



Demonstrating Sustainable Development in Higher Education

2016 Sustainable Campus
Best Practices from ISCN
and GULF Universities

International Sustainable Campus Network
(ISCN) in collaboration with the Global
University Leaders Forum (GULF) of the
World Economic Forum.



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Report launched at the GULF session of the WEF's Annual Meeting, January 20-23, 2016, in Davos-Klosters, Switzerland.

EXECUTIVE SUMMARY

The past year was important for the International Sustainable Campus Network (ISCN) and for sustainable development in general. In 2015, we saw the conclusion of the United Nations climate negotiations (COP21) in Paris, setting the direction and gaining the support of all nations in limiting CO₂ emissions to prevent temperature increases over the upcoming decades. The ISCN was present and involved in this process through its support of the open letter to the COP21 ministers and governments of the global alliance of tertiary, higher education and student sustainability networks, associations, and institutions.

During this past year the ISCN also transitioned into a Swiss-based nonprofit association. This change assures better involvement and positioning of its co-host member universities—those institutions that make significant financial and strategic investments in the network—and creates a more structured organization, including an advisory committee representing the network member universities of the ISCN. This transition is important to lay the basis for a sustainable and structured development of the ISCN in the coming years.

We were honored to welcome two new ISCN co-host member universities: the Technical University of Denmark (DTU) and KTH Royal Institute of Technology, Stockholm, Sweden. Having these new co-host members represented on the board of the ISCN will further strengthen the organization's leadership and broaden the representation. During 2015, we were also delighted to see the following universities join the ISCN: Ozyegin University, Istanbul, Turkey; University of Milano, Bicocca, Italy; Politecnico di Torino, Italy; Princeton University, New Jersey, USA; University of Campinas, Sao Paulo, Brazil; KEDGE Business School, France; City University of Hong Kong; Leuphana University, Lüneburg, Germany; and University of Sao Paulo, Brazil. Our membership is global and diverse, ideally positioning our group to strengthen worldwide knowledge exchange as we collectively work toward sustainable development.

The agreement of the COP21 defines the direction and ensures the engagement of nations. Now the work to realize the commitments made in Paris in practice begins. The ISCN understands that we need practical and applicable solutions to the issues at hand when implementing the COP21 agreement. Such solutions will require the best of today's knowledge, the capacity to trigger large changes in industry and public policy, and the involvement of leaders who understand these challenges and can manage disruptive change in a holistic manner. Our institutions have much to offer through teaching, research, and their role as living laboratories, but we can also be an important engine of change through our collaborations with other schools, organizations, and businesses.

The ISCN will help solve the challenges of sustainable development by ensuring that the next generation of leaders have the skills to address future challenges; that our education programs continue to transfer sustainability knowledge and skills and engage students on questions regarding future sustainable development; that our research continues to contribute to societal wellbeing with innovative solutions; and finally that our campuses continue to be showcases and living laboratories for new ways to enable sustainable development. The ISCN's important initiatives include workgroups on buildings and their sustainable performance, campus-wide planning and target setting, integration of research, teaching, and facilities, and a dialogue with businesses on which sustainability skills and capacities our graduates need to tackle future business challenges.

This report presents cases of best practice initiatives from members of the ISCN and the World Economic Forum's Global University Forum (GULF) universities, which have partnered in developing and disseminating the ISCN-GULF Sustainable Campus Charter. The cases reflect how universities are

developing sustainability skills and building capacities, collaborating with corporate partners, and demonstrating innovation in the built environment.

Developing skills and building capacities

As we face critical challenges, a holistic approach is needed to develop the skills of our future leaders. The **Yale** Center for Business and the Environment, The Global Network for Advanced Management, and the World Business Council for Sustainable Development (WBCSD) conducted a global study of more than 3,700 students at 29 top business schools. They found widespread consensus that businesses must lead on solutions to climate change and sustainability in order to attract and retain talent. The Global Social Enterprise Initiative (GSEI) at **Georgetown University's** McDonough School of Business aims to prepare current and future leaders to make responsible management decisions that create both economic and social value. The GSEI initiatives focus on five key issue areas, including Global Health and Well-Being, Clean-Tech Energy and Environment, Responsible Investing, Economic Growth and Financial Security and International Development.

Many universities now blend problem-based learning that transcends disciplinary boundaries into the learning experience on campus. For example, **Aalto University** has incorporated problem-based learning into its Nordic Case Competition, challenging students and stakeholders to develop the Otaniemi waterfront at Aalto University main campus. **ETH Zurich** has incorporated a new and innovative one-week interdisciplinary course where groups focus on a major societal challenge to develop their capacity for critical thinking, interdisciplinary group work, and sustainable behavior.

Experiential learning with outside partners offers students valuable insight into current challenges and a hands-on approach to developing solutions. The Sustainable Campus Leadership Program, a partnership between **Hong Kong University of Science and Technology (HKUST)** and the Shanghai Commercial Bank provides students with the opportunity to work directly with professionals in Hong Kong to develop, design, and implement sustainability projects that physically transform campus spaces for long-term environmental benefits for the HKUST community. In partnership with mentors and partner organizations, the **University of British Columbia** Sustainability Scholars are immersed in real-world learning where students apply knowledge and research skills gained on-campus to addressing the pressing issues facing our partners, cities, and society at large. **Ozyegin University** has introduced “sectoral solutions” to get students out of the classroom and into the field to experience different industries and functional departments through planned internship opportunities. **KTH Royal Institute of Technology** has integrated sustainability into education, research, and operation and has developed approaches and learning outcomes to gauge progress. Measurement and assessment of sustainability skills and capacities are evolving and present an opportunity for future collaboration between institutions.

Collaborating to catalyze change

Multi-sector collaborations push the boundaries of sustainable development and inspire change in business operations and broader society. To shift thinking, motivate, and increase the pace at which sustainability is incorporated into our organizations, **Harvard University** has developed a Sustainability and Health Initiative for the Net Positive Enterprise program. The program is a part of the Center for Health and the Global Environment at the Harvard T.H. Chan School of Public Health, which is dedicated to working with companies across industries to inspire and measure the positive impacts on people and the planet.

Research is essential to enhance efficiencies, discover new possibilities, and catalyze change. **Princeton University** researchers are collaborating with the private sector to transform a process for replacing rare metal catalysts in silicone manufacturing with abundant metals. This has the profound effect of reducing

cost and the environmental footprint of widespread industrial processes. **Korea Advanced Institute of Science and Technology** joined forces with Saudi Aramco, the world's leading fossil-fuel provider, to establish a joint research center to train students and engineers, and perform research in the area of CO₂ management through CO₂ capture, conversion, storage, and energy efficiency improvement.

Networks and communication tools are strategic avenues to rapidly acquire knowledge and resources. **University of Gothenburg** will host the secretariat for the Sustainable Development Solutions Network Northern Europe (SDSN NE), which aims to pool the knowledge, experience, and capacities of the regions' academic, business, and civil society actors. It also strives to promote the national and regional sustainable development of Northern Europe, as well as the region's efforts for sustainable development worldwide. Utilizing mobile technology, **Nanyang Technological University** is bringing together a smartphone virtual experience with practical initiatives on the campus with the PowerZ app, engaging campus users to do their part to reduce everyday electricity consumption on the campus. Also utilizing an online engagement tool, **University of California, Berkeley** is making engagement fun and effective for the Cool Campus Challenge to reduce their carbon footprint and create a culture of sustainability across campus.

Innovating for efficient built environments

Universities are hotbeds for developing sustainable production systems and testing innovative technologies. **Chulalongkorn University** is focused on addressing one of the most significant issues in Thailand—food waste—and making biogas for energy use. The **Technical University of Denmark** is partnering with public utility companies to develop integrated heating and cooling systems using the campus as a living lab demonstration site. **EPFL** and Romande Energie have joined forces to build the largest solar park in Switzerland, integrating it into an existing building complex on the EPFL campus. Additionally, a “Romande Energie Solar Lab” will open this summer, allowing researchers to evaluate the performance of solar panel prototypes from their labs in the real-world environment.

To inspire users and the community, **De La Salle University–Dasmariñas** is implementing energy conservation practices such as LED lighting and efficient HVAC systems in its campus library, Aklatang Emilio Aguinaldo. **National University of Singapore** is applying sustainability in mission and form in the design and construction of the “GreenMark Gold” Lee Kong Chian National History Museum, which will also become a sustainability teaching tool. The education and outreach work of the museum is made possible through generous monetary and in-kind donations from individuals, corporations, foundations, the University, and government bodies.

