluster

In this student team, the agricultural cluster consisted of students from the faculty of agriculture, the faculty of animal science, and the faculty of agricultural technology. In order to solve the environmental issue caused by cattle and goat excrement in Banyuyoso Village, they initiated to make manure. It was produced from the animal excrement and organic waste which were decomposed by microorganism. The student team taught the local community manure production, from its creation process to its packaging process. The manure products could then be sold by the local community, to help increase their income. Aside from producing manure, the bio-slurry produced from the biogas reactor could also be utilized by the farmers in Banyuyoso Village to fertilize their plantations.

Social-Humanitarian Cluster

The Social-Humanity cluster consisted of students from the faculty of law, the faculty of social and political science, the faculty of philosophy, the faculty of cultural science, as well as the faculty of economics and business. The programs they conducted were regarding to farming census as well as manure and biogas counseling. Farming census was required to provide data for the science-technology cluster, while the manure and biogas counseling was held to introduce the program and engage the local community. Thus, the people could comprehend the programs and be involved in the process. A forum with the local community held by the student team can be seen in Fig. 4.

Figure 4. Forum with local community [4]

Medicine Cluster

The medicine cluster consisted of students from the faculty of medicine, public health, and nursing as well as the faculty of veterinary medicine. In order to support the sustainability of manure production and biogas program, the students from themedicine cluster conducted cage disinfection, animal health counseling, and animal nutrition counseling for the breeders in Banyuyoso Village. In addition, they also held free health check-ups and sanitation counseling for the local community.

3. Multidisciplinary Collaborative Courses

Energy is one of the important aspects in national economic growth. Energy becomes the axis of development within various sectors including households, industry, transportation, etc. To this day, the primary energy in Indonesia is still dominated by fossil fuel. However, through the National Energy Policy, Indonesia has started to increase the renewable energy utilization with target of 23% in national energy mix in 2025 [5]. In order to encourage the energy transition in Indonesia, higher education plays an essential role in preparing qualified human resources who will be the future decision makers, planners, engineers, educators, etc. Thus, higher education has to provide education for sustainable development which can increase the students' skills, information and knowledge in order to move towards a sustainable future.

Responding to this energy issue, the Department of Nuclear Engineering and Engineering Physics (DNEEP), Faculty of Engineering Universitas Gadjah Mada has been including energy as one of its focus of study aside from instrumentation and building physics. In its implementation, DNEEP implements Research Based Learning (RBL) methods for improving the student's knowledge based on real energy problem solving through the synergy of several courses in the department. The scenario of this learning program is shown in Table 2.

Table 2. Scenario of the synergy of several courses in DNEEP [6]

Courses Synergy	Purposes	Activities	Outputs
▪ Renewable energy engineering ▪ Energy policy ▪ Research methodology ▪ Industrial management	Technopreneur in the field of new and renewable energy system	▪ Lecturing ▪ Internship ▪ Independent work	▪ "Company" ▪ Feasibility study report ▪ Business plan ▪ Prototypes ▪ Products
▪ Advanced reactor technology ▪ Nuclear fuel management ▪ Waste treatment technology ▪ Engineering Management	Conceptual industries based on advanced reactor's fuel cycle	▪ Lecturing ▪ Independent work	▪ "Company" ▪ Feasibility study report ▪ Business plan ▪ Conceptual product design
▪ Hydropower engineering ▪ Structure & properties of materials engineering ▪ Quality assurance	Quality assurance systems of local resources and wisdoms-based hydropower engineering	▪ Lecturing ▪ Independent field study	▪ Product design ▪ Quality assurance programs

In this scenario, the students were encouraged to be an inventive techno-entrepreneur where they are required to discover problems, originate creative ideas, and find innovative solutions. This scenario also drives them to discuss and produce new ideas in order to solve the problems they discovered. The student group members should come from various undergraduate study programs, as seen in Table 1. For improving the students' skill, the synergy courses were linked to the Student Community Services - Community Empowerment Learning (SCS-CEL) and renewable energy projects run by the Center for Energy Studies UGM. Through this cooperation, students from the synergy courses werea able to be directly involved in various research and community research activities. These synergy courses has resulted in emerging research based ideas and products as well as many energy business plans which are appropriate to address the real energy problems. On the other hand, the community empowerment learning activities succeeded in increasing the role of department to improve capability of relevant stakeholders in answering energy problems [6]. The synergy courses has encouraged the achievement of several Sustainable Development Goals (SDGs), such as quality education, affordable and clean energy, and collaboration.

Inspired by the years of success of these synergy courses, Universitas Gadjah Mada initiates to implement larger scope of multidiscipline collaborative courses by involving six faculties which can cover three aspects of sustainable development (economics, social, and environment), those are the Faculty of Engineering (the Department of Nuclear Engineering and Engineering Physics, the Department of Electrical Engineering and Information Technology), the Faculty of Economics and Business, the Faculty of Social Science and Political Science, the Faculty of Law, the Faculty of Biology, and the Faculty of Forestry. These collaborative courses aim to encourage energy transition in the academic environment (higher education) through multidisciplinary collaboration in the form of cross-faculty courses. A comprehensive approach is required to encourage energy transition. In addition, qualified human resources who have comprehension in various cross-field issues related to energy transition demands are also important. Therefore, the detailed plan regarding comprehensive study in each faculty is formulated based on these following considerations:

1. The study includes challenges on multidimentional energy system

2. Energy is defined as fuel and electricity
3. Courses in the Faculty of Engineering emphasize on the technology, requirements of sustainability, reliability, techno-economics, lesson learned, readiness of technology, research and development, national sustainable energy industries (renewable and nuclear energy)
4. Courses in the Faculty of Forestry include forest conservation related to opened coal mining, consequences of land conversion for palm oil industry, bio-energy management, biodiversity aspects
5. Courses in Faculty of Biology discuss challenges on biodiversity regarding coal and palm oil, bio-energy technologies
6. Courses in the Faculty of Social Science and Political Science include social-political impacts stemming from the current energy system (including coal and palm oil), acceptability of renewable energy systems (nuclear and renewable energy technologies), establishing energy system community and managerial institution, inclusive energy system, and geopolitical aspects in energy system transition
7. Courses in the Faculty of Law emphasize on regulation as a potential obstruction for energy transition, study on regulation making which encourages the acceleration of energy system transition, and international cooperation aspects.
8. Courses in the Faculty of Economics and Business discuss macro-financial framework in energy system, financial solution for energy system transition, as well as sustainable energy (renewable and nuclear energy) business and industrial development.

Development Plan
Cross-faculty collaborative courses are developed to become compulsory and optional courses. The lecture materials are designed to include economic, social, and environmental aspects. However, each faculty has a different emphasis corresponding to the faculty's field of expertise. Table 3 shows courses which will be implemented in each faculty.

Table 3. Courses implemented in each faculty [5]

No	Faculty	Course	Course Credit
1	Faculty of Engineering - DNEEP (Department of Nuclear Engineering and Engineering Physics)	Sustainable Energy System	Optional / 2 Credits
2	Faculty of Engineering - DEEIT (Department of Electrical Engineering and Information Technology)	Renewable Energy Integration in Electricity Power System	Optional / 2 Credits
3	Faculty of Economics and Business	Energy Economics (Regular and International Classes)	Optional / 2 Credits
4	Faculty of Biology	(strengthening cross-faculty courses)	
5	Faculty of Law	(strengthening cross-faculty courses)	
6	Faculty of Social Science and Political Science	Economical Sociology	Compulsory / 2 Credits
7	Faculty of Forestry	(strengthening cross-faculty courses)	

Through the cross-faculty collaborative courses, the students are taught by lecturers from other faculties, thus they can gain skills and knowledge regarding economics, environment, and society. The example of the detailed lectures materials in Faculty of Engineering (DNEEP) are shown in Table 4.

Table 4. Sustainable energy system course in Faculty of Engineering (DNEEP) [5]

Week	Lectures	Faculty in Charge
1	Energy System and Its Challenges	Faculty of Engineering (DNEEP)
2	Energy Transitional Options	Faculty of Engineering (DNEEP)
3	Energy Transition in Power Supply	Faculty of Engineering (DEEIT)
4	Economical Sociology	Faculty of Social Science and Political Science
5	Economical Sociology	Faculty of Social Science and Political Science
6	Energy Economics	Faculty of Economics and Business
7	Energy Economics	Faculty of Economics and Business
8	Mid-Term Examination	
9	Introduction of Law on Energy and Constitution 1945 Article 33	Faculty of Law
10	Energy Regulation in National Law	Faculty of Law
11	Prospect and Development of Micro-algae Bio-fuel	Faculty of Biology
12	Micro-algae Bio-fuel Production and Its Supportive Requirement	Faculty of Biology
13	Challenges on Biodiversity and Ecosystem Service	Faculty of Forestry
14	Energy Production and Energy Forest	Faculty of Forestry
15	Comprehensive Approach in Transitional Step	Faculty of Engineering (DNEEP)
16	Final Examination	

Table 5. Economical sociology course in Faculty of Social Science and Political Science [5]

Week	Lectures	Faculty in Charge
1	Introduction	Faculty of Social Science and Political Science
2	Economic and Science Sociology	Faculty of Social Science and Political Science
3	Classic and Modern Statements	Faculty of Social Science and Political Science
4	Economic Action and Types of Economic Action	Faculty of Social Science and Political Science
5	Embeddedness as institutional process	Faculty of Social Science and Political Science
6	Market and Consumption Community	Faculty of Social Science and Political Science
7	Case: Energy Community	Faculty of Social Science and Political Science
8	Mid-Term Examination	
9	Global Market and Energy Needs	Faculty of Economics and Business
10	Energy Domestication	Faculty of Economics and Business
11	Household Energy Consumption	Faculty of Engineering (DNEEP)
12	Energy Technology Engineering for Society	Faculty of Engineering (DNEEP)
13	Women and Renewable Energy Technology	Faculty of Social Science and Political Science
14	Review	Faculty of Social Science and Political Science
15	Final Examination	

The Sustainable Energy System course in the Department of Nuclear Engineering and Engineering is an optional course, the only compulsory collaborative course (Economical Sociology course) is implemented in the Faculty of Social and Political Sciences. The objective of the Economical Sociology course is to give a comprehension on the relations between society and economics. As an alternative energy, the society particularly those who have yet to obtain access to new and renewable energy would not accept the technology easily. Therefore, social and economical consideration has to be included in persuading the society to accept and support energy transition. Detailed lectures material of the Economical Sociology course in the Faculty of Social Science and Political Science in UGM is shown in Table 5.

Detailed lecture materials of the other collaborative courses in other faculties are described in a separate report. Based on the lecture materials and the implementation of those multidiscipline collaborative courses, 7 out of 17 Sustainable Development Goals (SDGs) are promoted; quality education, gender equality, affordable and clean energy, decent work and economic growth, sustainable cities and communities, climate action, and partnership to achieve the goal.

4. Conclusion

The SCS-CL program conducted in Banyuyoso Village reported in this paper is evidence that through the synergy of clusters, the sustainable program conducted as a compulsory sustainable course in UGM was a success. Each cluster played an important role where multidisciplinary approach is required in implementing the three pillars of sustainability (environment, social, and economics). By collaborating in solving society's real problems, the students acquired many soft skills (problem solving skills, social skills, community empowerment, and teamwork). Having the SCS-CL program and also the development of collaborative courses in and among faculties, has also proven that UGM strongly supports the SDG's. It is the principle underlying all of the indicators of UI GreenMetric to achieve sustainable university for a sustainable future.

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Nurturing "SEP/SD Mindset" through General Education Program for Sustainable University

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Abstract. "Sufficiency Economy Philosophy (SEP)", bestowed by King Rama IX and the goals of sustainable development (SD) have been regarded as the guiding principles of Siam University. Many initiatives were introduced to the 3Ss (Students, Staff, and Surrounding communities) but it was found that the most important factor is their "mindset". The university decided to redesign our general education program. PNI Modified data from a needs assessment research showed that sustainability-related competencies such as "appreciation, understanding, commitment to apply principles of SD and SEP in daily life and global/social issues"; "appreciation and preservation of Thainess/Thai culture"; "concern, awareness and understanding global/social issues and their impacts" were ranked among the highest priorities. Our general education program then introduced or revised many SEP/SD and SEP/SD-related courses. A teaching-learning dynamics with emphasis on "living lab" approach was also introduced to help nurture "SEP/SD mindset". The university encourages team teaching, experiential and project-based learning. Students are expected to do some projects in the communities so that all the 3Ss can work together. Some of these new courses were selected as pilot studies. The results revealed that this new general education program should be a key driver for "Sustainable University".

Keywords: General education, SEP/SD Mindset, sufficiency economy philosophy, sustainable development

1. Introduction

"Sustainability" has been regarded as the guiding principles of the Thai national development plans for decades. To be exact, "Sufficiency Economy Philosophy (SEP)", a unique development model of sustainability of Thailand, has been adopted as the core principle of the Thai National Economic and Social Development Plans since 2002. It is noteworthy that the development approach based on SEP is in conformity with the core principle of the 2030 Agenda and can serve as an approach to support the realization of the SDGs. SEP promotes sustainability mindset and provides guidelines for inclusive, balanced and sustainable development. Recognizing this importance, not only these development goals (SEP and SD) have been highlighted in the current constitution of the Kingdom but the cabinet has also decided on 25 October 2016 to promote the application of SEP for SDGs in all areas and at all levels. Recently, both SEP and SDGs have been integrated in the 20 – Year National Strategy Framework (2017-2036) and the 12th National Economic and Social Development Plan (2017 – 2021). This sustainability paradigm has gained significant institutional momentum over the past years in every sector including education. At higher education level, it is expected that sustainability would be integrated in the policies, curricula, and learning activities. This paper will examine how Siam University implements this policy through our general education program.

2. Significance of SEP and SD

Sufficiency economy is a philosophy conceived and developed by His Majesty King Bhumibol Adulyadej (King Rama IX) of Thailand over 60 years of tireless development work to improve the lives of the Thai people and bring them a genuine and lasting happiness. The goal of implementing SEP is to create a balanced and stable development, at all levels, from the individual, family and community to society at large by developing the ability to cope appropriately with the critical challenges arising from extensive and rapid changes (i.e. globalization) in the material, social, environmental, and cultural conditions of the world. In short, SEP stresses the importance of adopting the middle path for appropriate conduct. The philosophy consists of three components: moderation, reasonableness, and self-immunity or prudence, with two accompanying conditions: knowledge and morality or virtues. It can be summarized as follows. [1]

- **"Moderation"** emphasizes the awareness of living in the middle path, not in the extremes. In other words, it reminds us that we should try to avoid extreme thoughts, behaviors and actions. As His Majesty the King has stated: *"Being moderate does not mean being too strictly frugal; consumption of luxury items is permitted… but should be moderate according to one's means"* (Royal Speech, given at Dusit Palace, 4 December 1998)

- **"Reasonableness"** requires that the choices we make be justifiable by using academic approaches, legal principles, moral values or social norms. It should be noted that "reasonableness" will come through the accumulation of knowledge and experience. One should be aware of the consequences of one's actions both to themselves and others. Reasonableness then will lead to analytical capability, self-awareness, as well as compassion and empathy.
- **"Self-immunity" or "Prudence"** emphasizes the need for built-in resilience against the risks which arise from internal and external changes by having good risk management. It will help us cope with events that are unpredictable or uncontrollable. For instance, immunity to changes in material circumstance implies having enough savings, being insured against financial risks, and making long-term future plan. Immunity to social changes signifies unity among the people, along with their contentment and feeling at peace. Immunity to environmental changes prompts individuals and their communities to be aware of the impacts their actions may have on the environment, and subsequently their livelihoods, an awareness which leads them to live in harmony with nature. Immunity to cultural changes means that the people appreciate and value their culture and heritage and do not waver in their determination to uphold them. They also understand and have a positive attitude towards cultures of others.
- **"Knowledge"** is a necessary condition for SEP to work, as comprehensive knowledge and academic approaches play important roles at every stage of planning and implementation. It encompasses accumulating information with insight to understand its meaning and the prudence needed to put it to use.
- **"Virtues",** another necessary condition, refers to integrity, trustworthiness, ethical behavior, honesty, perseverance, and a readiness to work hard.

It is noteworthy that the Sufficiency Economy Philosophy has a strong influence in the country. Innovative practices applying SEP have been applied across the country in every sector including education. At higher education level, it is expected that each university will integrate sustainability in the policies, curricula, and learning activities. However, there are still some questions of how we can apply SEP in real life so that it can promote "sufficiency culture" which will lead to sustainable development. After reviewing literature, it is noted that the most important prerequisite of SEP/SD is "sufficiency thinking" or the transformation of one's mindset. [2] In doing so, SEP will consequently become the way of living or normal livelihoods which one might call "sufficiency culture", a culture that will enrich everyone's lives in a sustainable way. Applying explanation for implementing SEP in national level to individual or community level of Suwanee Khamman [3], the direction towards sufficiency economy or sustainability and sufficiency culture can be summarized as in the following figure (Fig. 1).

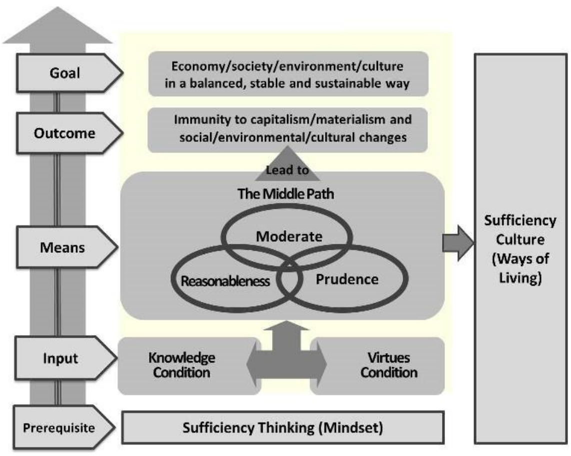

Figure 1. Relationship between SEP, "Sufficiency Thinking", and "Sufficiency Culture"

3. Nurturing "SEP/SD Mindset" at Siam University

Siam University (SU), one of the leading Thai private universities, decides to take a leading role in promoting SD and SEP in the surrounding communities since we are the only university in Phasi Charoen district. With this regards, "sustainability" has been adopted as one of the pillars of the strategic plan in accordance to the *"Sustainable University, Sustainable District"* policy. The university then identifies the 3Ss (Students, Staff, and Surrounding communities) as our target groups. In terms of implementation, we recognized that transformation of one's mindset is the most important prerequisite as mentioned earlier. The university thus decided to redesign our general education (GE) program at the undergraduate level with one of the aims to integrate SEP/SD mindset and sustainability competencies for the students.

A multidiscipline research team was appointed to do this mission. We decided to use backward design for curriculum development by investigating the expected key competencies and learning outcomes. Emphasis was given to the needs of the students since we believe that "students' voices" should be equally heard as those of the instructors and administrators. The study was then designed into two phases. The first phase aimed to assess students' key competencies for sustainability in the 21st Century as perceived by students and instructors. Findings from the first phase will be used as one of the basis for discussing and revising SU general education program in the second phase.

Mix-methods approach, using document research, expert interview, and questionnaire, was employed. A needs assessment questionnaire was designed by the researchers based on literature review and expert interview. After pre-test study, the questionnaire was then distributed to 440 students and 160 instructors (5% margin of error and 95% confidence level; Krejcie and Morgan, 1970). Both groups were asked to identify desirable sustainability competencies for the undergraduate students. Differential value between desirable sustainability competencies of students and their current sustainability competencies as determined by students and instructors were assessed. The data was ranked by Modified Priority Needs Index (PNI Modified). In case the results from PNI Modified were at the same value, Priority Needs Index (PNI) would be considered. The formula for calculation was PNI = (I-D) x I and PNI Modified = (I - D)/ D (when I = Important or expected GC, D = Degree of success or existing state in promoting GC). Findings could be concluded as follows.

3.1. Identifying key competencies for sustainability

It was found that 30 competencies were identified by students and instructors as key competencies for sustainability in the 21st Century. These competencies could be grouped into 5 domains; namely, normative and anticipatory competency (ability to convey, apply, and negotiate sustainability values, goals, and targets), critical and innovative thinking, inter-personal competency, intra-personal competency, and literacy. PNI Modified data from a needs assessment research showed that in relation to normative and anticipatory or sustainability-related competencies both students and instructors ranked "appreciation, understanding, and commitment to apply the principle of sustainable development (SD) and Sufficiency Economy Philosophy (SEP) of the late King Rama IX in daily life and global/social issues" as the first priority (PNI Modified = 0.17, 0.36), "appreciation and preservation of Thainess and Thai culture" as second priority (PNI Modified = 0.15, 0.34), "concern, awareness and understanding global/social issues and their impacts" as third priority (PNI Modified = 0.14, 0.28).

In the domain of critical and innovative thinking, "critical thinking" was ranked first (PNI Modified = 0.21, 0.40) by both the students and instructors. As for inter-personal competency, developing "Thai and foreign languages proficiency" was ranked as the first priority by both students and instructors (PNI Modified = 0.33, 0.45). The students ranked leadership and initiative skills as second priority, followed by respect for diversity, teamwork and team building, social manner and etiquette (PNI Modified = 0.22, 0.21, 0.19, 0.14, 0.12). In the intra-personal competency domain, "time management" was assessed as most needed by both students and instructors (PNI Modified = 0.22, 0.44). Moreover, the students ranked initiative and entrepreneurial spirit as second priority, followed by tolerance to uncertainty and ambiguity, lifelong learning, conflict management, digital and IT management skills, being adaptable to change, problem-solving and reasoned decision-making skills, positive thinking, High ethical standards in personal and professional life (PNI Modified = 0.21, 0.20, 0.18 (PNI = 2.94), 0.18 (PNI = 2.56), 0.15 (PNI = 2.35), 0.15 (PNI = 2.30), 0.14 (PNI = 2.27), 0.14 (PNI = 2.23), 0.12). Finally, "legal and political literacy" (PNI Modified = 0.25, 0.39) and "financial literacy" (PNI Modified = 0.21, 0.38) were ranked as first and second in the literacy domain. The students also ranked health literacy as third priority, followed by STEM literacy, (social) media and information literacy, environmental literacy [PNI Modified = 0.17 (PNI = 2.51), 0.17 (PNI = 2.34), 0.16 (PNI = 2.32, 0.16 (PNI = 2.19)].

Moreover, if we analyzed the findings carefully, it was interesting to see that the students indicated the followings as top five needed personal characteristics; leadership and initiative skills, tolerance to uncertainty and ambiguity, lifelong learning, adaptability to change and openness to new experiences, followed by social mindfulness, engagement, and responsibility.

