

**A thesis submitted to the Department of Environmental Sciences and Policy of
Central European University in part fulfilment of the
Degree of Master of Science**

**The role of Global University Partnership for Environment and Sustainability in
greening universities: CEU as a case study**

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July, 2014

Budapest

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ABSTRACT OF THESIS submitted by:

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The role of universities in promoting sustainability is widely recognized. It is not only in disseminating knowledge, but also in being an example of best environmental practice and taking the leadership position in achieving sustainable development in the world. That's why a great importance gains a goal to transform universities into green and sustainable campuses, with the capacity to address climate related risks, to reduce resource consumption and improve operational efficiency.

In the last decades universities tend to unite in associations, networks and partnerships, understanding the importance to cooperate, build the ties and combine efforts in achieving sustainability. One of the biggest partnerships is Global University Partnership for Environment and Sustainability (GUPES), launched by UNEP in 2012. In 2013 GUPES published "Greening Universities Toolkit", which is a guiding document for universities willing to perform green transformation of their campuses.

The paper is going to explore the role of GUPES in greening universities. For this purpose the case study of Central European University, which became a member of GUPES in 2013, will be analyzed. The paper will illustrate the research conducted in order to follow the recommendations in the "Toolkit", going through all the stages, from recognizing need for action, though establishing the baseline for CEU, making comparative analysis with Tongji University, GUPES member and exemplar of best environmental practice, to formulating Green Action Plan for CEU. The paper will show the contributions made by GUPES at each stage and finally will underscore the role of GUPES in the whole process.

Keywords: SUSTAINABLE CAMPUS, GREENING UNIVERSITIES, RESOURCE EFFICIENCY, UNIVERSITY PARTNERSHIP, TOOLKIT, GREEN INITIATIVE, ACTION PLAN

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1. Introduction

1.1 Introduction

Integrating sustainability into practices across the triple bottom line is becoming a key priority for many organizations nowadays, because it is resulting in minimizing environmental and social impacts, reducing costs and increasing of operational efficiency (Cole and Fieselman 2013).

Universities play the leading role in developing and disseminating knowledge in society (Figueredo and Tsarenko 2013). They can also become leaders in promoting sustainability worldwide by generating solutions to face environmental issues (Filho 2011). They can serve as agents of sustainable development on campuses by transforming them into sustainable model of best environmental practice through improving resource conservation and efficiency, addressing climate related risks, stimulating behavioral and consumption patterns change etc. (Schaffer 2012).

The establishment of partnerships between universities can help to advance sustainability on campus and in social communities by developing international cooperation and establishing platforms for sharing knowledge and experience in integrating sustainability initiatives into university action plans (Posner and Ralph 2013).

1.2 Aim and objectives of the research

The **aim** of this research is to assess the role of Global University Partnership for Environment and Sustainability in transforming universities into sustainable campuses with CEU as a case study. This implies understanding the mechanism of cooperation within the Partnership and its member-universities. The secondary but not the less important aim of the study is using this mechanism to contribute to formulation Action Plan for CEU, which is aimed to transform CEU into green and sustainable campus.

Therefore the main research questions under this research are:

- 1) What is the aim, objectives and methods of GUPES and which role it plays in promoting sustainability in universities and greening university campuses?

- 2) How sustainable is CEU now and how the situation will change after Redevelopment Project?
- 3) What are the most successful strategies used by GUPES member universities - global exemplars of best practice - on their way to sustainability?
- 4) Which are the best greening strategies, potentially applicable to CEU?
- 5) Which green actions could be incorporated into CEU Action Plan aimed to transform CEU into sustainable campus?

Therefore the detailed objectives were developed in order to find the answer to the research questions. The objectives are the following:

- 1) To explore aim, objectives and methods of GUPES and its “Greening Universities toolkit” as a guideline for steps to transform universities into sustainable campuses and to assess role of GUPES in transition of universities to sustainability;
- 2) To explore the current situation in CEU regarding implementation of sustainable practices and green initiatives as well as changes after Redevelopment Project and assess their compliance to suggested strategies in the “GUPES Toolkit”;
- 3) To study the most successful strategies used by GUPES member – Tongji University - global exemplar of best practice - on the way to sustainability;
- 4) Based on the collected data from both the GUPES toolkit and Tongji University, to conduct a comparative analysis of Tongji and CEU and to identify the best strategies, potentially applicable to CEU;
- 5) To formulate recommendations to contribute to developing an Action Plan for transforming CEU into a green and sustainable campus.

1.3 Limitations of the study

The main limitations faced during the research were the following:

- 1) Due to time constrain the study was limited to only one university – exemplar of best practice – Tongji University. Longer time would allow more comprehensive research involving bigger number of green universities to be studied and larger number of green initiatives to be explored more detail.
- 2) The ideal situation would involve choosing a Green University as a case study, which would be similar to CEU (size, local conditions etc.), that

preferably was located in Hungary, Budapest in order to have identic local conditions, which would facilitate the comparative analysis, but unfortunately currently no such university exist in Budapest.

- 3) Another limitation of this research is lack of knowledge on all the existing green technologies, including modern innovations.
- 4) The experience from the literature research in the area so far suggested that there is a lack of well documented and published data on costing of university greening actions, as well as difficulties in assessment of these costs for different universities, as they vary a lot depending on huge amount of factors including local conditions.
- 5) Ranking or weighting of actions as per their importance or relative contribution to sustainability is one of the major areas of contention. Similar to cost there is no simple and easy answer to this. Again, depending on the place and time this would and should change. However, existing numerous global and regional environmental/sustainability rating systems and tools that are being used for rating sustainability performance of everything starting from materials and products through to buildings, precincts and even cities were explored. These rating tools and assessment frameworks employ their own criteria for weighting, which is generally based on extensive research and consultations. The fact that no similar work was conducted for CEU with the help of stakeholder workshops and consultations, makes a serious limitation.
- 6) Ranking system used in the assessment of green initiatives is not 100% match with actions in Toolkit, therefore the amount of points awarded might not reflect the true score used in the original ranking system.
- 7) The “GUPES Toolkit” doesn’t provide information on costs of actions and their ranking as well. Therefore, categories developed for justification of their choice for CEU Action Plan, are quite approximate.
- 8) One important limitation is the fact that there is no data collected on the regular basis on biophysical characteristic in CEU. This makes it hard to establish a baseline for CEU, as well as impossible to create sustainability indicators at this stage.
- 9) The last but very important constrain is the limited budget in CEU targeted for sustainability purposes. This fact put limitation on selection of green initiative that could be incorporated into CEU Action Plan and further

implemented in CEU. It was the cause of need to justify the selection of green initiatives under the category combining “high ranking” and “low cost” as first priority actions.

1.4 Thesis outline

The complete thesis is comprised of seven chapters. Chapter 1 is the introduction, explaining the research aim, objectives and the limitations of the study. Chapter 2 gives focus on the most important facts, concepts in university sustainability, university partnerships and sustainability ranking systems and tools. Chapter 3 gives justification of selected research design and the methodological approach of this research. Chapter 4 is dedicated to presenting the results of exploring current situation in CEU regarding green initiatives implemented on campus. It also gives the description and assessment of CEU Redevelopment Project. Chapter 5 presents the main results of research of the case study of Tongji University as an exemplar of best environmental practice and top green campus. The data analysis and presentation are covered in Chapter 6. This chapter gives a comparative analysis of CEU and Tongji University and draws the categories developed for justification of selection of green initiatives applicable to CEU. The last Chapter 7 contains the recommendations of green initiatives that could be potentially incorporated in CEU Action Plan. The conclusion section is the brief summary of overall findings of the research. It explains the role of GUPES in the overall process of research and in greening universities in general.

2. Literature review

2.1 Universities and sustainability

Universities can play a leading role in the transition to sustainability, being centers of learning and catalyzers of political and social action (Forrest and Wiek 2012). In modern time of multiple environmental and sustainability challenges universities are coming under increasing pressure to face the situation and respond to environmental issues and associated risks. But recognizing the transformative role of universities implies that they need to transform themselves first (Karatzoglou 2013).

The concept of sustainable universities is about including sustainability in all aspect of life of higher education institutions (Geng *et al.* 2013). This concept has formed on ideas of the transition movement, pillars of sustainability and many other contributions (Koester *et al.* 2006). Universities all around the world have increasingly involved sustainability into their practice since the 1970s through implementation of environmental programmes and by greening their campuses (by reduction of waste production and energy consumption, building low and carbon-neutral etc.) (Olszak 2012). Many universities worldwide have signed international declarations towards implementing sustainability initiatives (Lukman *et al.* 2010). The most significant among them are shown on Figure 1.

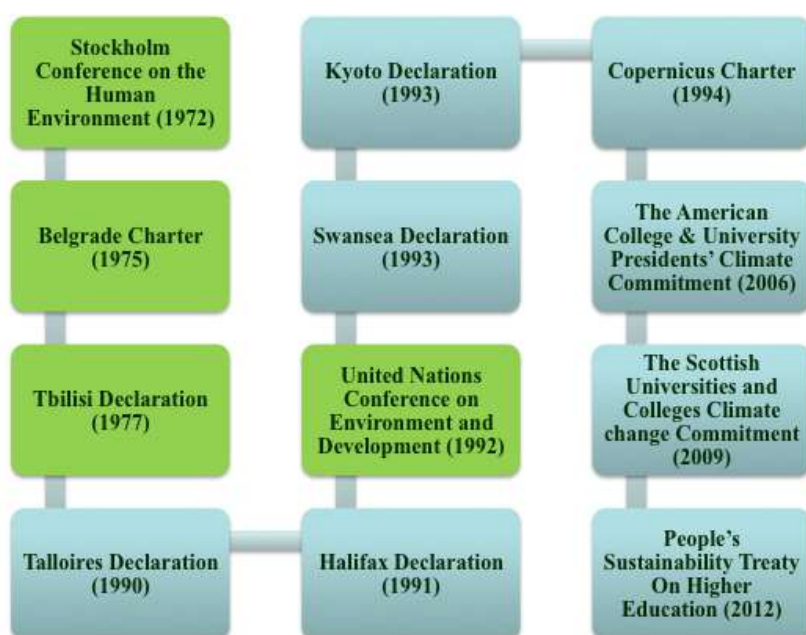


Figure 1. International declarations implementing sustainability in higher education institutions

A concept of sustainable university may be summarized as “one in which the activities of a university are ecologically sound, socially and culturally just and economically viable” (Alshuwaikhat and Abubakar 2008). A transition path towards sustainability in a particular university should reflect the social, cultural, economic and ecological circumstances of the region in which that university is located (Müller-Christ *et al.* 2014; Parece *et al.* 2013). It is precisely expressed by distinct foundational principles, which characterize university on the way towards sustainability:

- Clear formulation and assimilation of social, ethical and environmental concern in the university’s vision, mission and curriculum (Patel and Patel 2012);
- Interdisciplinary, critical thinking and “quadruple bottom line” approach to sustainability governance and research;
- Involving of the wider community, partnerships with institutions, industrial, governmental, non-governmental organizations (Ogbuigwe 2010);
- Sustainable campus design and planning aimed to achieve and surpass zero net carbon/water/waste (Mason *et al.* 2003);
- Regular monitoring, reporting and constant improvement (Lukman *et al.* 2009);
- Promotion of equity, cultural diversity and quality of life for students, university staff, and the local community (Silveira Marques Pereira *et al.* 2014);
- The campus as “living laboratory” – student participation in transforming the learning environment (Holmberg *et al.* 2012);
- Networks to encourage and maintain cooperation among universities on the regional and international level (Sedlacek 2013).

The features and responsibilities of a sustainable university as organization, teaching and research institution are expressed on Figure 2.



Figure 2. Features and responsibilities of a sustainable university (Osmond *et al.* 2013)

2.2 University partnerships

According to (Bekessi *et al.* 2007), becoming signatory to international declarations is very important for the success of implementing sustainability strategies. Apart from positive publicity for university, signing an international declaration has several functions (Lozano *et al.* 2013):

- it arouses attention;
- it gives excellent guidelines for transition to sustainability;
- it assigns university's progress on the way to sustainability to public consideration.