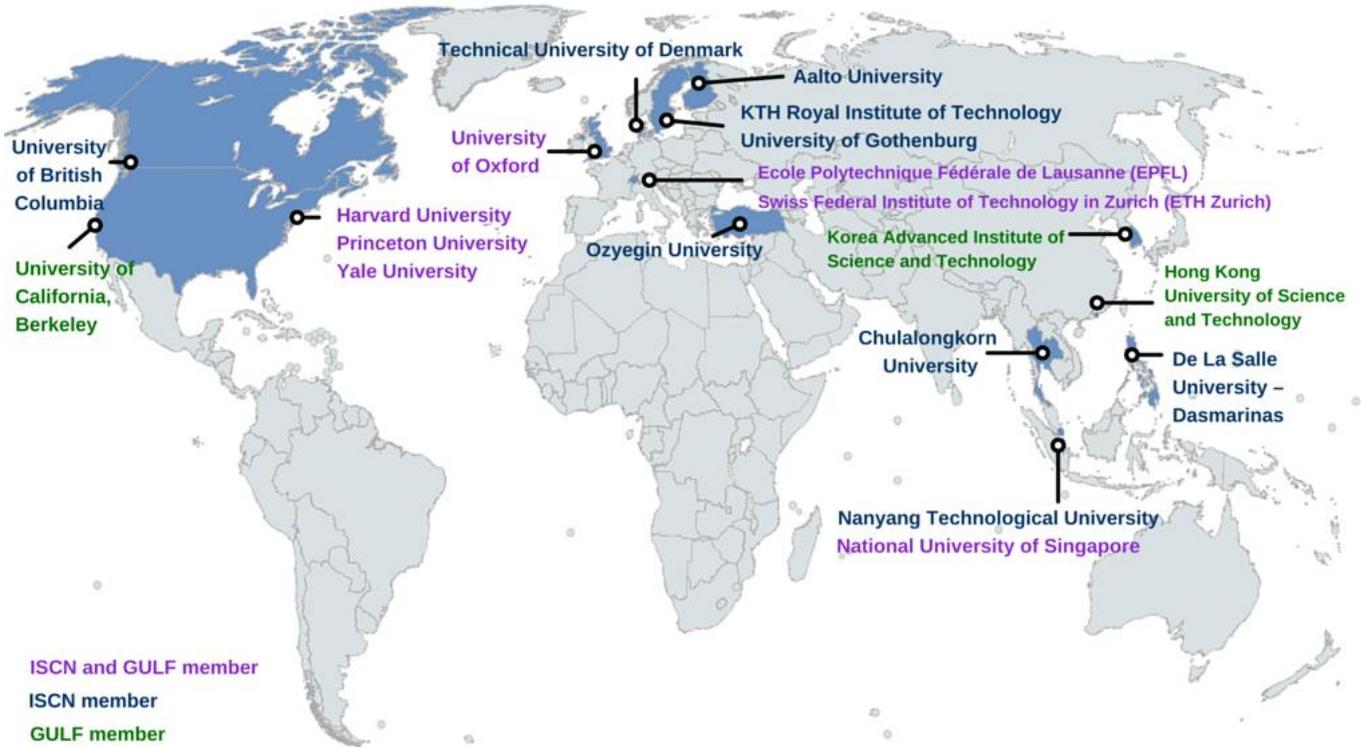
Underscoring flexibility, climate resiliency, and next-generation building methods, the **University of Oxford** is investing in sustainable construction that goes beyond the targeted BREEAM Excellent sustainability assessment for the design of their Big Data Institute building, a future-proof concept.

We hope that these cases inspire others in higher education and the corporate world as we all seek the best avenues to a sustainable future. I would like to thank all the ISCN-GULF members for their excellent work on sustainable development and for their open and active knowledge exchange in our network—the life force of the ISCN. We are eager to continue to develop innovative programs and solutions that support the COP21 implementation process and further the sustainability awareness and skills of our students and graduates. We look forward to engaging further at the next ISCN conference, June 13–15, 2016, hosted by the University of Siena in Italy.

André Schneider
Founding President of the ISCN Board
Vice-President Resources and Infrastructure, EPFL

Capacity Building, Collaboration, and Innovation for Sustainable Development

ISCN and GULF Universities Share Sustainable Campus Best Practices



CHAPTER 1: DEVELOPING SKILLS AND BUILDING CAPACITIES

Rising Leaders on Environmental Sustainability and Climate Change

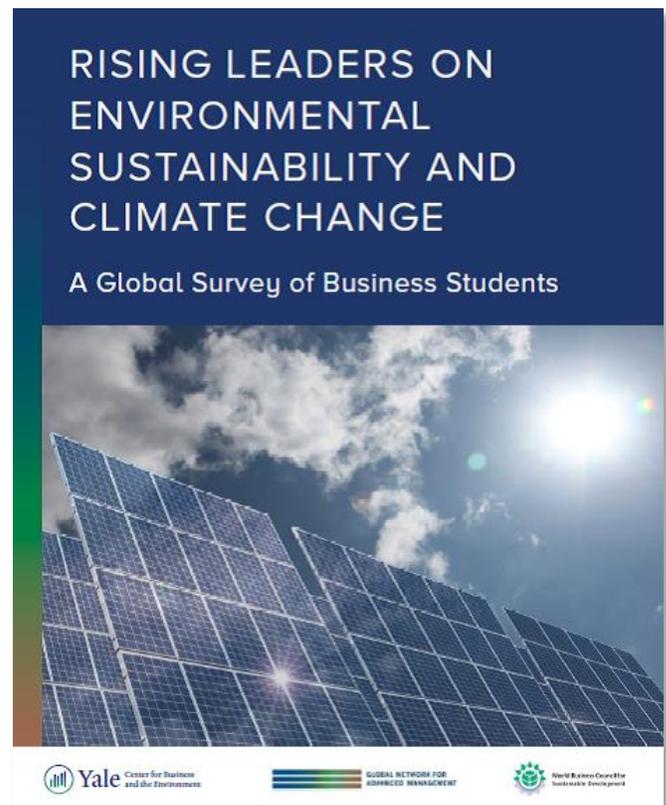
The Yale Center for Business and the Environment, The Global Network for Advanced Management and the World Business Council for Sustainable Development (WBCSD) conducted a global study of more than 3,700 students at 29 top business schools which found widespread consensus that business must lead on solutions to climate change and sustainability to attract and retain talent. Report can be downloaded at: <http://cbey.yale.edu/programs-research/rising-leaders-environmental-sustainability-and-climate-change>

Yale University’s School of Management is a member of the Global Network for Advanced Management, a group of 28 business schools that collaborate to provide enhanced programming and connections between business students across the globe. Based on the strong and growing theme of sustainability in this network, the Yale Center for Business and the Environment developed a project to explore deeply the opinions and attitudes of today’s business students on climate change and related environmental sustainability issues, and how they expect business to respond to these issues. Yale was also recently designated as the first “Knowledge Partner” of the WBCSD, which provides us an avenue to utilize findings from this research as we collaborate on business challenges facing their member companies.

Key findings indicate that the majority of current business students (1) are gravely concerned about the state of the environment, (2) believe business has a responsibility to move the world onto a more sustainable path, (3) see a competitive advantage for companies who incorporate environmental sustainability into their business strategy (4) express a desire to work with more responsible practices even if it might mean a lower salary (5) want to address challenges related to environmental sustainability and climate change regardless of the job or industry they work in, and yet (6) feel insufficiently prepared by their business school for this challenge.

Communication

Students, faculty, and staff collaborated to design and execute this research, generating conversations across Yale and Global Network schools about environmental sustainability, climate change and MBAs’ expectations from business schools and prospective employers in this space.



Results of this survey were covered by press in the US, Canada, UK, China, Chile, South Africa, Germany, Turkey and more, spurring dialogue across the globe. Anthony Leiserowitz, Director of the Yale Program on Climate Change Communications, posted about this report to his followers (nearly 50,000 strong).

Additionally, CBEY faculty co-director Todd Cort presented results at a COP 21 event to representatives of the over 200 multinational companies in the WBCSD.

Lessons Learned

The survey results have implications for both the private sector and business schools. Across the globe, business students want to see companies, governments and business schools lead the effort to provide business solutions to environmental sustainability challenges. They have a nearly unified perspective that the private sector must search aggressively for solutions to climate change.

The results of this report upend the conventional wisdom about business students. The vast majority of students intend to work for companies with strong environmental performance track records. Only a small portion are motivated by compensation alone. They embrace the opportunity to lead and solve challenges related to environmental sustainability and climate change in their work. They believe that protecting the environment will improve economic growth and provide new jobs and see a competitive advantage for companies who incorporate environmental sustainability into their business strategy.

The results also indicate that there is a carbon tax on talent. Companies with a strong scientific and forward thinking approaches on environmental sustainability and climate change will be able to recruit and hire a wider group of candidates at potentially lower costs. Companies with poor environmental performance will pay more to hire a smaller group of potential candidates.