3.2. Designing GE courses to nurture sustainability

A focus group discussion among selected scholars, university administrators, instructors, and students was held to discuss the research results. It was agreed that we need to change both the content and instruction methods of our GE program. "Confidence", "(Social) Mindfulness", "Lifelong Learners" were proposed as the new outcomes for desirable students' characteristics. These three characteristics are considered one of the important requirements for sustainability. Moreover, in order to implement our *"Sustainable University, Sustainable District"* policy, SU staff should also have these characteristics so that they will become prime mover for sustainability in our surrounding communities

The next step was to redesign GE curriculum by introducing or revising SEP/SD courses and SEP/SD-related courses. We also decided that there should be fewer required courses and that the students should have more opportunities to select as much elective courses as they like. As for SEP/SD courses, all students will be required to take a course in "Sufficiency Economy Philosophy for Sustainable Development". They can then choose courses in "Green Technology for Sustainable Development" and "Living Lab for Campus Sustainability". Several SEP/SD-related courses will also be offered to the students. To mention a few, these are "Civic Literacy in Thai and Global Context", "Logic and Design Thinking for Innovation and Start Up", "Designing Your Dream", "Life, Well-Being and Sports", "Yoga, Meditation, and Art of Living", Designing Your Self and Personality for Leadership", "Thai Appreciation and Unseen in Siam", and "Community Explorer and Service Learning".

Nevertheless, we think that without changing the learning approach, our attempt to nurture "SEP/SD Mindset" will not be successful. The University academic committee then announced the policy that our staff should integrate SD/SDGs in their teaching and research activities. A teaching-learning dynamics with emphasis on "living lab" approach was also introduced to help nurture "SEP/SD mindset". It is encouraged that student engagement and project partners among the 3Ss should be integrated in the GE courses. Moreover, "project-based", "experiential-based", and "team teaching" shall be practiced. Students are expected to do some projects in the communities so that all the 3Ss can work together.

In order to be certain that this newly design program will work well, Siam University has offered these new courses in the pre-semester period. Feedback from these pre-semester courses was collected in order to improve our teaching in the next semester.

4. Summary/ Concluding Remarks

"Sufficient Economy Philosophy (SEP)" is a unique sustainable development model of Thailand. The philosophy was bestowed by King Bhumibol Adulyadej (Rama IX) to the Thai people in 1977 when the country faced economic crisis. SEP consists of three principles (moderation, reasonableness, and prudence) and two conditions (knowledge and morality or virtues). It is now widely accepted that SEP-based development approach is in conformity with the core principle of SDGs. However, the most important factor for implementing this philosophy is that we must nurture "SEP/SD mindset". With regards to this development approach, Siam University decided to revise our general education (GE) program to nurture competencies needed for this mindset and philosophy. A research-based curriculum was designed in accordance to research findings and focus group discussion. The University Academic Committee set a policy to integrate SEP and SDGs in teaching and research activities. The newly designed GE identified "Confidence", "(Social) Mindfulness", "Lifelong Learners" as the new outcomes for desirable students' characteristics. Both SEP/SD courses and SEP/SD-related courses were offered to the undergraduate students. This new curriculum should be a skill-based one. New approach of instruction with emphasis on the "living lab" approach as well as "project-based", "experiential-based", and "team teaching" were encouraged with the believe that these approaches will help nurturing mindset of both the students and staff involved. At the same time, it will be beneficial to the surrounding communities. It is hope that this new general education program should be a key driver for the implementation of SEP/SD mindset leading to a “Sustainable University, Sustainable District”.

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The 5th International Workshop on UI GreenMetric
University College Cork, Cork, Ireland, 14-16 April

The User Role and Risk Factors for Human Health in UI GreenMetric World University Rankings: Open Scientific Problems

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Abstract. Nowadays the Earth's ecosystems are almost at point of no return. A large segment of energy consumption and pollution emission is attributed to construction sector and, although the buildings are often perfectly engineered, the role of users can promote the sustainable conditions and improve energy efficiency and energy saving. The research team of Roma Tre University worked on human and buildings interaction issues designing, for Solar Decathlon Competition prototypes, an informative system of energy efficiency data visualization, that provided, in real-time, information to let the dweller have an aware and guided use of the environment where he lives. The subject of this paper is focused on two topics on which, the research group, is investigating. The aim is to propose an upgrading of UI GreenMetric World University Rankings parameters that takes into account also the presence of informative digital system, to optimize the users role in the energy reduction process, and that consider, as assessable, also the evaluation of healthiness of the building. The research is still ongoing, particularly on schools, investigating on models of energy efficiency prediction and drafting a protocol of use that considers also the risk factors for human health, as mold, bacteria, electromagnetic fields and ionizing radiation.

Keywords: Building performance comparison, comfort conditions, energy monitoring, home automation, human and building interaction

1. Introduction

Because of global warming impact, the Earth's ecosystems are currently at a critical stage. Italy, and the rest of the world too, have had more than its fair share of extreme weather in previous years and 2018 too.

In October 2018, the Intergovernmental Panel on Climate Change (IPCC) released a report setting out why we must stop global warming at 1.5°C above pre-industrial levels, and how to do so. If the planet warms by 2°C, the widely touted temperature limit in the 2015 Paris climate agreement, twice as many people will face water scarcity than if warming is limited to 1.5°C. That extra warming will also expose more than 1.5 billion people to deadly heat extremes, and hundreds of millions of individuals to vector-borne diseases such as malaria, for example [1].

Moreover, the latest IPCC special report underplays another alarming fact regarding to *accelerated warming* due to which, in the next 20 years, climate change will be faster and more furious than anticipated.

In addition to this reference scenario, there is inadequate existing building stock of which a large proportion of energy consumption is attributed to the residential sector. Despite national measures adopted in 2015, the energy demand trend has been reversed with respect to 2014, with primary energy demand actually rising by 4%. In particular, the residential sector saw a 2.7% uptick in final energy consumption, equal to 116.4 Mtoe in 2015 compared to the previous year [2]. Representing 10% of final uses, 27.9% of energy uses are for residential buildings (approximately 24 Mtoe/year), compared with 34% for transport and 22.3% for industry.

The subject of this paper is focused on two topics on which, the research group, is investigating. The aim is to propose an upgrading of UI GreenMetric World University Rankings parameters that takes into account also the presence of informative digital system, to optimize the users role in the energy reduction process, and that considers, as assessable, also the evaluation of healthiness of the building.

2. Research Focus and Methodological Approach

2.1. Research focus

The first research focus is on the comparison between "Nearly-Zero-Energy-Buildings" design and use energy consumes. Although perfectly engineered, a lot of buildings, studied with a post occupancy evaluation methodology, show often energy consumption higher than expected. It has been studied how in some cases, users behave and consume in the exact same way as in non-efficient homes [3], as if they would not recognize a direct relationship between behavior and performance of the house.

So the occupancy behavior plays an important role in energy consumption in buildings because can promote the sustainable conditions and improve energy efficiency and energy saving too. Currently, the shallow understanding of occupancy has led to a substantial performance gap between predicted and measured energy use. The introduction of digital technology into home management is historically connected with home automation and the user is satisfied if he does not have to worry about systems. But the role of a "well-educated" dweller, who knows how to manage his house, seeing in real time the results of his behavior, can really improve the energy efficiency promoting the energy saving.

Considering energy saving in buildings as one of the most important topics of the scientific investigation, this first focus addresses on "smart buildings" (as defined in UI GreenMetric World University Rankings parameters), assessing if an automation system is sufficient to guarantees user's comfort, or if it is worthy to provide an information system that make him aware of his own behavior.

The second research focus is that a building can be energy efficient but not necessarily healthy. Nowadays, the high level of demand for sustainability in buildings brings some international Protocols to define dedicated Certifications asking to the designers to conduct in-depth sustainability analyses based on a building's form and urban location, origins of selected materials, HVAC systems and so on. In some of these protocols, the indoor air quality (IAQ) performance and the control of polluting sources is also required. In particular LEED® (Leadership in Energy and Environmental Design), BREEAM® (Building Research Establishment Environmental Assessment Method), HQE™ (High Quality Environmental standard), CasaClima Nature, Protocollo ITACA, consider the indoor air quality, the presence of polluting sources, and the sustainability of building materials.

Buildings, where we spend around 90% of our time, are less healthy than we think: in many cases indoor air is more polluted than the outdoor one, because of numerous sources of VOC (Volatile Organic Compounds).

For this reason, in Italy, two years ago the *Minimum Environmental Criteria* (Criteri Ambientali Minimi - CAM) have been defined. They define the performances of product, materials and procedures, required for assessing and monitoring the sustainability of interventions. To recur to these CAM is mandatory for all the public procurements.

This second research suggests revising UI GreenMetric World University Rankings parameters, adding the above-mentioned Criteria, in order to evaluate sustainable aspects in universities, where young people live for most of their day-long.

2.2. Methodological approach for an informative system of data visualization

In these two focus areas, the research group of the Department of Architecture - Roma Tre University- worked in last years, acquiring an interesting know-how thanks to the participation at Solar Decathlon Competitions.

Solar Decathlon in an international competition, established by the United States Department of Energy in 2002. It involves 20 multidisciplinary teams selected internationally among universities. Teams are required to design, engineer, build and maintain zero-energy housing prototypes, powered by solar energy, built on a shared site to form a fully functional "solar smart city".

Design and construction of such prototypes require a high level of integration in a fully multi-disciplinary team, involving people with very different background, mindset and, more importantly, age and experience. The base requirement of this competition, in fact, is that the entire operation runs around students: they participate to design, engineer, communicate, fund, and even assembly, on site, the house.

One of the most important challenges consists in a full set of sensors, installed in every competing home, and connected to a centralized data-logger, that transmits real-time performance (comfort and energy balance) data over the web. Every team is required to simulate the tasks of daily home functioning, according to a Competition Calendar that establishes what is to be accomplished daily, leaving it up to the teams to decide how and when to combine these activities, such as laundry, showers and cooking. Therefore, user behavior becomes one of the parameters influencing the result of the performance, and therefore of the competition.
Roma TRE was selected to participate at the 2012 edition, in Madrid, with a prototype called *MED in Italy*, fast-assembly lightweight energy efficient housing tailored to the Mediterranean climate, awarded 3rd prize,

and again in 2014, in Versailles, with a prototype called *RhOME for denCity* (a home for Rome) a prototype of an apartment in advanced but affordable social housing, awarded 1st prize (Figure 1).

Figure 1. South and North facades of RhOME for denCity prototype in Versailles

To improve the possibility to better manage the house operation and optimize the user's participation, the RhOME prototype hold a monitoring system, called *dwell!* (*do well to dwell well!*). The purpose of this solution was to provide exhaustive information to let the dweller have an aware and guided use of the environment where he lives.

In fact, as happens with cars, the impact of people awareness on reduction of energy consumption is particularly evident. Currently cars are equipped with increasingly complex information systems, that continuously tell the driver the impact of his driving attitude, stimulating him on changing his behavior and adopt a less consuming style.

Starting from this suggestion, *dwell!* is a monitoring system for the correct end-user information about what is going on in the house.
The system, supplied by the Italian Company Almaviva, collects various information (about temperature, humidity, luminance, water and energy production and consumption etc.) by sensors located in every room, and have three different levels of interaction with users: a web app (dwell! dashboard), a WebGL based model (dwell! Digital Mirror), and an analytic database (dwell! discovery). The three different interfaces meant to reach the widest number of dwellers, from the well-informed to the less aware ones:

Digital Mirror: this WebGL interface is a user friendly door to a digital representation of the house, where intuitive dynamic graphics represent what is happening in the real world and let a non-expert user understand e.g. the variation of comfort parameters in real-time and according to the factors that affect it.

It's meant to be social and entertaining, so that is possible to bring users to explore the house with growing interest, also in the other sections of the interface.

Figure 2. Dwell! digital mirror: urban model

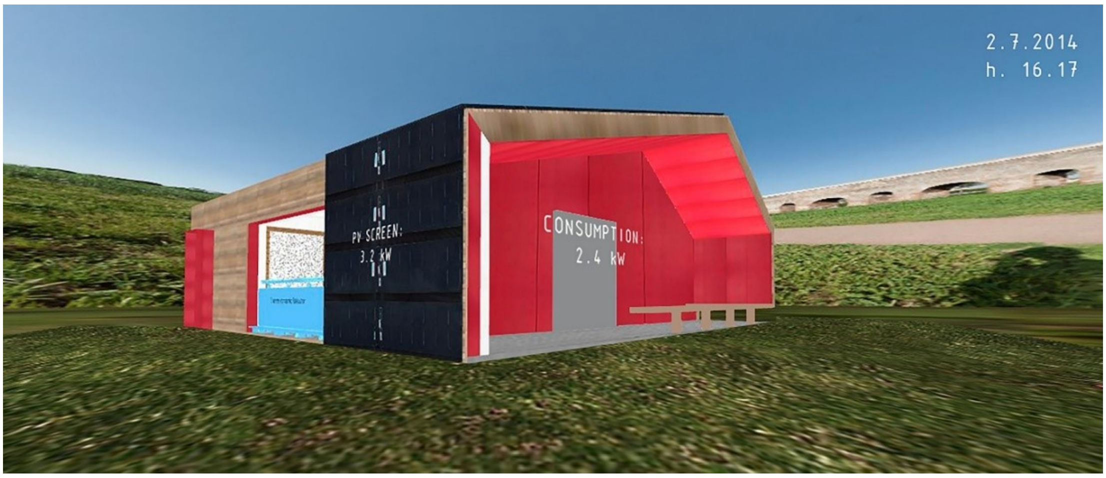

Figure 3. Dwell! digital mirror: prototype model from outside

It is also an interactive point-and-click model of the house where the user can visualize what's going on in real-time through simple animations (changing colors, point clouds, opening/closing windows and doors etc.) and popup windows. Also a child could interact and learn thanks to this intuitive solution.

This interface consists of two webpages, the first representing the urban area (Fig. 2), where is placed the project, and on the webpage, the citizen can view different colored results according to the average real-time energy balance of every apartments; the second webpage represent the single apartment (Fig. 3 and 4), that competed in Versailles, and the inhabitant can select the month-day-hour he wants to explore (or real-time by default) and enter the virtual apartment walking exactly like in a videogame [4]. This way the user can explore not only the apartment geometry but also the data collected by the sensors: numbers upon the objects express consumption or production and the data refresh.

Dashboard: the contemporary house is a complex, technological organism that needs to communicate in a real-time, simple and direct way to the user, exactly like a car dashboard does. This is the aim of this interface section, where it's possible to check, wherever the user is, the current state of house by simple counters that express the levels of energy consumption in relation with the data detected from the sensors installed in the house. With this web app (Fig. 5), wherever the user is, and whatever device has with him (smartphone, tablet, computer), he can view the current state of the house by simple counters that express the most relevant relations among the data detected from the sensors installed in the house.

This way it's possible to check, for example, how much the photovoltaic is producing in relation to the installed power, or if the instantaneous balance of the house is positive or not. The meters gradually change color on a predefined range, in relation to the expressed data, so that the visualization is immediate and incisive.

Figure 4. Dwell! digital mirror: prototype photo/prototype model from inside

Discovery: the third tool is a presentation of the data collected in the course of time (Fig. 6 and 7), exposed in an analytical way that can improve the environmental awareness and the comprehension of the connections between different physical events and between physical events and energy cost. The analysis of past behavior is the ultimate and deeper step to personal awareness and responsibility.

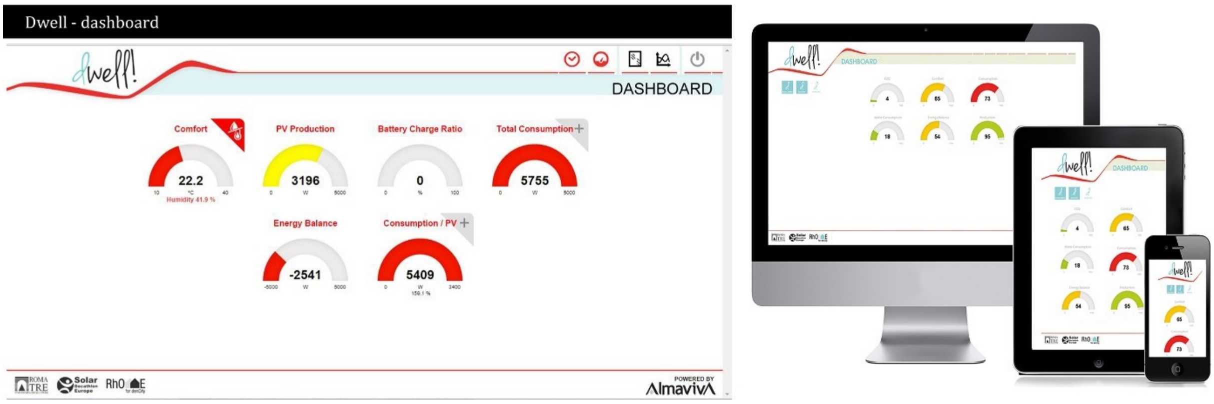

Figure 5. Dwell! dashboard: a multidevice web app

The graphics, organized in the production-consumption and comfort-consumption sections, are designed in order to offer a visualization, at the same time simple and complete, of the most relevant physical connections and, in addition to this, the user can also open a third category where it's possible to select the single measurement and the calculated values, putting together his own graphic and examining events in detail.

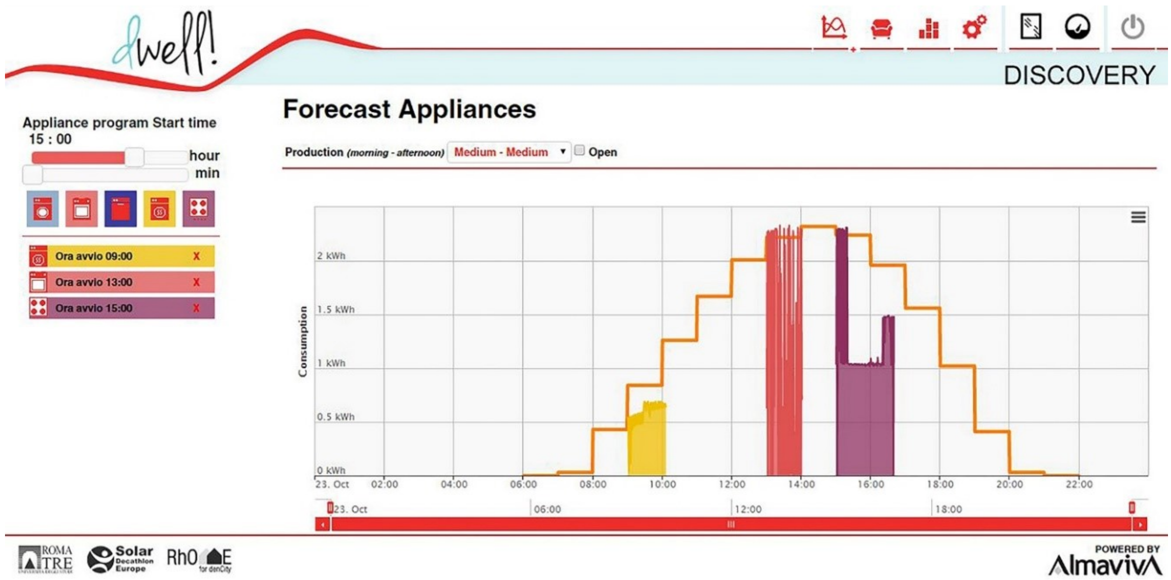

Figure 6. Dwell! discovery: previsional graph

Through these interfaces every dweller will have the possibility to be aware of the consequences of his actions in the house [5]. It will be easy to understand how to save energy identifying wrong and right behaviors but never being forced into a predefined conduct by the home automation.

To underline the importance and effectiveness of this monitoring system, the *RhOME for denCity* prototype, won also the first place in House Functioning, the fourth place in Energy Efficiency, the fourth place in Sustainability, the second place in the Comfort Conditions, the third place in Innovation.

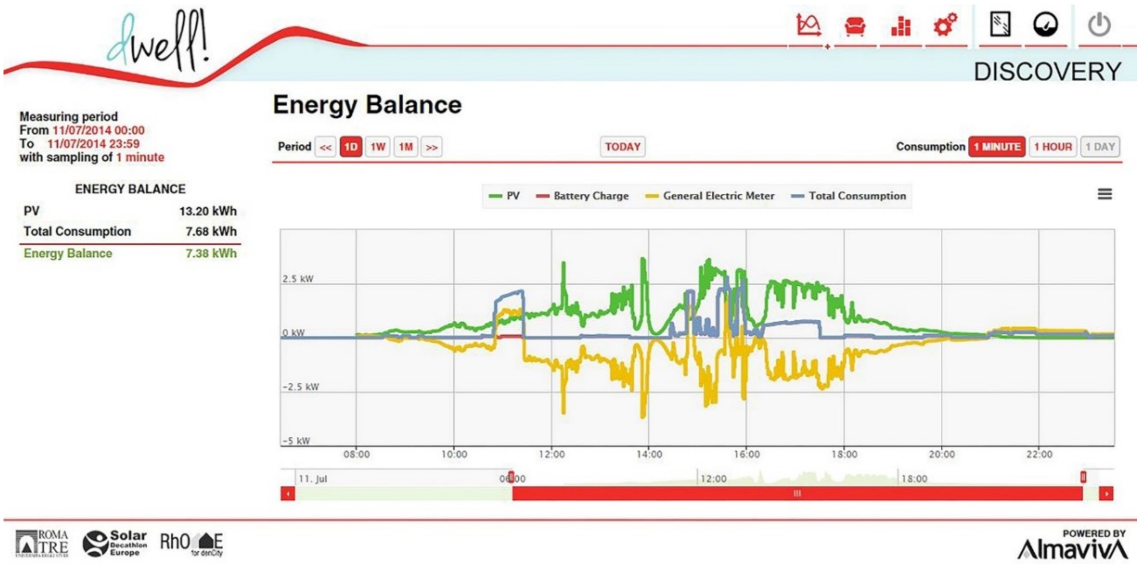

Figure 7. Dwell! discovery: energy balance graph

Moreover, the research group is now engaged in *SoS - Sustainability of Schools. Definizione di tecnologie, metodologie e protocolli d'uso per salubrità, benessere e risparmio energetico nei luoghi di formazione* (SoS - Sustainability of Schools. Definition of technologies, methodologies and protocols of use for health, well-being and energy saving in training places), published in Extraordinary research development plan, Action 4, for experimental funding action for innovative and interdisciplinary research projects, and financed with 64,000 euros.

The aim of this ongoing research is to investigate and upgrade the method explained also in public buildings, especially in schools, creating models of energy efficiency prediction, considering also risk factors for human health, such as the presence of mold, bacteria, ionizing radiation and electromagnetic fields and drafting a protocol of use to promote models of behavior aware of the citizens of tomorrow.