However, while these international declarations encourage progress and offer general guidance, they are not designed to provide specific direction, don't necessarily lead to implementation of its principles and thus are not sufficient to change institutional practices (Bilodeau *et al.* 2014). A critical role in putting sustainable strategies into practice of universities campuses belongs to international universities partnerships and networks combined with government support (Borgia *et al.* 2011).

The first example that had global influence on catalyzing efforts of universities is US and Canadian University networks. It generated Higher Education Sustainability Act (Alshuwaikhat and Abubakar 2008) organizing 'University Sustainability Grants Program' which got a budget of more than \$50 million for support the implementation of sustainability initiatives on campus (Osmond *et al.* 2013). In 2010 the UK government introduced a carbon emission reporting – Carbon Reduction Energy Efficiency Scheme – mandatory for not intensive in energy sectors of economy, including higher education (Alonso-Almeida *et al.* 2011; Townsend and Barrett 2012). According to it, universities are required to measure and report their carbon emissions every year. Together with it, UK Funding Council developed Carbon Strategy setting carbon reduction targets for universities (Borrero 2010; Townsend and Barrett 2012).

University partnerships began to form in 1980s as universities started to recognize the increasing importance to cooperate, to learn on best practice and to combine resources and efforts in addressing common environmental issues. Nowadays many university associations, coalitions and partnerships exist on international and regional level (Lopez 2013; Ogbuigwe 2008). The most famous of them on the international level are represented in Table 1.

On the regional level partnerships bring together universities committed to sustainable agenda, the largest of them are listed in Table 1. The number of members has grown significantly in all of them recently (Lozano *et al.* 2013).

Table 1. The most famous international and regional university partnerships and networks

Scope of partnership	Name of partnership
International	Global Higher Education for Sustainability Partnership University Leaders for a Sustainable Future Association for the Advancement of Sustainability in Higher Education Global University Network for Innovation International Sustainable Campus Network International Alliance of Research Universities Global Universities Partnership for Environment and Sustainability
Regional	Copernicus Alliance Japanese Higher Education for Sustainable Development Network Pasific Network of Island Universities Australasian Campuses Towards Sustainability Network Mexican Consortium University for Sustainable Development Association for the Advancement of Sustainability in Higher Education (US) Mainstreaming Environment and Sustainability in African Universities Partnership

University partnerships and networks have a number of advantages to help universities on the way of transformation into sustainable campuses (Pacheco *et al.* 2006). They include:

- combination of forces and efforts of universities for achieving sustainable campus operations;
- scientific and academic cooperation (Labodová *et al.* 2014);
- global forum to exchange information, ideas and promising practices (Khalifa and Sandholz 2012);
- diverse community engaged in partnership;
- great opportunities for professional development and improvement based on competitiveness and demonstration of success;
- creation of incentives for universities by developing various award schemes (Trencher *et al.* 2013).

2.3 GUPES

One of the biggest and the most successful university partnerships on international scale is the Global Universities Partnership on Environment for

Sustainability (GUPES). It was formed from 3 successful university partnerships: the Mainstreaming Environment and Sustainability in African Universities (MESA), the nascent Mainstreaming Environment and Sustainability in the Caribbean Universities (MESCA) and the Asia-Pacific Regional University Consortium (RUC) (Osmond *et al.* 2013).

It was established by UNEP and its partners to increase successful engagement with universities around the three pillars of education, training and applied research. Its activities are focused on informing and supporting universities to implement curriculum improvements for sustainability and greening of universities campuses, increasing awareness on UNEP's priority thematic areas, sustainability issues and emerging concepts such as 'Green economy', facilitating gaining of relevant skills by university policy makers, strengthening collaboration on environment and sustainability between universities on all continents, UNEP regions as well as in North-South and South-South frameworks all taking part in the GUPES network (Osmond *et al.* 2013).

More than 420 universities from five continents of the world are now part of this network. CEU also became a member of GUPES in 2013.

2.4 Greening universities toolkit

Under the umbrella of GUPES was published a toolkit titled Greening Universities Toolkit: Transforming Universities into Green and Sustainable Campuses. Its objective is "to inspire, encourage and support universities to develop and implement their own transformative strategies for establishing green, resource-efficient and low carbon campuses. It aims to encourage and promote higher education's contribution to the overall sustainability of the planet" (Osmond *et al.* 2013).



Figure 3. The main sections of the Greening Universities Toolkit (Osmond *et al.* 2013)

The main focus of the Toolkit is sustainable design and planning of university's campuses, ways and strategies for its successful management in order to complete transformative process into 'green, low carbon institutions with the capacity to address climate change, increase resource efficiency, enhance ecosystem management and minimize waste and pollution' (Osmond *et al.* 2013) (Figure 3).

2.5 Global exemplars

One of the objectives of the Greening Universities Toolkit is 'to provide information that can assist universities that are beginning their journey of campus greening' (Osmond *et al.* 2013). So one of its chapters is dedicated to description of real-world examples of green universities worldwide – members of GUPES - that have achieved success in making their campuses sustainable. Among such universities are Tongji University (China), Copenhagen University (Denmark), Chalmers University (Sweden), New South Wales University (Australia) and many others.

Studying the cases and experience of green universities is supposed not only to inspire and encourage other universities, but also to facilitate learning as it provides important information on general background of universities and issues they were facing, on local conditions and other factors that were outlining the area of action and defined the initiatives implemented. The evidence of measured

improvement helps to assess efficiency of green actions and could help other universities on deciding about their own solutions. This choice can be further supported by evaluation of costs and outcomes achieved of projects implemented. Finally, this study can make an important contribution to understanding different environment issues and opportunities of the university and to formulation of its own green strategies and initiatives.

2.6 Ranking systems of Universities sustainability

Ranking and rating systems are now becoming a comprehensive tool for assessing sustainability level (Baboulet and Lenzen 2010). Yet, they vary a lot in terms of criteria of evaluation, approaches, points assigned etc. Universities has elaborated their own sustainability rating systems or adopted other systems by choosing for assessment separate categories (Nejati and Nejati 2013). Nowadays several such systems exist, the most well known include US Green Building Council, Princeton Review, Greenopia, National Wildlife Federation, Peterson's Guide, Sierra Magazine, Sustainable Endowments Institute, LEED, BREEAM and AASHE STARS (Kamal and Asmuss 2013).

2.6.1 LEED

LEED (Leadership in Energy and Environmental Design) is a famous worldwide green building certification system, which provides the assessment of design and building strategies of a building in such areas as energy and water efficiency, CO₂ emission reduction, indoor quality, resource management etc. (Suwartha and Sari 2013).

It was developed by US Green Building Council (USGBC) and may be applied to all building types, including university campuses. It embraces all the stages of life cycle of the building – from construction to operation and retrofit (Swearingen White 2014).

LEED uses a point system for rating buildings. The scoring is given in 5 main categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, and Indoor Environmental Quality. The higher score corresponds to higher extent of green strategies implemented. The levels of achievements are varied from Certified, Silver, Gold, to Platinum.

LEED is being applied for ranking university sustainability assessing design, construction and operation of new and existing buildings. Four LEED categories are used for this purpose: Building Design and Construction, Core and Shell, Interior Design and Construction, and Operations and Maintenance.

2.6.2 BREEAM

BREEAM is a worldwide recognized rating system of sustainable building design, construction and operation. It uses a wide range of categories for assessing building environmental performance, such as energy and water efficiency, waste reduction, pollution, indoor environment and health, materials and transportation, as well as environmental management practices.

Similar to LEED, BREEAM can be used to measure performance of all kinds of buildings in all stages of life cycle, that is why it is highly used for assessing university campuses. Following BREEAM building code encourages universities to use green technologies to minimize their environmental impact in order to get higher scoring.

BREEAM rating system was developed by UK Green Building Council and is preferred by Universities in the big number of countries across Europe, including Hungary.

2.6.3 AASHE STARS

The Sustainability Tracking, Assessment & Rating System (STARS) is a rating system, which provides a special framework for universities to assess their sustainability performance. STARS was developed by the Association for the Advancement of Sustainability in Higher Education (AASHE), which is an organization founded in 2001 to enhance sustainability in higher education (Crisman 2011).

STARS rating system include such categories of university sustainability as:

- operations (buildings, energy, water, waste, grounds, procurement and transport);
- administration and planning (management, investment and stakeholders engagement);
- education and research (integration of sustainability into university curricular, research and other activities);
- innovations (new sustainable initiatives).

According to Mr. Mahesh Pradhan, head of Global University Partnership on Environment and Sustainability, “STARS is the most suitable ranking system for measuring university sustainability because it embraces all the categories which identify a sustainable university, not only focusing on building performance, but is also assessing integration of green practices into university curricular and everyday life. On the beginning stage of greening the university it can help to establish a baseline, to understand the priorities and set the goals, and to develop stages for university green transformation. In Asian Universities STARS rating system also serves as a platform for sharing data and knowledge on greening university process.”

3. Methods

3.1 Research design

The research has been classified as a combination of exploratory (objectives) and qualitative (inquiry mode) types of research (Kumar 2005). This classification is justified by three main focus questions explaining the purpose of the research:

- 1) What are the main strategies and initiatives that could be implemented in CEU to ensure its sustainability?
- 2) What are the factors that determine applicability of different strategies to a university and which criteria are important for comparative analysis of universities?
- 3) How can GUPES help in greening universities and transforming them into sustainable campuses?

Methods of research were developed to answer these questions. They included two types of surveys – literature survey and field study.

Literature survey had the aim to understand the concept and to explore the main technics of greening universities. A field study had the aim to gain the practical experience of implementation of these technics and strategies. The important part of a field study was also to understand the mechanism of knowledge sharing and cooperation within a university partnership.

3.1.1 Study area

The aim of the research is not only to suggest green initiatives for CEU Action Plan but also to justify their choice. One of the approaches used is based on comparison between CEU and a top green university – member of GUPES.

Tongji University has started its way to sustainability in 2002. As a result in 2007 the university has demonstrated first in China resource-efficient campus (), for which it received a national award of building energy conservation in China. In 2008 Tongji university gained 1st prize in Technology and Science of Chinese Ministry of Education for “Demonstration and Integration of Technologies in Sustainable Campus Construction”. Since then Tongji university has undergone the transformation from resource-efficient campus to sustainable campus, actively integrating sustainability in its management, campus culture, education and research.

And in 2012 it was the first university in Asia-Pacific region to be given “Excellence in Campus Award” by International Sustainability Campus Network (ISCN). Tongji University was the initiator of foundation of the China Green University Network (CGUN) in 2011. The network nowadays consists of 18 members including 8 core universities and 2 research institutes. Tongji University has the first chairmanship in it. In June 2012 Tongji University became one of the cofounders of Global University Partnership on Environment and Sustainability and in 2013 one of the coauthors of “Greening Universities Toolkit”.

The research included the detailed study of both CEU and Tongji campuses, green initiatives implemented as well as local conditions and all the factors that could determine the choice of transition path to sustainability.

3.1.2 Interview targets

In order to answer the research questions, across all the stages of the research open-ended semi-structured interviews were conducted with Sustainability personnel of Universities, university professors and alumni, executive members of University Partnerships, UNEP Education and Training Unit program coordinators. The names and positions of the interviewees are shown in Table 2.