There is a call to action for business schools as well: to adapt curriculum and resources to better explore business solutions to the environmental challenges of the 21st Century. The alternative is to lose applicants and reduce the potential student pool in the future.

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GEORGETOWN UNIVERSITY

Corporate-University Collaboration



GEORGETOWN UNIVERSITY

Georgetown University is one of the world's leading academic and research institutions, offering a unique educational experience that prepares the next generation of global citizens to lead and make a difference in the world. We are a vibrant community of exceptional students, faculty, alumni and professionals dedicated to real-world applications of our research, scholarship, faith and service. Established in 1789, Georgetown is the nation's oldest Catholic and Jesuit University.

In keeping with our Jesuit heritage, our core mission of creating knowledge and our commitment to justice and common good, Georgetown University is addressing critical sustainability challenges through our academic mission, our physical footprint and our financial operations. We are committed to engaging sustainability issues, creating real-world solutions and using the campus as a living laboratory to develop a long-term strategy.

Partnerships and collaboration, including corporate-university collaboration, are an essential part of Georgetown's work in addressing critical sustainability challenges. An example is GU's Global Social Enterprise Initiative (GSEI), which prepares current and future business leaders to create social, economic and environmental value. GSEI was established through a founding partnership with the Bank of America (BofA), and in 2015 BofA reinvested in the GSEI's work. In another example, through intentional efforts to integrate sustainability considerations into key vendor relationships, GU is accelerating sustainability outcomes in our campus footprint and operations.

Global Social Enterprise Initiative

The Global Social Enterprise Initiative (GSEI) at Georgetown University's McDonough School of Business aims to prepare current and future leaders to make responsible management decisions that create both economic and social value. The GSEI initiatives focus on five key issue areas, including Global Health & Well-Being, Clean-Tech Energy & Environment, Responsible Investing, Economic Growth & Financial Security and International Development. For information about GSEI, please contact gsei@georgetown.edu.

Some recent examples of GSEI's work in collaboration with corporate partners include:

- Co-sponsorship of US Secretary of State John Kerry's Climate and Clean Energy Investment Forum in October 2015, a two-day forum co-sponsored by the State Department, Google, GSEI and the Georgetown Environment Initiative which emphasized the role that investment can play in catalyzing climate change solutions.
- Through GSEI's partnership with Bank of America, two undergraduate students had the opportunity to support the work of the World Business Council for Sustainable Development through summer internships. The students worked with the council's marine plastics initiative and green investments. Georgetown's partnership with Bank of America (BofA) and its Charitable Foundation enabled the creation of GSEI to prepare current and future leaders to make responsible management decisions that create both economic and social value.
- Through this collaboration and the funding provided by BofA, GU awards fellowship and internship opportunities to GU students, hosts annual leadership series events, and brings the

bank's experts in environmental sustainability, impact investing and corporate social responsibility to guest lecture in academic courses.

- In 2015, BofA reinvested in the GSEI's work, contributing \$500,000 from the BofA Charitable Foundation to support the initiative's work training business leaders to create social, economic and environmental value. This funding will support the initiative's many activities, including a senior research fellow for GSEI, a corporate responsibility speaker series and five internships for undergraduate and graduate students.
- A partnership with the health and well-being company Philips has included a series of three expert roundtables to examine the challenges, opportunities and necessary action steps associated with aging well. In June 2015, Philips announced the creation of an AgingWell Hub, a unique new research center for open innovation that will examine and share solutions for aging well in collaboration with GSEI and others.

Sustainability and Vendor Relationships

Through intentional efforts to integrate sustainability considerations into key vendor relationships, Georgetown is accelerating sustainability outcomes in our campus footprint and operations. Several recent examples include:

- A sustainability sponsorship by our beverage provider Coca Cola has enabled GU to install new amenities for bicyclists on campus, including over 100 new bicycle parking spaces, three bicycle repair stands, and a student-run bicycle rental program; provided seed funds and mini-grants to offices and student organizations on campus to integrate sustainability into their workplaces and programs; and is supporting sustainable energy innovations including a live, real-time energy dashboard for residence halls and three outdoor solar-powered charging stations for mobile devices, which will be unveiled in Spring 2016.
- Through a sustainability sponsorship from our business partner Car2Go, Georgetown's Office of Sustainability has launched an annual Sustainable Campus Stewardship Award for undergraduates who are playing a leadership role on sustainability in the campus's physical footprint and operations.
- Through funding from our energy provider Direct Energy Business, GU installed and pilot-tested three water-bottle filling stations on campus and distributed 2,500 high-quality, reusable water bottles to members of the campus community as part of a "Think Global, Drink Local" campaign to reduce waste from disposable bottled water. The program helped reduce waste from over 300,000 bottles in its first year.

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Nordic Case Competition course in sustainable urban planning

Nordic Case Competition is a multidisciplinary urban planning course focused on socio-ecological approach and brought together students, teachers, professors, practitioners and leading experts from Nordic countries to work on a real-life planning case, Otaniemi waterfront walkway at Aalto University's main campus in Finland.

The case was an excellent example of problem-based learning and strongly anchored into existing concerns. All stakeholders were eager to hear and implement the results. The program included input from Otaniemi campus stakeholders like local residents' representatives, student union AYY, city of Espoo, Espoo association for nature conservation ESPYY, leading landscaping company Ramboll Oyj and landowners representatives like Aalto University principal architect and vice president for campus development.

The participants in the Nordic Case Competition were invited by leading professors in the field and represented all Nordic countries. Students' backgrounds were in landscape architecture, biology, urban development, sustainable design and engineering to ensure multidisciplinary encounters. Among best achievements were the excellent plans for the area and stakeholders meeting in a very constructive atmosphere to meet the social, economical and ecological challenges.

The course was facilitated by experienced researchers and practitioners with orientations around urban planning. In addition, the course featured inspirational talks e.g. from the Stockholm Resilience Centre. Student teams presented their solutions to a wider audience, professional jury evaluated the results and gave feedback, most valuable being from a private company, Ramboll. The course work also included a pre- and after assignments to ensure high-quality learning outcomes.

Communication

Nordic Case Competition involved equally the stakeholders in communicative efforts to ensure successful project outcomes. Social media, VC and face-to-face-meetings, good texts and audiovisuals. Organizers included Aalto University and Nordic Sustainable Campus Network (NSCN), Hanasaari Swedish-Finnish Cultural Centre, the Urban Academy which is a joint effort by Aalto and Helsinki University. Additionally, the city of Espoo was involved and Nordic Council of Ministers partially funded the



project. Naturally also Nordic universities choosing the students were involved. Companies and stakeholders were engaged by lectures, mentoring tasks, jury nominations and communications.

All Nordic Case Competition 2015 materials and student works:

nordicsustainablecampusnetwork.wordpress.com/nordic-case-competition-2015

Lessons Learned

Involve stakeholders from the beginning, mix with ambitious students and give academicians clear tasks but enough freedom. Choose a case where there's a real need and momentum for development. Then you get also the companies and municipalities on board. Look for win-wins, and be ready to work hard yourself!

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ETH Week

ETH Week is a new and innovative course open for students from all backgrounds. During one week, they work together in interdisciplinary groups on a major societal challenge to develop their capacity for critical thinking, interdisciplinary group work, and sustainable behavior.

The pilot project ETH Week is part of ETH's Critical Thinking Initiative that aims to instill intellectual agility, critical thinking and a responsible approach to taking action in students and to give them the tools to address socially relevant and ethical aspects and the principles of sustainable development. In

the first pilot project in 2015, almost 130 participants from 15 different ETH departments and of 27 different nationalities tackled the complex societal problem of the world food system. Experts from ETH and the public and the private sector supported the interdisciplinary student groups with expertise and insights into their business life through excursions. With these insights the teams defined relevant problem statements for which, in a



TEAM WORK DURING ETH WEEK 2015, PHOTO: ALESSANDRO DELLA BELLA

creative process, they developed and presented solution approaches. The

guiding concept of ETH Week is the integration of the scientific and design thinking methods. Team building processes accompany this integration in order to foster self-awareness, self-management, empathy, and relationship skills. Another important element of the week is the side program that offers content in a more informal way and gives space to network among participants and with e.g. start-ups and journalists.

Communication

Complementary to the disciplinary and methodological competences conveyed in their regular studies, the participants got the opportunity to acquire interdisciplinary and system-oriented competences in this course and learned to work independently in intercultural teams. All these competences are necessary to take responsibility and play a constructive role as critical members of society and are highly demanded on the labor market.

Lessons Learned

This new learning form was very well received by the participants despite a very dense and demanding schedule. This became obvious in the well-prepared and creative final presentations and a very good

course evaluation by the students. A few solution approaches were taken beyond ETH Week by very motivated students.