3. Conclusions on future advancement of research

In conclusion, the future advancement of the research, interesting to improve UI GreenMetric World University Rankings parameters, is to face also the emergence of devices and sensors, increasingly embedded into buildings, that provide dynamic information on its behavior: comfort conditions, healthiness parameters, energy usage but also user interaction.

In this perspective, the Solar Decathlon Competition give good lessons [6], to be considered as well for UI GreenMetric World University Rankings. In Solar Decathlon users are deeply involved in simulating during the competition the normal life trough house functioning tasks, in order to assess the real use of the produced solar energy. All these data are taken in real time, and published online allowing them to be compared defining who performs better. Moreover, this system will have the possibility to include in energy strategy also a great variety of bioclimatic devices overtaking the separation between active and passive behavior in order to maximize energy efficiency with active user participation. Finally, it will be really important to consider, in a so-called *Smart Building* also the indoor air quality and risk factors for human health as mold, bacteria, electromagnetic fields, ionizing radiation.

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The 5th International Workshop on UI GreenMetric
University College Cork, Cork, Ireland, 14-16 April

Interdisciplinary Sustainable Architecture

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Abstract. This poster reports the results obtained on the 2018 'Interdisciplinary Sustainability Architecture Laboratory' ('ISAlab') workshop, which took place over a week at Universitat Politècnica de València. The workshop drew together for the second successive year, students and faculty from a range of disciplines from across engineering and science, law and the social sciences and from a range of countries and backgrounds, including North and South America, Europe and Asia. It also facilitated a rich co-creative learning environment as it was led by (engineering) academic faculty from across Europe (Spain, UK and Ireland) as well as North America (US and Canada), as well as local experts who helped provide participants with appropriate context and guidance.

The faculty members guiding the process did not have a clear idea of the workshop structure or format for the week ahead, except for having produced a bespoke presentation based on their own backgrounds and expertise. Nevertheless (or perhaps because of these contextual circumstances), the resultant contingency, allied to a highly motivated group of faculty, students and local experts actually led to a highly creative and productive week of co-created learning opportunities and ultimately inspiring emergent proposals for which will allow a future academic initiative.

Keywords: Multidisciplinary, PBL, urban sustainability

1. Introduction

The indispensable need for bridges between the different disciplines is attested to by the emergence of pluridisciplinarity and interdisciplinarity around the middle of the twentieth century. Pluridisciplinarity concerns studying a research topic not in only one discipline but in several at the same time. For example, a painting by Giotto can be studied not only within art history but within history of religions, European history, and geometry. The topic in question will ultimately be enriched by blending the perspectives of several disciplines. Moreover, our understanding of the topic in terms of its own discipline is deepened by a fertile multidisciplinary approach. Multidisciplinarity brings a plus to the discipline in question (the history of art or philosophy in our examples), but this "plus" is always in the exclusive service of the home discipline. In other words, the multidisciplinary approach overflows disciplinary boundaries while its goal remains limited to the framework of disciplinary research.

Interdisciplinarity has a different goal from multidisciplinarity. It concerns the transfer of methods from one discipline to another. One can distinguish three degrees of interdisciplinarity: (a) degree of application (for example, when the methods of nuclear physics are transferred to medicine, this leads to the appearance of new treatments for cancer); (b) an epistemological degree (for example, transferring methods of formal logic to the area of general law generates some interesting analyses of the epistemology of law); (c) a degree of the generation of new disciplines (for example, when methods from mathematics were transferred to physics, mathematical physics was generated, and when they were transferred to meteorological phenomena or stock market processes they generated chaos theory). Like pluridisciplinarity, interdisciplinarity overflows the disciplines but its goal still remains within the framework of disciplinary research. It is through the third degree that interdisciplinarity contributes to the disciplinary big bang [1].

In most instances, higher education pedagogy tends to focus on transmitting disciplinary knowledge and learning. Disciplinary knowledge is substantive knowledge accrued by a discipline. Substantive knowledge comprises both: (a) complex concepts that are essential to understanding a subject; and (b) second order concepts that underlie the practice of making sense of the substance of the discipline. Using the history discipline as an example, complex concepts include monarchy, constitutions and slavery. Second order concepts would include cause and consequence, change and continuity, empathy, the nature of historical accounts and evidence, and what counts as significant in history [2]

Sustainability issues are widely recognized as wicked problems [3], which should not be considered as problems to be solved, but as conditions to be governed [4]. There is a general agreement on the need to reform scientific expertise to deal with sustainability challenges, by developing new ways of knowledge production and decision-making. In that sense, Sterling [5] maintains that the nature of sustainability requires a fundamental change of epistemology and education.

The delivery format for the implementation of these principles is Project Based Learning (PBL) widely recognized as an emerging pedagogical asset for engineering education [6].

The workshop highlights the sustainability competences, that engineering students should achieve. Given the challenges of sustainable development and the need for policy and behavioral change, Rowe [7] and others argue that universities need to reconsider the competencies students are expected to acquire. The emphasis needs to shift from descriptive-analytical knowledge, logical reasoning, and critical thinking alone to the inclusion of normative competence and effective change-agent skills. This implies a re-emphasis on the role of universities in not only educating academics and professionals, but in educating responsible citizens and decision makers. And even the profile of academics needs to get revisited and revised. For moving forward to a sustainable world, Martens and Rotmans [8] argue that it is time for many (more) scientists to become 'scientivists' (scientists-activists): individuals and groups that are engaged in systematic knowledge acquisition and generation (the scientist part), as well as in promoting and directing societal change (the activist part). See Box 29.1 on the roles of sustainability experts (academics and professionals).

2. Approach/Experimental

Under the previous concepts 6 Universities (Cambridge, UBC, Cork, Carnegie-Mellon, TU Delft and UPV) delivered a 5-day workshop (2017 and a second edition in 2018) including morning lectures and evening work around a selected (real) project. Faculty from all Universities delivered the lectures and supervised the students (20+26) organized on project teams from different programs, nationalities and backgrounds. The basic design was to organize students onto teams dealing with real projects related to Urban Sustainability.

The main parameters handled for the program design were:

1) The Design Challenge(s): Selected projects which required a base analysis for their development and connected to relevant stakeholders including their participation on the program development and evaluation.
2) Staff interests: Developing teaching skills/process in multi-disciplinary real-world project environment, working with colleagues and engineers from different perspectives. Developing an inspirational and sustainable platform for multi-disciplinary training.
3) Stakeholders: Defining requirements and providing necessary information. Previous participative processes have resulted in low levels of engagement and perception of poor choices.
4) Students interests: Gain insights from international academics from different disciplines, experience problem solving with multi-national multi-disciplinary colleagues, working on real world problems to develop solutions which have the potential to make a difference and provide a stretching but satisfying intellectual and practical experience during the week.

Considerations for sustainable value capture:

1) How to deliver value to the customers so they provide projects, data and support (financial or otherwise) in the future.
2) How to give students a good self-contained experience.
3) How can Masters projects be cultivated for future students, this could reinforce / add value to the customers and encourage academic involvement (i.e. through well scoped industrially relevant project with good links and data availability).
4) How can we keep academics coming back and attract new academics to the group?

Key Outputs

- Stakeholders:
  - A possible process framework for organising multiple stakeholder perspectives and planning and making decisions around complex projects or projects.
  - An outline proposal (built by passing the available data through the proposed process).

- A recommendation for projects/activities to address key uncertainties identified during the course of the workshop.
- On the long run new collaborative opportunities for applied research.

- Students:
  - Reflective learning log.
  - Resource pack/reference list of presentations/key ideas.
- Staff:
  - Experience new teaching methodologies.
  - Satisfied students (motivation).
  - Future ideas/opportunities for projects, and funding.
  - Academic collaboration.

Apart from some project descriptions (see Table 1), and a requirement for each of the faculty to bring with them a presentation on an agreed area of their own personal expertise which would help guide the students over the course of the week (to be delivered on consecutive mornings), the structure of the week was largely left open and was not predetermined. It was largely up to the faculty team to help develop and create the program 'on the run'.

The impending task of improvisation appeared both daunting and exhilarating, though mainly the former! While the largely blank sheet presented to us facilitated a lot of creativity, it also necessitated a high degree of cohesion and at times negotiated consent, and a willingness to be receptive to, incorporate and build upon differing perspectives and ideas.

Table 1. 2017-2018 Projects on ISAlab

Title	Stakeholder	Description
Tabarca	Alicante Port	Developing a carbon neutral island
NBSs for Benicalap	Valencia	NBS solutions against heat island and water saving
nZEB park refurbishment	Meliana	Carbon neutral parks
Albufera	Valencia	Waste water treatment with NBSs
Alboraya orchards	Polo	Sustainable tourism
Escuelas de Artesanos	EEAA	nZEB building
Sustainable fallas	Artists	Sustainable tourism
Via Augusta	Regional Gov.	Sustainable tourism
Vietnam best practices	Vietnam	UN sustainability goals
Matchup	Valencia	Sustainable neighbourhood engineering

Figure 1. ISAlab team 2018

3. Results and Discussion

Following on from the jazz metaphor - the output of jazz is spontaneous music, so what music did our groups make? Right up to the final day, the faculty guiding the workshop were never quite sure how this might play out in terms of ultimate output and presentations. Would there be evidence that the group had become more than the sum of their (disciplinary and individual) parts? Different teams might work with the same project and obtain very different solutions.

Those fears proved wholly unfounded, with each group presenting a distinct take on the problem and a unique approach to telling their story. Whether developing a systems map to understand and illustrate the different dynamics which influenced the problem or drawing inspiration from the lectures to frame the problem in terms of green infrastructure at multiple scales - the presentations used a range of themes and techniques to organize their individual and collective contributions.

There was some evidence of students disciplinary background in the presentations and a technical underpinning to some of the proposed concepts (the projects of course needed to be feasible, cost-effective and safe!). However, there was also evidence that they had stepped beyond their own (chiefly technical) disciplines as a group to come up with a more holistic approach, benefiting from building on each other's ideas and strengths to address multiple dimensions of performance in an integrated way.

4. Summary/ Concluding Remarks

After the ISAlab workshop experience the main conclusions have been: (1) Interdisciplinary project teams based on real projects allow an excellent development of transversal and sustainability competences; (2) The workshop serves as the basis for multi-University academic collaboration developing new educational approaches; and (3) Stakeholder involvement adds an inspirational dimension to students, as well as funding, opening new collaboration channels. These results have been obtained with support from the Erasmus+ KA2 program.

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Challenges and Opportunities for a Sustainable University in the Green Region of Europe*:* The case of "G. d'Annunzio" University

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Abstract. The "G. d'Annunzio" University is located in "Green Region of Europe" (Abruzzo) with over one-third of its area covered by National Parks and Protected Areas. In addition to the natural setting, the area is strongly contaminated by history, religion, and culture features, as demonstrated by numerous monuments, museums, castles, archaeological excavations, churches, millenary monasteries including some of the most beautiful Italian villages. In order to promote the Sustainable Development Goals (SDGs) and contribute to their achievement, the University of Studies "G. d'Annunzio" approved, in June 2018, the membership of the Network of Universities for Sustainable Development (RUS). This network was promoted by the association of Italian state and non-state universities (CRUI) in 2015 as the first experience of coordination and sharing among all the Italian universities involved in environmental sustainability and social responsibility issues. To strengthen the recognition and value of Principles of Sustainability and to encourage the development of collaboration between the whole university and its local community the "G. d'Annunzio" University is currently building a new green metric framework capable of spreading the culture of green sustainability practices. The paper describes the initial process of involvement of internal and external stakeholders at different levels from a contingency perspective.

Keywords: Abruzzo region, green sustainability, G. d'Annunzio" University, RUS

1. Background and Literature Review

The concept of sustainability appeared firstly in 1987 by Brundtland Commission report for finding a path to challenge the tradeoff between dealing with a scarcity of natural resources in parallel with emphasizes the harmful consequences of environmental degradation (Kuhlman & Farrington, 2010). The World Commission on Environment and Development firstly identified the definition of sustainable development and considered it as a development that meets the importance of the present without negotiating the ability of future generations to meet their own needs (WCED, 1987, p. 41). Moreover, Porras (2009) posits that sustainability is to practice economic activity while promoting environmental management. Salonen & Åhlberg (2011) contend that sustainable development is a holistic and systemic phenomenon.

Similarly, the Regional Council of Abruzzo[6] states that a sustainable business is any manufacturing firm which operates in at least one of the following three sustainability dimensions: environmental (maintaining of resource supplies and waste receiver), economical (make a constant increase of economic indicators) and social (assure safety, health, education, and equality). This definition is a comprehensive approach as it contains the three sustainability poles which stem from the Triple Bottom Line framework (Elkington 1998): preservation of the environment, economic performance, social cohesion (Lukman & Glavič, 2006), this model can be used also for the universities concerning with the sustainable development (Lukman, Krajnc & Glavič, 2010).

A recent study (Dagiliūtė, Liobikienė and Minelgaitė, 2018) indicated universities' contribution to sustainability admittedly plays a pivotal role for each dimension (economy, society, and the environmental development) considering their prominent participation in the process of the evolution of human cognition, research, innovation and entrepreneurship and the undertaking of the social progress (Dabija et al. 2017), radically adjusting our way of living and working (Bowers, 1997).

This leads to the concept of sustainable higher education institutions (SHEIs), Velazquez (2006, p. 3) defines the sustainable university as "HEI that addresses, involves and promotes, on a regional or a global level, the minimization of negative environmental, economic, societal, and health effects impacts of using the resources

[6] " http://www.abruzzolavoro.eu/wp-content/uploads/2016/07/A5_CartadiPescara_EN.pdf"

in order to fulfil the function of teaching, research, outreach and partnership, and stewardship in ways to help society make the transition to sustainable lifestyles”.
However, the integration of sustainability principles into universities’ whole daily activity is one of the main challenge that a university faces (De Castro & Chiappetta, 2013; Too & Bajracharya, 2015). Many universities have comprehended their environmental effect and bear their social responsibilities applying these fundamental principles on their everyday activities (performance) and organizational structure (Lukman & Glavič, 2006). Moreover, it extends to a wide range of stakeholders. These principles have to be integrated into the educational process of research, teaching, learning methods (Lukman & Glavič, 2006) and operate the facility and build the infrastructure (Yuan et al., 2013).

Moving towards, more sustainable universities will need wide system change, for instance, encompassing stakeholders, practices, and policies, thus requiring more effort and flexibility from managers and the all the people responsible for advanced education for having a successful and sustainable development (Orr, 2004; Cortese, 2003). Besides, the transition to sustainability entails a change in behaviour (Salonen & Åhlberg, 2011). Thus, universities sustainability deems as a conversion phrase toward organizational culture which entrenches the principles of sustainable development (Adams et al., 2018).

Coming more specifically to the Italian context, according to Vagnoni and Cavicchi (2015), being most universities public, sustainability apparently challenges financial limitations and economic pressure because of the reforms which have been involving the whole sector. These reforms began initially with Bologna Declaration (Declaration B., 1999), which implied ten objectives which European higher education has to undertake within a framework and considers the variation in values, languages, domestic education system and the independence of the university to have a consolidated higher education in the EU Area. These objectives involve the adaptation of a comprehensible and equivalent degrees system based on two phases: undergraduate (not less than three years) and postgraduate (Master and/or Doctorate degree), set a system of credits (ECTS system), facilities students mobility (free movement and training) and for professors, researchers and administrations (value the time spent in Europe for the academic context), enhance of European collaboration in quality assurance, European extents required in higher education, for instance, the development of curricular, cooperation between institutions, mobility and incorporated programs of study, training, and research (Lukman & Glavič, 2006).

Currently, Green business models are promising in comparison with the traditional one regarding its relationship with the performance (Abuzeinab & Arif, 2014), notwithstanding green sustainability practice, in Italian universities, lack in the scientific literature. Vagnoni and Cavicchi (2015) reveal that Italian universities undertake the constant research besides their responsibility towards the stakeholder involvement in the sustainable development process but have to confront sustainability challenges by proper tools in order to make positive feedback to the society. Since stakeholder engagement in this implementation process is a key driver that helps organizations in promoting sustainable development goals (Koc H., 2014; Abuzeinab & Arif, 2014). The main purpose of that engagement is to develop a sustainable relationship between internal and external stakeholders (Chinyio & Akintoye, 2008),

Considering that Abruzzo is the “greenest region” in Europe, in terms of the presence of national parks and other protected areas within its territory, here stem, for a University located in Abruzzo Region, the necessity and the responsibility to achieve an advanced position in the annual UI GreenMetric World University Rankings (Team U.G., 2016), which shows the range to which a university is ‘green’ and it is the role model for others universities regarding sustainable society. UIGM has six criteria considered as significant to evaluate and rank universities involved with the sustainability process: “Setting and Infrastructure”, “Energy and Climate Change”, “Waste”, “Water”, “Transportation” and “Education and Research”.

The importance of UIGM arises from its role in determining the level of universities’ sustainability, which is reflected on the stakeholders by an elevated level of satisfaction and better life quality, in contrast of non-green universities (Tiyarattanachai & Hollmann, 2016). Thus, each university can access its strength and also its weakness regarding green sustainability practices (Suwartha & Sari, 2013).

Considering the different above reported aspects, it is consequently clear why "G. d'Annunzio" University is currently building its green metric framework in the pursuit of imparting the knowledge and to disseminate the culture of green sustainability practices through the educational process taking into account the six categories of the environmental performance indicator in the construction and implementation phase.

- The question that then naturally arises is: what are the factors and drivers which can hinder the new green process or catalyze the whole framework building in the application process?
- A further question is: what is the role that stakeholders (internal and external) can play in the adoption of green sustainability practices in the university?

2. The Case of G. d'Annunzio University

The university Gabriele d'Annunzio (Ud'A) of Chieti-Pescara it is situated in Abruzzo region, which, as described above, it is also called the "Green Region of Europe" because more than one third of its surface is constituted by 3 national parks, one regional park and 38 protected areas among oasis, regional and government reserves.

Some decades ago, Abruzzo was the only region in Italy in which wolves, chamois, the native Marsican bear, as well as eagles and lynxes were still alive, and this permitted to repopulate other Italian territories in which – because of human intervention against the natural ecosystem together with a barbarian hunting – these native wild animals had disappeared. Abruzzo is also the territory with the most elevated number of medicinal plants in Italy. In synthesis, it is a great example of biodiversity and preservation of territories and wild native animals.

The region also presents other important records: it is one of the most ancient populated Italian regions, being inhabited since the Paleolithic period. In this region was firstly coined the term Italy, having in Corfinio, nearly a century BC, the first capital of the association of the preexisting populations of Centre and South Italy which were conflicting against the growing Ancient Rome. In synthesis, in addition to the natural frame structure, one can enjoy a land rich in history, religion, and culture. This is demonstrated by the numerous monuments, castles, archaeological excavations, churches and millenary monasteries scattered in every corner of the region that counts as 20 towns belonging to the Club of the most beautiful medieval boroughs in Italy.

But it is not only the historical and natural scenario. Abruzzo has also ski and seaside tourism since it has 17 ski resorts and 130 km of coastline partly interspersed with the Trabocchi Coast, as an ancient fishing machine and one of the identifying aspects of Abruzzo. Recently the coast of the trabocchi has been transformed into Greenway, a pedestrian cycle track among the most attractive and fascinating in Europe. It is a place of recognizable sheep tracks even nowadays and presents a gastronomic tradition among the best known and appreciated even outside the Italian context and artistic craftsmanship with great value. The enhancement and exploitation of the territory and its natural, historical, artistic assets are also favored by an adequate infrastructural situation, which can count on the presence of an airport, railway stations distributed in the territory and a network of roads and highways distributed in connecting form that allows easy movements inside the region, both on a national and non-national level.

The Ud'A was established in 1965 as "independent University" then it became a public state university in 1982. Today it is one of the great universities of Italy with 27 thousand students. It offers 55-degree courses relating to thirteen departments, 2 Schools all situated in 2 University Campuses: one in Chieti, the statutory seat of the university containing the central administrative offices, including the rectorate and general directorate, and another in Pescara. At the end of 2017, the campuses covered an area of over 200,000 square meters. If we also consider other locations within the two campuses, the surface exceeds 220,000 square meters with an area covered with planted vegetation of about 100,000 square meters. Inside the main campus, there is also the presence of a life and nature training path inaugurated in 1999, with a layout of one thousand four hundred meters in length and about three in width, which draws a landscape through oak groves, within the university campus area of Chieti Scalo.

The Life and Nature Path was built with the precise objective of increasing the spaces intended for livability to meet students' needs. University staff and citizens who wish to perform physical activities and exercises at various levels, or those who just like to do a walk outdoor, without traffic and noise pollution can use the route which has no particular difficulties and is well equipped with resorts, with wooden gymnastic equipment and special signs with the instructions for performing the exercises. The Life and Nature Path/ healthcare and nature tour represent, in a symbolic way, the journey of life.

Inside the Chieti Scalo campus, there is also the "Giardino dei Semplici" (the garden of simple people), a garden dedicated to teaching and disseminating scientific knowledge but also a space with a high aesthetic, environmental and ecological impact, which enhances the university structure and the urban center where the campus is located. The Giardino dei Semplici contains over 400 types of herbs and woody plants related to traditional medicine and still used today in the pharmaceutical, cosmetic or industrial sectors.

The measure by which the plants are grouped in the different flowerbeds is based on their properties and the use that derives from them. It includes native, exotic plants and also plants that are at risk of extinction, which is collected and stored according to the principle of protection of plant biodiversity.

In 2017 the Ud'A had a change of governance after the election of a new Rector. Indeed, soon after the election, it was immediately evident that now Ud'A challenge is to deploy a holistic and systemic approach to sustainability. The new governance instantly understood the need to integrate a sustainability perspective into University's activities, realizing that the main factor that hindered a full "application" of sustainability was a "short-sighted" vision, besides managerial and organizational inertia on sustainability. In 2018, Ud'A became a member of the Network of Universities for Sustainable Development (RUS). This network was promoted by the association of Italian state and non-state universities (CRUI) in 2015 as the first experience of coordination and sharing among all the Italian universities involved in environmental sustainability and social responsibility issues.

The main purposes of the RUS are:

1) spread the culture and best practices about sustainability, both inside and outside the university, sharing skills and experiences, in order to increase the positive impacts of the actions implemented by each individual university;
2) promote the Sustainable Development Goals (SDGs) of the Agenda 2030 and contribute to their achievement;
3) Strengthening the recognition and the value of Italian experience at an international level.

The RUS arises itself also as a best practice to be extended also to other bodies of the public administration, of the education and the in the regional territory at large, encouraging the development of collaboration between universities and cities, spreading social innovation in the area and providing cultural stimulation for the whole country system. Within RUS, specific working groups have been created on issues of particular relevance aiming at the launching and promotion of best practices.