Table 2. List of interviewees

N	Name	Position
1	Mahesh Pradhan	Head of UNEP Education and Training Unit, chief of Global University Partnership for Environment and Sustainability
2	Malay Dave	Professor of New South Wales University (Sydney, Australia), coauthor of «Greening Universities toolkit»
3	Chen Shuqin	Professor of UNEP-Tongji Institute of Environment for Sustainable Development
4	Tan Hongwei	Professor of Tongji University, Director of Institute of Environment for Sustainable Development
5	Sun Jie	Program coordinator, UNEP-Tongji Institute of Environment for Sustainable Development, GUPES Secretariat
6	Haixing Meng	Program coordinator, UNEP-Tongji Institute of Environment for Sustainable Development, GUPES Secretariat
7	John Holmberg	Vice president, UNESCO Chair, Professor of Chalmers University of Technology
8	Jennica Kjällstrand	Environmental manager, Chalmers University of Technology
9	Ulrika Lundqvist	Senior Lecturer, Chalmers University of Technology
10	Stuart Durrant	CEU Campus Redevelopment Director

11	Logan Strenchock	CEU Campus Environmental and Sustainability Officer
12	Shi Han	Professor of City University of Hong Kong

3.2 Research methods

On the preliminary stage of the research the comprehensive literature review was conducted in order to formulate the aim and objectives and to establish a clear perspective on the subject of study. Various journal articles, books and web sources were explored and the importance was given to the following questions:

- what studies have been carried out so far in the area and whether the clear concept of green and sustainable university has been formulated;
- existing approaches in greening universities and scientific opinions on their effectiveness;
- past and current experience of transforming universities into sustainable campuses, case studies at the world-best exemplars of university sustainability;
- which methods and tools exist for assessing university sustainability and which are deemed to be the most comprehensive;
- study of Global University Partnership on Environment and Sustainability and its methods of promoting sustainability in universities worldwide;
- detailed study of the “Green University toolkit” as a guideline for transforming universities into sustainable campuses.

The main ideas on forming of the research strategy were gained through experience and knowledge sharing of leaders and members of GUPES network. After this, the methods were adopted and the main body of research was divided into three different stages.

3.2.1 Stage one

The current status of sustainable practices implementation at CEU has being explored during an internship at the CEU Campus Service Office through data collection on biophysical characteristics and its analysis. Also the Redevelopment Plan was explored and assessed regarding compliance to the “Greening University toolkit”. The internship involved participant observation of the university management and sustainability practices and conducting semi-structured interviews with Office staff members. The analysis allowed to establish the baseline for CEU in the process of transformation into sustainable campus.

After the useful experience was gathered through research conducted in Tongji University as a case study of top green university, member of GUPES network through exploring redevelopment plans, campuses plans, green strategies implemented, data on its costs etc. and semi-structured interviews with university practitioners.

The data collected and analyzed was used to conduct comparative analysis of Tongji University and CEU based on comparison of campuses and local conditions. The comparative analysis helped in assessing applicability of discovered successful strategies to CEU and possibility of their incorporation into CEU Action Plan.

The preliminary research results were presented to and approved by Mr. Mahesh Pradhan, head of UNEP Education and Training Unit and Global University Partnership for Environment and Sustainability.

The essential ideas on campus greening initiatives and approaches were gained within two events:

- on the 5th alumni meeting of Asia-Pacific Universities on Education for Sustainable development during presentation of successful change projects in the field;
- at the International Student Conference on Environment and Sustainable Development through discussion and interviews with professional community and in the group “Education for Sustainable Development”. Feedback was incorporated into the recommendations to CEU Action Plan.

3.2.2 Stage two

At this stage the collected data have been analyzed and the decisions were made regarding the methods of choosing and justifying the appropriate green initiatives for CEU Action Plan. For this purpose the system of categories of green actions were developed based on subcategories of costs of implementation and results ranking.

According to Mr. Malay Dave, professor of New South Wales University and one of the authors of the Greening Universities Toolkit, “there is no “one size fits all” approach to addressing the economic dimension of sustainability. The intent of the “Toolkit” is to provide a conceptual framework, which allows participating universities to take from it what is appropriate to their circumstances. It is very

difficult to determine the approximate cost of implementation or even workout rules of thumb for costing for greening initiatives as these depend on specific conditions, economic contexts, scope and nature of work as well as many other factors that vary with time as well as place”.

The experience from the literature research in this area so far suggested that there is a lack of well documented and published data on costing of university greening actions.

However, the Toolkit’s Section 5 ‘Resources for Change’, which includes a list of international and regional associations, networks and other resources of relevant information existing in this field, was explored. Also the data within the Section 6 of the Toolkit - ‘Global Exemplars’ - that includes some information on costing – was used. Although this information is limited and generally indicates an overall cost/budget only.

Also the information obtained through interviews with Campus Sustainability personnel in Tongji University concerning the costs of green initiatives and technologies implemented on campus was used.

Finally, the collected information on costing of green actions was organized into the table and all the actions were split into two contingent subcategories - “low” and “high cost” actions. These were used further in the analysis.

Ranking or weighting of actions as per their importance or relative contribution to sustainability is one of the major areas of contention. Similar to cost there is no simple and easy answer to this. Again, depending on the place and time this would and should change.

However, existing numerous global and regional environmental/sustainability rating systems and tools that are being used for rating sustainability performance of everything starting from materials and products through to buildings, precincts and even cities were explored. These rating tools and assessment frameworks employ their own criteria for weighting, which is generally based on extensive research and consultations.

It might be useful to do similar work for CEU with the help of stakeholder workshops and consultations.

Also the appropriate rating/assessment system that Tongji University uses was assessed.

Finally, AASHE STARS was chosen as a ranking system of actions in “Greening universities toolkit”. The assessment was based strictly on publicly available information and the standards and guidelines published by the system’s administrator. Using this information two subcategories of green actions were developed – “low” and “high results”.

Having mentioned all of the above, I would like to emphasize that there is the need for greater information and guidance in the Toolkit on cost vs. environmental benefit of greening actions and any updates on expansion of the Toolkit to include that would be very useful. Hopefully the next version would be of more help to everyone looking for similar information.

3.2.3 Stage three

Based on assessment of costs and results ranking of green actions as well as on current situation in CEU, best suitable strategies were identified that could potentially be included into action plan for CEU.

The action were prioritized according to following:

- first priority were given action that have low cost and high result, as well as action having no cost of implementation and high/low result.
- second priority were given actions that have low cost and low result, as well as actions with high costs and very high result/value for CEU.

Another question answered at this stage was about the role of GUPES in greening universities and transforming them into sustainable actions.

4. Current situation in CEU and CEU redevelopment plan

4.1 General information about CEU

Central European University is a university located in Budapest, Hungary. It offers postgraduate education to about 1500 students every year from more than 100 countries. Faculty staff includes around 100 professors from 30 countries.

The total CEU campus does consist of Nador Utca 9, 11, 13, 15, Zryini Utca 14, October Utca 6/7, the CEU dorm, the Business School, and the School of Public Policy. CEU additionally manages the Open Society Archives as well. CEU is located in a world heritage buffer zone, 3 of CEU campus buildings have historically protected facades, and Nador Utca 9/monument building has monument designation in Hungary. All the buildings are mostly office type. There is no green zone attached to campus, as well as no parking area. The street territory, adjoining the campus, doesn't belong to CEU property.

The majority of students and workers report to the centrally located campus, in the heart of Budapest. Most students and staff arrive using public transportation (more than 100 per day by bike). Around 400 student live in the university dormitory (Residence Center), which is situated in the X district of Budapest city (about 40 minutes by public transport from central CEU premises).

The University is a signatory to the Copernicus University Charter for Sustainable Development and has its own Sustainable Development Policy. The role of sustainability body belongs to CEU Campus Services Office and CEU Sustainability Campus Initiative (SCI). Sustainability management functions are performed by Logan Strenchock, Campus Environmental and Sustainability Officer.

4.2 Redevelopment plan

The redevelopment project in CEU was adopted as a part of the strategy for continuous improvement of the university, it's facilities, studying and recreation spaces, which are recognised to have a huge influence on the academic success of students. The redevelopment is planned in be performed in 3 phases:

- 1) September 2014-2016 - first phase of redevelopment. In this phase Nador 9 monument building will undergo some minor refurbishment. The faculty tower will be reconstructed: library and Japanese garden will be substituted with more

floors.

- 2) 2017-2018 - second phase. Nador 13 building will be reconstructed, the big auditorium will be built on the upper floor. Nador 15 building will be demolished and rebuilt, occupying the green space on the back yard. A new library will be constructed on the upper floor. On the top (above library and auditorium) a roof garden will be reorganised, with capacity of 270 people.
- 3) 2019-2020 - third phase. Nador 11 building will be reconstructed and October 6 building will be demolished and rebuilt with modern insulations. The connection will be built between these two buildings.

4.3 Toolkit compliance

During the internship in CEU Sustainability Campus Office the current situation in CEU, regarding implementation of green initiatives on campus, was explored. The redevelopment project was also analyzed according to these criteria. In order to formulate the baseline, all the green actions from the Greening University Toolkit (Osmond *et al.* 2013) were organized into Table 3 and were given the status of “compliant”, “non compliant”, “partially compliant” or “compliant after redevelopment project” depending on findings of research mentioned above.

Table 3. Compliance of CEU to green actions from «Greening universities toolkit» and CEU redevelopment plans

Actions	Compliance status				Description
	compliant	not compliant	partially compliant	compliant after redevelopment	
Energy and climate change measures					
Employment of Energy Manager	+				these manager duties are currently performed by Logan Strenchock
Energy efficiency standards for new construction and refurbishments				+	currently not applied
Energy efficiency purchasing standards		+			currently not applied
Staff energy conservation training		+			CEU doesn't have it at the moment
Improved space utilization to avoid new construction or heating/cooling of underutilized space				+	the design of the new campus includes a distribution of occupancy sensors to allow to only light, heat or cool, and produce max air circulation in spaces which are occupied, and window actuators which cancel interior heating/cooling settings when someone in an office opens a window (to avoid heating/cooling the outdoors)

Thermal comfort policy (e.g. widening heating/cooling temperature settings)			+		<p>Currently efforts are made to maintain an interior environment of 18-22 degrees year round in CEU spaces. The ability to strictly monitor and control these settings is different in each CEU building depending on the heating/cooling and ventilation infrastructure and the age and profile of the insulation, windows, and building fabric in each CEU property. The design of the new campus BMS system will allow to set, maintain, and monitor ideal conditions in each space and know when conditions are not being maintained.</p> <p>New campus premises will allow to increase inside temperature in summer to +26 degrees without decreasing comfort.</p>
Financial strategies to assign energy costs incurred – and savings achieved – to the responsible cost centers		+			no such strategy exists at the moment because the savings achieved from improvements are currently not possible to calculate
Energy / climate change awareness programs – posters, stickers, events and competitions, websites, awards and incentives for switching off etc.	+				<p>Student activist group organized, numerous events, facebook page http://www.facebook.com/sustainable.ceu with pictures, posters. Stickers on the walls for switching off. Climate Ambassadors Program (beginning) aims to assign staff, student, and faculty volunteers to serve as climate ambassadors/green ambassadors to encourage best practices on their floor; CEU Bike Share Program (ongoing)</p>
Establishment of “energy champions” network across campus buildings		+			currently not performed
Detailed energy audit to identify priority areas		+			no audit is performed at the moment
Periodic recommissioning and building tuning to optimize energy efficiency				+	buildings will get new tuning

Building retrofitting – installation of external shading devices, sealing, insulation, double glazing, low emissivity window film, light colored paint			+	+	During the next few years, as part of the campus redevelopment project it will be the first time that at a wide scale investments in retrofitting the building fabric (insulation, windows, and mechanical systems) are carried out. Additionally, within the last two years the CEU dormitory has carried out infrared scanning of window insulation and replaced or added more robust insulation in problematic areas.
Lighting – delamping, installation of high efficiency lighting fixtures, use of task lighting, lighting controls (timers/sensors)			+		Most recently, period investments to replace old incandescent lighting with energy efficient bulbs has been carried out. Light sensors exist in some of CEU premises.
Heating, ventilation and air-conditioning (HVAC) – high efficiency chillers, boilers, motors, pumps and air handling units, variable speed drives, variable air volume fan systems, recommissioning, tuning and regular maintenance, heat recovery systems				+	In the past the University has utilized a standard maintenance program to ensure that the mechanical systems and HVAC systems are running at satisfactory levels. During redevelopment campus project the boilers and cooling systems in most of the buildings will be replaced. The level of other updates will depend on the building: Nador 15 will be completely rebuilt, and the Oktobor 6 th street property. Nador 13 will be completely renovated (the building structure, façade, etc will be maintained) and Nador 11 will receive a major refurbishment which includes mechanical systems. The fate of the faculty tower is under discussion at the moment. The Monument building is historically protected and only minimal changes, mostly aesthetic will be made to this portion of the campus.
Installation of building management and control systems (BMCS) and sub-metering for major building energy uses, energy use displays				+	it is currently a goal to utilize data collected by the BMS system to create real time, interactive displays of relatable consumption data, and place them in centrally located areas of our campus.