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SCB-HKUST Sustainable Campus Leadership Program (SCLP)

The SCLP is a partnership between HKUST and the Shanghai Commercial Bank that provides students with the opportunity to work directly with professionals in Hong Kong to develop, design, and implement sustainability projects that physically transform campus spaces for long-term environmental benefits for the HKUST community.

More than 6% of HKUST coursework already focuses directly on sustainability topics. However, with learning increasingly taking place outside of the classroom, the SCLP was developed as a platform for delivering intensive training in project management, hands-on experiential learning and problem solving, and developing results-oriented campus sustainability projects. The emphasis on skill-building creates environmental ambassadors who have the tools to foster change throughout their careers, while the completed projects themselves become visible demonstrations of sustainable thinking and planning for the rest of the HKUST community. The partnership with the Shanghai Commercial Bank provides

2016 ISCN-GULF Best Practice Case Study

Institution: Hong Kong University of Science and Technology

Project Title: SCB-HKUST Sustainable Campus Leadership Program (SCLP)



Project Grasshopper – one of the SCLP student proposed projects that combines project management skills, collaboration with landscape architects, and market research to transform an underutilized space into an area with multiple environmental and social benefits.



Shanghai Commercial Bank manager addressing the SCLP students. Project workshop with management consultants.

several critical pieces that contribute to the success of the program. First, the generosity of the SCB in annual funding provides certainty and scope for student projects. With funding the projects can be developed all the way through the project management process, without being limited as theoretical or conceptual exercise. Equally as important, SCB members have taken an active interest in the student projects, meeting and mentoring students and providing a real sense of a “client/consultant” relationship.

Current and past projects include harvesting rainwater, redeveloping underutilized spaces, feasibility of solar resources for shaded walkways, building a community garden, and designing a “living green wall.”

Communication

The intention of the SCLP is to produce results that are visible, durable, and serve as real-life examples of sustainability thinking and management. One of the goals for each of the student groups is “to produce an outcome that is still generating positive results for at least the next five years.” With this mission, student teams recognize that their efforts not only transform the campus, but become highly visible models of their achievements.

Lessons Learned

“Learning by doing” is a powerful concept, and students are capable of remarkable achievements with the right guidance and supervision. Campuses are excellent laboratories for experimentation, but outside professional support is critical for turning theoretical exercises into successful outcomes.

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UBC Sustainability Scholars

Working under the mentorship of partner organizations, the University of British Columbia (UBC) Sustainability Scholars are immersed in real world learning where they apply knowledge and research skills gained on-campus towards addressing the pressing issues facing our partners, cities, and society at large.

Among the many issues facing regions, nations and the world, urbanization and climate change are at the forefront. As of 2014, 54% of the total global population lives in the cities – by 2050, some estimates by the United Nations suggest that the urban population share will increase by at least 2.5 billion (leading to 70 per cent of global population living in cities). Associated with some 70 per cent of global energy consumption and energy related greenhouse gas emissions, urban areas face complex, systemic and societal challenges yet are also seen as essential agents in the pursuit of a more sustainable future.

Universities are well suited to help address these challenges and at the University of British Columbia (UBC), the campus serves as a societal-test bed for the design, implementation and testing of sustainable solutions at a municipal scale. These efforts support our teaching, learning and research mandate while at the same time help prepare students to be agents of change.



The UBC Sustainability Scholars Program facilitates corporate-university partnerships and embeds highly qualified graduate students within partner organizations through a paid internship model. Under the mentorship of partner staff, students experience real world learning and apply their research skills while at the same time helping partners build capacity to address sustainability challenges in the community.

The UBC Sustainability Initiative (USI) manages the program, matching our partners' projects with skilled graduate students to support and further their sustainability efforts across a range of thematic areas including climate adaptation, local food, transportation, zero waste, green buildings and wellbeing.

Communication

To date, mentors and students report a high level of satisfaction with the program. In 2014/2015, 30 Sustainability Scholars made significant contributions in helping private, public, and non-profit and First

Nations partners advance a number of sustainability aspirations; partners included the City of Vancouver, British Columbia's major hydroelectricity authority, BC Hydro, and natural gas utility, FortisBC, amongst others. Based on the successes to date, the program expanded to include new partners in 2015, with further expansion expected next year.

Beyond career development, the Scholars are able to expand their professional network and share their work with the broader community through an online project library and presentations. After their project is complete, students remain engaged through an online network of alumni.

In addition to providing benefits to the partners, communities, and the Scholars themselves, the program adds to the university's knowledge dissemination efforts, enables others to accelerate their own research undertakings and helps advance a civil and sustainable society.

Lessons Learned

Conducting evaluations with both the scholars and the mentors at the conclusion of the internships has been essential in maintaining partner and student satisfaction and overall program quality. As the program expands to include more partners, project topics and a greater breadth of students from the UBC community, better coordination with other existing programs and offices on campus that offer sustainability-related curricular and co-curricular learning experiences for students is essential. Further, while the principal internship period runs from early May to mid-August each year, the program offers some flexibility to accommodate partner needs.

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Sustainable Development Principles Understanding as a Leading Foci of Sectoral Education

Based on Ozyegin University's (OZU) own development strategy, sustainable development principles are targeted as one of the leading foci in its Sectoral Education program model which aims to abridge private sector's requirements for employability skills with the endorsement of OZU students.

Real-life problems for undergraduate students start right before the graduation. Graduating candidates need a variety of skills to face the challenging life conditions and the competitive work environment in Turkey. On the other hand, private sector companies can most of the times be hesitant in employing new graduates for their lack of the so-called 'real-life experience'. Trying to bridge this gap, a Sectoral Solutions model has been introduced involving six different courses with various learning methods ranging from guest speakers, industry analyses and case studies to company practicum projects. These in-classroom



experiences are augmented with the second dimension of Sectoral Solutions that takes the students out to the field and allows them to personally experience different industries as well as different functional departments through systematically planned internship opportunities. Integration of the principles of sustainable development is one of the key items aimed to be delivered in this model by taking an embedded approach and including these principles to the extent possible. For example, SEC 302 course on Local Expertise discusses also the crosscutting issues for all sectors from population dynamics, resource scarcity to climate change and even big data with an associated term project.

Communication

As is the most recent norm in the business world, OZU believes that the principles of sustainable development should be part of the everyday life of OZU community involving education and research, infrastructure and operations as well as social responsibility efforts. OZUs sectoral education program model serves in this by actually integrating these to the sectors and the business world in general. The courses are a mandatory part of the curriculum for Business Students and electives for all other students. An increasing number of OZU students are becoming a part of this program, cooperating with 189 companies to date.

Lessons Learned

Emphasized by the recent decisions of Sustainable Development Goals and COP21 on Climate Change, it is time to move forward to undertake a major role as universities. Such complementary and

comprehensive programs are good examples of innovative tools of private sector-university partnerships in the endeavor for a sustainable global world.

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A holistic approach for integration in education, research and operations – results after 5 years.

In 2011 KTH Royal Institute of Technology started several new initiatives on sustainable development. An overall aim is that KTH should be one of the leading technical universities on sustainable development. Two new organizations were established; *Sustainable Campus* and *KTH-Sustainability*. The President decided that KTH shall have an ISO 14001 certified environmental management system (EMS) built up by the Sustainable Campus-organization, while KTH-Sustainability supports integration of sustainability in the core activities education, research and collaboration. An Environmental manager leading Sustainable Campus was hired and a Vice-president for sustainable development leading KTH-Sustainability was appointed.

Both Sustainable Campus and KTH-Sustainability work closely with KTH's ten schools in developing the sustainability work. They also work closely together and are partly overlapping since integration of sustainability in the university's core activities is included in the EMS. The two organizations have now also been merged into KTH Sustainability Office. Implementing an EMS implies that there is a regular and systematic follow-up of the results and continuous improvements. Early autumn 2015 KTH and the ten schools received the ISO 14001 certificate indicating a successful work of the Sustainable Campus organization.

Education for sustainable development is a prioritized area. One of the overall aims is that sustainable development should be integrated in all educational programs. The activities are focused on two complementary approaches: evaluation of the program's work and providing tools and support for teaching staff and program directors. The evaluation process focused on engineering and architect programs on bachelor and masters levels and was conducted in several steps including a self-assessment made by the schools, a dialogue between the schools and KTH-Sustainability on strengths and weaknesses based on the self-assessment, the set-up of action plans by all schools on how to develop and integrate the objectives on sustainable development in all educational programs, and finally a follow-up of the programs' progress.