From the operational point of view, after joining the RUS, Ud'A has appointed its own representatives in the working groups on waste, energy and climate change, mobility, education, and food. Ud'A working groups already started to identify the relevant representatives on gender and safety and health issues that are not yet formalized within the RUS but considered very important within Ud'A.

All working groups meet regularly as the various representatives consider it appropriate and useful to match and share the initiatives to be implemented, whenever and wherever it is possible.

Beyond first symbolic initiatives on sustainability such as participation, through an initiative, the European waste week, SERR 2018 *(The European Week for Waste Reduction),* which involved about 140 people including undergraduate students, PhD students and university staff, to participate in the initiative CACCIA AT KWH (I will use less light) aimed at making staff and students aware about the importance of the reduction of energy consumption, the RUS-Ud'A group is conducting actions to "reconstruct" the situation concerning the aspects of energy, mobility, waste and education and training of the Ud'A in order also to provide items and information to the administration to develop a course of actions leading towards sustainability.

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Innovative Educational Technologies for the Education on Sustainability and Environmental Safety: Experience of RUDN-University

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Abstract. Modern education on sustainability and environment protection needs to reflect not only the current state of the global sustainability policy and main environmental challenges. It is necessary to apply the most efficient tendencies in the knowledge exchange and to use the best available techniques and technologies for the distribution of new educational programs. Presented article shows some best practices of educational technologies developed in the RUDN University. Virtual training technologies has been applied for the development of the training complex for the preparation of specialists on HSE-management (management in sphere of occupational health and safety, environmental and industrial safety) in oil and gas industry. The virtual training complex allows to "immerse" into the modelled situation in the professional environment and to take part on decision making for the most efficient elimination of modelled accident. The massive open online courses (6 programs on environmental issues) are a part of a new initiative of the RUDN University allowing to distribute our best educational practices for most wide number of students. And the project approach (development of the project on environmental monitoring of the RUDN) allowed us to involve the students of different specialties into the environmental initiatives and research.

Keywords: Education for the sustainability, environmental education, MOOC, RUDN-University, virtual training complex

1. Introduction

Currently it is possible to find some special courses or educational programs on sustainability and environmental protection virtually in the universities in all parts of the world. The education for the sustainable development counts now about 70 years history and develops rapidly and intensive. Together with the development of the content, the forms are to be developed. We find now different examples of the new educational technologies that make the educational programs more efficient. In the present article we would like to show some examples of the educational technologies we use in the Peoples' Friendship University of Russia (RUDN-University). Here, the courses and programs (first on environmental protection, now on sustainability in general) has been developed and tested more than 30 years. Even the Ecological faculty (one of the first in Russia) was created immediately after the Rio Summit in 1992.

We speak about application of the innovative educational technologies for different levels of education: these are bachelor courses and programs, Master programs, PhD-doctoral programs and LLL-courses. For each direction and educational level there are various programs that need to meet requirements of actuality of the content, but also need to be as much efficient as possible. The condition of an efficiency can be guaranteed with application of the special education technologies and forms of the involvement of students, with the transition to the concept "from teaching to learning" in the university and with the suggestion of a variety of forms of educational programs.

2. Virtual Training Technologies

Virtual training technologies has been applied for the development of the training complex for the preparation of specialists on HSE-management (management in sphere of occupational health and safety, environmental and industrial safety) in oil and gas industry [1]. The virtual training complex allows to "immerse" into the modelled situation in the professional environment and to take part on decision making for the most efficient elimination of modelled accident. This project started in the University in 2007, with winning in the competition of the oil company "TNK-BP". The company made a great contribution into the creation of a master program on HSE issues (not only financing but also the informational support). To develop the program, we used an experience of the leading universities of the industrial countries where the similar programs were presented.

And the most interesting and specific part of a master program is a virtual training complex on environmental safety in oil and gas complex. In the center of the complex is a model of the main pipeline accident. To begin the work with a simulator, the student needs to study a "textbook" (a part of the training complex) and to pass the exam. After that it will be possible to make a model of the pipeline (to select all the necessary characteristics of the pipeline and surrounding territory) and after that, receiving the data on the level of the accident (from local to the transboundary) the student will become an operator on the oil spill response.

It is to be noted, that all the activities of a "virtual operator" are absolutely independent; the role of the teacher is only to check the initial data and to correct the results of calculations for oil spill response measures. Thus, the student applies his knowledge and practical competences in the praxis and use them most efficient. So, according to the "learning pyramid" (i.e. presented in [2]), the immediately application of knowledge allows to absorb up to 90% of the information (in comparison with the traditional lectures with no more than 10%). The main components of the virtual simulator are presented in the Fig. 1.

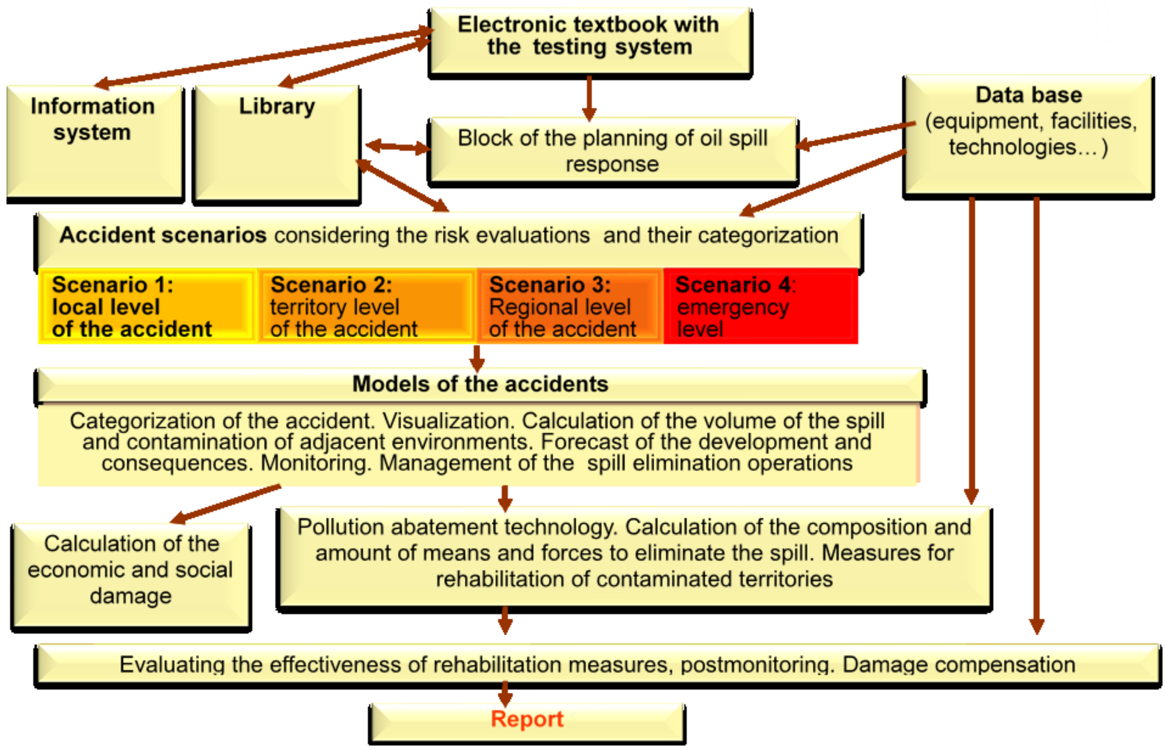


Figure 1. Architecture of the virtual training complex on th environmental safety

During the 12 years after the start of a project, some decades of students specializing in the environmental safety in oil and gas industry prepared their qualification works using the simulator. The approach showed really a very high efficiency as a teaching instrument and as a measure for motivation of the students. The study itself occurs as a game, but playing the student immerse into the accidental situation; it is necessary to make decisions in the short time, to suggest the best ways for the elimination of the accidental spills. In our opinion such approach is really efficient and needs to be developed for another directions of the environmental safety programs.

3. Massive Open Online Courses

The massive open online courses are a part of a new initiative of the RUDN-University allowing to distribute our best educational practices for most wide number of students. The start of this project is due to the new state program on the maintenance of the Russian universities named 5-100. Currently, there are 2 ready MOOCS on sustainability and 4 "under construction" (will start in autumn 2019). The running courses has about 200 followers now:

- Environmental standards and norms for the sustainability [3];
- Surface Water Pollution: Control and Modeling.

The new 4 courses are devoted to the issues of the sustainable energy management, HSE-management, waste recycling and climate modeling.

Use of the MOOCs allows the students to take part in the educational programs of different universities and independent teachers. In our case, all the courses are developed as free; the results are accepted as a part of a relevant educational program. The MOOCs are not obligatory, but they are really popular: more than 30 bachelor and master students decided to attend absolutely voluntarily despite some initial difficulties by some of them (necessity to improve English). We consider the MOOCs not only as a comfortable form of educational programs. Even for the teachers it is a good opportunity for the experience transfer.

4. Project Approach

In general, the project approach is a wide used form of teaching and learning. In our case, this educational model has been applied for the project on environmental monitoring of the RUDN University campus. Due to its multidisciplinary character, the environmental monitoring project allows to involve the students into the different processes, from use of the easiest environmental control techniques and methodologies to the unique environmental analyses, data processing and decision making on the optimization of the environmental monitoring network.

Thus, since the start of the project in 2016, few hundreds of measurements of air, soil and snow quality, radiation and noise levels, state of the green plants was carried out (Fig. 2 presents the monitoring points). The campus area is situated in the relative comfortable zone: in this part of the Moscow city there are not any significant industrial pollution sources. But the traffic is really very intensive, and practically all the territory is under this pressure.

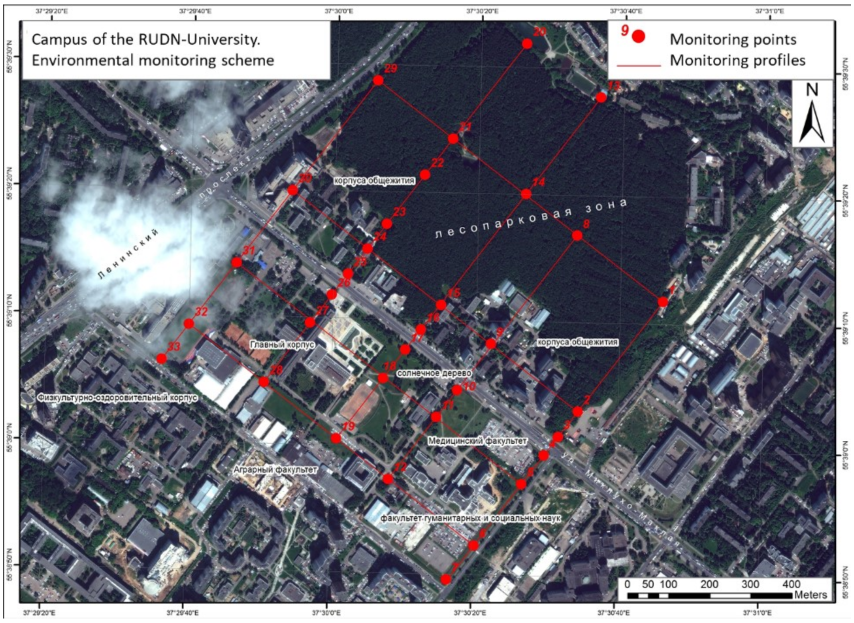


Figure 2. Environmental monitoring net of the RUDN campus

Under these conditions it is possible to consider the campus territory as a specific "living laboratory", where all the technogenic influences are to be fixed and estimated. It is possible to apply the wide used methodologies of the environmental assessments and to understand their accuracy, to visualize the results (Fig. 3) and to model the consequences of the pollution (Fig. 4).

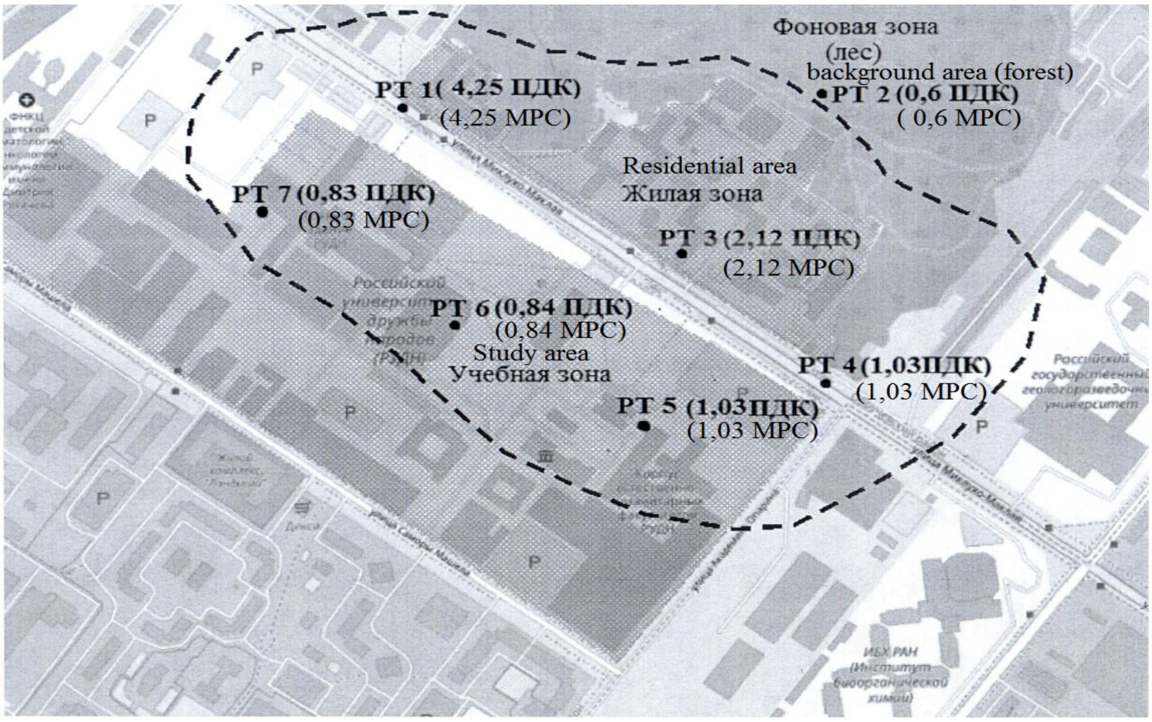
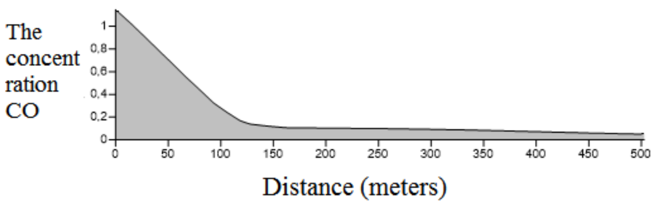


Figure 3. Map of dispersion of NO_2 concentration on the transport pressured and background areas



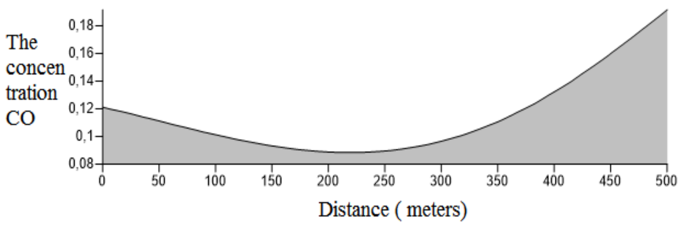


Figure 4. Change in the concentration of carbon monoxide from Leninsky Prospekt to the park area and from Miklukho-Maklay street through the business and social-active zone of the main building

Thus, as shown on the Fig. 3 and 4, the effects of the traffic load are felt at a distance of more than 500 metres, and the nature of the effects can be complex due to the mutual influence of several sources and the shielding effect of residential development, as well as the protective role of green spaces.

The example of the above models successfully demonstrates how the environmental load is formed in the city. A detailed study of the state of all components of the campus ecosystem allows you to optimize the monitoring structure: the location of control points, the scheme of measurements. However, the decision on this should be offered by the project participant himself, based on the material received and processed by him together with the group.

Another part of the project is the application of the UI GreenMetric methodology to the campus conditions [4]. Some of the indicators obtained in the course of monitoring are closely related to the characteristics that are taken into account when ranking universities. In particular, it is the carbon footprint and vegetation characteristics. Therefore, a group of students is also currently engaged in carbon footprint modeling: the contributions of campus ecosystem components and anthropogenic objects to the total carbon footprint are assessed.

All the listed activities are included into the realization of the monitoring project. Currently, more than 10 students prepare their bachelor and master works obtaining and processing these data. Some of these works was nominated as the best in the student research work competitions. Some best results are included into the new textbook for the universities "Environmental monitoring" (Khaustov & Redina, 2019).

5. Concluding Remarks

The above shown examples of the innovative educational approaches are only a part of the educational programs on sustainability in the RUDN University. Currently the RUDN offers educational programs on various issues of the sustainability, not only on environmental protection and sustainable resources consumption. These are also economical, law, humanitarian courses. But each of them is devotes to the achievement of the sustainable development goals.

Modern educational programs must response very rapidly on the changes and challenges in the sustainability policy, occurring of new technologies, new scientific results and sustainability management approaches. This requires applying also the modern teaching and learning methodologies, must efficient for the knowledge "absorption".

Innovative educational technologies must meet vary conditions, including flexibility, efficient time management, and the main result of them is training of the specialist with good theoretical competences and practical skills. We plan to continue the development of the presented approaches that must help the students to receive the wide multidisciplinary theoretical knowledge and to get adapted to the professional environment.

Acknowledgement

The publication was financially supported by the Ministry of Education and Science of the Russian Federation (the Agreement number 02.a03.0008)

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Higher Education and Research in Sustainability: Actions of the University of Zanjan

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Absrtact. Education and research activities in sustainability have been considered as one of the main categories for assessing the contribution of higher education institutions in sustainable development in both the UI GreenMetrics World University Rankings and the Sustainable Development Goals. The purpose of this paper is to show the importance of this criteria and describe the activities of the University of Zanjan in this aspect. This criterion focuses on the ratio of sustainability courses towards total courses/subjects, the ratio of sustainability research funding towards total research funding, sustainability publications, sustainability events, sustainability student organizations, sustainability website, and sustainability report. The experience of the University of Zanjan shows the encouragement of students and staff towards sustainable approaches rather than conventional education and research in terms of focusing on sustainable contents in courses' syllabuses, student and staff activities through their associations, and orienting research projects, publications and investments toward sustainability. Linkage with local community, local, national and international organisations, and academic and research institutions worldwide for sustainable development is another step in this regard. A sustainable higher education institution is expected to have much more contribution in sustainability through innovation research and development; knowledge management and networking, enhancing staff and students' sustainability knowledge, establishing and enhancing social capacity and associations in universities, changing a campus to an eco-friendly environment, enhancing social and human capacities of local communities' advocacy and networking with public and private institutions to improve their knowledge and change policies towards sustainability.

1. Research and Education in Sustainability

Higher education institutions (HEIs) and research organisations at national and international levels have an important responsibility for interconnected and complex sustainability challenges. Their contribution in sustainable development can be through several mechanisms, such as innovation and technology research and development, enhancing staff and students' sustainability knowledge and social capacities, changing HEIs' environment to an eco-friendly and sustainable environment, and enhancing social and human capacities of rural and urban communities and public and private institutions [1, 2].

Since the start of discussions regarding environmental issues and sustainable development, HEIs have been expected to play important roles. According to the United Nations Academic Impact (UNAI), the critical role of academia in ensuring the well-being of mankind and the ideals was pursued by the United Nations since its founding in 1945 [3]. The 2030 Agenda for SDGs has also raised the necessity of the involvement of HEIs [4]. So universities have crucial role in achieving the Sustainable Development Goals (SDGs), serving as incubators of new ideas, inventions and solutions. They also raise awareness, educate and inform about the SDGs, on their campuses, in their communities and beyond. Based on this rationale, the UNAI has chosen 17 universities to be the Hubs for 17 SDGs for the 2030 Agenda for Sustainable Development, as part of the ongoing campaign on the SDGs carried out by the United Nations.

Education and research activities in sustainability have been considered as one of the main categories for assessing the contribution of higher education institutions in sustainable development in the UI GreenMetric World University Rankings [5]. The Times Higher Education World University Ranking has also recently initiated a ranking based on the SDGs.

Despite these international efforts, many higher education institutions still have a lack of policies, monitoring and reporting mechanisms for sustainability [6]. In addition to these policies, higher education institutions need formal and informal learning settings of new approaches of developing key competencies for sustainable development [7].

The purpose of this papers is to utilize the evidences of the University of Zanjan as a case for the involvement of HEIs and research in sustainability.

2. Methodology

The UI GreenMetric has assessed the contribution of universities and other higher education institutions in sustainability based on 12 measures as follows:

1. Number of courses/subjects related to sustainability offered at a university. Some universities have already tracked on how many courses/subjects available for this. The definition of the extent to which a course can be stated to be related to sustainability (environment, social, economic) or both, can be defined according to that university's situation. If a course/subject contributes in more than a minor or passing way to increasing awareness, knowledge, or action related to sustainability, then it counts. The number of courses/subjects can be counted by specifying related sustainability keywords used in the subjects. For example: environmental chemistry is the subjects for the study program of chemistry.
2. Total number of courses/subjects offered at a university yearly. This information will be used to calculate to what extend environment and sustainability education has been defined in your university teaching and learning.
3. The ratio of sustainability courses divided by total courses/subjects.
4. Total research funds dedicated to sustainability research (in US Dollars). This is the average funding for research on sustainability per annum over the last 3 years.
5. The average total research funds (in US Dollars) per annum over the last 3 years. This information will be used to calculate the percentage of environment and sustainability research funding to the overall research funding.
6. The ratio of sustainability research funding divided by total research funding.
7. Number of scholarly publications on sustainability published annually (the average number of indexed publications based on Google scholar) on environment and sustainability over the last 3 years.
8. Number of events related to sustainability (e.g. conferences, workshops, awareness raising, practical training, etc.) related to environment and sustainability hosted or organized by a university (average per annum over the last 3 years).
9. Number of student organizations related to sustainability (For example, a student association on green campus in the Faculty of Humanities can be considered as an organization).
10. Existence of a university-run sustainability website.
11. Sustainability website address if available
12. Existence of a published sustainability report

Other criteria based on the SDGs can also be utilised to assess the education, research and innovation activities of universities towards sustainable development. Involvement in facilitating the SDGs has been utilised by the University of Zanjan in this regard.