Purchase of certified “green power”		+			market of green power in Budapest doesn’t allow to track the final destination of costs paid, thus the “greenness” of power might be questioned
Installation of photovoltaic, wind, biomass, etc. systems		+			CEU sustainability committee found it too expensive and beyond university budget capabilities to install photovoltaic panels at the moment taking into account also not high abundance of sunlight in Budapest, but the grid for it exists on the roof
Installation of cogeneration and trigeneration		+			Considered to be not feasible by CEU sustainability committee
University managed revegetation program to offset greenhouse emissions			+		Japanese garden was recently supplied with more plants; within redevelopment project two green roofs are planned to be constructed
Water conservation, efficiency, reuse and recycling					
Employment of Water Manager	+				these manager duties are currently performed by Logan Strenchock
Water efficiency standards for new construction and refurbishments		+			currently not applied
Water efficiency purchasing standards		+			currently not applied
Staff water conservation training		+			CEU doesn’t have it at the moment
Financial strategies to assign water costs incurred – and savings achieved – to the responsible cost centers		+			no such strategy exists at the moment

Water conservation awareness programs – posters, stickers, events and competitions, websites, awards and incentives	+				Student activist group organized, numerous events, facebook page http://www.facebook.com/sustainable.ceu with pictures, posters. Stickers on the walls to save water, not to consume bottled water. Video-campaign against bottle water.
Extension of “energy champions” network to incorporate water conservation		+			currently not performed
Detailed water audit and campus water balance to identify priority areas	+				the audit was performed for campus redevelopment project
Active maintenance program of early detection and repair of faulty plant, equipment and fixtures		+			currently doesn’t apply to CEU
Retrofitting of water saving devices – timed flow taps, waterless urinals, dual flush cisterns, eater efficient shower heads		+			CEU is currently running projects on deciding the final layouts for the wet block areas, the priority with be given to energy and water efficient devices (low flow toilets, timed taps, efficient hand dryers, etc.)
Underground pipework leak detection and repair				+	CEU doesn’t have it at the moment, but it is planned to be done in the nearest time
Use of pervious paving		+			CEU currently doesn’t have paving area
Specification of low water use species for campus grounds		+			CEU currently doesn’t have green area and vegetation
Installation of building management and control systems (BMCS) and sub-metering for major building water uses, water use displays				+	It is currently a goal to utilize data collected by the BMS system to create real time, interactive displays of relatable consumption data, and place them in centrally located areas of our campus.

Capture and reuse of rainwater from roofs and other hard surfaces for non-potable uses (irrigation, laboratories, toilet flushing, cooling towers, construction works, swimming pools, etc.) – may also be treated to potable standard				+	the roof top areas of N13 and N15 will be accessible and the rainwater collected on them will be harvested and used for watering the plants located on the roof
Installation of grey water recycling system for treatment of kitchen, laundry and shower water for non-potable uses		+			The amount of grey water generated is not enough to justify construction of recycling systems
Installation of blackwater recycling system to treat sewage for non-potable uses.		+			The amount of black water generated is not enough to justify construction of recycling systems
Resource recovery and minimization of waste to landfill					
Employment of Waste Manager	+				these manager duties are currently performed by Logan Strenchock
Sustainable procurement standards which address longevity, durability, repairability recyclability and recycled content			+		don't apply to CEU at the moment apart from purchasing recyclable paper
Financial strategies to assign waste costs incurred – and savings achieved – to the responsible cost centers		+			the amount of waste generated currently at CEU is not enough to obtain profits

CEU eTD Collection

Waste management awareness programs – posters, stickers, events and competitions, websites, awards and incentives	+				Student activist group organized, numerous events, facebook page http://www.facebook.com/sustainable.ceu with pictures, posters. Events: Earth Day 2010, 2011, 2012, and 2013 (coming soon 2014); WasteFest 2013; World Food Day 2013 Celebration; CEU's first annual Sustainability Festival September 2013); Buy Nothing Day at CEU November 2013; No Impact Man Visits CEU (May 2013); Local Food at CEU program (ongoing); Creative Recycling Eco Educational Program (youth outreach program, ongoing); Hungarian Sustainable University Newtork Development (Ongoing)
Programs targeting teaching and research to minimize generation of hazardous wastes		+			no such programs
Waste characterization study to identify waste stream components and prioritize response		+			doesn't currently exist in CEU
Individual staged and prioritised programs for waste minimisation which address each component of the university waste stream according to environmental impact		+			currently applies only to paper
Performance-based waste management contracts to specify resource recovery targets			+		currently applies only to paper

In-house collection of recyclables (e.g. paper / cardboard) where practicable, to support local job creation	+				<p>Several types of recyclables are currently collected on campus: paper, glass, plastic, metal.</p> <p>In 2014 were separately collected:</p> <ul style="list-style-type: none"> -over 15,000 L (347 kg) of PET Plastic; -over 47,000 L (2150 kg) of cardboard; -over 6,000 L (3600 kg) of mixed glass; -over 4,400 L (775 kg) of mixed office paper. <p>In total sending of 1100 L of waste to landfill was avoided.</p>
Provision of adequate storage spaces for waste and recyclables	+			+	<p>currently collected separated waste is stored in the N11 and N15 courtyards in the bins provided by recycling collection agency. Electronic waste is stored in the basement and taken away when necessary to proper handling facilities. Waste storage centers in basement of the N13 building and Oct 6th street building are included In the redevelopment campus plan. An expansive waste collection system is also planned throughout the campus.</p>
Secure storage spaces for hazardous wastes to minimize risk of spillage / leakage			+	+	<p>Currently only electronic waste (lights, computers, old equipment) and some chemical waste associated with tools (oil, cleaning solvents) are produced and both are handled and disposed of properly by the maintenance team. A specific hazardous waste storage area is planned to be constructed in the new campus.</p>
Campus based exchange and reuse programs – e.g. office furniture, stationery, lab equipment, computers and office equipment			+		<p>currently exchange and reuse programs exist for furniture</p>
On-site composting of food and garden organics for reuse on campus grounds		+			<p>no campus grounds at the moment</p>

Campus based programs to process collected recyclables – e.g. shredding of food-contaminated paper, broken furniture, etc. for compost and mulch		+			no such programs at the moment
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4.4 Need for Action plan

Taking into account CEU's current low level of compliance to high standards of green sustainable universities and a limited scale of green initiatives planned to be implemented under the future redevelopment project of CEU due to several important reasons as low availability of resources and budget, specific local conditions etc., there is a strong need for formulation of comprehensive green action plan.

The Action plan should take into account the base line, all the underlying circumstances and local conditions and involve rich international experience and knowledge of successful cases of top green universities. It should include prioritized aims, short-term targets and long-term goals, and outline the transformation of CEU into green and sustainable campus through several stages over several time periods that are both challenging and appropriate for CEU.

The most important, the Action plan should reflect commitment of CEU to sustainable development, responsibility to manage its activities in a way that reduces the negative environmental impacts and willingness for continuous change and improvement.

5. Tongji University

5.1 General information

Tongji University is one of the oldest and the most prestigious universities in China, located in Shanghai city. Its departments of engineering and environmental science among others are very highly ranked.

The university has four main campuses (Figure 4), which cover the total area of 1501281 m² (Osmond *et al.* 2013), it consist of 420 buildings and a huge green area including lawns, flowerbeds, gardens, green terraces and walls, parks, ponds etc. Around 39000 students study every year in 29 faculties of the University.



Figure 4. Map of campuses of Tongji University

The most popular kind of transport among students for travelling to university and on campus is a bicycle. University staff usually uses cars and motor cycles.

According to Dr. Chen Shuqin, the professor of Tongji Institute of Sustainable Environment Development, in 2012 the total energy consumption in the year 2012 was 40604 tce, from this amount, the electricity made as much as 32000 tce. The water consumption in the same year was 3878898 tons. The ratio of energy sources and energy consumption in the campus is shown on Figure 5.

Tongji University has started its way to sustainability in 2002. As a result in 2007 the university has demonstrated first in China resource-efficient campus (Tan *et al.* 2014), for which it received a national award of building energy conservation in China. In 2008 Tongji university gained 1st prize in Technology and Science of Chinese Ministry of Education for “Demonstration and Integration of Technologies in Sustainable Campus Construction”.

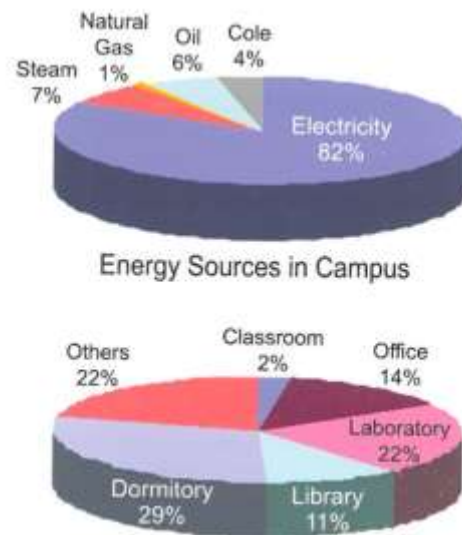


Figure 5. Ratio of energy consumption in Tongji Campus

Since then Tongji university has undergone the transformation from resource-efficient campus to sustainable campus, actively integrating sustainability in its management, campus culture, education and research. And in 2012 it was the first university in Asia-Pacific region to be given “Excellence in Campus Award” by International Sustainability Campus Network (ISCN).

The green campus management system includes a Sustainable Development Committee, which is responsible for the sustainable campus construction and development within three priority areas: technology, management and education/research (Yuan *et al.* 2013). Its organizational structure is shown in Figure 6.

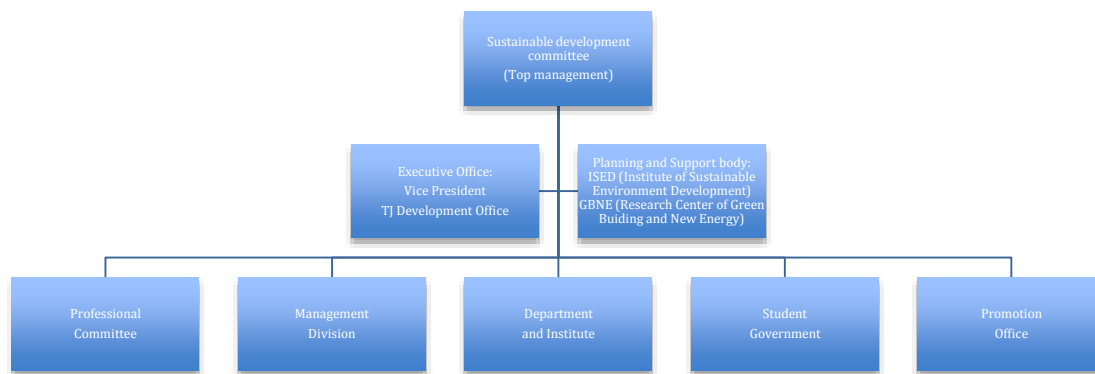


Figure 6. Organizational structure of Tongji Campus Management system

Tongji University was the initiator of foundation of the China Green University Network (CGUN) in 2011. The network nowadays consists of 18 members including 8 core universities and 2 research institutes. Tongji University has the first chairmanship in it.

In June 2012 Tongji University became one of the cofounders of Global University Partnership on Environment and Sustainability and in 2013 one of the coauthors of “Greening Universities Toolkit”.

5.2 Greening initiatives implemented

Tongji Campus is demonstrating sustainability, integrating several approaches: through technologies, management, education and behavior.