Communication

To support the process, several tools and inspirational activities were conducted. A list of learning outcomes that should be included in the engineering programs were defined that can be used by program directors and teachers. Also, a toolbox containing definitions and good examples on learning activities for integration of sustainable development in higher education was developed and launched as an open website. KTH-Sustainability has been involved in development/support of three course modules that can be implemented in all educational programs at KTH including an introductory module, one on social sustainability and one on sustainable business development. Also several events on teaching activities with inspiring talks by teachers from KTH and colleagues from other Universities have been organized. In order to facilitate further education of the teaching staff, a pedagogical course on "Learning for Sustainable Development" was developed as an effort of two schools at KTH in collaboration with KTH-Sustainability. The course is given at least once per year.

For research, the aim is that KTH should increase the research related to sustainable development and the research should be at a high international standard. KTH-Sustainability's activities have focused on supporting seed projects, building networks and meeting places and support PhD education. For collaboration the aim is to increase KTH's visibility and improve collaboration with stakeholders. KTH-Sustainability has developed internal and external newsletters, as well as several types of meeting places and collaboration platforms. Especially the cooperation with KTH's main landlord Akademiska Hus on sustainability issues is important.

Lessons Learned

During 2015 an evaluation of the KTH-Sustainability was performed in several steps including a self-evaluation, an interview study with internal and external stakeholders, and an evaluation by three national and international experts. Some of the overall conclusions were that KTH had made significant progress in several areas, that KTH-Sustainability has played an important role, that there is a strong support for the goal that KTH should be a leading university and that the special initiatives therefore should continue.

Since 2011 KTH's performance on several sustainability-related indicators has developed well. This includes:

- The number of courses with learning outcomes related to sustainable development has increased.
- Progress has been made in many educational programs on the integration of sustainable development.
- Publications and citations of scientific papers related to sustainable development have increased.
- External research grants from a number of sustainability related funders have increased.
- KTH won the ISCN Excellence in Campus Award 2015 for the Campus Plan developed together with Akademiska Hus.
- Energy use at campuses has decreased.
- Carbon dioxide emissions from air travelling by KTH staff have decreased.
- The number of procurements with environmental demands has increased.

Based on these results, the successful evaluation of KTH-Sustainability, and the ISO 14001 certificate, the President has decided to continue the initiatives started in 2011. During 2015 KTH has decided on a new sustainability policy and new sustainability goals for the period 2016-2020. It is clear that significant progress has been made, but also that there is a need for a long-term commitment.

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CHAPTER 2: COLLABORATING TO CATALYZE CHANGE



Sustainability and Health Initiative for Net Positive Enterprise

The Sustainability and Health Initiative for NetPositive Enterprise (SHINE) is a program within the Center for Health and the Global Environment at the Harvard T.H. Chan School of Public Health dedicated to working with companies across industries to measure and motivate positive impacts on people and the planet— impacts such as raising population well-being through healthy workplaces and meaningful work, and raising the health of the planet through the conservation and regeneration of natural resources. For more information visit: <http://chgeharvard.org/category/corporate-sustainability-and-health-shine-0>



SHINE bridges health with corporate sustainability and empowers companies to ensure a NetPositive impact on their communities, stakeholders, and the planet. Together with our member companies, SHINE is working to build the evidence base for ways in which we can generate handprints—actions that result in a reduction of harm, or in the improvement of people’s well-being, or in the healing or sustainability of the planet compared to business as usual. In the spirit of NetPositive impact—doing more good than harm—we work with companies to measure their current positive impacts that benefit people and the planet, while also helping to identify new opportunities to create positive change.

Companies often work ambitiously toward reducing the amount of harm that they do and measure their progress in terms of a reduction in their environmental footprint. SHINE is working to define important metrics, develop an evidence base, and measure how a corporation improves:

1. Our environment
2. The health of the general public
3. The lives of the corporations’ employees, families, and communities in which they do business.

For example, SHINE has worked on the following projects:

- Partnered with Johnson & Johnson to develop metrics to investigate the employee health impacts of work.
- Worked with the investor community to produce key performance indicators for evaluating the health and well-being impacts in responsible investment portfolios.

- Partnered with Dassault Systems to research potential to create environmental and human-health handprints by leveraging 3-D technology.

Communication

SHINE draws on the talents of affiliated faculty, student scholars, and its member companies to develop the framework, metrics, methodology, tools, training, and infrastructure for companies seeking to measure and document the amount of good that they are already doing for human health and the environment, and assess where else they can invest their efforts.

- Publish case studies and analytics from the Wellbeing Index and other metrics.
- Co-define and refine the standards for reporting on sustainability and health targets
- Apply rigorous metrics to demonstrate success and results of sustainability and health initiatives
- Articulate the value of sustainability and health initiatives to corporate leadership
- Gain insights and advice from experts and peers
- Pool knowledge about concepts, best practices, resources, and tools for advancing sustainability and inclusion of workplace well-being standards in reporting

Lessons Learned

The real value of SHINE collaborations comes from the shared learning between the academic and business partners—bringing research evidence to bear on future business decision-making.

By including positive environmental impact and health and well-being under the NetPositive umbrella, organizations can cast a much wider—and more impactful—search for avenues of action that bring about sustainable outcomes. This is, in turn, also inspires employees who already work on sustainability within the companies, and drawing others into the initiatives.

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An academic-industry partnership improves the sustainability profile of industrial silicone production

A corporate-research partnership discovers an industry-transforming process for replacing rare metal catalysts in silicone manufacturing with abundant metals – substantially reducing the cost and environmental footprint of widespread industrial processes.

Silicones are found in a range of consumer products including household utensils, adhesives, medical devices, healthcare products and low rolling resistance tires. The majority of these products are prepared by an industrial process using rare platinum catalysts. In addition to their high cost, price volatility and toxicity, extraction of such rare elements from the Earth's crust has significant environmental consequences. Obtaining one ounce of a precious metal often requires mining approximately 10 tons of ore, one mile deep and as a consequence creates a CO₂ footprint that estimated to be 6000 times that of iron. In manufacturing silicone products, often times the platinum catalyst is not recovered and results in a significant environmental footprint.

Princeton University's Professor Paul Chirik and his research group, in collaboration with Momentive Performance Materials, have discovered a new class of catalysts based on earth's abundant transition metals such as iron and cobalt that have superior performance to existing platinum catalysts, generate less waste, and require fewer processing steps. This technology is based upon a broad catalysis concept pioneered by the Chirik group at Princeton University and has significant CO₂ footprint reduction implications associated with widespread industrial processes.

Communication

The discovery of easily synthesized iron and cobalt catalysts with unprecedented utility are transforming the industrial approach to silicone production. The current estimated cost of cobalt catalysts is approximately 3% of the cost of commercial platinum. Both the iron and cobalt catalysts have been prepared at large scale and have undergone pilot manufacturing plant evaluation. This new process will likely impact at least five major product lines ranging from agricultural adjuvants to tires to health care products to fiberglass. Evaluation of environmental benefits, reproducibility, and process safety are ongoing and once complete further steps toward commercialization will be taken.

Lessons Learned

This work demonstrates that earth abundant metals can mimic or even surpass the function of precious elements. These new fundamental chemical concepts change the way chemists approach the periodic table and inspire new approaches to replacing precious elements in alternative energy, pharmaceutical synthesis, commodity and fine chemical production.

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KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY



Saudi Aramco-KAIST CO2 Management Center

KAIST joined forces with Saudi Aramco to train students/engineers and perform research in the area of CO2 management through CO2 capture, conversion, storage, and energy efficiency improvement.

KAIST has joined forces with Saudi Aramco, the world's leading fossil-fuel provider, to establish a joint research center on CO2 management. The goal is to develop fundamental understandings and integrative solutions to reduce anthropogenic CO2 emission, which is seen as the main culprit for climate change. The Saudi Aramco-KAIST CO2 Management Center, housed at the KAIST Institute of KAIST campus, is currently sponsoring ten research projects involving more than 20 PhD-level researchers and over 100 students. The research projects provide requisite technical and financial support for developing creative and impactful solutions that are fundamental as well as applied. Our research portfolio includes materials for more energy-efficient CO2 capture, catalysts and processes for converting CO2 into valuable products, novel storage methods, and system-level analyses of major CO2 emitting industries to suggest industry-specific CO2 reduction strategies including energy efficiency improvement. The center activity also includes analyzing impact of potential government or industry-wide policies in the face of various uncertainties, which are technological and economic as well as political. The center-sponsored research projects have already generated a large number of publications, patents, and public presentations. Some energy-saving commercial devices and solutions are also under development for release in 1-2 years. Besides the research activities, the center has also sponsored a seminar series and workshops throughout the year to raise awareness of the importance of CO2 management in building a sustainable future, in light of the world becoming ever more energy-intensive.

Communication

From the outset, the center is intended to be 'multi-disciplinary' bringing together a number of academic disciplines including chemistry, materials science, chemical engineering, mechanical engineering, and civil/environmental engineering. It has prompted researchers and students of highly different backgrounds and skill sets to come together and join forces to develop integrative and systematic solutions to real problems of critical importance to the world's sustainability. Carbon management is a problem that requires continuous dialogues and close collaborations among researchers, company managers, politicians, and community citizens; the center has played and will continue to expand its role in bringing all the stakeholders to the common ground.