3. University of Zanjan's Sustainability

3.1. Setting and infrastructure

As a public university, the University of Zanjan was established as an agricultural higher education institute in a public granted land in a semiarid rural area 6 km away from the Zanjan City in 1975, which was gradually developed as a comprehensive university in five main faculties titled Agriculture, Engineering, Humanities, Science and Art and Architecture in its main campus, comprising 37 educational departments and a research institute with 4 research departments. It has almost 10000 students with 1000 academic and administrative staff. Its main campus is located in an area of 400 hectares, in the south west of the Zanjan City, the centre of the Zanjan Province, at the north west of Iran (with a distance of 330 km away from the capital city of Tehran. The university has also two research and education stations in the Abhar Township and the Tarom Township of the Zanjan Province.

The ZNU has obtained rank 50 among 719 universities worldwide. Following the sustainability policy of the university, this rank has been improved during the last 6 years (Fig. 1).

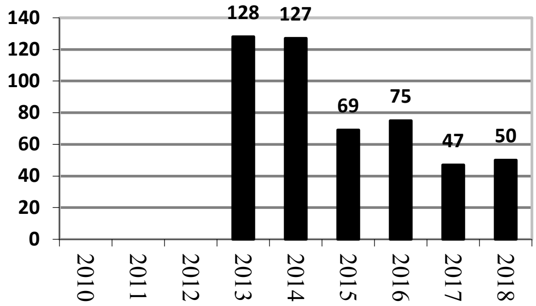

Figure 1. ZNU rank in the UI GreenMetric in 2013-1018

In 2018, the highest scores have been related to the indicators of water andwaset management, setting and infrastructure and education and research. The lowest criteria was related to energy and climate change management (Fig. 2 and 3).

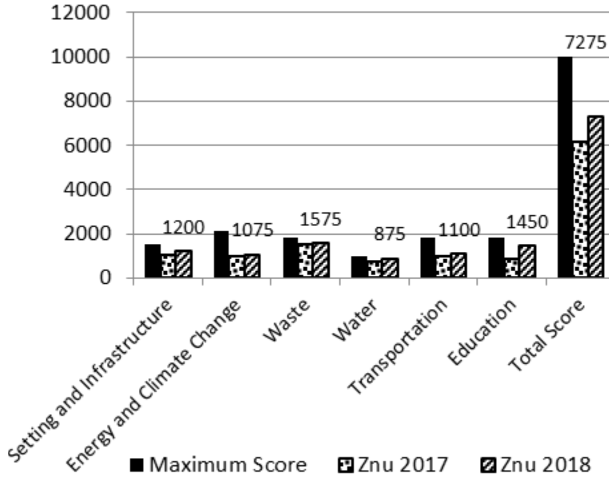

Figure 2. ZNU's indicator scores in the UI GreenMetric in 2017-1018 assessments

The maximum score that a university can obtain from education and research is 1,800 out of 10,000 total score of the UI GreenMetric. This criteria in the ZNU was 1,450 in 2018, which shows 80.56 percent of the maximum score.

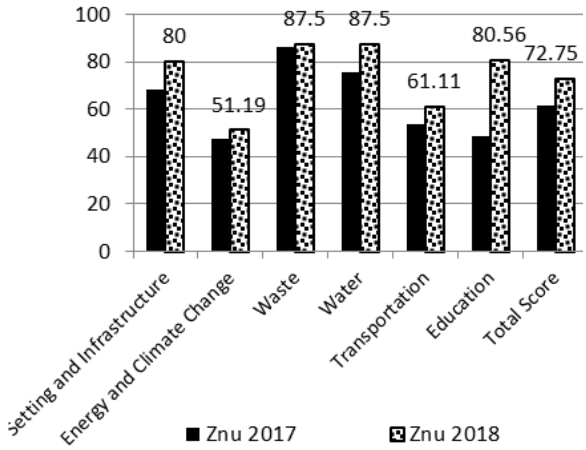

Figure 3. ZNU's percentage of highest scores in terms of the indicators of the UI GreenMetric in 2017-1018 assessments

3.2. Education

The University of Zanjan consists of five main faculties including Agriculture, Engineering, Science, Humanities and Art and Architecture. The enrolled students in the academic year of 2018-2019 have been over 10000 (65% Bachelor, 27% Master and 8% PhD) in 177 undergraduate and postgraduate programmes (23% Bachelor, 52% Master and 25% PhD) studying in 37 educational departments. Total number of courses offered by these departments in 2017 were totally 4,873 courses/modules. The courses with at least 10 percent of sustainability (socio-economic, societal or environmental aspects of sustainable development) contents were assessed to be 2,028 courses. This means the academic staff or curricula have considered sustainability in 41.6 percent of the university courses. The highest percentages are related to the departments of Environment, Agricultural Extension, Communication and Rural Development, Soil Sciences, Horticulture, Agronomy, Plant Protection, Water Engineering, Architecture, Animal Sciences, Food Sciences, Industrial Engineering, Geography, Mining, Biology Civil Engineering, Material and Economics, respectively.

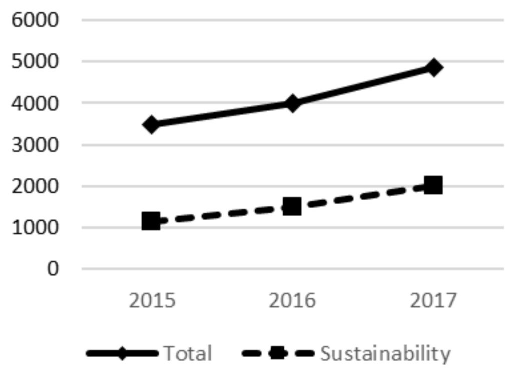

Figure 4. Total number courses and sustainability number of courses provided by the ZNU in 2015-2017

3.3. Equity in education

Most Iranian students do not pay any tuition fee for their education, but if they should, they get loans for their education. Almost 55 percent of the students are female. The university facilitates low cost and subsidised accommodation for all students inside the campus through student halls, located in separate areas for male and female students. These student halls have all the facilities required for student life, including IT services, reading rooms, gyms, restaurants, subsidised meals, mosques, and so on. Single foreign students with scholarship can use free-catered accommodation. The university also facilitates accommodation for other married and single foreign students without scholarship, through university private accommodation. The university provide free shuttle bus between the campus and the city and inside the campus for all students. All the staff and students are accepted to the university based on their qualification and through equal opportunities, regardless of gender, race, religion, nation, wealth, ethnic group and physical ability. Disable student are considered by the university health service and the Advisory Service Office provides consultation to all students.

3.4. Research

The ZNU published or produced 3,226 research records in 2017 in English or Persian, as the master and PhD theses, international journal papers, national journal papers, research projects, books, and conference/ congress/ workshop papers. According to the report of researchers and staff of this university, 2,062 out of these 3,226 records were related to sustainability, showing 63.9 percent of the research records. This percentage for books and national journal papers was higher than other records.

The research fund has increased from 2.5 million US$ in 2014 to 3.6 million US$ in 2017 and the research fund for sustainability has increased from 0.800 to 1.500 million US$. This shows a rise of 1.875 times in sustainability research fund between 2014 and 2017. Moreover, the proportion of sustainability research fund to total research fund has also been increased from 32 percent in 2014 to 41.7 percent in 2017. The average sustainability research fund for three years of 2015-2017 was calculated to be 1.086 million US$.

Table 1. Sustainability publications and research projects in the ZNU in 2017

Title	Total	Sustainability	%
Master and PhD Thesis	805	469	58.3
International Journal papers	433	186	43.0
National Journal papers	803	613	76.3
Research Projects	22	15	68.2
Books	16	16	100.0
International and national conference papers	1147	763	66.5
Total	3226	2062	63.9

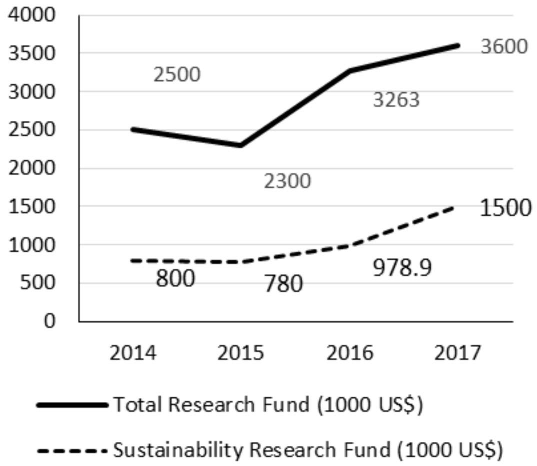

Figure 5. Total research fund and sustainability research fund allocated by the ZNU in 2014-2017

3.5. Events in the university

Over 50 events were organized annually through international and national conferences, workshops, meetings, campaigns, speeches, etc in 2015-2017. There are also 33 students' organizations in the university that participate in facilitating sustainable and environment activities. The events have focused on climate change, renewable energies, waste management, sustainable agriculture, water management, ethical issues in sustainability, etc. The first week of March every year, the Iranian celebrate natural resources management and environment week and one of the days is called "Tree Planting Day", in which the university calls its students and staff to participate in this event for plantation. Several workshops and meeting are also provided for the role of people in conserving natural resources and environment, particularly forests. This campaign has led to the significant increase of woodland area in the campus since its establishment, though it was originally covered by rangelands and croplands. Woodland and orchard areas inside the campus have increased from 0 ha in 1975 and 30 ha in 2010 to over 73 ha in 2018 (17.75 percent of the university area).

3.6. Extension and relation with society

The ZNU has started contributing in sustainable development activities and projects in local rural and urban communities, through meetings, workshops, campaigns, research and innovation projects, capacity building and empowerment projects, etc.

3.7. International contribution

The Znu has been the member of the United Nations Academic Impact (UNAI) since 2015. The UNAI is an initiative that aligns institutions of higher education with the United Nations in supporting and contributing to the realization of United Nations goals and mandates, including access to education, sustainability, conflict resolution, etc. The UNAI network is currently composed of over 1,300 universities and colleges, including 25 Iranian Universities, in some 140 Member States. The main task of this institution is connecting universities and colleges with the 2030 Agenda for Sustainable Development. In October 2018, 17 new SDG Hubs for 17 SDGs (one university as hub for each SDG) were selected from the UNAI members as exemplars for their innovative engagement related to the Sustainable Development Goals (SDGs). These institutions were designated for three-year renewable terms and will serve as resources for best practices for the UNAI network. The ZNU was also selected for its innovation, dynamism and commitment to educate future generations about sustainability as the Hub for SDG 15 by the UNAI. The SDG 15 (Life on Land) is to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. The targets and indicators of the SDG 15 are available in United Nations (2015).

The ZNU is also the national coordinator of the UI GreenMetrics in Iran, which has facilitated meetings at the nation for sustainable development. The ZNU is also one of the National Contacts for sustainable agriculture and food security subject in the Horizon 2020 Programme of the European Commission.

4. Conclusion

Universities, research institutes and other higher education institutions need to move and facilitate their education and research towards sustainability through changing curricula and programmes, research orientations and policies, publications and events. Universities can also play as a role model for other institutions and communities and can institutionalize the sustainability concept in these institutions and communities. The graduates and trained people through universities will be responsible and accountable staff and citizens to take care of their environment and society, if they learn sustainability in their courses.

The University of Zanjan has not only increased and improved its vegetation, energy, waste, transportation and water management, but it has encouraged students and academic staff to move their conventional education and research to more sustainable approaches. This sustainability perspective includes changing courses syllabuses and teaching, student association activities, research projects, publications, research investments and networking for SDGs. The university still have a challenge of innovation and technology development in sustainability. It is essential to work on enhancing staff and students' sustainability knowledge and their social capacities. It is also crucial to take advantage of facilitates and opportunities, such as being the hub of the SDG 15 to influence and enhance social and human capacities of rural and urban communities and public and private institutions to be more responsible to conserve environment and natural resources.

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Best practices towards a sustainable campus: Holy Spirit University of Kaslik, Lebanon case study

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Abstract. In countries like Lebanon, where governmental authorities lack proper actions, universities bear the same responsibility to confront the emergent challenges. This is particularly true when it comes to advancing sustainability and respecting the environment through research, education, and public service programs. Holy Spirit University of Kaslik (USEK) administration believes that education should emphasis about learning how to sustain our world for generations to come. In fact, being a Catholic institution, USEK's approach to sustainability acknowledges a respectful stewardship of the environment with the faithful care of God's creation. That's why, in winter 2016, and after the waste crisis in Lebanon, USEK has created a Green Committee who had been assigned the responsibility of developing a sustainable vision for our campus, in ensuring that sustainability will be well integrated into campus facilities, decision-making, learning, and the daily life of the campus community. In order to accomplish the assigned goals, the Committee has partnered with departments and divisions across campus to launch initiatives and programs intended to make the University more sustainable. This along with national partnerships resulted in studies and strategic choices for the creation of a sustainable campus by applying innovative, community-based approaches to sustainability goals in all campus operations. In this paper, we summarize the major decisions and actions that USEK took and implemented for engaging the university community in sustainability.

1. Introduction

The Green Committee of USEK was created to develop and support sustainability initiatives within the campus and community in order to create an environmentally friendly culture next to students, faculty and staff. As we always like to say "we wanted to show that, a small village, of 10000 people can show the example to be applied in Lebanon".

In order to accomplish the goals, we have set a Sustainability Strategy [4]. The latter was set after the Committee has partnered with departments and divisions across campus to launch initiatives and programs intended to make the University more sustainable [6].

In fact, and after many meetings held with different stakeholders (USEK staff, national and international experts), the committee decided that university actions should first benefit the human. Secondly, our decisions and actions must respect the planet's inherent value and consider both immediate and long-term impacts on its resources [1]. Finally, we must consider the economic impacts of our actions to ensure the University's financial health [3].

This strategy has been guided by a group of faculty, staff, and students in its development; however, the strategies outlined here will succeed only if each member of the USEK community embraces this vision and takes action to bring it to fruition. Transmitting this type of message is indeed very difficult especially due to the mentality that people tend to have towards the environment [5].

That's why the committee had the strategic decision to give an awareness session in the Civic engagement course, which is a course given to all students on campus mainly in their first semester [5]. The course aims to teach USEK student concepts and practical applications indicative of a civic and citizenship commitment which would contribute to the development of society [6]. This course is built on theoretical and practical learning areas as follows: a) Acquiring the concept of commitment and its forms (contract, charity work, activism, promise, voluntarism, giving, love of the other, etc), b) Adopting the fundamental values of citizens such as: freedom of religion and expression, justice, equality, togetherness, family and social solidarity, patriotic and world collective identity, the place of religion in society, etc); c) Integrating the components of social life: democracy, laws, rights, civil society, communal life, social and community diversity, participation in political and public life, elections, individual, institutional and collective security, municipal activities, union activities, etc) d) Addressing and dealing with social issues such as sustainable development, community health, social discrimination, work ethics, the integration of people with special needs, etc. (A description of performed observation and action is provided with the course, based on concepts covered in class).

In all, this strategic decision helped increasing overall student awareness of environmental issues and promoted our green campus initiatives [6] and it helped us to enroll in each semester students volunteering in many chapters, nurturing our goals and events. Among which:

- G.A.E.A program (Green And Ecological Art): Art and up-cycling
- Operation program: Recycling, sorting, cleaning site, monitoring carpooling system
- Awareness program: Social media, photos, graphic design
- Social Studies program: Study the impact of each green intervention and social impact on USEK community.
- Architectural Program: To redesign the concept of outdoor events and decoration, into an Upcycle program and settings.

Moreover, because we believe that our job is a holistic approach, the committee gave sessions to all janitors, security personnel and all the personnel at the university, including faculty members, to ensure the full understanding of the green initiatives.

Consistent with sustainability aims and our Catholic character, the Committee sought to approach the effort from three fundamental perspectives:

- Respect for the human condition
- Respect for the conservation of natural resources
- Economic viability

In the following paragraphs, we summarize the major decisions and actions that we took and implemented for engaging the university community in sustainability.

2. Sustainability Initiatives

For many years the University has acted to inspire and encourage environmental sustainability, both academically and administratively [2], through the implementation of hybrid petrol-electric vehicles since 2010, energy conservation measures across facilities, the design and construction of LEED-certified buildings like the Medical building, and the establishment of the Office of Sustainability, academic and research centers.

However, for the first time, the Green Committee developed a clear document with SMART objectives. This document developed the following recommendations as the University's commitment to act with greater deliberation toward sustainability and with greater transparency [7]. These recommendations and initiatives aim to provide an inspirational statement of broad goals, serving as a compass for future direction. However, this document is neither final nor complete, and it will continue to evolve along with the University's lived commitment to sustainability. The Committee will also identify new opportunities for expansion and improvement, such as constructing Net Zero buildings, creating an academic major in Sustainability Studies, transitioning to fully renewable energy sources, and procuring only sustainable products.

The Comprehensive Sustainability Strategy recommendations focus on the University's continued actions and aspirations in different areas:

2.1 Energy and Emissions

Energy consumption is an integral part of civilization - heating our buildings, lighting our way, fueling our travel, and fostering communication and convenience [11,12]. While the University historically has relied heavily on nonrenewable fuels, we now understand better how their use negatively impacts the environment. In addition, as a Catholic university, we strive to be responsible stewards of the Earth and its resources. We strive to respect all the people with whom we share the planet and to leave a legacy for generations far into the future.

In our endeavor to act as good stewards, we are working to reduce our energy consumption through conservation and efficiency and by switching from diesel private energy generators into cleaner and renewable sources of energy, such as Photovoltaic Solar Electric Arrays and solar water heating system. Indeed, we get 30 percent of our energy from renewable sources.

Although it is not economically or operationally feasible to immediately discontinue all fuel use, we strive to lessen the negative impact of our energy use by reducing our energy demand, increasing our energy efficiency, and increasing the percentage of our energy fueled by renewable and sustainable energy sources [9,10]. To this end, we have developed a number of energy and emission strategies where we are gradually reducing our fuel consumption by relying more on the photovoltaic system. Moreover, we signed an MOU with a local petroleum company to develop a biodiesel plant from which we can get green fuel to use in our generators in a proportion of 20% (B20); thus, without any engine modifications.

1) Increase energy conservation and efficiency
   Each building on campus consumes steam, chilled water, potable water, and electricity. However, few buildings are currently metered, so specific information on resource use and efficiency is unavailable. That's why we created the energy team, headed by an electrical engineer form our faculty of engineering, to start organizing the electrical work and to set the energy baseline as per the ISO 50001. Indeed, team members has been professionally trained and certificate to implement the ISO 50001. In order to further identify opportunities to reduce demand and increase efficiency, they explored the feasibility of implementing extensive metering across campus, the demand has been deposited to the higher administration.

2) Decrease harmful emissions
   Atmospheric emissions are unavoidable end products of modern life [13]. Although we cannot expect to eliminate all emissions, all the above help us reduce those most harmful to people and the planet. Carbon dioxide and other harmful emissions come from varied sources, large and small, such as power plants, dry cleaners, landfills, automobiles, trucks, airplanes, and lawn equipment. Much of the University's current effort is directed toward reducing emissions originating from the power plant and energy production, that's where our effort in the biodiesel plant will pay off. In addition to this larger effort, we are aiming to reduce emissions from smaller and mobile sources across campus and so we are applying a Car-Free campus by using hybrid electric cars to commute its members, inside the campus [14].

3) USEK carpooling program
   One of the most important programs that the committee implemented so far is the carpooling [15]. Even though carpooling is something so familiar in many countries, this concept is almost invisible and challenging in Lebanon due to many cultural aspects. In fact, the committee opened a closed Facebook page and is working on creating an application to facilitate the arrangement among students, staff and faculty members (automobile owners), where each owner from same region, drives the others to and from USEK. This Facebook page is working as a ride-matching platform which allows potential carpoolers to find ride- sharing partners by searching for other students who live close by or on the commute route, and who have similar schedules. This program aims to reduce the negative impact on the environment; it might help reduce the number of cars on the road, it will reduce the number of miles driven, and it definitely does reduce the amount of pollution generated by gas emissions.

   In order to ensure the success of this initiative we decided to reward each of the registered automobile owner with more than 3 passengers (students, staff or faculty members) a secure parking spot and prizes to be distributed to carpooler.

2.2 Water

Water plays a vital role in University operations. We use it for heating and cooling, for food, drink, and hygiene, and for keeping our campus beautiful [16]. Fortunately, the University's geography and climate provide easy access to clean and abundant water. The amount of water drawn on campus and the amount of wastewater sent for treatment are measured but metering of specific facilities or uses is currently not available. To determine opportunities for better water conservation, we are working to quantify specific areas of water use [16]. New construction projects generally include building-specific water metering, but some retrofitting of older buildings to measure use is also necessary. As the campus continues to grow, with both new construction and renovations, the ability to measure use will become more refined and widespread. We are aiming to install flow meters in key representative buildings and facilities across campus, to track individual building use where practical, to track and measure all water usage, to track and measure all water used in green spaces and landscaping in greater detail, so as to partition distribution.

Moreover, we know that everyone has the right to clean drinking water, and at USEK, we take this to heart, as we do our commitment to a more sustainable planet. That's why we've teamed up with talaya, a local bottled water company, to ensure that every member of our community has access to fresh drinking water all year round. Using top-of-the-line food and beverage-grade piping, we now deliver crystal-clear drinking water straight to our students through a network of 5 fountains, so they can have a refreshing sip at any time of the day. We've called it the USEK-talaya Waterfull Initiative, because it truly is a wonderful way to make sure our bottles and our campus are always full of water. By encouraging the reuse of bottles, the initiative helps us all cut down on the plastics sent to our landfills, protect our environment, develop new habits and commit for being responsible Eco citizen students and community.

2.3 Building and Construction

University buildings and structures are long-lasting commitments to our educational mission [17]. They provide space for learning, living, and social interaction, but they also create spaces that reflect the University's values and mission. The design and construction of University buildings, with their long-lasting energy and resource demands, can greatly impact sustainability. We have taken a number of actions to make its new and existing buildings functional, efficient, esthetically pleasing, and sustainable. Current standards ensure that major renovations include increased building and energy efficiency, increased water conservation, and more sustainable design. However, additional steps can ensure the continued sustainability of all of our buildings and construction [17].

Ensure efficient space utilization before constructing new buildings in one of our new targets. Our foremost consideration in this aspect of sustainable development is fully utilizing our existing space. Before tearing down structures, digging up land, and committing extensive natural and economic resources to creating brand-new facilities, we should fully consider whether our current facilities meet our demands.

2.4 Waste

This aspect is considered one of the most developed at our university. In fact, we know that waste creates a number of problems for people and the environment, including contributing to ground and water pollution, increased space demands for landfills, potential leaching of toxins, and increased greenhouse gases. As mentioned before, the Green Committee was created in response to the waste problem in Lebanon in general. Although the University has been actively combating waste on a number of fronts, there is much opportunity for improvement, including moving toward setting an informed goal. The University's current goals are to divert 95% of all waste by 2022; that's why we decided to continue to work toward these goals. We like to note here that we are the only university in Lebanon to install its own Materials Recovery Facility (MRF) on campus, where all the waste is being sorted and treated in an aim to reach a state of Zero waste to landfill (ZWtl).