Sustainability management of campus operations is practiced through such measures as:

- installation of intelligent card system in dormitories and bathhouse to manage water and electric power use by students, which resulted in decrease in consumption of electricity and water by 30% and 40% respectively;
- increasing the capacity of bathhouse from 1700 to 4000 people, which has led to saving of big amount of investment.

Sustainability approach through education and behavior includes demonstration of resource-saving technologies, arousing sustainability awareness and supporting sustainable activities of students. Green activities and event like water-saving and power-saving week, food-saving week, green week of environmental protection are constantly being organized on campus. Besides various lectures on

energy and resource-saving are being held for students, staff and people outside university.

Technology approach includes implementation of various green projects and best practices on campus. Among them:

- campus energy management system (CEMS) for monitoring and reporting of energy consumption of 182 on campus, approximately 1.16 million square meters;
- eco-retrofit of campus buildings covering total area of 296647 square meters;
- eco-campus planning;
- biomass energy factory;
- solar thermal application;
- BIPV;
- building of eco-park;
- water source recycle etc.

The map of demonstration projects of Tongji University campus is shown on figure and its short description is given below (Figure 7).



Figure 7. Map of green demonstration projects of Tongji campus

5.2.1 Students' bathhouse

The building of students' bathhouse in Tongji University campus (Figure 8) was renovated with implementation of such green technologies as solar energy heating system, water heat recovery system, wastewater recycling system.



Figure 8. Students' bathhouse

5.2.2 Constructed wetlands



Figure 9. Constructed wetlands

An artificial wetland (Figure 9) was constructed in the area between buildings in Tongji campus. It acts as a natural biofilter for purifying grey water, removing

sediments and pollutants. It is also used as a demonstrate project for environmental education of students.

5.2.3 Refit of XuRi Building for energy efficiency

The project of energy efficiency refit was implemented for existing building XuRi (Figure 10). Energy-saving measures included installation of HVAC system and thermal isolation of building envelope. Also the air conditioning and ventilation is now performed with the help of newly constructed ground source heat pump and radiation panel system.



Figure 10. Energy-efficient XuRi Building after refit

5.2.4 New energy-efficient Tongji Synthetic Building

The newly built Synthetic building (Figure 11) in Tongji campus involves a lot of green solutions. Among them are air-conditioning system based on ice thermal storage, highly efficient HVAC system. The conference room has modern displacement ventilation system, atrium uses hybrid ventilation and garage in the underground is lightened with natural daylight.



Figure 11. Energy-efficient Tongji Synthetic Building

5.2.5 Energy-efficient gymnasium – Natatorium

Having total area of 5,5 thousand square meters (4 thousand above and 1,5 thousand underground), the Natatorium building (Figure 12) features solar heating and air-source heat pump systems, and a flexible open-close roof.



Figure 12. Natatorium

5.2.6 Eco-refitted Tongji Hall

Being a historic building, Tongji Hall (Figure 13) was eco-refitted in order to save the original construction and at the same time to enhance its resource efficiency. Main greening technics implemented include remote window control enabling natural ventilation and allowing to save up to 30% of energy, displacement

air-conditioning and ventilation systems and underground cooled tube used for heating or cooling.



Figure 13. Tongji Hall after eco-refit

5.2.7 Energy efficient French Center



Figure 14. French Center Building

The new building was recently constructed for research and educational purposes. French center (Figure 14) has a total area of around 14 thousand square

meters. The building envelope has thermal isolation. Natural daylight systems almost eliminate the need for supplementary electric lighting during the day.

5.2.8 Energy-efficient lighting of Campus Lawn

The lighting of campus lawn (Figure 15) was decreased in time for energy saving purposes. It is performed with utilization of energy-efficient bulbs such as dual-rear-light capacitance metal halide lamps, which resulted in reduction of electric energy consumption by 20%.



Figure 15. Energy-efficient lighting of campus lawn

5.2.9 Eco-refitted Wen Yuan Building

Wen Yuan (Figure 16) is a historic Bauhaus style building on campus, it was built in 1953. The refit project for the building was aimed to protect its original architecture but also to implement various eco-technics. Among them: thermal isolation of interior building envelope, low-E glass, solar photovoltaic system, ground source heat pump, light control system, green roof and rainwater collection system.



Figure 16. Wen Yuan Building after eco-refit

5.2.10 The Laboratory Building after renovation

The building (Figure 17) was totally renovated with utilization of green configuration and indoor environmental technologies, natural ventilation and ecological design of premises, reuse of waste water, green roofs etc. Only environmentally friendly materials were used for renovation, and the majority of energy supply of the building comes from renewable sources. Technologies for energy saving include double-glazing wall, low-E glass, thermal isolation of building envelope and passive solar energy technology.



Figure 17. Laboratory Building after renovation

5.2.11 New green Jiading campus

The Jiading campus (Figure 18) is a newly built campus of Tongji University. It is a demonstration project of sustainable campus and has a greening rate of 70%.

All the building were built according to national energy efficiency standards. Highly efficient rainwater and wastewater reuse systems satisfy 100% of irrigation needs on campus.



Figure 18. Jiading Campus with zero net energy houses (two pictures below)

5.2.12 Architectural Design and Research Institute Building

The building for Architectural Design and Research Institute (ADRI) was made from retrofitting the existing abandoned car parking building that was planned to be demolished. It was renovated into a 5-story office building with total area of 68000 square meters and is now a demonstration building on campus. It has 630KWp BIPV system on the roof, covering 6600 square meters, which is generating 535MWh of electricity per year. This installation helps to reduce annual CO₂ emissions by 566 tons. The building is also hosting an educational center for energy conservation and renewable energy technologies.

5.3 Ranking system

In order to assess its level of sustainability, Tongji University uses the Sustainability Tracking, Assessment & Rating System (STARS). The performance of Tongji campus is being measured in such areas as operations (energy and resource efficiency of buildings, waste reduction, grounds and green areas, procurement and transport); administration and planning (management, investment and community

engagement); education and research (integration of sustainability into university curricular, research and other activities) and innovative green solutions.

According to Mr. Mahesh Pradhan, head of Global University Partnership on Environment and Sustainability, “STARS is the most suitable ranking system for measuring university sustainability because it embraces all the categories which identify a sustainable university, not only focusing on building performance, but is also assessing integration of green practices into university curricular and everyday life. On the beginning stage of greening the university it can help to establish a baseline, to understand the priorities and set the goals, and to develop stages for university green transformation. In Asian Universities STARS rating system also serves as a platform for sharing data and knowledge on greening university process.”

5.4 Costs of implementation

The greening projects of Tongji campus were funded by Ministry of Housing and Urban and Rural Development of China, World Bank Loan Program and Shanghai Government.

The total costs for establishment of Campus energy management system was 1,3 million USD, total cost of building retrofit projects – 7,62 million USD. The renovation of ADRI building cost was 16 million USD (Tan 2013).

Table 4 contains data on costs of implementation of green initiatives for one building – students’ bathhouse.

Table 4. Approximated costs of implementation of green technologies in students’ bathhouse

Green initiatives implemented	Costs, USD
Bathhouse smart control system	323,000
Prepaid control system for students’ dormitory	460,000
Solar heat system for water	470,000
Heat pump	140,000
Waste water recycle	769,000
Heat recovery from bath water	123,000
Heat recovery for the boiler gas	29,000
Energy-efficient lighting	68,000
Campus Energy Management System	860,000
Data collection system of water use	227,000

6. Analysis

6.1 Comparative analysis of local conditions

The local conditions of the place, in which the university is situated, plays a huge role in identifying and choosing the best strategies for university's sustainable transformation. Taking this fact into account, the comparative analysis of CEU and Tongji University was an important step to perform before making comparison of institutions themselves. The comparative criteria were: geographic position and conditions, economical specific with focus on green technologies and renewable energy, as well as environmental policy and government support of sustainability in the country. The results for both universities are presented in Table 5.

Table 5. Comparative analysis of local conditions for CEU and Tongji University

Criteria	CEU (Budapest, Hungary)	Tongji University (Shanghai, China)
Locale (Large city, Urban fringe of large city, Mid-size city, Urban fringe of mid-size city, Large town, Small town, or Rural)	Large city	Large city
Geographic conditions	<ul style="list-style-type: none"> ■ Conditions are favorable for development of renewable energy sources – country's renewable energy potential is > 2200 PJ/year; ■ Biomass total feasible potential 145-188 PJ/year; ■ Biogas potential - 24-48 PJ; ■ Annual average wind speed is above 5,5 m/s; 43% of area is suitable for wind power utilization. ■ Annual amount of sunshine in the country is 2,200 hours, photovoltaic potential is ~ 480 billion kWh; ■ Geothermal gradient in Hungary is 1,5 times higher than the world average 	<ul style="list-style-type: none"> ■ Moderate sunlight, rainfall and temperature, fertile soil; ■ Favorable conditions for agriculture, big biomass potential; ■ China has the largest wind resources in the world; 3/4 of its wind farms are offshore; ■ Wind power potential: >500 GW onshore, 750 GW offshore; ■ Exploitable hydropower potential: 379 GW; ■ Geothermal resources are abundant and widely distributed, > 2,700 hot springs at the surface, $t > 250^{\circ}\text{C}$.
Local economy (focus on renewable energy and green production)	<ul style="list-style-type: none"> ■ Hungary is a biggest high-tech exporter; ■ Excellent transportation system – most developed highway network in EU; ■ High quality of life; ■ Abundant resources and potential capacities; ■ Developing market of renewable energy and green technologies; ■ Developed infrastructure; ■ Numerous talented and high skilled labor force; 	<ul style="list-style-type: none"> ■ Continuous rapid growth of industrial production in Shanghai city; ■ Exceptionally developed transportation system of Shanghai provides links between the city zone and the suburbs; ■ Increasing innovation and creativity in development of local enterprises; ■ Abundant and skilled labor force; ■ 17% of electricity from renewable sources in 2007

		<ul style="list-style-type: none"> ■ Excellent ratio of cost/quality of renewable energy technologies; ■ Elaborated incentive system; ■ Sustainability is supported by the government; ■ In the National Development Plan 280 M were aimed for investment into renewable energy and energy efficiency projects; ■ > 200 international quality technological and industrial parks; ■ Huge investment opportunities 	<ul style="list-style-type: none"> ■ Biggest number of hydroelectric generators in the world; ■ Investments in renewable energy are part of country's economic incentive strategy; ■ China is a largest producer of wind turbines in the world, 4th place in wind power production in the world in 2008, wind power is a main economy growth driver; ■ Producer of 63% of solar PV in the world; world largest producer of solar panels; ■ 3d largest manufacturer of ethanol-based bio-fuels in 2005; ■ 2d place in using of geothermal energy in the world in 1990; ■ Sustainability is supported by the government
Environmental policy in the country (focus on renewable energy and green production)		<ul style="list-style-type: none"> ■ Commitment to CO2 emissions reduction and enhancing energy efficiency; ■ Political goal of 10% energy saving; ■ Renewable target – 13%; ■ Promotional schemes and subsidies for the development of RES 	<ul style="list-style-type: none"> ■ Multiple policies to promote renewable energy (Renewable Energy Law; emphasis on green energy in Five-Year Plan; Golden Sun program - subsidies and market incentives for development of solar power industry; Suggestions on Promoting Wind Electricity Industry etc.) ■ Policies to standardize renewable energy products, to regulate green energy price, to prevent environmental damage (Renewable Energy Law, Safety Regulations of Hydropower Dams, National Standard of Solar Water Heaters)
Popularity of university sustainability in the country	CEU ETD Collection	Emerging	Very popular
Support and funding by government of sustainability initiatives	CEU	Preferred and supported	Preferred and supported

Identical location in a large city, analogous climate conditions, high level of environmental concern, popularity of sustainability initiatives, development of renewable energy sources and green technologies both in Hungary and China all together makes it possible to identify local conditions as quite similar and allows to perform further comparative analysis of CEU and Tongji University.