Lessons Learned

All significant challenges concerning sustainability stretch beyond the boundaries of nations, disciplines, and sectors. Hence, developing effective long-term solutions demand that academic institutions, governments, and private sectors across different nations work together. Only then can dialogues and discussions of substantive weight and breadth occur. The aforementioned collaboration between the two very different (yet excellent in their own rights) institutions, Saudi Aramco, the world's biggest fossil fuel provider, KAIST, one of the world's best research-oriented universities, has generated much publicity and positive driving force for addressing this important problem.

It is thought to be a good partnership as KAIST can provide elite research workforces, education, and facilities while Saudi Aramco can efficiently bring developed solutions to practice. Participation by additional parties, such as the two nations' governments and various international organizations, should follow in due time. The lesson is that strong and sincere commitments by significant parties of involved sectors to work together can quickly raise global awareness and generate positive vibes towards meaningful solutions.

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UNIVERSITY OF GOTHENBURG



The Sustainable Development Solutions Network Northern Europe (SDSN NE)

The University of Gothenburg and Chalmers University of Technology have sustainable development as a driving force and a guiding principle for all activities, namely in education, research, outreach and environmental management systems. The university's leading role in sustainable development, in close cooperation with business and society stands at the core of the universities' visions for a sustainable future. At the University of Gothenburg, staff and students alike share responsibility for the development of the university and together work towards a *quality-driven research, education and cooperation in an inspiring environment, strong social responsibility and global engagement enable the University of Gothenburg to contribute to a better future*. Similarly, Chalmers University of Technology's vision, *Chalmers – for a sustainable future*, is guided by the principle that societal challenges are shared by all. The vision acts as a driver and imbue all operations; spanning from research, education and campus developments to societal cooperation, utilization and strategic partnerships.

Consequently, exemplifying the concept of *walk the talk*, in close collaboration with business and government, the University of Gothenburg and Chalmers University of Technology are hosting a UN mandated initiative for sustainable development, the Sustainable Development Solutions Network Northern Europe (SDSN NE). Gothenburg's Centre for Environment and Sustainability, GMV, a joint Centre between both universities, was recently mandated to host the secretariat for the SDSN NE.



The SDSN NE pools knowledge, experience and capacities of the regions' academic, business and civil society actors and strives to promote the national and regional sustainable development of Northern Europe, as well as the region's efforts for sustainable development worldwide. As part of the operationalization of the Sustainable Development Goals (SDGs) the Sustainable Development Solutions Network (SDSN) was established in 2012, under the auspices of UN Secretary-General Ban Ki-moon. The SDSN is a global multi-stakeholder network led by Jeffrey Sachs at Columbia University that aims to identify and share the best pathways to sustainable development and mobilize academia, civil society, the private sector and financing institutions to find and disseminate innovative and applicable solutions at local, national and global scales.

The SDSN NE intends to place the search for and creation of new solutions at the heart of its network activities, and to work closely with existing processes in politics and with business. The members of the SDSN NE want to ask questions and join with others to develop answers. The SDSN NE will:

- promote sustainable development and the SDGs as a guiding principle in business, politics, science and education in Scandinavia and Northern Europe
- create a forum that enables stakeholders to search for, develop and implement practical solutions for sustainable development in the Northern European region and worldwide by supporting cooperation between academia, business, government and the civic sector
- actively support and engage existing dialogues and cooperation platforms in the Northern

- European region and beyond, and share experiences, strategies, evidence and solutions
- provide science-based decision-making support to stakeholders and ensure that policy-makers, business and social actors can better access and process academic findings and recommendations
- partner with major national and regional media outlets

The SDSN NE has a governance structure that promotes transparency, mobilizes resources, facilitates collaboration between members and partners, prioritizes action and ensures the effective operation of the network. It consists of a regional Leadership Council with representatives from the private sector, government, international organizations and academia, network co-chairs and a Secretariat. Membership is open to all universities, higher education institutions, knowledge centers and networks, and other non-governmental institutions.

SDSN NE aims to work with interested partners to develop pathways for implementing the SDGs. The pathways can be a central instrument to implement the SDGs in line with clear priorities in the Northern European region and beyond. The SDG pathways could contain three key processes:

1. Localizing the SDGs to national and regional contexts through an inclusive process where stakeholders can interpret the relevance, priority, applicability and transformation potential of the SDGs.
2. Choosing the correct indicators on the national level that can feed into the global indicators for the SDGs.
3. Developing detailed stakeholder profiles that will highlight interest areas, capacities, capabilities, strategic aims etc., for respective stakeholders, and thereby clarify respective stakeholder roles in the implementation of the SDGs.

The SDSN NE will also create a data visualization interface (tool) named **The Sustainability Atlas** used for collection as well as visual presentation of data and information. The initial output of the Sustainability Atlas will be the SDG pathways. Its objective will be to present a visual guide for stakeholders and processes to meet their responsibilities and visualize opportunities in support of the SDGs. The information visualized via the Sustainability Atlas interface can interlink stakeholders and civil society to concentrate efforts, prioritize, engage, discover knowledge and technological gaps and align strategies and reporting.

The SDSN NE will be officially launched on February 25-26, 2016 in Gothenburg, Sweden. On the 25th, the SDSN NE is hosting an open launch event with a focus on science-based transformations. On the 26th, the SDSN NE is hosting a high-level launch event that will bring together leaders from business, academia and government from Northern Europe. SDSN NE: <http://www.unsdsn-ne.org>

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PowerZ: A collective experience to improve energy efficiency @ NTU

NTU developed a mobile app to help the university reduce its energy usage.

NTU's commitment to sustainable development is demonstrated by the EcoCampus Initiative, whose goal is to reduce the consumption of resources (energy, water, waste) by 35% by 2020. EcoCampus aims, among other things, to give students and staff the chance to play an active role in this revolution. The PowerZ app is developed in collaboration with ENGIE Lab Singapore (formerly GDF Suez), a leader in energy services and solutions. The idea is to involve everyone in increasing the energy efficiency of the campus while having fun at the same time. Bringing together a smartphone virtual experience with practical initiatives on the campus, PowerZ is a team effort, with campus users doing their bit to reduce everyday electricity consumption (e.g. air conditioning) on the campus. Earthlink NTU, the biggest student organization dealing with environmental issues at NTU, is supporting PowerZ through the involvement of its management committee.



The app has gone through 10 months of development, test bedding and research since September 2014, involving about 1800 students. Based on a sociological and technical analysis, it has been demonstrated that PowerZ raises the general awareness about Energy Efficiency, has the potential to foster sustainable behavior, and that potentially substantial savings could be achieved.

Communication

NTU launched, together with ENGIE and Earthlink, an advertisement campaign to attract students to use the PowerZ app. The main elements of the campaign were: Social media (mainly Facebook with regular updates, challenges with lucky draw), mailing lists, events/publicity road show, lucky draws, flyers, posters and a trailer, see <http://ecocampus.ntu.edu.sg/Pages/powerz.aspx>.

PowerZ inspires and nudges staff and students to do something for the environment with simple, daily activities. There is a big potential for scaling-up. NTU provided, together with ENGIE, a Launchpad for developing a nationwide app for reducing energy and improving thermal comfort.

Lessons Learned

Gamification tools can play an important role in engaging people in sustainability. For the development of such tools, collaborations between a university, a company and a student organization can be beneficial. Apps like PowerZ have a great potential for scaling-up.

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Making Staff Engagement Fun and Effective

UC Berkeley works to effectively engage staff, especially those that identify as sustainability champions, through multiple programs and campaigns.

UC Berkeley works to effectively engage staff, especially those that identify as sustainability champions, through multiple programs and campaigns. These efforts were developed after input from staff that they need flexible and targeted ways to learn about sustainability. Staff are also time constrained in their ability to apply what they learn in the workplace, but adding the new programs has proven effective at helping more staff find ways to more easily engage.

Existing staff programs, like Green Department certification, involved clearly defined actions but could also be time consuming to complete. The addition of staff training (WORKbright green), where forty campus staff have attended eight hour sessions, focused on simple and feasible ways to reduce the environmental impacts of their work – and asked staff what they wanted to learn. The staff represented a range of departments and job roles, from student affairs officers to administrative assistants to custodial supervisors. The training equipped staff with tools to make informed choices to improve sustainability in the workplace, bring green projects back to the office, and collaborate with other campus sustainability stewards.