Improve campus-wide single-stream recycling

Single-stream recycling is a system in which all recyclables, including cardboard, plastic, aluminum, junk mail, etc., are placed in a single bin or cart for recycling. These recyclables are collected by a single truck and taken to a Materials Recovery Facility (MRF) to be sorted into various commodity streams for sale to markets, where it is processed into feedstock which can be used in the manufacture of new products [9,10].

In fact, our philosophy is that waste is not a one-source or one-person problem. Nor is it merely an "end-of-product-life-time" problem. Our choice in products we bring onto campus has an impact on our volume of waste, and we all play a role in choosing what to use and how to dispose of it. To ensure the success of the University's waste sustainability goals, all divisions should have responsibility for meeting the University's goals and reducing waste in individual operations. And that means thinking beyond the amount of waste transported away; we must look to actions earlier in the process if we want to more aggressively reduce the University's overall waste.

The simpler it is to recycle, the more likely a person is to participate. The University attempts to make recycling as simple as possible for its community by, among other things, providing single-stream recycling for most of its waste products. Single-stream recycling relieves users from having to separate their recyclable waste into categories. Rather, all recyclables can be commingled in the same containers (Blue bag for all recyclable materials and Black bag for all organic materials). Even with the more simplified system, the on- campus single-stream recycling rate is less than the national average. Adding to the problem is our lack of knowledge of more specific recycling practices. Among our achievements:

- Increased single-stream recycling rate to approach the overall University objectives.
- Mapped and tracked current recycling signs and containers in campus buildings and facilities.
- Standardizing signage and containers for ease of use.
- Conducted routine and standardized waste and recycling audits in more specific areas.
- Increased recycling and diversion at all events by creating a data baseline, working on packaging and service ware options, and improving messaging.
- Tracked and reported single-stream diversion rates by more specific type and user group.
- Increased accountability and responsibility of all campus divisions for measurable increased recycling, decreased waste production, and decreased waste sourcing.

In addition, and in a reuse thinking, students installed a G.A.E.A project aiming to collect trash from the MRF and to turn it into art.

2.5 Smart Agricultural Practices and Landscaping

The University has been trying to be pesticide and fertilizers free since 2015, that's why we are trying to depend on organic fertilizers and as much as possible implement the integrated pest management system [18]. Moreover, the committee is strengthening to have more green spaces at the university. In order to combat invasive species threat and to maintain local biodiversity, we are trying to use as much as possible native species in campus landscaping or species that are adapted to our local conditions, requiring minimal watering and fertilizers. When possible, we are also using mulches and lawn hedges for all their agricultural benefits.

2.6 Procurement, Licensing, and Food Sourcing

There is an important connection between purchasing and sourcing decisions and enhancing sustainability [17]. Each sourcing decision we make presents an opportunity to choose environmentally and socially preferable products and services and to support companies with strong commitments to sustainability. We are also ensuring that vendors align with our goals and values, including the commitment to sustainability. By thoughtfully using its purchasing power, we are able to impact not only the growth of sustainability on campus but the greater growth of a sustainable economy. We have already written our procedures that are currently under study by each concerned office in order to find the proper way to implement them. The targets set out in these procedures are considered as a starting point, subject to ongoing scrutiny and revision. They intend to address, in the first instance, the needs and policy that will affect the operations on USEK premises.

2.7 Education, Research, And Community Outreach

Worldwide, campuses are discovering innovative ways of increasing environmental awareness and incorporating sustainability into curricula. Many things have to change course, but it is we human beings above all who need to change. A great cultural, spiritual and educational challenge stands before us, and it will demand that we set out on the long path of renewal [20]. As we know to change, we must educate—and education and research are the lifeblood of a university. Scholarly activity impacts more than the University's current carbon footprint—it impacts global actions and outcomes for generations to come. By highlighting the sustainability-related education and research conducted at USEK, the University confirms its commitment to sustainability and its commitment to Catholic values. By enhancing the number of courses and research projects that expand the knowledge, understanding, and advancement of sustainability and by increasing community engagement in sustainability, the University continues to act in conjunction with its Catholic mission, an integral component of all our education and research initiatives.

The key to success in increasing sustainability is individual action. The University can set goals and devise initiatives, but without individual involvement, there is little hope for success. The University must inspire its students, faculty, staff, alumni, and friends to work toward these goals and plans through greater engagement and outreach. That's why we are trying to raise awareness campaigns inside the campus, however after the success of our committee many institutions, municipalities, schools, etc. are asking us to share our success story which is enabling us to work for a sustainable community. Conferences, events and many other initiatives play a major role in diffusing our values. Among the events that our committee had organized

1. Corporate social responsibility events: (we will only develop the sustainable hunting conference)
    - Endorse Lebanese apple farmer's day
    - Christmas sustainable market
    - Hiking events
    - Open doors: to brand our university for all new comers as the first green university in Lebanon
    - Bird watching
    - World migratory bird day
    - Book earth day
    - Sustainable Hunting : Driven by our conscious as Green Committee to tackle this issue, as no academic institution have touched such topic before and have highlighted the damage it does to our image as Lebanese, to our culture and to our obligation to the environment. With the value of birds in general, to the local agriculture industry and biodiversity and the conservation of the migrating birds, for what we owe humanity and as Lebanon is considered to be a main spot and supposedly safe haven place for these passing birds to rest at what we have left of green oasis and last but not least to what this topic is doing to our national image for being categorized as the third country in the Middle East to be listed as the Worst locations reported for illegal killing of birds. Among the 159 potential worst locations for illegal killing identified across the region by national Experts, according to UNEP report. This conference highlighted the importance of birds to the environment, tried to find solutions and recommendations. 600 people attended this conference from different ministries, group of hunters, etc.

The aim of this Conference was to provide useful information for priority-setting both across the Levant region and what types of illegal activities may be most significant, which are the reasons for illegal hunting. It wasn't a simple, academic conferences, there were solutions discussed by each party:

- Ministry of Environment: The ministry was about to announce new Hunting regulations in Lebanon, sustainable ones.
- Ministry of Interior: they discussed their way to enforce the law.
- Sustainable Hunters.
- To call for a proto-type hunter and what are the ethics of this sport.
- To know their way to enforce the law.
- Recommendations were given at the end.

B. Promote research and startups

Some projects or startups were developed in full cooperation between students (from the civic engagement course) and members of the green committee among them.

- Startup to recycle shotgun cartridges
- Startup for a specific Carpooling application
- Five master theses were directed by members of the green committee to better understand the compost of USEK and the possibility of its reuse.

Not to mention our MRF who turned to be an endless source of material for final year project development for students.

C. Sustainability Social media

As green committee we are aware of the importance of communication and especially using social media. That's why we have created with the help of volunteers students our "Awareness team" whose responsibility is to communicate, making social media marketing an imperative tactic for boosting our programs. For this matter, Facebook and Instagram pages were recently created under the name "green usek".

The goal of these platforms is to show our commitment to being a sustainable learning community. Recent posts have highlighted to flow of carpooling, the life and process of recycling at the campus and the involvement of students with the sustainable green living, etc.
All is updated frequently with news and events and provides full contact information.

3. Conclusion:

In recent decades, many environmental problems have increased as the result of human activities leading to pollution, deforestation, and other environmental issues that led to climate change and global warming. Therefore, a dispute between the importance of conservation and preservation of ecosystems to protect our environment and the necessity to satisfy human desires by sacrificing the environment is one issue that is arising throughout the world these days. However, groups of people every day, all over the world, are desperately trying to make a change in this world and fight for environmental protection.

The green committee of USEK was launched after the eco-consciousness of faculty who strongly believed that "We should live on this planet, knowing that we don't have another one to go to" and they wanted to make the difference. The committee is trying to develop and provide support for sustainability initiatives within our campus and the community in order to create a culture of students, faculty, and staff who are economically, socially, and environmentally responsible. As mentioned before, we have so far being able to implement many projects, however it was clear all the way that the main challenge is the human factor. We always had to find a way to work with people, intelligently fighting resilience, trying to implement the learning by doing experience where we used our campus as an environmental and sustainable laboratory

To conclude, we will use the words of one of the volunteering students

"Go Green program is definitely an experience that I will never forget. I completed my Civic Engagement volunteering hours and I called it "Go Green: much more than just volunteering" Why that? Because it made me realize that my engagement to Go Green was not going to stop there. I decided to become a volunteer with this committee and to come help the team whenever I can during my breaks between classes. USEK's ranking as #1 green university in Lebanon is not a coincidence. And being part of the committee that led USEK to this ranking was really an honor and it made us proud to belong to USEK, this green university that cares about the environment much more than we think it does.

If every one of us makes a tiny effort towards the environment, we can definitely make USEK greener. We should act, even with the simplest actions, to try to make a difference starting in our smallest community because change doesn't appear in the middle of a crowd; it appears within one person who has the courage to transmit it to this crowd.

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A Smart Flexible Transport Service in a university city.

The “Night Bus” experience in Padua

Alessandro Nalin[1]
[1]*Municipality of Padua*

Abstract. The lack of good public transport alternatives during evenings penalize those who want to enjoy the nightlife but haven’t any car. Flexible Transport Services (FTS), a sub-set of Demand Responsive Transport, are increasing they contribute to increase the public transport quality and accessibility. Padua, one of the most famous italian “university city”, set “Night Bus”, a cheap and smart FTS based on a user-friendly-designed application, in order to make the nightlife of youngsters and students easier and safer.

1. Padua and its context

Padua is the capital of the Padua Province, located in the centre of Veneto Region, North-East of Italy, in a relevant crossing area for trade/logistic connections (enclosed in two Trans-European transport networks: Lisbon-Kiev and Berlin-Palermo). It ranks 3rd in the list of the main cities of Veneto with 210,000 inhabitants, following Venice (264,000) and Verona (250,000). In terms of demographics, the Province counts 936,274 inhabitants (2016); it ranks first in the Region (with 19.1% up to the total amount of Veneto region, i.e. 4,907,529 inhabitants).

On top of that, Padua is the core of a wide metropolitan area called COMEPA (“Comunità Metropolitana di Padova”, which is a majors’ forum but not an administrative entity), within a radius of about 10 km including 437,000 inhabitants, equal to 46.7% of the population of the entire Province, an area that, indicatively, can be roughly placed among the top ten Italian municipalities by demographic entity.

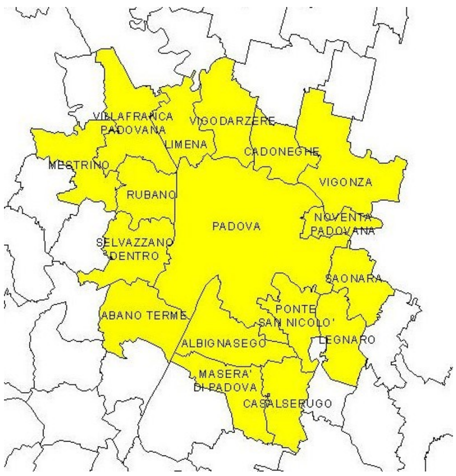

Figure 1. Map of COMEPA

Considering the economical point of view, Padua can be described as an entrepreneurial city: 88,615 enterprises located in the city and 19,332 in the nearby province, resulting in a vital entrepreneurial eco-system of 107,947 enterprises, typically SMEs but also large companies, generating a turnover of 38.7 billion €. Padua is the first province of Veneto Region in terms of number of operating companies, ranking 9th in Italy (10th, excluding agricultural activities, with a total of industrial and tertiary companies reaching 76,223 units). One of the main sectors is ICT, which showed a boom recently: 2905 ICT and digital companies in Padua, ranking 1st for the Veneto region and 7th at national level. The metropolitan area has a concentration of ICT companies among the highest in Italy: taking as a reference all the Italian provinces by ICT density, Padua area ranks 2nd in Italy in ICT, following the Province of Milan (4.3%), Moreover, the city represents an important cultural and tourist destination: from year 2000 the number of visits almost doubled.

Another important component of Paduan economy and society is R&D, pivoting on the University. Padua is seat of one of the most ancient European University, founded in 1222 and currently among the five best on a national scale, and ranked first as overall quality of research (ANVUR, 2015). The "UniPd" counts 60,000 enrolled (in the top ten of Italian Universities), spread among Padua and other cities in Veneto region (the University settled some departments out of Padua; one of them, in Legnaro, is an important and integrated campus called "Agripolis"). Directly connected to the history of the University is the first botanical garden, founded in 1545; since 1997 it is in UNESCO World Heritage list. The students living in Padua are more than 48,000 and they live spread around the city, in different accomodations as residences or renting apartments. Most of the departments are located nearby the historical centre, so students use to live and enjoy it all around the day, studying or spending their freetime even in the evening.

2. The public transports in Padua

The public transport authority in Padua and its Province is BusItalia Veneto, which belongs to the national railway company (Ferrovie dello Stato Italiane). BusItalia provides urban and interurban bus services connecting Padua and the other towns spread around the province. Moreover, it operates the urban tram service, a 10.3-km long line from the North to the Southof Padua called SIR ("Sistema Intermedio a Rete"); the tramway uses the Translohr rubber-tyred vehicles (1st example in Italy). The line is strategic for the entire urban mobility: the route meets more than 50% of urban population. The railway system allows only interurban connections, because the municipality of Padua has just one railway station. A taxi service is regularly operative in Padua.

There is not a fare integration, so tickets must be purchased depending on the typology of service and they are valid only for the respective means of transport. Urban ticket costs 1.30€ and allows rides within 75 minutes inside the paduan municipality. The so-called suburban ticket (valid for Padua and the boarding municipalities) costs 1.50€; the validity is 90 minutes. These tickets are valid for buses and the tram. Both interurban rides and railway services fares depends on the travelled distance.

The urban bus services in Padua reflects the structure of the city and the urban fabric: an historical centre sorrounded by massive and characteristic walls, a 20th-century "extra moenia" (out of city wall) expansion based on streets arranged in a radial pattern with suburbs grew up tumultuosly; most of the bus routes correspond to the radiuses (the tram linee too). In addiction, some of the urban bus lines connect Padua and the boarding municipalities. The operating time is diversified and depends on the hierarchy of the lines and the day of the week: on workdays, buses run on average every 15-20 minutes, on Saturdays every 20-25 minutes, on Sundays every 40-90 minutes. The tram service is an exception: it runs every 6-7 minutes from Monday to Saturday, and every 12-15 minutes on Sundays. It is been operating since 2007, and nowadays it moves more than 25,000 people every day, so it can be described as the backbone of the urban transport system.

In the last years, the urban public transport services have been affected by huge changes, dealing both with economical and technical reasons: some lines were cancelled and rescheduled.

These changes impacted on routes and timetables, mostly affecting off-peack hours and evenings. In fact, from 9pm to midnight, only three lines operate: the tram line (every 15 minutes), bus lines number 10 (on average every hour) and number 12 (every 70-90 minutes). Most of the city, in particular the periphery, is not served by a regular public transportation, so taxis are the only alternative in getting aroud Padua.

Figure 2. The paduan tram running between the the city centre and Railway station

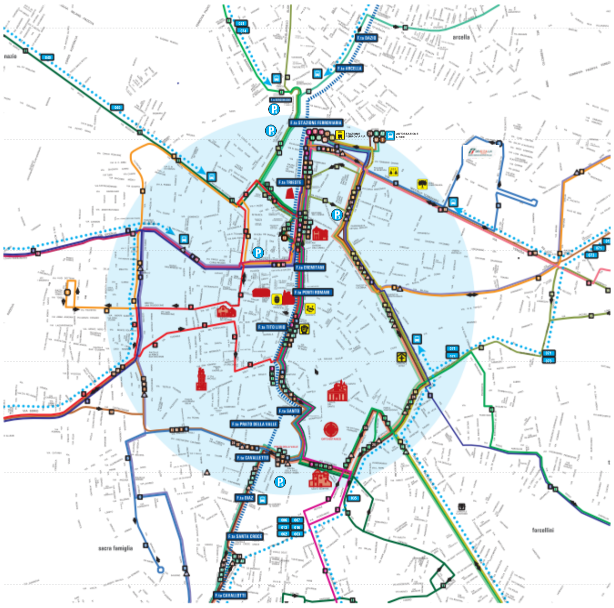

Figure 3. Map of paduan urban public transport. Focus on city centre

3. A DRT in Padua: the Night Bus

In order to make up for the lack of evening and night transit, from 19th January until 30th September, on an experimental basis, is activated the new transport service via app called “Night Bus”.

This service can be described as a Demand Responsive Transport (DRT), a sub-set of Flexible Transport Services (FTS). This form of public transport is a “middle ground” between traditional transit (buses, tramways, etc) ad taxi. It has risen up in the last decades all around Europe, and it is becoming an effective alternative to traditional transit for those public administrations which suffer a deficit in funding or difficulties in planning transit. The strength of DRTs is their flexibility and their perfect adherence to the needs of population. In this context, the contribution of Intelligent Transport Systems (ITS) can be decisive, because they allow to optimize the planning and scheduling of the whole service.

Night Bus can be considered as a “dial-a-ride” service, using the anglo-saxon lexicon, or a “servizio a chiamata” in Italian. Night Bus is available on Mondays, Tuesdays, Thursdays and Sundays from 9pn to midnight; on Wednesdays, Fridays and Saturdays from 9pm to 3am. The fleet includes small buses (up to 16 seats, set up to carry weelchairs). The service is carried out by the Municipality and the University of Padua (this “co-founding” symbolizes the importance and the presence of the University in the paduan life, culture and economy), in collaboration with BusItalia Veneto.

The “call”/reservation can be made only by using the official application “Night Bus” (available on App Store and Google Play), developed by Padam, with a user-friendly design and interface; the user must create an account and fill their data containing the departure and destination, the desired departure or arrival time and the number of expected passengers. The served area corresponds to the entire municipality of Padua and people can choose as arrive/departure ponts the urban trasport stops (not the tram stops). After the choice of parameters, the app shows all the available connections and the eventual walking paths. The booked ride can be also cancelled. 20 minutes before the departure time, an alert informs the user about the ride: on a GMaps-based map the details are shown, and it’s possible to monitor the bus thanks to the GPS signal. After the ride, the passenger can valuate the ride. Every route is possible, so the Night Bus is a many-to-many riding scheme. The ticket price is 1.50€ per person per ride and it is a special ticket (there is not any fare integration, no matter if user has a pass). The user can pay the ride by cash to the driver getting on the bus or by credit card (using the app).

Considering the first months of service, Night Bus is appreciated by people, mostly youngsters and students: people now can enjoy the paduan nightlife, benefiting of a smart public transport service, cheap (comparing to the taxis), safe, flexible and fully customizable. The Night Bus was also awarded by Legambiente, the Italian environmentalist association, as a mobility best practice. At the end of the experiemental period, a reasoned review of the experience could be useful in order to complete the (modal and fare) integration of the Night Bus to the other public transport service.

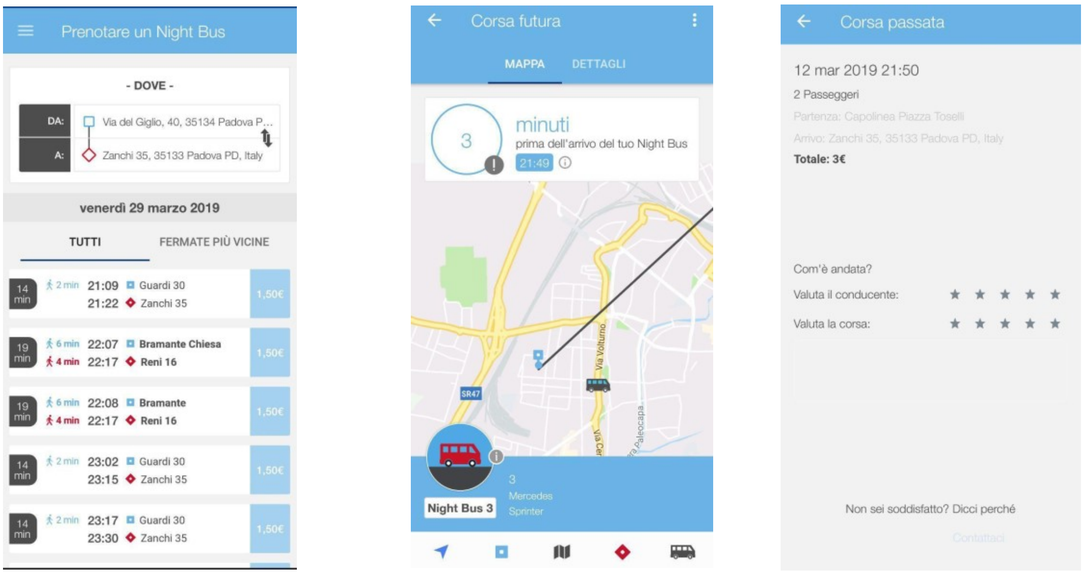

Figure 4-6. Screens of Night Bus app interface

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Appendix

Speakers

HE. Mr. Simon Coveney
Ireland's Deputy Prime Minister

Simon was one of the youngest T.D.s to be elected to the Dail, aged 26, when he won the Cork South Central seat in 1998. In opposition, Simon was spokesperson on Drugs and Youth Affairs before being appointed by the Party Leader to the position of Deputy Chief Whip in 2001. He was appointed Minister for Agriculture, Food and the Marine by the Taoiseach with this portfolio expanded to incorporate Defence (July 2014). In June 2017, Simon was appointed Deputy Leader of Fine Gael, following the resignation of Enda Kenny from the role of Taoiseach and subsequent leadership challenge. He became Minister for Foreign Affairs & Trade with special responsibility for Brexit in the new cabinet when Leo Varadkar T.D. assumed the role of Taoiseach and Leader of Fine Gael.On 30 November 2017, Simon was appointed Tánaiste and Minister for Foreign Affairs and Trade with responsibility for Brexit.

Dr. Michael John O'Mahony
Director of the Environmental Education Unit, An Taisce (The National Trust for Ireland)

Dr. Michael O'Mahony has been Director of the Environmental Education Unit, An Taisce (The National Trust for Ireland) since Jun 2015. He is Professor and Sensory Scientist in the Department of Food Science and Technology, University of California, Davis, CA. A very entertaining and informative lecturer, Mike is well known for his approach to communicating new concepts to broad audiences. He consults extensively with consumer products companies globally. He holds a Ph.D. in Chemistry and Psychology from Bristol University, United Kingdom.