6.2 Comparative analysis of universities

The comparative analysis of two universities – Central European University and Tongji University – was performed according to such main criteria as size of the university, number of students and staff, kind of institutional control and funding, presence of green area, historical buildings, cafeteria and student dormitory, type of transportation used by students and staff and some sustainability characteristics of universities. These are shown in Table 6.

Table 6. Comparative analysis of CEU and Tongji University

N	Criteria	CEU	Tongji University
1	Size of university	The total CEU campus does consist of Nador Utca 9, 11, 13, 15, Zryini Utca 14, October Utca 6/7, the CEU dorm, the Business School, and the School of Public Policy. CEU additionally manages the Open Society Archives as well	The university has four main campuses, which cover the total area of 1501281 square meters, it consist of 420 buildings
2	Institutional control (Public, Private for-profit, or Private non-profit)	Private non-profit	Public
3	Number of students/university staff	CEU offers postgraduate education to about 1500 students every year from more than 100 countries. Faculty staff includes around 100 professors from 30 countries	Around 39000 students study every year in 29 faculties of the University
4	Green area	There is no green zone attached to campus. The street territory, adjoining the campus, doesn't belong to CEU property	University campus has a huge green area including lawns, flowerbeds, gardens, green terraces and walls, parks, ponds etc. comprising around 60% of campus territory
5	Transport	The majority of students and workers report to the centrally located campus, in the heart of Budapest. Most students and staff arrive using public transportation, more than 100 per day by bike. There's no parking area belonging to university	The most popular kind of transport among students for travelling to university and on campus is a bicycle. University staff usually uses cars and motor cycles
6	Dormitory	Residence Center accommodating around 400 students is situated in 10th district of Budapest, 40 minutes away from central campus. Other students rent apartments in the city	Student dormitories are situated on campus close to educational premises and are able to accommodate all the students of the university

7	Cafeteria	One cafeteria is located on the 1st floor of monument building, Nador 9. Another cafeteria is in CEU Residence Center	Each campus has at least 3 student cafeterias as well as around 3 restaurants
8	Laboratories	None	Several
9	Historical buildings	CEU is located in a world heritage buffer zone, 3 of CEU campus buildings have historically protected facades, and Nador Utca 9/monument building has monument designation in Hungary	Main campus on Siping Road has several historical buildings. Among them Tongji Hall and Wen Yuan, which is a historic Bauhaus style building
10	Budget and funding of sustainability initiatives	Private funding	\$1.3 million for the establishment of Campus energy management system; \$7.62 million for building retrofit projects; \$16 million ADRI. Funding partners: Ministry of Housing and Urban and Rural Development (MO-HURD); World Bank Loan Program; and Shanghai Government
11	Sustainability management organizational structure	The role of sustainability body belongs to CEU Campus Services Office and CEU Sustainability Campus Initiative (SCI). Sustainability management functions are performed by Logan Strenchock, Campus Environmental and Sustainability Officer	The green campus management system includes a Sustainable Development Committee, which is responsible for the sustainable campus construction and development within three priority areas: technology, management and education/research. Planning and support body are IESD (Tongji Institute of Environment and Sustainable Development) and GBNE (Research Center of Green Building and New Energy). Executive functions are performed by Vice-President of Tongji Development Office
12	Sustainability declarations signed by university	The University is a signatory to the Copernicus University Charter for Sustainable Development and has its own Sustainable Development Policy	Global Youth Declaration on Environment and Sustainable Development – is being released every year since 2011 during International Student Conference on Environment and Sustainability in

			Shanghai, China
13	Membership in university networks and partnerships	Member of Global University Partnership on Environment and Sustainability since 2013	Tongji University was the initiator of foundation of the China Green University Network (CGUN) in 2011 and has the first chairmanship in it. It is a member of International Sustainability Campus Network as well. In June 2012 Tongji University became one of the cofounders of Global University Partnership on Environment and Sustainability
14	Sustainability ranking system used	BREEAM	AASHE STARS
15	Awards for sustainability achieved on campus	None	National award of building energy conservation in China in 2007. In 2008 1st prize in Technology and Science of Chinese Ministry of Education for “Demonstration and Integration of Technologies in Sustainable Campus Construction”. In 2012 it was the first university in Asia-Pacific region to be given “Excellence in Campus Award” by International Sustainability Campus Network (ISCN).

The comparative analysis of the universities helped to come to the following conclusions:

- 1) CEU is much smaller and the number of students is 20 times less than in Tongji University. This can help to identify the approximate size and cost of green initiatives in proportion to those of Tongji University;
 - 2) CEU is a private institution which determines the specifics of its funding, which means that budget for sustainability transformation of CEU is limited to the size of private donations;
 - 3) The type of transportation used is determined by the location of university's dormitory and places of accommodation of students living outside it. Nevertheless, in both cases it is identified as environment-friendly and not requiring big changes. But one aspect could be further promotion of using bicycles;
 - 4) CEU doesn't have green area and surrounding territory belonging to it, therefore some green initiatives as "use of pervious paving", "specification of low water use species for campus grounds", "composting toilets and urine recovery for fertiliser", "on-site composting of food and garden organics for reuse on campus grounds", "campus based programs to process collected recyclables – e.g. shredding of food-contaminated paper, broken furniture, etc. for compost and mulch" are not applicable to CEU;
 - 5) CEU, in difference to Tongji University, doesn't have laboratories, that is why there are no big sources of production of hazardous wastes. Therefore, green initiatives "programs targeting teaching and research to minimize generation of hazardous wastes", "secure storage spaces for hazardous wastes to minimise risk of spillage / leakage" are not applicable for to CEU.
 - 6) Both CEU and Tongji University have historical buildings. This allows to use Tongji specific experience in retrofitting of such kind of buildings.
- 6.3 Categorizing green actions

6.3.1 Costs categories

According to Mr. Malay Dave, professor of New South Wales University and one of the authors of the Greening Universities Toolkit, "there is no "one size fits all" approach to addressing the economic dimension of sustainability. The intent of the "Toolkit" is to provide a conceptual framework, which allows participating

universities to take from it what is appropriate to their circumstances. It is very difficult to determine the approximate cost of implementation or even workout rules of thumb for costing for greening initiatives as these depend on specific conditions, economic contexts, scope and nature of work as well as many other factors that vary with time as well as place”.

The research experience in the area so far suggested that there is a lack of well documented and published data on costing of university greening actions.

However, the Toolkit’s Section 5 ‘Resources for Change’ being explored, includes a list of international and regional associations, networks and other resources, as well as Section 6 of the Toolkit - ‘Global Exemplars’ - includes some information on costing, although this information is limited and generally indicates an overall cost/budget only. Another source of data used was AASHE STARS data platform based on annual universities reporting system.

The information obtained through interviews with Campus Sustainability personnel in Tongji University (Table 4) concerning the costs of green initiatives and technologies implemented on Tongji campus, played an essential role in forming the insight about the pricing of green actions.

Finally, the collected information was organized into Table 7, and all the actions were split into two contingent categories - “low cost” and “high cost” actions. These were used in further analysis. The logic of division was based on the average cost of the initiative implementation. The initiatives priced above the mean were deemed to have “high cost” (in the table they are highlighted with red), and below the mean – accordingly, “low cost” (highlighted with green). For convenience, it was decided to neglect the price of some green actions, which was very low in comparison with high cost actions, so it was assigned “zero cost”. Of course, this didn’t change the results of categorizing.

Table 7. Cost categories of green actions recommended in GUPES Toolkit

Green action	Approximate cost of implementation	Cost category	
		Low cost	High cost
Energy and climate change measures			
Energy efficiency standards for new construction and refurbishments	0		

Energy efficiency purchasing standards	0		
Staff energy conservation training	0		
Improved space utilization to avoid new construction or heating/cooling of underutilized space	0		
Thermal comfort policy (e.g. widening heating/cooling temperature settings)	0		
Financial strategies to assign energy costs incurred – and savings achieved – to the responsible cost centers	0		
Energy / climate change awareness programs – posters, stickers, events and competitions, websites, awards and incentives for switching off etc.	0		
Establishment of “energy champions” network across campus buildings	0		
Detailed energy audit to identify priority areas	0		
Periodic recommissioning and building tuning to optimize energy efficiency	0		
Building retrofitting – installation of external shading devices, sealing, insulation, double glazing, low emissivity window film, light colored paint	50,000		
Lighting – delamping, installation of high efficiency lighting fixtures, use of task lighting, lighting controls (timers/sensors)	68,000		
Heating, ventilation and air-conditioning (HVAC) – high efficiency chillers, boilers, motors, pumps and air handling units, variable speed drives, variable air volume fan systems, recommissioning, tuning and regular maintenance, heat recovery systems	756,000		
Installation of building management and control systems (BMCS) and sub-metering for major building energy uses, energy use displays	860,000		
Purchase of certified “green power”	~\$0.15/GSF depending on energy use		
Installation of photovoltaic, wind, biomass, etc. systems	779,000		
University managed revegetation program to offset greenhouse emissions	0		

Water conservation, efficiency, reuse and recycling			
Water efficiency standards for new construction and refurbishments	0		
Water efficiency purchasing standards	0		
Staff water conservation training	0		
Financial strategies to assign water costs incurred – and savings achieved – to the responsible cost centers	0		
Water conservation awareness programs – posters, stickers, events and competitions, websites, awards and incentives	0		
Extension of “energy champions” network to incorporate water conservation	0		
Detailed water audit and campus water balance to identify priority areas	0		
Active maintenance program of early detection and repair of faulty plant, equipment and fixtures	0		
Retrofitting of water saving devices – timed flow taps, waterless urinals, dual flush cisterns, water efficient shower heads	24,000		
Underground pipework leak detection and repair	0		
Installation of building management and control systems (BMCS) and sub-metering for major building water uses, water use displays	229,000		
Capture and reuse of rainwater from roofs and other hard surfaces for non-potable uses (irrigation, laboratories, toilet flushing, cooling towers, construction works, swimming pools, etc.) – may also be treated to potable standard	0		
Installation of grey water recycling system for treatment of kitchen, laundry and shower water for non-potable uses	400,000		
Installation of black water recycling system to treat sewage for non-potable uses.	369,000		
Resource recovery and minimization of waste to landfill			
Sustainable procurement standards which address longevity, durability, repairability recyclability and recycled content	0		

Financial strategies to assign waste costs incurred – and savings achieved – to the responsible cost centers	0		
Waste management awareness programs – posters, stickers, events and competitions, websites, awards and incentives	0		
Waste characterization study to identify waste stream components and prioritize response	0		
Individual staged and prioritised programs for waste minimisation which address each component of the university waste stream according to environmental impact	0		
Performance-based waste management contracts to specify resource recovery targets	0		
In-house collection of recyclables (e.g. paper / cardboard) where practicable, to support local job creation	0		
Provision of adequate storage spaces for waste and recyclables	0		
Campus based exchange and reuse programs – e.g. office furniture, stationery, lab equipment, computers and office equipment	0		

6.3.2 Result categories

According to Mr. Malay Dave, “ranking or weighting of actions as per their importance or relative contribution to sustainability is one of the major areas of contention. Similar to costs of implementation, there is no simple and easy answer to this. Again, depending on the place and time this would and should change”.

However, existing numerous global and regional environmental/sustainability rating systems and tools are being used for rating sustainability performance of everything starting from materials and products through to buildings, precincts and even cities. These rating tools and assessment frameworks employ their own criteria for weighting, which is generally based on extensive research and consultations. It might be useful to do similar work for CEU with the help of stakeholder workshops and consultations.

AASHE STARS – a rating system used by Tongji University – was chosen as a ranking system of actions recommended by “Greening universities toolkit”. According to Mr. Mahesh Pradhan, head of Global University Partnership on Environment and Sustainability, “STARS is the most suitable ranking system for

measuring university sustainability because it embraces all the categories which identify a sustainable university, not only focusing on building performance, but is also assessing integration of green practices into university curricular and everyday life. On the beginning stage of greening the university it can help to establish a baseline, to understand the priorities and set the goals, and to develop stages for university green transformation. In Asian Universities STARS rating system also serves as a platform for sharing data and knowledge on greening university process.”