Newer engagement opportunities have offered flexibility and allowed participants to make varying time commitments. The new Berkeley Sustainability Community held its first ‘community of practice’ meeting in 2014 and is for “people who share a concern or a passion for something they do [to] learn how to do it better as they interact regularly” ([Wenger-Traynor](#)). With a common interest in sustainability and a desire to learn, both new and old members alike came together to work toward a more sustainable future for the Berkeley community. The forum includes students, faculty, and staff in a way like never before and opens up discussions to topics such as food security, zero waste standards, and mindfulness and sustainability.

Communication

Perhaps the most exciting new staff engagement tool has been the [Cool Campus Challenge](#) (CCC). From October 6 to December 10, 2015 UC leadership, faculty, staff and students engaged in a friendly, fun competition aimed at reducing UC’s carbon footprint and creating a culture of sustainability across campuses. Berkeley staff worked with researchers and others to

create a university-specific online tool and outreach campaign, the first of its kind, focused on motivating individuals across the UC system to take specific carbon reducing actions our office, labs, classrooms, and residence halls. Individual staff could choose how much time to devote to the Challenge and were given tools to dive deeper in specific topics.



Exceeding expectation, over 19,000 UC people joined in on the inaugural Cool Campus Challenge, with students and staff participating with enthusiasm. That's 4% of the whole UC system! Together Challenge participants will reduce 15.5 million of pounds of carbon emissions each year with their new actions! An example of the marketing is below.

Lessons Learned

One key lesson learned was that sustainability champions find the sustainability office, not the other way around. The key is to be ready with a range of programmatic offerings for those who express an interest. Having done that, though, challenges around translating interest into action still persist, and are likely to require an ever-shifting set of staff engagement efforts. For example, a large number of UC Berkeley participants in the CCC registered for the campaign but didn't complete a single pledge. Finally, staff in any large organization likely receive large numbers of messages, email, and communications on any given day. It is key to work with professional communications staff to help ensure that sustainability messages are well-crafted and -received.

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CHAPTER 3:
INNOVATING FOR
EFFICIENT BUILT
ENVIRONMENTS



Canteen Food Waste to Biogas

As the country's major driving force behind sustainability movement, Chulalongkorn University has done many of researches in this field. "Biogas from Food Waste" is one of the research projects that the university is particularly proud of. This is because the project addresses one of the most significant waste issues in Thailand, which is food waste. The waste (including food residues, grains, fruits, vegetables etc. from retail restaurants and households), causes serious environmental problems (such as odor & leachate production), if not treated properly. Landfill, which is one of the most typical approaches to food waste management in Thailand, is also a major source of greenhouse gas emissions. Another reason behind our pride of this particular project is that it has actually been implemented into the university's waste management system. Its prototype full-scale two-stage anaerobic digester has been successfully running at Mahitalatibet Building to generate biogas from whole food waste and sewage sludge.

Participating in the program of in-situ building energy recovery from waste utilization under Ministry of Natural resource and Environment (MONRE), with the support from JICA - Water Intro Project, Japan, the university constructed a full-scale anaerobic two-stage co-digestion system (total volume of 2,500 liters) to receive the whole food waste (sourced & separated at the canteen of Mahitalatibet Building) and the sewage sludge from building wastewater treatment plant inside the university campus (at a design maximum of 100 kilograms per day). The main objective is to evaluate the performance of anaerobic co-digestion of food waste and sewage sludge for energy recovery together with organic waste reduction in full-scale operation. The benefit of co-digestion includes: dilution of potential toxic compound, improved balance of nutrients, synergistic effects of micro organism, increased load of biodegradable organic matter and better gas yield. Anaerobic co-digestion system also provide more balanced nutrient for efficient digestion and high biogas production. Therefore, the anaerobic co-digestion system is also expected to be an excellent solution for food waste management & digestion.



The result of the study is very promising. The prototype anaerobic co-digestion system gives an encouraging amount of biogas (64% of methane composition, which is acceptable for cooking purpose). Also, as the digester was operated at a various hydraulic retention times (HRTs) of 24, 19, and 16 days (corresponding to organic loading rate of 8.66, 12.56 and 16.04 kg COD/m³d), the study shows that longer the retention time, the higher the percentage of methane yield. The result also shows the highest efficiency in term of COD removal and total volatile solid (TVS) reduction at HRT 24 days.

The prototype anaerobic co-digestion system created by Chulalongkorn University, as a result, can be a good option for energy recovery because of its high efficiency in biogas production. This study does show the country another promising alternative to treat sewage sludge from wastewater treatment plant and food waste from canteen in the high-rise buildings. The alternative is much needed in the near future as Thailand is aiming to limit landfill to reduce greenhouse gas emission and negative environmental impacts of landfill.

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DTU Smart Campus - Energy

Technical University of Denmark (DTU) and public utility companies are developing integrated heating and cooling systems. The main motivation for this collaboration is to reduce cost and environmental impact of heating and cooling at district level using the university campus as living lab.

DTU Campus is supplied with district heating originally designed for on campus stand-alone coal powered boilers. During the 1980s a gas powered combined cycle steam turbine CHP plant was installed to replace the old boilers by a private operator. Early after the year 2000, DTU's district heating grid was linked to the cooperative Holte District Heating system by the private CHP owner. In 2005 DTU and Holte District Heating formed a private limited company and purchased the pipe connecting DTU Campus and Holte District Heating.

Due to the high fraction of wind turbine electricity now available in the Danish power grid, prices for CHP generated electricity is experiencing heavy competition thus making combined heat and electricity generation a poor business. DTU is planning to install heat regeneration from the university wide district cooling system thus imposing additional competition on the CHP profitability.

DTU, Holte District heating, the private CHP owner, other regional utility companies and municipalities are currently collaborating to increase the performance of the integrated heating and cooling system.

DTU is using the heating and cooling system as a research and education platform. A triple helix collaboration between the municipality, private companies and the university is established in the form of the association 'Lyngby Vidensby' (Lyngby Knowledge City).



Lessons Learned

Stakeholders involved in this collaboration learn about the technologies for district and regional (Greater Copenhagen) integrated energy heating and cooling systems.

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Romande Energie and EPFL unveil their urban solar park

Romande Energie and EPFL have joined forces to build the largest solar park in Switzerland, which is integrated in an existing building complex on the EPFL campus. The solar park, which is being inaugurated today, has a surface area of 15,500 m² and covers the roofs of more than 25 buildings - it is like a power plant on all the rooftops of a neighborhood. It will also serve as a major research and teaching laboratory for EPFL.

The project to build the Romande Energie-EPFL solar park was announced in 2009, and construction took place in phases. When fully online, the solar park has the capacity to generate 2.2 million kilowatt-hours of electricity per year, which is equivalent to the annual consumption of 610 households.

Phased construction meant that the project's technical solutions kept pace with advances in the state of the art and the market.

A technological showpiece, this solar park is proof of the maturity of solar energy and its enormous potential.

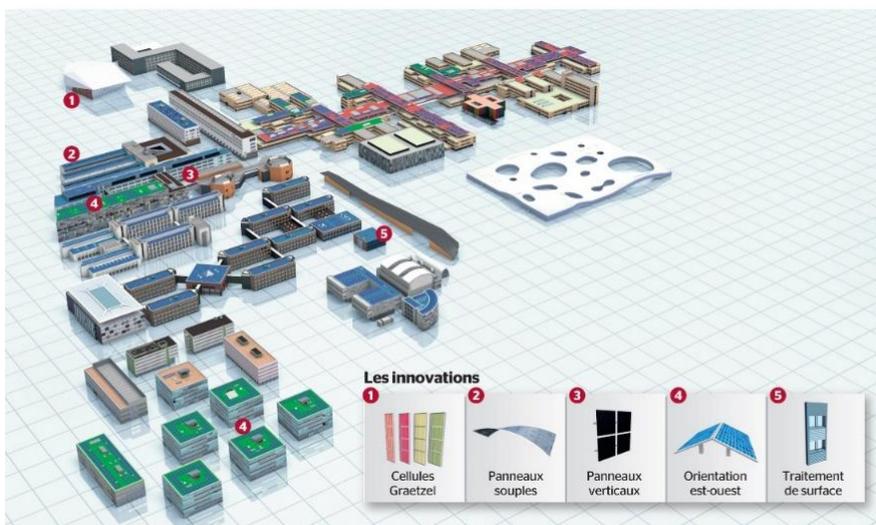
Communication

Marking the end of construction and the start of 25 years of power generation

The inauguration ceremony was attended by officials from both Romande Energie and EPFL, along with Jacqueline de Quattro, state councilor in charge of the Department of Planning and the Environment, and Roger Nordmann, national councilor and president of the association Swissolar.