Prof. Dr. Ir. Muhammad Anis. M.Met.
Rector, Universitas Indonesia, Ireland

Muhammad Anis graduated from the Faculty of Engineering, Universitas Indonesia majoring in metallurgy in 1983. He then continued his education and earned his doctoral and master's degree in metallurgy from School of Materials, University of Sheffield, UK. Muhammad Anis has held various position within the Faculty of Engineering, among others as Vice Dean for Academic Affairs (1993-1997), Vice Dean for Cooperation (1997-2000) and Director of Extension Program for two terms (1993-2000). He was in member of the university's Senate (2000-2007). He was Universitas Indonesia's Director of Education for the terms 2003-2007 and was appointed a Vice Rector of Academic for the Term 2007-2012. In 2013, he was appointed as Interim Rector of Universitas Indonesia and was elected as a Rector of Universitas Indonesia for the term 2014-2019.

Prof Patrick O'Shea
President, University College Cork, Ireland

Professor Patrick O'Shea became the 15th President of University College Cork on 1st February 2017. A UCC Physics graduate and former Vice President and Chief Research Officer at the University of Maryland in the US. He is a Fellow of the American Physical Society, the Institute of Electrical and Electronic Engineers, the American Association for the Advancement of Science, and is a University of Maryland Distinguished Scholar-Teacher. Professor O'Shea attended secondary school at Coláiste Chríost Rí in Cork and holds an M.S. and a Ph.D. in Physics from the University of Maryland.

Prof. Dr. Ir. Riri Fitri Sari, M.M., M.Sc.
Chairperson of UI GreenMetric

Riri Fitri Sari is a professor of Computer Engineering at Electrical Engineering Departement, Faculty of Engineering, Universitas Indonesia (UI). She holds PhD in Computer Networks from the School of Computing, University of Leeds, UK. Her current main teaching and research area includes Computer Network, Grid Computing, Intenet Things, and ICT for Sustainability. Since April 2010, she has been the Chairperson of UI GreenMetric Ranking of World Universities, a flagship program from the Universitas Indonesia to rank universities worldwide based on their green campus and sustainability programs. UI GreenMetric Network became an active network of more than 619 Universities from 76 Country. Since September 2015, she has been appointed a member of Special Task Force for Improving Indonesia Universities Academic Reputation for the Ministry of Research and Higher Education. She was awarded as an honorary of professor from Kazakh National Agrarian University, Almaty – Kazakhstan on June 2017.

Prof. John O'Halloran
Deputy President, University College Cork, Ireland

Professor John O'Halloran is the Deputy President and Registrar at UCC. Prior to taking up this role in February 2018, John served as Vice-President for Teaching & Learning for almost four years. John is a founding member and current Director of UCC's Quercus Talented Students'Programme. He is the Chair of the Green Campus Forum at UCC which has received many awards in recognition of its efforts to promote the Green Agenda at UCC, including the first green flag ever awarded to a university. He was a finalist in the Green Gown Leadership Awards (UK & Ireland) in 2017 for his leadership of sustainability objectives at UCC. John is a zoologist and was awarded a PhD for his research in 1987 and a DSc for his published works in 2009 by the National University of Ireland.

Dr. Gerard Mullally
Departement of Sociology, University College Cork, Ireland

Dr. Gerard Mullally is a lecturer in the Department of Sociology, specialising in the Sociology of the Environment, Community, Sustainable Development and Climate Change. Gerard began his career in the *Centre for European Research, UCC* (1992-1997), after graduating from the inaugural cohort of the M.A. in the Sociology of Development (now globalisation and development), where he was a researcher on a number of EU projects on environment and sustainable development. He also lectured on the *National Diploma in Applied Social Studies in Social Care*, Regional Technical College, Cork (now Cork Institute of Technology) from 1993-1994. In 1997, he was awarded a scholarship to the Advanced Study Course *Systemic Complexity and Eco-Sustainable Development,* Erice, Sicily, September, 8th –27th, organised by Professor Ivano Spano. In retrospect, his exposure to the international faculty of that course, including: Ervin László, Alfonso Montuori, and Edgar Morin had a much more enduring impact than he had realised.

Dr. Nyoman Suwartha, ST., MT, MAgr.
Secretary of UI GreenMetric

Nyoman Suwartha is an Assistant Professor of Environmental Engineering at the Civil Engineering Department, Faculty of Engineering, Universitas Indonesia (UI). He graduated with a BSc in Civil Engineering from Universitas Gadjah Mada (UGM) Yogyakarta. He gained a master's in civil engineering - Water Resources from UGM. Subsequently he completed his MAgr degree in Environmental Resources from the Graduate School of Agriculture, Hokkaido University, Japan, funded by JICA Scholarship. He hold a PhD in Environmental Resources from Graduate School of Agriculture, Hokkaido University, Japan, funded by KUBOTA Foundation and Monbukagakusho Scholarship.

Mr. Junaidi, M.A.
Expert Member of UI GreenMetric

Junaidi is an expert member of UI GreenMetric World University Rankings, and Lecturer in Linguistics and Cultural Studies at English Department, Faculty of Humanities, Universitas Indonesia. He holds degrees from English Department, Universitas Indonesia (Sarjana Sastra/BA in English language and Literature); and Warwick University, UK (M.A in British Cultural Studies, with Distinction). He is currently doing PhD in Linguistics at Universitas Indonesia. He has been actively involved in the internationalization of Universitas Indonesia from 2004 to 2015 with different university positions. He is UI 2011-2015 Head of International Office and Chairperson of ASEAN University Network- ASEAN Credit Transfer System (AUN-ACTS). He is also one of the resource persons for internationalization of Indonesian universities at Ministry of Research and Higher Education, Republic of Indonesia. Since 2015 he is an expert member of UI GreenMetric World University Ranking and set up UI GreenMetric World University Rankings Network in 2016.

Prof. Mustafa Cufali
Rector, Bulent Ecevit University, Turkey

Prof. Mustafa Cufali is appointed as a Rector of Bulent Ecevit University in March 2018. Previously, he worked at Ankara Sosyal Bilimler Universitesi. He was awarded with a PhD in Political Science in the Nottingham University, UK in 1995.

Dr. Chang-Hsien Tai
President, National Pingtung University of Science and Technology, Chinese Taipe

Dr. Chang Hsien Tai is Academic Vice President, NPUST, Chinese Taipei, since 2006. In 2002-2006, he is the Dean at the Institute of Technology (NPUST), Chinese Taipei. He worked on the development of CFD algorithm and its applications, Design of wind power system/ hybrid power system, and Shock interaction and its applications. He got his bachelor's degree from the Dept. of Mechanics Engineering, Chung-Cheng Institute of Technology, Chinese Taipei in 1979. He completed his Master's degree in Dept. of Mechanics Engineering, National Chinese Taipei University, Chinese Taipei and in Dept. of Aerospace Engineering, University of Michigan, USA. In 1990 he acquired a PhD at the Dept. of Aerospace Engineering, University of Michigan, USA.

Kitikorn Charmondusit, Ph.D.
Acting Vice President for Environment and Sustainable Development, Mahidol University, Thailand

Assoc. Prof. Dr. Kitikorn Charmondusit received PhD. in Chemical Technology from Chulalongkorn University, Thailand including Post-doctoral fellow in Chemical Engineering from University of Waterloo, Canada. He has been an Associate Professor in Environmental Science and Technology since 2012 and has been appointed as Director of the Eco-Industry Research and Training Center, Faculty of Environment and Resource Studies, Mahidol University since 2007. His research interests are in Environmental Management; Eco-Industrial Park Management; Development of Eco-Indicator for Industry and Industrial Estate; Eco-Efficiency; and Plastics Recycle Technology. Currently he has been serving as Vice President for Environment and Sustainable Development of Mahidol University.

Prof. Denyse Rémillard
Vice – Principal Adm. and Sustainable Development, Université de Sherbrooke, Canada

Denyse Rémillard is Vice-Principal - Administration and Sustainable Development - at Université de Sherbrooke. PhD in Management Sciences from Université Catholique de Louvain, Belgium, she is a Finance graduate from Université de Sherbrooke and Université Laval, Canada. In the recent years, she has successively been Vice-Dean and Director of the Masters' Program at Université de Sherbrooke's Business School. A specialist in Corporate Finance and Corporate Governance, her research interests focus on the regulation of financial markets and the reconciliation of environmental, social and economic considerations in the strategic decisions of publicly traded companies. Professor Rémillard is chairperson on various boards of directors and specialized committees.

Prof. Kiyoshi Tanaka
Vice President of International Affairs and Director of Global Education Center, Shinshu University, Japan
Kiyoshi Tanaka received his B.S and M.S. degrees in Electrical Engineering and Operations Research from National Defense Academy, Yokosuka, Japan, in 1984 and 1989, respectively. In 1992, he received Dr. Eng. degree from Keio University, Tokyo, Japan. In 1995, he joined the Department of Electrical and Electronic Engineering, Faculty of Engineering, Shinshu University, Nagano, Japan, and currently he is a full professor in the academic assembly (Institute of Engineering) of Shinshu University. He is the Vice-President of Shinshu University as well as the director of Global Education Center (GEC) of Shinshu University. His research interests include image and video processing, 3D point cloud processing, information hiding, human visual perception, evolutionary computation, multi-objective optimization, smart grid, and their applications.

Prof. Dr. Ir. Ambariyanto, M.Sc.
Vice-Rector for Research and Innovation, Universitas Diponegoro, Indonesia

Prof. Ambariyanto is a marine scientist working at Diponegoro University, Indonesia, and his current position is Vice Rector for Research and Innovation. He completed his master's degree at the University of North Wales, Bangor U.K. and completed his PhD at the University of Sydney Australia. His research interest mainly on marine endangered species and biodiversity of marine organisms. He has been working in collaboration with various foreign researchers. He also has experience working closely with coastal communities, especially on the management of coral reef and mangrove rehabilitation and conservation. Until now, he is often asked to assist local governments in Indonesia in solving the problems related to coastal and marine area. He is responsible for developing SDGs program at Diponegoro University.

Prof. Paulo Jorge de Sousa Cruz
Pro-Rector for Quality of Life and Infrastructures, Universidade do Minho, Portugal

Faculty member of the University of Minho since 1989, initially at the Civil Engineering Department, where he was Head of Department from 2003 to 2004. Dean of the School of Architecture from 2004 to 2011. Full Professor of Construction and Technology at the School of Architecture since 2008. Pro-rector for Quality of life and Infrastructures since 2018. Founder and President of the International Association of Structures and Architecture since 2016. Chairman of several international conferences in this field (ICSA2010, ICSA2013, ICSA2016 and ICSA2019). Secretary to the Executive Committee of IABMAS - International Association for Bridge Maintenance and Safety (2001-2018). Founder of ASCP - Portuguese Association for the Safety and Maintenance of Bridges and President since 2006.

Prof. Mirko Degli Esposti
Deputy Rector, Universita di Bologna, Italy

Prof. Mirko Degli Esposti is a Deputy Rector of Universita di Bologna since November 2016. He is full Professor in Mathematical Physics. He had been Head of the Department of Mathematics and member of the Academic Senate of the University of Bologna in 2008-2015. He graduated with a bachelor's degree from Physics of University of Bologna in 1988. Subsequently, he completed his PhD in Mathematics (Caltech and PennState, USA), 1992 and his Postdoctoral fellow in Mathematical Science Research Institute (M.S.R.I), Berkely, California USA, 1993. In 1998-2000, He was visiting Professor at the Georgia Institute of Technology, USA. He is also member of the Center «L. Galvani» for integrated studies on bioinformatic, biophysics and bio-complexity. He was representing the University of Bologna as a member of the IREG Observatory, since 2016. He was a member of the QS Intelligence Unit Advisory Board (since November 2016). He was an acting as coordinator of a working group on Academic rankings (access with password) at the Conference of Italian University Rectors, CRUI (since October 2017- 34 participating universities).

ing. Sandro Petruzzi
Representative of Rector, University of Turin, Italy

ing. Sandro Petruzzi is the Director of Real Estate, Logistic and Sustainability at University of Turin, Italy. In 1995 he achieved a bachelor degree of civil engineering from Polytechnic of Turin. Thanks to the professional work experience that has been done, he developed skills and competences in structural safety of buildings and infrastructures with particular reference to existing buildings; maintenance and management of public buildings and infrastructures. He has also worked as a designer, project manager and was appointed by the Province of Turin as a member of the jury for various and important assignments of works. ing. Sandro Petruzzi still serves as a company tutor for students of the Faculty of Engineering and Architecture, Polytechnic of Turin and collaborates with several departments as co-supervisor of graduation theses in engineering.

Dr. Freddy Leonardo Franco Idarraga
Representative of Rector, Universidad Nacional de Colombia, Colombia

Dr. Freddy Leonardo is a Doctor of Civil Engineering Department, Engineering Faculty, National University of Colombia. He graduated as Civil Engineer from the National University of Colombia, specialist in Systems and Computation Oriented to the Assisted Design from the University of Manizales, master in sanitary and environmental engineering from the University of Cantabria, and Doctor in Technology and Project for the environment from Polytechnic of Milan. His areas of activity including engineering and technology, civil engineering, environmental engineering, environmental and geological engineering natural sciences, computing and information sciences, and computer science. He also has worked as participant in scientific events and a consultant for Computer Aided Design (CAD) of wastewater treatment plants.

Mr. Andy Nolan
Representative of Vice-Chancellor, University of Nottingham, UK

An experienced director-level professional with expertise in sustainable development, estate management, cities, universities, governance, policy and strategy. 15 years of experience working in both the private and public sector. Has worked within a local authority, in multi-authority partnerships locally and at 4 UK universities (Bradford, Leeds Beckett, Sheffield and Nottingham). Andy is responsible for providing strategic direction to the University around sustainability and for delivery of a comprehensive and progressive sustainability strategy, further developing and embedding sustainability to improve the University's campus, curriculum and community sustainability. Operational responsibilities include energy and carbon management, environmental management (including waste, transport, engagement and communication), space and resources management and the University of Nottingham farm.

Prof. Dr. Klaus Helling
Representative of President, Umwelt - Campus Birkenfeld, Germany
Prof. Dr. Klaus Helling, born 1964 is dean of the faculty of environment, business and law at the Environmental Campus of Birkenfeld (ECB). The ECB is a location of the University of Applied Sciences Trier. Since 1998 Helling is professor for environmental management and business administration. In 2001 he was one of the founders of the Institute of Material Flow Management (IfaS). His current research focuses on the implementation of the 17 Sustainable Developments Goals in companies and universities.

Antonio Jose Guerrero Lucendo
Representative of Rector, Miguel Hernández of Elche University, Spain
Environmental technical works at the Miguel Hernández of Elche University during more than 10 years, including waste management, climate change, volunteering, environmental management systems, etc. Also President of the Spanish ONG Environmental Sciences Online (ACAOnline) developing environmental communication projects.

Ms. Samantha Fahy
Representative of President, Dublin City University, Ireland

Samantha Fahy holds a primary Science degree from NUI Galway (1991), a Master in Optoelectronics from Queen's University Belfast (1992), a diploma in Management from Trinity College Dublin (1997) and an MBA from Dublin City University (2010). In 2004 Samantha was appointed Centre Manager for the National Centre for Plasma Science and Technology. In 2012 Samantha took on the part-time role of Manager of Sustainability at DCU, an initiative to develop and promote Sustainability across all educational functions, and moved to full-time in 2013. Samantha has over 20 year of experience in the management and administration of high technology research projects and has developed a deep understanding of research practice gained from working closely with outstanding researchers engaged in complex projects, such as SFI Strategic Research Clusters.

Dr. Maria Kirrane
Representative of President, University College Cork, Ireland

Dr. Maria Kirrane is a Sustainability Officer of University College Cork since May 2017 until now. In 2009, she graduated with her bachelor's degree in Ecology, her main interests being the effects of invasive species on ecosystems. This, combined with a fascination in honey bee behavior, led her to pursue research in the area of the varroa mite. She was Postdoctoral Researcher of University of Limerick in 2016 – 2017. She completed her Doctor from University College Cork, Ireland

Prof. Martin O'Connor
Representative of Dean, Inseec U, France

Martin Paul O'CONNOR is Professor of Economics at the Université Paris-Saclay (France). During 2010-2015 he was based at the C3ED/UVSQ, then Director of REEDS (Research in Ecological economics, Eco-innovation and Tool Development for Sustainability) at the UVSQ (France). New Zealand born, he has research degrees in natural sciences, humanities and economics ((PhD in 1991 from Auckland University), and specialises in research on the "interface" society-nature, ecological economics, political economy, deliberative sustainability assessment, social sciences epistemology. A leader in educational multimedia design (KerBabel, ePLANETe), he was also catalyst for recognition of the Greater Western Paris RCE (UNU Regional Centre of Expertise in Education for SD, now named "Paris Seine RCE").

Prof. Tadeu Malheiros
Representative of Rector, University of Sao Paulo (USP), Brazil

Prof. Tadeu Malheiros is an environmental engineer and worked for several years with local government environmental agencies, with most of the activities focused at the interface environment, health and society. Now, Malheiros works at the São Carlos School of Engineering of the University of São Paulo - Brazil, teaching and researching sustainability assessment and indicators. He graduated at Engenharia Civil from Universidade de São Paulo (1991), master's at Resources Engineering from Universitat Karlsruhe (1996) and ph.d. at Collective Health from Universidade de São Paulo (2002). He has experience in Sanitary Engineering, focusing on Sanitary Engineering, acting on the following subjects: sustainable development, indicators, environmental management.

Dr. Suchada Chaisawadi,
Representative of Rector, King Mongkut.s University of Technology Thonburi, Thailand

Dr. Suchada Chaisawadi is currently Energy Environment Safety and Health Office Director and Office of Sustainability Director at KMUTT. She joined Chiangmai University as a lecturer in Faculty of Medical Science from 1976-1990 and transfer to KMUTT as a researcher in Pilot Plant Development and Training Institute. Suchada was appointed to Process and Environmental Analytical Center as Laboratory Manager and then appointed as Energy Environment Safety and Health Office Director since 2005 and Sustainable Office Director since 2016.Suchada graduated from Chiangmai University in Faculty of Medical Technology since 1975 .She received Cert. in Molecular Genetics(Biotechnology) from Rikagaku Kenkyusho RIKEN (Institute of Physical and Chemical Research) Japan and Cert.in Molecular Biology(Molecular Genetics) from Cancer Research Institute, Kanazawa University.

Mr. Dick Jager
Representative of Rector, University of Groningen, Netherland

Mr. Dick Jager is a Hanzehogeschool Groningen graduate. He worked as researcher for 5 years. Currently he is responsible as program manager of integrated sustainability at University of Groningen, board member of the sustainability steering group, and coordinator of biological safety.

Prof. Mansour Almazroui
Representative of Rector, King Abdulaziz University, Saudi Arabia

Prof. Almazroui is currently the head of the Department of Meteorology at the Faculty of Meteorology, Environment and Arid Land Agriculture in King Abdulaziz University, Jeddah, Saudi Arabia. Dr. Almazroui is also the associate fellow in the (Climatic Research Unit), University of East Anglia, England. He obtained his Bsc in 1991 and master's degree in 1998 from the Department of Meteorology, Faculty of Meteorology, Environment and Arid Land Agriculture, King Abdulaziz University. He completed his PhD in CRU in 2006. The title of his PhD was "The relationships between atmospheric circulation patterns and surface climatic elements in Saudi Arabia". Beside lecturing he is also University representative in the National Saudi Committee to prepare "The national detailed strategic plan for Environmental Technology in Saudi Arabia". The Departmental head of the Academic Accreditation and the Faculty head of the internet committee.

Prof. Mario A. Gandini
Representative of Rector, Universidad Autonoma de Occidente, Colombia

Prof. Mario A. Gandini holds a B.Sc. in Sanitary Engineering, a M.Sc in Environmental Policy and Management and a Ph.D in Environmental Engineering. He has been working in the academic sector as a lecturer and a researcher for 20 years, in the main area of pollution control, including wastewater treatment, ecological sanitation and solid waste management with a focus on leachate treatment. At the Universidad Autónoma de Occidente –UAO- (Cali, Colombia), currently he is the Head of the B.Sc. Program in Environmental Engineering, as well as, the Head of the UAO Sustainable Campus Program.

Prof. Dr. Sany Sanuri Mohd. Mokhtar
Representative of Vice-Chancellor, Universiti Utara Malaysia, Malaysia

Sany Sanuri Mohd Mokhtar is an Associate Professor at School of Business Management, University Utara Malaysia. His areas of research interest and specialization 2include quality management, strategic marketing, service quality, innovation management, customer relationship management and higher education management performance. He holds a bachelor's degree in Business Studies from University of Huddersfield, United Kingdom, a Master's in Business Administration from the Universiti Utara Malaysia and a PhD in Marketing and Quality Management from Universiti Utara Malaysia.

Dr. Margarita Redina
Representative of Rector, People's Friendship University Russia (RUDN), Russia

Dr.Sc. Econ, Margarita Redina is Dean of the Ecological Faculty of RUDN-University. She received master of ecology and nature management in ecological faculty of PFUR in 1999. She got Doctor of Economics, associate Professor (dissertation for the degree of doctor of economic Sciences, specialty "Economics and management of national economy (environmental Economics) "Methodological principles of ensuring ecological and economic sustainability of oil and gas companies" in 2012. She has experience in scientific projects on geoecology, nature management, environmental economics, environmental regulation, IT for environmental safety, environmental education and Successfully partnership with companies of oil and gas sector (more than 15 projects). She is Author of more than 180 publications.

Prof. Matteo Colleoni
Representative of Rector, Universita degli Studi di Milano Bicocca, Italy

Prof. Matteo Colleoni took his dotor's degree at University of Trento in 2003 and got his 2nd Level master's Degree in Time Policies for the Quality of Life and Sustainable Mobility Politecnico of Milan at Universität Hamburg. He is a Professor of Urban policies, a member of BASE Office and the Rector's delegate for the Network of Italian Universities for Sustainable Developing. He, also, plays the role of Mobility Manager of the University of Milan-Bicocca and of Deputy Coordinator of the Italian Network of Mobility Managers. His research and teaching works concern issues of urban mobility, accessibility & transport exclusion, metropolitan areas, urban change & sustainability.

Ir. Joris Fortuin
Representative of Rector, Wageningen University & Research, Netherland

Mr. Joris Fortuin is the Head of Integrated Facility Management at Wageningen University. He is responsible for Facility Management-wide policy support and strategy development approaching to sustainability. He has experience of working as a Head of Education Facilities for 9 years, Head of CID for 3years, Associated Expert of Environmental Information Systems at UNESCO, and Associated expert GIS and IT. He also an expert in sustainable development, ecology, environmental awareness, education support, and facility management.

Luciana Sacchetti
Representative of Rector, Universita di Bologna, Italy

Luciana Sacchetti is a qualified auditor for ISO 9001 (quality management system) and CAF (Common Assessment Framework). Her main field of activity is to give support to the thirty-two research departments in implementing a quality management system focused on research processes. She also deals with the implementation of proactive actions to improve the institutional standing of the University of Bologna in both international and national university rankings and league tables.