The assessment was based strictly on publicly available information and the standards and guidelines published by the system’s administrator. Using the information about the number of points being awarded in case of implementation of each green action, they were divided into two subcategories – “low result” and “high result” actions (Table 8). The logic of division was based on the average amount of points, which was calculated to be 0,94. The initiatives awarded amount of points above the mean were deemed to have “high result” (in the table they are highlighted with green), and below the mean – accordingly, “low result” (highlighted with red).

Table 8. Result categories of green actions recommended in GUPES Toolkit

Green action	Points awarded for implementation	Result category	
		Low result	High result
Energy and climate change measures			
Energy efficiency standards for new construction and refurbishments	1,75		
Energy efficiency purchasing standards	0,25		
Staff energy conservation training	0,25		
Improved space utilization to avoid new construction or heating/cooling of underutilized space	1,75		
Thermal comfort policy (e.g. widening heating/cooling temperature settings)	0,5		
Financial strategies to assign energy costs incurred – and savings achieved – to the responsible cost centers	0,5		
Energy / climate change awareness programs – posters, stickers, events and competitions, websites, awards and incentives for switching off etc.	1,25		

Establishment of “energy champions” network across campus buildings	0,5		
Detailed energy audit to identify priority areas	0,5		
Periodic recommissioning and building tuning to optimize energy efficiency	1,5		
Building retrofitting – installation of external shading devices, sealing, insulation, double glazing, low emissivity window film, light colored paint	1,5		
Lighting – delamping, installation of high efficiency lighting fixtures, use of task lighting, lighting controls (timers/sensors)	1,5		
Heating, ventilation and air-conditioning (HVAC) – high efficiency chillers, boilers, motors, pumps and air handling units, variable speed drives, variable air volume fan systems, recommissioning, tuning and regular maintenance, heat recovery systems	1,5		
Installation of building management and control systems (BMCS) and sub-metering for major building energy uses, energy use displays	1,5		
Purchase of certified “green power”	2,33		
Installation of photovoltaic, wind, biomass, etc. systems	2,33		
Installation of cogeneration and trigeneration	1,33		
University managed revegetation program to offset greenhouse emissions	1		
Water conservation, efficiency, reuse and recycling			
Water efficiency standards for new construction and refurbishments	0,37		
Water efficiency purchasing standards	0,37		
Staff water conservation training	0,25		
Financial strategies to assign water costs incurred – and savings achieved – to the responsible cost centers	0,75		
Water conservation awareness programs – posters, stickers, events and competitions, websites, awards and incentives	0,25		
Extension of “energy champions” network to incorporate water conservation	0,25		

Detailed water audit and campus water balance to identify priority areas	0,75		
Active maintenance program of early detection and repair of faulty plant, equipment and fixtures	0,75		
Retrofitting of water saving devices – timed flow taps, waterless urinals, dual flush cisterns, water efficient shower heads	0,75		
Underground pipework leak detection and repair	0,75		
Installation of building management and control systems (BMCS) and sub-metering for major building water uses, water use displays	0,75		
Capture and reuse of rainwater from roofs and other hard surfaces for non-potable uses (irrigation, laboratories, toilet flushing, cooling towers, construction works, swimming pools, etc.) – may also be treated to potable standard	2		
Installation of grey water recycling system for treatment of kitchen, laundry and shower water for non-potable uses	0,5		
Installation of blackwater recycling system to treat sewage for non-potable uses.	0,5		
Resource recovery and minimization of waste to landfill			
Sustainable procurement standards which address longevity, durability, repairability, recyclability and recycled content	0,99		
Financial strategies to assign waste costs incurred – and savings achieved – to the responsible cost centers	0,54		
Waste management awareness programs – posters, stickers, events and competitions, websites, awards and incentives	1,4		
Waste characterization study to identify waste stream components and prioritize response	0,54		
Individual staged and prioritized programs for waste minimization which address each component of the university waste stream according to environmental impact	1,4		
Performance-based waste management contracts to specify resource recovery targets	0,54		

In-house collection of recyclables (e.g. paper / cardboard) where practicable, to support local job creation	0,54		
Provision of adequate storage spaces for waste and recyclables	0,54		
Campus based exchange and reuse programs – e.g. office furniture, stationery, lab equipment, computers and office equipment	1,4		

There is a need to mention that the following actions were excluded for categorizing process:

1) Green actions, excluded from the analysis because of non-applicability:

- Use of pervious paving;
- Specification of low water use species for campus grounds;
- Composting toilets and urine recovery for fertilizer;
- On-site composting of food and garden organics for reuse on campus grounds;
- Campus based programs to process collected recyclables – e.g. shredding of food-contaminated paper, broken furniture, etc. for compost and mulch;
- Programs targeting teaching and research to minimize generation of hazardous wastes;
- Secure storage spaces for hazardous wastes to minimize risk of spillage/leakage;

2) Actions, that have already been implemented:

- Cogeneration and trigeneration are not applicable to CEU because the University currently does not produce power itself, it uses central electricity supply grid;
- Campus based exchange and reuse programs – e.g. office furniture, stationery, lab equipment, computers and office equipment.

Having mentioned all of the above, I would like to emphasize that there is the need for greater information and guidance in the Toolkit on cost vs. environmental benefit of greening actions and any updates on expansion of the Toolkit to include that would be very useful. Hopefully the next version would be of more help to everyone looking for similar information.

7. Recommendations for CEU action plan

Based on assessment of costs and results ranking of green actions as well as on current situation in CEU, I tried to identify best suitable strategies that could potentially be included into action plan for CEU.

The action were prioritized according to following:

- first priority were given action that have low cost and high result, as well as action having no cost of implementation and high/low result.
- second priority were given actions that have low cost and low result, as well as actions with high costs and very high result/value for CEU.

7.1 Green Action Plan (2014 - 2020)

1t Phase (2014 – 2017):

1. To install sub-metering equipment for major building energy uses

This action was decided to implement in the 1t phase of the Plan because of its high importance and necessity for establishment of the baseline. Sub-metering will make possible to:

- separate energy consumption in different facilities, floors, buildings, departments or other campus units;
- compare of energy consumptions among them, identify priority areas for increasing of energy efficiency;
- stimulate competitiveness in energy consumption reduction among campus units;
- verify savings from implementation of green projects and to track the progress;
- identify failures and to enable quick response.

2. To perform energy and water audit, campus water balance and a waste characterization study.

This will not only help to identify problem areas and prioritize a response, but also to establish the baseline. The audit should be performed on regular basis.

3. To establish a baseline, calculate the carbon/water footprint
4. To identify the base (initial) level of energy/water consumption and waste generation by components/campus units, which is necessary for developing sustainability indicators and tracking the progress at each stage of the Action

Plan.

5. To adopt energy/water efficiency standards for new constructions and refurbishments

Implementation of this action is important at this stage because after the beginning of campus redevelopment in 2016 all new constructions and installations should comply with these standards to achieve energy/water efficiency and to preserve outdoor and indoor environmental quality.

6. To adopt energy and water efficiency purchasing standards and sustainable procurement standards which address longevity, durability, repairability, recyclability and recycled content

These standards should become essential criteria in university sustainable purchasing policy.

7. To organize a broad energy / climate change awareness program
8. To implement energy awareness campaign. The University should require all its employees and students to adopt best practice that will aid energy conservation. To organize an energy event, which will include competition among students on the best poster/sticker; to create a system of incentives and awards for energy conservation among departments. To create a website of CEU green campus, where all the updates and progress should be publicly available.

9. Special suggestion for minimizing of food wastage in CEU:

- introduce the system of selling food by weight (everybody will take not more that is able to eat);
- to put a lot of stickers, posters etc. in the eating area encouraging not to waste food;
- to make available reusable containers for leftovers that could be taken away and saved for further consumption.

10. University managed revegetation program to offset greenhouse emissions

As CEU doesn't have green area and doesn't possess territory where it could be organized, a possible solution is to create green zones/green walls with potted plants on each floor inside CEU premises, it might be a green campaign for students: everyone should bring/plant one plant and take care of it.

11. To create a waste management awareness programs

12. To organize a “waste” event, which will include competition among students on the best poster/sticker; to create a system of incentives and awards for waste minimization among departments. To create a waste management section of CEU green campus website, where all the updates and progress should be publicly available.
13. To adopt individual staged and prioritized programs for waste minimization. The program should base on the results of waste audit and address each component of the university waste stream according to environmental impact
14. To improve space utilization of new and old constructions to avoid heating/cooling of underutilized space

To design newly constructed and existing floor area with efficiency that fulfills spatial and functional requirements, including services and circulation. To identify spaces that can carry more intensive occupancy or accommodate more functions.

15. To install task lighting and lighting controls.

To install light control sensors in all CEU premises where it is viable (preliminary study on premises occupancy is required).

16. To adopt a schedule of periodical tuning and recommissioning of buildings to reduce energy use, heating loads, and cooling loads of existing facilities.

The tuning schedule should be done in the following order: lighting; building envelope; controls; testing, adjusting, and balancing; heating and cooling system (). The procedures should include calibrating of devices like sensors and thermostats, optimizing operating schedules of equipment, cleaning for optimal devices efficiency etc.

17. To perform building retrofitting that answers the requirements of law on historical buildings and historically protected facades.

To improve sealing and insulation, to install double glazing windows and low emissivity window film. These will passively greatly increase energy savings.

18. To install rainwater collectors on the roofs and to organize its reuse for non-potable purposes.

To make the roof top areas of N13 and N15 accessible and to organize capture of the rainwater on them, which should be harvested and used for watering the plants located on the roof.

2d Phase (2018 – 2019):

19. To establish “energy champions” network across campus buildings

This network will help to arouse awareness and to encourage energy and water savings. It also can be a step to organization of Student Monitoring Programme, when energy/water consumption will be monitored and reported by student activists and volunteers.

20. To introduce staff energy and water conservation training

To organize sustainability training program for CEU staff members addressing energy and water conservation issues and practices.

21. To install heating, ventilation and air-conditioning system (HVAC) - high efficiency chillers and boilers, and air handling units

This action was placed into the second phase because it is the time when CEU HVAC system is going to be changed for a modern one. That’s why the campus redevelopment project should consider making more investigation on chillers and boilers and should prioritize purchasing highly efficient ones for installation in CEU.

22. To adopt thermal comfort policy

To use features of building site and orientation to widen heating/cooling temperature settings by optimizing the effect of microclimatic conditions; to perform new constructions in a way that can benefit from natural ventilation to provide natural cooling at the time when outdoor air is cooler than indoor air.

23. To adopt financial strategies to assign energy, water and waste costs incurred – and savings achieved – to the responsible cost centers

Savings obtained from utilization of green technologies should be assigned to special university’s sustainable fund and further used for sustainability purposes.

24. Water conservation awareness programs – posters, stickers, events and competitions, websites, awards and incentives

To organize a “water” event, which will include competition among students on the best poster/sticker; to create a system of incentives and awards for water conservation among departments.

To create a “water” section of CEU green campus website, where all the updates and progress should be publicly available.

25. To introduce active maintenance program of early detection and repair of faulty plant, equipment and fixtures.
26. To retrofit the water saving devices to install timed flow taps and dual flush cisterns.
27. To organize the program of underground pipework leak detection and repair

Work in partnership with the water supplier to trace and repair water leakages on site.

28. To organize the adequate storage spaces for waste and recyclables in basement of the N13 building and Oct 6th street building as included in the redevelopment campus plan, as well as an expansive waste collection system throughout the campus.

3d Phase (2020 - 2022):

29. To start purchase of certified “green power” and to make its share to reach 10% of the whole power purchase
30. To install photovoltaic panels and collectors on the roofs

Hungary has a big solar power potential and an emerging market of solar panels, this makes possible installation of solar panels and collectors on the roofs of CEU buildings for generation and storage of power. Grids for plug in the PV panels already exist on the roof of Nador 13 and 15 buildings.