"Today we are celebrating the launch of a solar park that, during its lifespan of at least 25 years, is expected to generate nearly 60 million kilowatt-hours of electricity," said Pierre-Alain Urech, CEO of Romande Energie. André Schneider, Vice-President for Resources and Infrastructure at EPFL, said: "Through this project, EPFL is not only breaking new ground but is also showing the real potential for solar energy production in our country. At the same time, EPFL is contributing to the development of new photovoltaic technologies by virtue of the ideal testing ground found on its own rooftops."

The general public may explore the solar park up close on a walking tour!



Lessons Learned

Promoting renewable energies through an innovative partnership - The partnership between Romande Energie and EPFL goes beyond simple electricity generation. The construction of the solar park is coupled with a strategic partnership focused on encouraging innovation.

In fact, 15% of the investment is devoted to projects at several EPFL laboratories working on solar energy and to related applications. EPFL is engaged in several cutting-edge research projects in this area. Evidence of them can be seen, for example, in the Grätzel panels lining the western side of the SwissTech Convention Center and in the colored panels gracing the southern facade of the ELL building - two projects supported by Romande Energie. In addition, a "Romande Energie Solar Lab" will open this summer, allowing researchers to evaluate the performance of solar panel prototypes from their labs in the real-world environment.

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DE LA SALLE UNIVERSITY – DASMARINAS



Green Library: Aklatang Emilio Aguinaldo

Named after the 1st Philippine President and with an architectural design patterned after the site where Philippine Independence was declared in 1896, the Aklatang Emilio Aguinaldo is De La Salle University – Dasmaringas' University Library serving more than 17,000 students and faculty.

In support of the University's program to reduce its carbon footprint, the Aklatang Emilio Aguinaldo began an energy and resource efficiency program in 2011. This included:

1. Rehabilitating electrical connections and capacity to avoid energy loss. The increase in the University's population led to the expansion of the library's space and subsequently its energy requirement.
2. Installing energy efficient equipment. Since 2011, 80% of the University's HVAC systems were replaced with energy efficient technologies and light fixtures are gradually replaced by LED lights. At present, 90% of the library's lighting systems are LED.
3. Implementing energy conservation practices such as turning off air-conditioning units one hour after closing time; pre-setting the temperature in the library to 24 degrees Celsius; regulating the number of air-conditioning units turned-on based on the number of users; Maximizing natural lighting especially near book shelves and learning areas.
4. Using digital resources such as online and paperless communication.



Lessons Learned

Embracing sustainable programs has led to a very significant decrease in energy consumption. The program has reduced the library's energy cost from about USD \$67,000 annually to only about USD \$16,000 even with an increasing number of users.

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Sustainability in mission and form: The Lee Kong Chian National History Museum

The mission of Lee Kong Chian Natural History Museum (LKCNCNHM) at National University of Singapore (NUS), Singapore's first and only such natural history museum, is to showcase Southeast Asia's biodiversity and increase conservation awareness through research, education and outreach. The museum's biodiversity specimens are part of the region's biodiversity memory and used in research and its new galleries that are designed to nurture public interest in biodiversity and associated environmental issues.

The Museum building itself is also a "teaching tool" on sustainability. The main building resembles a rock with one side being home to cliff garden consisting of trees and vines while the rest of the façade is expected to be colonized by moss. Other features include a mangrove tree grove between the main building and the education wing and a "beach to land forest zone" that illustrates the gradual changes in species diversity between these extreme habitats. The plants throughout the museum simulate natural habitats in order to encourage local fauna, such as birds and butterflies, to inhabit the spaces and hence creating a naturally biodiverse building complex. This greening effort enhances the building's energy efficiency by acting as a heat screen to cut down the heat absorbed by the building, while drawing visitors to interact with the living gardens. There are three gardens within the building:

- a) Mangroves, Swamps and Dryland Forests landscape area that features some of the unique plant species found in Singapore, which are specially adapted to inundated soils and the mangrove habitats
- b) Phylogenetic Garden which is a living showcase of the various clades of plants, from the simplest algae to the exotic flowering plants
- c) Beach to land forest area that highlights a selection of native plants found at the sea shore to an inland forest habitat

The building has also been awarded the Building Construction Authority GreenMark Gold certification, and the 2015 National Parks Excellence Award for the "Community Facility" category for Skyrise Greenery.



The education and outreach work of the museum is made possible through generous monetary and in-kind donations from individuals, corporations, foundations, the University, and government bodies. In particular, the private sector supported the exhibits and student programs / workshops, as well as the development of an interactive Museum Gallery web applications and the gallery web (<http://lkcnhm.nus.edu.sg/nus/index.php/egallery>).

Communication

LKCNHM's building façade, conceived as a "moss- and vegetation-covered rock" in the landscape cleaved to reveal a plant-filled strata of planter boxes and gardens, is a geological allegory derived from the Museum's natural history roots. By encouraging other living organisms to inhabit the wall's vegetation and eventually creating a natural biodiversity-rich wall feature, the building captures the attention of the visitors even before they step into the exhibit area.

The gardens located at the upper first storey of the building are freely accessible to the visitors and provide opportunities for social interaction and learning. The numerous signs in the gardens also convey educational information about the plants.

Coupled with the curriculum-based educational workshops and programs that provide opportunities for NUS students, teachers and students to work with the museum's researchers, the museum offers an unparalleled outreach experience for the wider Singapore community.

Lessons Learned

Other than the typical green building strategies of building orientation, construction materials etc, the design and use of building façade materials as well as in-situ plants can also be a strong environmental narrative to inform and educate the public. This can be reinforced with appropriate signs communicating the sustainability aspects and the underlying rationale of the design or material choice.

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Investing in flexible and sustainable construction

The Big Data Institute building, which forms part of the University of Oxford's Old Road Campus research site, is a 7500m² facility designed to be at the pinnacle of sustainable design for the built environment. The University of Oxford has targeted BREEAM Excellent for all its major projects since 2009 but the aim of this project has been to go further to create an exemplar sustainable building.

Two main drivers have been at the heart of our approach:

- The use of simple, sustainable design using the surrounding environment and waste energy resource to reduce energy consumption
- The provision of a flexible future-proof space able to deal with increasingly demanding climate conditions

The building encompasses several uses, accommodating two research departments, seminar space and a data processing facility. Through innovation and a collaborative design team approach, a complex design brief has been turned into a series of energy saving opportunities.

Central to the concept of the building is the use of passive design and natural ventilation principles to reduce the energy consumed by mechanical ventilation and active heating and cooling systems. The design is also mindful of the principle of energy conservation and seeks to recover energy (i.e., waste heat from equipment and extract) and to convert it to a new form, and continuously recycle it where possible.

The passive design approach begins in the building's form; open floor plates surround a central atrium and, along with high level atrium ventilation, use the buoyancy of the internal warm air heated by the room conditions to naturally extract from the spaces, using the 'stack' effect. This removes the requirement to mechanically extract air for significant periods.



Despite the relatively intensive use of the floor plate, the building will not require mechanical cooling to meet CIBSE Guide A and BCO thermal comfort levels. This is primarily (and relatively uniquely) achieved by the use of a thermal labyrinth, positioned approximately nine meters underground. Using the near constant temperature of the ground and ground water, this provides tempering to external air before it is supplied to the occupied spaces via low velocity, low pressure distribution plenums beneath the floor. This air path also delivers night cooling to the floor slab via the labyrinth, recharging the building's ability to stabilize daytime heat loads.

The labyrinth consists of three chambers (or air paths), totaling 600 linear meters of travel. A relatively constant ground/groundwater temperature of ~12 degrees C will provide the cooling in the summer, and a proportion of heating in winter. CFD analysis shows in peak summer conditions we see a reduction in air temperature of approximately 9-9.5 degrees C.

There are limited examples of this approach internationally and the University hopes that this aspect of the project will provide an exemplar demonstration of passive design. As well as the labyrinth itself, the University has significantly invested in metering to ensure that data from the project can be shared widely. A working group has also been established with M&E consultants not involved in the project to foster the wider adoption of this technology and other low-tech solutions for hi-tech environments.

Few buildings have tackled the challenge of delivering low energy, comfortable internal environments for large scale research and office buildings with high internal loads and which would normally require energy intensive mechanical cooling. The University has a unique opportunity, as a long sighted owner occupier of commercial buildings, to invest in and lead on proving the viability of technologies such as this.

In addition to the passive measures above, the re-use of energy is integral to the sustainability credentials of the building. When the building is in heating mode, the atrium ventilation system closes, and waste heat is re-used to further warm air supply air from the labyrinth.

Whilst the above is a relatively standard form of heat recovery, The BDI building goes further still in the capture and reuse of heat. The building houses a 320kW data centre, which produces significant waste heat. This is principally rejected using free cooling via dry air coolers. However, when the building is in heating mode, this waste heat is used to further pre-heat the incoming air.

Between the Labyrinth, heat recovery, and capture of the waste heat from the data facility, there is very little need for conventional boiler heating, other than to provide accurate zonal control.

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