Mr. Juris Iljins
Representative of Rector, Riga Technical University, Latvia

Mr. Juris Iljins currently is a Quality Manager and Sustainability Director at Riga Technical University. Currently he us doing his PhD in field of Change Management. Mr. Iljins is also former board member of Latvian Higher Education Council. He has been active internationally to promote sustainability with his scientific interest mainly focusing on how to effectively manage and measure change in various processes. Mr. Iljins is responsible for developing, maintaining quality management system within RTU and pursing sustainable development goals at RTU. Mr. Iljins is two-time alumni of Riga Technical University with degree in MSc. Industrial Engineering and Management, bachelor's degree and engineering qualification in Heat, Power and Thermal Engineering.

Prof. Habib M. Fardoun
Representative of Rector, King Abdulaziz University, Saudi Arabia

Dr. Habib M. Fardoun has a PhD in Model-Based Approach for the Development of Quality Higher Educational Environments (2011), and Master in Aptitude for Teaching (2008), and Master's in Advanced Computer Technologies (2007), by the University of Castilla-La Mancha. Currently, he is occupying the position of Associate Professor at the Faculty of Computing and Information Technology, and as Advisor of the Vice-President for Development for the University International Relationships and Ranking, at the King Abdulaziz University (Jeddah, Saudi Arabia). With several years of experience on effective solutions for the improvement of universities rankings, Habib has diversified his work along many areas that are key factors in the improvement of the overall academic and research reputation. And, gained the experience of the creation of long/short-terms strategic plans and management towards excellence.

Dr. Jaime Alberto Romero Infante
Representative of Rector, El Bosque University, Colombia

Dr. Jaime Alberto Romero Infante taking his Doctorate in Civil Engineering at Politecnico di Milano. His areas of activities including social sciences, economy, business, civil engineering, technology, management, environmental and geological engineering, industrial biotechnology, bioproducts, and production engineering. Currently he is the Director of Environmental business management Master program at El Bosque University. He also has many experiences as member of the board of directors, member of the board of directors, board member of the Faculty of Engineering, tenured professor, jury in evaluation committees, and as consultant in Technical production-Scientific and Technological Consulting and Technical Report.

Prof. Nisar Ahmed Siddiqui
Vice Chancellor, Sukkur IBA University, Pakistan

Prof. Nisar Ahmed Siddiqui became the Director (Vice Chancellor) of Sukkur Institute of Business Administration in 2004, after gaining wide experience in Management, Administration, and Academia at national and international levels. He obtained his full time master's in economics from University of Sindh, Jamshoro. His academic achievement was rewarded with a Gold Medal. He proceeded to the USA in 1987 and did his MBA with major in Finance from Boston University. He has also the experience of working as Managing Director SITE (Sindh Industrial Trading Estate). Recently, in recognition of his valuable services for the education of Pakistan, Government of Pakistan has bestowed him with Sitara-e- Imtiaz.

Mr. Pascal Caizergues
Representative of Dean, Inseec U., France

Mr. Pascal Caizergues is Manager of Quality and CSR at Inseec U. He was taking his two master's in economy, Finance, and International Affairs, and Master of Risk Management, Quality and Decision at Aix-Marseille University. He has skill in management.

Mr. Chris Fogarty
Representative of University of Limerick

Mr. Chris Fogarty is a qualified accountant (ACA certicication by Chartered Accountants Ireland) in 2014. He obtained his diploma from Maynooth University in 2011. He has many experiences as quantity surveyor and audit team. Currently he is active as Energy Manager, The Buildings and Estates Department, University of Limerick

About Universitas Indonesia

Universities, today, are uniquely positioned to address global challenges. As the result thereof, Universitas Indonesia (UI) is fully committed to seek solutions to the century's most pressing global challenges, enhance the education of future leaders and strengthen its academic endeavor. UI is innovative within our own institutions, in terms of how we are structured and governed and how we adapt to global challenge.

Having experience from year 1849 in higher education, our university is rich in history, academic excellence and its contribution to both Indonesian and international society. UI plays an active role on higher learning associations in Asia Pacific, Europe, Southeast Asia, and worldwide association such as APRU (Association of Pacific Rim Universities), ASAIHL (Association of South East Asia Institution of Higher Learning), and AUN (ASEAN University Network), in which UI is the host for AUN Credit Transfer Secretariat. Quality Culture is one of UI mottos to preserve and improve the good quality in academic and non-academic aspects, in order to provide the best services to its stakeholders. In return, UI retains its position to be amongst the top 400 universities in the world. UI is also an active member of ASEAN University Network – Quality Assurance (AUN-QA) since 2002. In 2017, UI completed the AUN QA Assessment at Institution level and received a better than adequate level (score 5 out of 7). In 2016, Undergraduate study program of Chemical Engineering received JABEE accreditation. Until 2018, 28 undergraduate study programs have accomplished AUN-QA assessment at study program level, Magister Public Health Study Programme has achieved accreditation through Asia Pacific Academic Consortium for Public Health (APACPH), and Magister Management Study Programme has been accredited by the Alliance on Business Education and Scholarship for Tomorrow (ABEST 21). Furthermore, also in 2018 Department of Management accredited by AMBA and Chemistry undergraduate study program received accreditation from Royal Society of Chemistry. UI is ranked 292 in QS World University Ranking 2018 and ranked among 600 best universities in Times Higher Ranking. On the Times Higher Innovation and Impact ranking based in Sustainable Development Goals (SDGs) released on April 2019, UI ranked 80.

Last but not least, the campus of UI is located in greeneries consisting of 320 hectares with 6 lakes. The university maintains the ecology conservation while developing world class academic facilities. In addition to that, as a member of IREG Observatory on Academic Ranking and Excellence (IREG observatory), UI has released UI GreenMetric University Rankings that ranks universities throughout the world according to appointed indicators of campus environmental issues such as setting and infrastructure, energy, waste management, water, transportation, and education for the past 8 years. Currently, UI have 46.000 students and approximately 6,000 academic staffs.

Landscape of Universitas Indonesia, Depok Campus

About University College Cork

University College Cork (UCC) is a constituent university of the National University of Ireland, and located in Cork, Ireland. UCC, a world-class university, which is a long-established university with distinguished history founded in 1845. Its motto 'Where Finbarr Taught, Let Munster Learn,' refers to the 6th century Saint Finbarr, whose monastery and school once stood nearby.

UCC is proud to be ranked in the top 2% of universities in the world. UCC opened its gates to just 115 students in 1849. UCC now have a student population of over 21,000.'

The landscaped gardens and surrounds of UCC are known as 'the quad' and superstition holds that students crossing the quad before graduation risk bad luck and failure in exams. Alongside the quad, the university is centred around its Aula Maxima – the Great Hall, which acts as the ceremonial and symbolic heart of the university. The Hall's design, inspired by the great universities of the Middle Ages, was the work of renowned Irish architects Thomas Deane and Benjamin Woodward.

UCC is the first university in the world to be awarded the international Green Flag for environmental friendliness. UCC was ranked 21st in the world in the inaugural 2019 Times Higher Education (THE) University Impact rankings placing it as Ireland's leading university that is working towards the development of the world in a sustainable way. It has been ranked as one of the leading universities in the world for sustainable social and economic impact.

UCC was ranked number 1 in the world for its work in assisting the UN goal of 'responsible consumption and production'. The transition to sustainable consumption and production of goods and services is necessary to reduce negative impacts on our climate and environment, and on people's health. UCC was also ranked number 1 in Ireland for working towards the UN goal of 'peace, justice and strong institutions' (12th globally) and number 3 in Ireland (21st globally) for its contribution towards the UN goal of 'good health and well-being.'

UCC has a consistent record of being recognised as an international leader in sustainability. It is the only university in Ireland to make the top 10 in the UI GreenMetric World University 2018 rankings of the 'greenest' universities in the world, and UCC also holds a gold star rating from the Association for the Advancement of Sustainability in Higher Education (AASHE). Later this month experts from more than 30 countries will gather at UCC for a major international sustainability rankings conference.

Landscape of University College Cork, Ireland

Participant List

TITLE	FULL NAME	NATIONALITY	INSTITUTION	POSITION	EMAIL
Prof.	**Patrick O'Shea**	Ireland	University College Cork	President	president@ucc.ie
Prof.	**John O'Halloran**	Ireland	University College Cork	Deputy President	j.ohalloran@ucc.ie
Mr.	**Mark Poland**	Ireland	University College Cork	Director of Buildings and Estates	mpoland@bldg.ucc.ie
Prof.	**Riri Fitri Sari**	Indonesia	UI GreenMetric	Chairperson	riri@ui.ac.id
H.E. Mr.	**Simon Coveney**	Ireland	Prime Minister of Ireland	Ireland's Deputy Prime Minister	-
Dr.	**Michael John O'Mahony**	Ireland	The National Trust for Ireland	Dir. of the Env Ed. Unit, An Taiscer	-
Dr.	**Maria Kirrane**	Ireland	University College Cork	Sustainability Officer	m.kirrane@ucc.ie
Assoc. Prof.	**Kitikorn Charmondusit**	Thailand	Mahidol University	Vice President	kitikorn.cha@mahidol.ac.th
eng.	**Sandro Petruzzi**	Italia	University of Torino	Director	sandro.petruzzi@unito.it
PhD	**Freddy Leonardo Franco Idarraga**	Colombia	Universidad Nacional de Colombia	Dir. of the sustainability area (Manizales)	flfrancoi@unal.edu.co
Mr	**Andy Nolan**	United Kingdom	University of Nottingham	Director of Estates (Sustainability)	Andrew.nolan@nottingham.ac.uk
Prof.	**Klaus Helling**	Germany	Environmental Campus, Trier Univ. of Applied Sciences	Representative of Rector	k.helling@umwelt-campus.de
Prof. Dr.	**Klaus Rick**	Germany	Environmental Campus, Trier Univ. of Applied Sciences	Sustainability Studies	k.rick@umwelt-campus.de
Mr.	**Antonio Jose Guerrero Lucendo**	Spain	Universidad Miguel Hernandez de Elche	Environmental Officer	aguerrero@umh.es
Ms.	**Samantha Fahy**	Ireland	Dublin City University	Sustainability Manager	samantha.fahy@dcu.ie
Prof.	**Martin O'connor**	France	INSEEC U	Representative of Dean	pascal.caizergues@esce.fr
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Workshop Program

<table>
<tr><th colspan="2">THE 5th INTERNATIONAL WORKSHOP ON UI GREENMETRIC WORLD UNIVERSITY RANKINGS (IWGM 2019)
"Sustainable University in a Changing World: Lessons, Challenges and Opportunities"
14-16 April 2019
University College Cork, Ireland</th></tr>
<tr><th colspan="2">DAY 1: 14 APRIL 2019 - SUNDAY</th></tr>
<tr><td>Timing</td><td>Session</td></tr>
<tr><td>Whole day</td><td>Arrival of participants</td></tr>
<tr><td>01:00 PM – 02:00 PM</td><td>Networking Lunch (by invitation)</td></tr>
<tr><td>02:00 PM - 05:45 PM</td><td>UI GWURN Steering Committee Meeting (by invitation)
Venue: North Wing Council Room, Main Quadrangle, UCC
1. Welcome of National Coordinators, quorum established
2. Secretariat UI GreenMetric (Prof. Riri Fitri Sari, Mr. Junaidi, M.A., and Dr. Nyoman Suwartha)
3. Adoption of the agenda
4. Remarks by Prof. Riri Fitri Sari, Chairperson of UI GreenMetric
5. Remarks by Prof. John O'Halloran, Deputy President of University College Cork
6. Adoption of the minutes of the 2nd Steering Committee Meeting in Semarang, 8 April 2018 (Doc. 3)
7. Report of Activities of UI GWURN and national coordinators:
1.) Prof. Tadeu Malheiros, Representative of Rector, University of Sao Paulo (USP), Brazil
2.) Dr. Freddy Leonardo Franco Idarraga, Representative of Rector, Universidad Nacional de Colombia and Dr. Jaime Alberto Romero Infante, Representative of Rector, El Bosque University, Colombia
3.) Mr. Pascal Caizergues, Representative of Dean, Inseec U., France
4.) Dr. Mochamad Arief Budihardjo, Representative of Rector, Universitas Diponegoro, Indonesia
5.) Prof. Mirko Degli Esposti, Deputy Rector, University of Bologna, Italy
6.) Prof. John O'Halloran, Deputy President, University College Cork, Ireland
7.) Mr. Juris Iljins, Representative of Rector, Riga Technical University, Latvia
8.) Prof. Nisar Ahmed Siddiqui, Vice Chancellor, Sukkur IBA University, Pakistan
9.) Prof. Paulo J. S. Cruz, Pro-Rector for Quality of Life and Infrastructures, Universidade do Minho, Portugal
10.) Dr. Sc. Redina Margarita Mikhailovna, Representative of Rector, RUDN University, Russia
11.) Prof. Habib M. Fardoun, Representative of Rector, King Abdul Aziz, Saudi Arabia
12.) Dr. Chang Hsien Tai, President, National Pingtung University of Science and Technology (NPUST), Chinese Taipei
13.) Prof. Mustafa Çufalı, Rector, Bulent Ecevit University, Turkey
14.) Kitikorn Charmondusit, Ph.D., Acting Vice President for Environment and Sustainable Development, Mahidol University, Thailand
15.) Prof. Dr. Sany Sanuri Mohd. Mokhtar, Representative of Vice-Chancellor, Universiti Utara Malaysia, Malaysia
16.) Mr. Andy Nolan, Representative of Vice-Chancellor, University of Nottingham, United Kingdom
17.) Dr. Esmail Karamidehkordi, Representative of President, University of Zanjan, Iran (by skype)
18.) Mr. Abzal Abdramanov, Representative of Rector, Kazakh National Agrarian University, Kazakhstan (by skype)
19.) Dr. Dario Liberona, Representative of Rector, Universidad Federal Tecnico Santa Maria, Chile (read by Mr. Junaidi)
8. Discussion on the future activities of UI GWURN
- Shaping Global Higher Education and Research in Sustainability</td></tr>
</table>

	(Research Collaboration, PIC: The University of Zanjan and Universiti Utara Malaysia) - **Creating Global Sustainability Leaders** **(Student Mobility, PIC: University of Sao Paulo)** - **Partnering on Solutions to Sustainability Challenges** **(World University Campus Tour, PIC: University of Nottingham, Bangor University, Nottingham Trent University)** 10. Any other business 11. Closing	
06:30 PM – 07:30 PM	Registration for Dinner and Drinks South's Bar, Imperial Hotel, Cork City	
07:30 PM - 10:00 PM	**Dinner and UI GreenMetric Awards Presentation (all participants)** Venue: Imperial Hotel, Cork City	
DAY 2: 15 APRIL 2019 – MONDAY Venue: UCC Western Gateway Building, Western Road, Cork		
08:00 AM - 09:00 AM	**Registrationof Delegates**	
09:00 AM - 09:30 AM	**Opening Speeches** Venue: Room 1.07, Western Gateway Building • **Prof. Patrick O'Shea,** President, University College Cork • **H.E. Mr. Simon Coveney,** Ireland's Deputy Prime Minister • **Prof. Riri Fitri Sari,** Chairperson, UI GreenMetric World University Rankings	
09:30 AM - 10:30 AM	**Keynote Addresses** • **Dr. Michael John O'Mahony,** Director of the Environmental Education Unit, An Taisce (The National Trust for Ireland) • **Dr. Gerard Mullally**, Department of Sociology, University College Cork, Ireland	
10:30 AM - 10:40 AM	Group photo	
10:40 AM - 10:50 AM	The Signing of Declaration of Membership of UI GreenMetric Network	
10:50 AM - 11:00 AM	Coffee Break	
11:00 AM - 12:15 PM	**Parallel Session 1 A** **Issues and Innovation in Managing Setting and Infrastructure** Venue: G.01, Western Gateway Building Chair: **Prof. Paulo J. S. Cruz** Pro-Rector for Quality of Life and Infrastructures *Universidade do Minho, Portugal* *(3 presentations – 15 Minutes Each)* Speakers: • ***Eco-University Policy and Implementation of Mahidol University, Thailand*** **Kitikorn Charmondusit, Ph.D.,** Acting Vice President for Environment and Sustainable Development, Mahidol University, Thailand • ***Green as a decision-making driver for planning infrastructures and actions*** **ing. Sandro Petruzzi,** Representative of Rector, University of Turin, Italy • ***Universidad Nacional De Colombia a Multicity-Multicampuses University***	**Parallel Session 1B** **Issues and Innovation in Managing Energy and Climate Change** Venue: Room G.03, Western Gateway Building Chair: **Dr. Chang-Hsien Tai** President National Pingtung University of Science and Technology, Chinese Taipei *(4 presentations – 15 Minutes Each)* Speakers: • ***Growing Bigger and Reducing Carbon - The Challenge*** **Mr. Andy Nolan**, Representative of Vice-Chancellor, University of Nottingham, UK • ***Mission Zero Emission - Managing Energy and Climate Change at the Environmental Campus Birkenfeld*** **Prof. Dr. Klaus Helling**, Representative of President, Umwelt - Campus Birkenfeld, Germany

	Dr. Freddy Leonardo Franco Idarraga, Representative of Rector, Universidad Nacional de Colombia, Colombia *Question and Answer*	• ***Calculation and Registration of the Carbon Footprint of the Miguel Hernandez of Elche University (Spain)*** **Mr. Antonio Jose Guerrero Lucendo,** Representative of Rector, Miguel Hernández of Elche University, Spain • ***Energy Exceeding the 2020 target of 33% Energy Efficiency: Dublin City University*** **Ms. Samantha Fahy,** Representative of President, Dublin City University, Ireland *Question and Answer*
12:15 PM – 13:15 PM	Networking Lunch	
13:15 PM – 14:30 PM	**Parallel Session 2 A** **Issues and Innovation in Managing Waste** Venue: G.01, Western Gateway Building Chair: **Dr. Maria Kirrane** Sustainability Officer University College Cork, Ireland *(3 presentations – 15 Minutes Each)* Speakers: • ***Digital Transformation & Waste Management as Twin Vectors for Transition towards Sustainability*** **Prof. Martin O'Connor,** Representative of Dean, Inseec U, France • ***Sustainability Culture at USP –São Carlos Campus*** **Prof. Tadeu Malheiros,** Representative of Rector, University of Sao Paulo (USP), Brazil • ***Engagement students toward single use plastics reduction in KMUTT Thailand*** **Dr. Suchada Chaisawadi**, Representative of Rector, King Mongkut.s University of Technology Thonburi, Thailand *Question and Answer*	**Parallel Session 2 B** **Issues and Innovation in Managing Water** Venue: Room G.03, Western Gateway Building Chair: **Prof. Mirko Degli Esposti** Deputy Rector **University of Bologna** *(4 presentations – 15 Minutes Each)* Speakers: • ***The sustainable agenda of the University of Groningen*** **Mr. Dick Jager**, Representative of Rector, University of Groningen, Netherland • ***Implementation of Integrated Water Resources Management Practices at the Universidad Autónoma de Occidente (UAO)*** **Dr. Mario A. Gandini**, Representative of Rector, Universidad Autónoma de Occidente, Colombia • ***Water Sustainability in Campus: A Framework in Optimizing Social Cost*** **Prof. Dr. Sany Sanuri Mohd. Mokhtar**, Representative of Vice-Chancellor, Universiti Utara Malaysia, Malaysia *Question and Answer*
14:30 PM – 14:45 PM	Coffee Break	
14:45 PM – 16:00 PM	**Parallel Session 3 A** **Issues and Innovation in Managing Transportation** Venue: G.01, Western Gateway Building Chair: **Dr. Sc. Redina Margarita Mikhailovna** Dean of the Ecological faculty RUDN University, Russia *(4 presentations – 15 Minutes Each)* Speakers: • ***15 years of Innovation in Sustainable Mobility*** **Denyse Rémillard, Ph.D.,** Vice – Principal Adm. and Sustainable Development, Université de Sherbrooke, Canada	**Parallel Session 3 B** **Issues and Innovation in Managing Education and Research** Venue: Room G.03, Western Gateway Building Chair: **Mr. Juris Iljins** Representative of Rector Riga Technical University, Latvia *(4 presentations – 15 Minutes Each)* Speakers: • ***Activities of student-centered Practical Environmental Education at Shinshu University*** **Prof. Kiyoshi Tanaka,** Vice President of International Affairs and Director of Global

<table>
<tr><td></td><td>• Achieving a modal shift and improving sustainability at UL
Mr. Chris Fogarty, Representative of President, University of Limerick, Ireland
• Sustainability plan and sustainable mobility management at the University of Milano-Bicocca
Prof. Matteo Colleoni, Representative of Rector, University of Milan-Bicocca, Italy
• NPUST Sustainable Operation and the Development of Circular Economies
Dr. Chang-Hsien Tai, President, National Pingtung University of Science and Technology, Chinese Taipei

Question and Answer</td><td>Education Center, Shinshu University, Japan
• Sustainable University in a Changing World Strategic action to develop a sustainable university – Case Study Wageningen University & Research
Mr. Joris Fortuin, Representative of Rector, Wageningen University & Research, Netherland
• King Abdulaziz University initiatives in the establishment of climate change research center
Prof. Mansour Almazroui, Representative of Rector, King Abdulaziz University, Saudi Arabia
• Publications and Course Units for the Sustainable Goals
Ms. Luciana Sacchetti, Representative of Rector, Universita di Bologna, Italy
Question and Answer</td></tr>
<tr><td>16:00 PM – 16:05 PM</td><td colspan="2">Report of University of Zanjan, Iran (Host of IWGM 2020)
• Dr. Esmail Karamidehkordi, Director of International Scientific Cooperation Office, University of Zanjan, Iran</td></tr>
<tr><td>16:05 PM – 16:15 PM</td><td colspan="2">Closing Remarks
• Prof. Riri Fitri Sari, Chairperson of UI GreenMetric</td></tr>
<tr><td>16:15 PM - 17:15 PM</td><td colspan="2">Campus Tour</td></tr>
<tr><td>17:30 PM – 19:00 PM</td><td colspan="2">Closing Reception, Aula Maxima, University College Cork</td></tr>
<tr><td colspan="3">DAY 3: 16 APRIL 2019– TUESDAY
Complimentary Tour</td></tr>
<tr><td>09:00 AM – 09:30 AM</td><td colspan="2">Transfer to Blarney Castle, Meet at Western Gateway Building or River Lee Hotel</td></tr>
<tr><td>09:30 AM – 12:00 AM</td><td colspan="2">Exploring Blarney Castle</td></tr>
</table>

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University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

UNIVERSITAS INDONESIA

UI GreenMetric
World University Rankings

ISBN 978-979-456-799-9
9 789794 567999