Conclusions. Role of GUPES in greening universities

This research was conducted not only to contribute to the process of transformation of Central European University into green and sustainable campus, although the author of this thesis believes, it was among the most important objectives, and hopes that the results will be taken into account by CEU authorities.

The main purpose of this research was to show the contributions made by GUPES on each stage in order to underscore the role that GUPES plays in greening universities of the partnership, e.g. worldwide. Five key aspects are shown below:

1. GUPES as a driving force for initiating the sustainable transformation of the university

CEU had performed single green actions before, but the need for a comprehensive Green Action Plan to start the transforming of campus into green and sustainable one, was realized only after CEU has become a member of GUPES in 2013.

2. GUPES as a guide in the process of greening universities

The “Greening Universities Toolkit” published by GUPES serves as a guidelines, explicitly outlining all the steps that should be followed to achieve success in university transformation into green and sustainable campus, as well as it serves “to inspire, encourage and support universities to develop and implement their own transformative strategies for establishing green, resource-efficient and low carbon campuses. For the purpose of this research, 3d section of “toolkit” was used for analysis and assessment of current situation and existing green practices in CEU in order to establish a baseline, as well as it played a role of carcass for formulation of CEU Green Action Plan.

3. GUPES as a platform for sharing knowledge and experience

Sixth section of “Greening Toolkit” contains information on green universities - global exemplars of best sustainability practice that serve as models for other universities who wish to develop a comprehensive sustainability program; 5th section includes a list of international and regional associations, networks and other essential resources of information existing in the field. Last version of toolkit, which

publication is scheduled for September 2014, is going to contain also useful information on costing of green initiatives, as well as more case studies of successful "university greenings".

4. GUPES as an instrument of direct knowledge transfer

During research process the author of this thesis was able to do a field study in one of the green universities - members of GUPES - Tongji University in Shanghai, China. This unique opportunity, provided by GUPES, made possible to get invaluable knowledge on implementation of green initiatives, on their costs through discussions and interviews with university Sustainability personnel, but also with authors of the toolkit, GUPES and UNEP program coordinators and other organisations. It also allowed to conduct a comparative analysis of Tongji University and CEU, and finally played a great role in formulating Green Action Plan for CEU. Mechanism established by GUPES makes it possible to get as much knowledge and practical experience, as possible and necessary because of enormous diversity of universities - GUPES members, which account for around 420 nowadays, from all around the world, representing all cultures and all types of local conditions. Special help was given by Mahesh Pradhan, head of GUPES, at all stages of the research through continues guidance, advices, useful connections and possibilities to participate in events and workshops in the field of education for sustainable development.

5. GUPES as an accountability tool

Continues reporting of the results, first, after adopting a Green Action Plan, and finally, after implementing all planned green initiatives, makes CEU accountable to GUPES and to all partnership members, stimulating competitiveness and willingness to achieve success, which works as a perfect incentive. Especially because the results are planned to be presented as a case study in the next version of "Greening toolkit".

References

- Alonso-Almeida, M.d.M., Marimon, F., Casani, F. and Rodriguez-Pomeda, J. 2011. Diffusion of sustainability reporting in universities: current situation and future perspectives. *Journal of Cleaner Production* (0):
- Alshuwaikhat, H.M. and Abubakar, I. 2008. An integrated approach to achieving campus sustainability: assessment of the current campus environmental management practices. *Journal of Cleaner Production* 16. (16): 1777-1785.
- Baboulet, O. and Lenzen, M. 2010. Evaluating the environmental performance of a university. *Journal of Cleaner Production* 18. (12): 1134-1141.
- Bekessi, S., Samson, K. and R.E., C. 2007. The failure of non-binding declarations to achieve university sustainability: A need for accountability. *International Journal of Sustainability in Higher Education* 8. (3): 301-316.
- Bilodeau, L., Podger, J. and Abd-El-Aziz, A. 2014. Advancing campus and community sustainability: strategic alliances in action. *International Journal of Sustainability in Higher Education* 15. (2): 157-168.
- Borgia, D., Bonvillian, G. and Rubens, A. 2011. Case Study of Chinese and U.S. University, College of Business Partnerships: Form, Process, Opportunities, and Challenges. *Journal of Management Policy and Practice* 12. (1): 98-107.
- Borrero, N. 2010. Urban School Connections: A University-K-8 Partnership. *Catholic Education: A Journal of Inquiry and Practice* 14. (1): 47-60.
- Cole, E.J. and Fieselman, L. 2013. A community-based social marketing campaign at Pacific University Oregon. Recycling, paper reduction, and environmentally preferable purchasing. *International Journal of Sustainability in Higher Education* 14. (2): 176-195.
- Crisman, P. 2011. *STARS Sustainability Analysis for the University of Virginia School of Architecture*. Global Sustainability.
- Figueredo, F.R. and Tsarenko, Y. 2013. Is “being green” a determinant of participation in university sustainability initiatives? *International Journal of Sustainability in Higher Education* 14. (3): 242-253.
- Filho, W.L. 2011. About the Role of Universities and Their Contribution to Sustainable Development. *Higher Education Policy* 24. 427-438.
- Forrest, N. and Wiek, A. 2012. Learning from success—Toward evidence-informed sustainability transitions in communities. *Environmental Innovation and Societal Transitions* (0):

- Geng, Y., Liu, K., Xue, B. and Fujita, T. 2013. Creating a “green university” in China: a case of Shenyang University. *Journal of Cleaner Production* 61. (0): 13-19.
- Holmberg, J., Lundqvist, U., Svanstrom, M. and Arehag, M. 2012. The university and transformation towards sustainability: The strategy used at Chalmers University of Technology. *International Journal of Sustainability in Higher Education* 13. (3): 219-231.
- Kamal, A.S.M. and Asmuss, M. 2013. Benchmarking tools for assessing and tracking sustainability in higher educational institutions. Identifying an effective tool for the University of Saskatchewan. *International Journal of Sustainability in Higher Education* 14. (4): 449-465.
- Karatzoglou, B. 2013. An in-depth literature review of the evolving roles and contributions of universities to Education for Sustainable Development. *Journal of Cleaner Production* 49. (0): 44-53.
- Khalifa, M.A. and Sandholz, S. 2012. Breaking barriers and building bridges through networks: An innovative educational approach for sustainability. *International Journal of Environmental & Science Education* 7. (2): 343-360.
- Koester, R.J., Eflin, J. and Vann, J. 2006. Greening of the campus: a whole-systems approach. *Journal of Cleaner Production* 14. (9–11): 769-779.
- Kumar, R. 2005. *Research Methodology: a step-by-step guide for beginners*. London: Sega Publication.
- Labodová, A., Lapčík, V., Kodymová, J., Turjak, J. and Pivko, M. 2014. Sustainability teaching at VSB – Technical University of Ostrava. *Journal of Cleaner Production* 62. (0): 128-133.
- Lopez, O.S. 2013. Creating a sustainable university and community through a Common Experience. *International Journal of Sustainability in Higher Education* 14. (3): 291-309.
- Lozano, R., Lukman, R., Lozano, F.J., Huisingh, D. and Lambrechts, W. 2013. Declarations for sustainability in higher education: becoming better leaders, through addressing the university system. *Journal of Cleaner Production* 48. (0): 10-19.
- Lukman, R., Tiwary, A. and Azapagic, A. 2009. Towards greening a university campus: The case of the University of Maribor, Slovenia. *Resources, Conservation and Recycling* 53. (11): 639-644.
- Lukman, R., Krajnc, D. and Glavič, P. 2010. University ranking using research, educational and environmental indicators. *Journal of Cleaner Production* 18. (7): 619-628.
- Mason, I.G., Brooking, A.K., Oberender, A., Harford, J.M. and Horsley, P.G. 2003. Implementation of a zero waste program at a university campus. *Resources, Conservation and Recycling* 38. (4): 257-269.

- Müller-Christ, G., Sterling, S., van Dam-Mieras, R., Adomßent, M., Fischer, D. and Rieckmann, M. 2014. The role of campus, curriculum, and community in higher education for sustainable development – a conference report. *Journal of Cleaner Production* 62. (0): 134-137.
- Nejati, M. and Nejati, M. 2013. Assessment of sustainable university factors from the perspective of university students. *Journal of Cleaner Production* 48. 101-107.
- Ogbuigwe, A. 2008. Delivering Education for Sustainable Development through the MESA Partnership. *Journal of Education for Sustainable Development* 2. (2): 157-165.
- _____. 2010. UNEP's work to implement good practice at a regional level: contribution to the UNDES. *Int Rev Educ* 56. 353-372.
- Olszak, E. 2012. Composite indicators for a sustainable campus—Design rationale and methodology: The case of the Catholic Institute of Lille. *Ecological Indicators* 23. (0): 573-577.
- Osmond, P., Dave, M., Prasad, D. and Li, F. 2013. *Greening Universities Toolkit: Transforming Universities into Green and Sustainable Campuses*. Shanghai: United Nations Environment Programme Tongji University.
- Pacheco, P., Motloch, J. and Vann, J. 2006. Second Chance Game: local (university-community) partnerships for global awareness and responsibility. *Journal of Cleaner Production* 14. (9–11): 848-854.
- Parece, T.E., Younos, T., Grossman, L.S. and Geller, E.S. 2013. A study of environmentally relevant behavior in university residence halls. *International Journal of Sustainability in Higher Education* 14. (4): 466-481.
- Patel, B. and Patel, P. 2012. Sustainable campus of Claris lifesciences through green initiatives. *Renewable and Sustainable Energy Reviews* 16. (7): 4901-4907.
- Posner, S.M. and Ralph, S. 2013. Understanding and advancing campus sustainability using a systems framework. *International Journal of Sustainability in Higher Education* 14. (3): 264-277.
- Schaffer, R.H. 2012. Nonprofit and University Strategic Partnerships to Strengthen the Sector. *Nonprofit Management and Leadership* 23. (1): 105-119.
- Sedlacek, S. 2013. The role of universities in fostering sustainable development at the regional level. *Journal of Cleaner Production* 48. (0): 74-84.
- Silveira Marques Pereira, G., Jabbour, C., Borges de Oliveira, S.V.W. and Teixeira, A.A. 2014. Greening the campus of a Brazilian university: cultural challenges. *International Journal of Sustainability in Higher Education* 15. (1): 34-47.

Suwartha, N. and Sari, R.F. 2013. Evaluating UI GreenMetric as a tool to support green universities development: assessment of the year 2011 ranking. *Journal of Cleaner Production* 61. (0): 46-53.

Swearingen White, S. 2014. Campus sustainability plans in the United States: where, what, and how to evaluate? *International Journal of Sustainability in Higher Education* 15. (2): 228-241.

Tan, H. 2013. *Tongji University Green Campus*. Shanghai: Research Center of Green Building and New Energy TJ.

Tan, H., Chen, S., Shi, Q. and Wang, L. 2014. Development of green campus in China. *Journal of Cleaner Production* 64. (0): 646-653.

Townsend, J. and Barrett, J. 2012. Exploring the applications of carbon footprinting towards sustainability at a UK university: reporting and decision making. *Journal of Cleaner Production* (0):

Trencher, G.P., Yarime, M. and Kharrazi, A. 2013. Co-creating sustainability: cross-sector university collaborations for driving sustainable urban transformations. *Journal of Cleaner Production* 50. (0): 40-55.

Yuan, X., Zuo, J. and Huisin, D. 2013. Green Universities in China - what matters? *Journal of Cleaner Production* 61. 36-45.

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6	Haixing Meng	Program coordinator, UNEP-Tongji Institute of Environment for Sustainable Development, GUPES Secretariat
7	John Holmberg	Vice president, UNESCO Chair, Professor of Chalmers University of Technology
8	Jennica Kjällstrand	Environmental manager, Chalmers University of Technology
9	Ulrika Lundqvist	Senior Lecturer, Chalmers University of Technology
10	Stuart Durrant	CEU Campus Redevelopment Director

11	Logan Strenchock	CEU Campus Environmental and Sustainability Officer
12	Shi Han	Professor of City University of Hong Kong