Setting the Foundations for International and Cross-disciplinary Innovation

The U.S.-Denmark Summer School "Renewable Energy: In Practice"

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Setting the Foundations for International and Cross-disciplinary Innovation: The U.S.-Denmark Summer School ”Renewable Energy: In Practice”

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Tela Favaloro received a B.S. degree in Physics and a Ph.D. in Electrical Engineering from the University of California, Santa Cruz. She is currently working to further the development and dissemination of alternative energy technology; as project manager of a green building design initiative and researcher with the Center for Sustainable Engineering and Power Systems. Her background is in the development of characterization techniques and laboratory apparatus for advancement of novel electronic devices, in addition to curriculum development for inquiry-based learning and facilitation of interdisciplinary, student-led project design. She emphasizes engineering sustainable solutions from a holistic perspective, incorporating analysis of the full technological life cycle and socioeconomic impact.

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Prof. Bryan Jenkins teaches and conducts research in the areas of energy and power, with emphasis on biomass and other renewable resources. Dr. Jenkins has more than thirty years of experience working in the area of biomass thermochemical conversion including combustion, gasification, and pyrolysis. His research also includes analysis and optimization of energy systems. He teaches both graduate and undergraduate courses on energy systems, heat and mass transfer, solar energy, and power and energy conversion, including renewable energy and fuels, combined heat and power systems, economic analysis, and environmental impacts. Prof. Jenkins is a recipient of an Outstanding Achievement Award from the U.S. Department of Energy for exceptional contributions to the development of bioenergy, and the Linneborn Prize from the European Union for outstanding contributions to the development of energy from biomass. He is a Fellow of the American Society of Agricultural and Biological Engineers.

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Dr. Martin Lehmann is Associate Professor of Sustainable Development at Aalborg University, Denmark, co-founder of The Danish Centre for Environmental Assessment, and co-founder and director of KlimaLab, a climate change innovation laboratory aimed at rapidly scaling climate action and solutions locally and regionally. His primary research field is in the area of sustainable innovation systems and partnerships for sustainable development.

He has for more than 15 years worked closely with national and international public and private stakeholders in developing local and regional partnerships for sustainable development.

Since 2012 he has led the Erasmus Mundus Joint Master Degree ’Cities & Sustainability (JEMES CiSu: http://www.jemes-cisu.eu), a joint degree programme between universities in Denmark, Germany, Spain, Portugal, the US, Australia, Thailand, and China.

Dr. Lehmann is member of the steering group of the UCCRN’s (Urban Climate Change Research Network) Second Assessment Report on Climate Change and Cities (ARC3-2) and leads Aalborg University’s contributions. He is member of the Aalborg University Steering Group on Smart Cities, and committee member of the Network for Sustainable Business Development in Northern Denmark (www.nben.dk).

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Michael Isaacson is the Narinder Singh Kapany Professor emeritus, professor of electrical engineering, Director of the Center for Sustainable Energy and Power Systems (CenSEPS) and a member of the Sustainable Engineering and Ecological Design Program at UCSC. He is recipient of numerous awards including a Sloan Foundation Faculty Fellowship, the Burton Medal from the Microscopy Society of America, an Alexander von Humboldt Senior Scientist Award, the Rank Prize in Optoelectronics and the Distinguished Scientist Award from the Microscopy Society of America. He is a Fellow of the AAAS and the MSA. He has been elected to the executive board of the Engineering Research Council of the American Society of Engineering Education and is series co-editor of "Advances in Microscopy and Microanalysis" published by Cambridge University Press. He is the PI on an NSF-PIRE grant on "US-Denmark Cooperative Research and Education in Intermittency-Friendly Community-scale Renewable Energy Micro-grids". Professor Isaacson has a B.S. in Engineering Physics from the University of Illinois at Urbana-Champaign and an M.S. and PhD in physics from the University of Chicago. He came to UC Santa Cruz in 2003 from Cornell University where he was a professor of Applied and Engineering Physics, director of the Keck Foundation Program in Nanobiotechnology and Associate Dean of Research, Graduate Studies and Professional Education in the College of Engineering.

Setting the foundations for international and cross-disciplinary learning: the US-Denmark Summer School "Renewable Energy: In Practice"

Introduction: Program and Participant Overview

Beginning in 2008, the US-Denmark Summer School on Renewable Energy (In Practice)[*] has sought to integrate international research and perspectives to form a foundational program in systems-level thinking for sustainable living and commercial enterprise. This course responds to the intensifying demand in energy, food, and water together implicate global grand challenges: climate change, resource insecurity, and volatility in international markets. As such, solutions must not only be technically feasible, but also economically, environmentally, and socially viable. Thus, truly impactful innovations cannot be isolated to linear track constructs such as zero net energy or carbon neutrality, but must be addressed holistically as a complex system involving diverse stakeholders and with outcomes that may include such metrics.[1]

Training the next generation of leaders and professionals to tackle such challenges in today's globalized economy requires a pedagogy that reflects these complex themes and fosters creativity, engagement and entrepreneurship required for innovation. Municipalities in Denmark and California have actively committed resources to achieve 100% renewably powered communities by 2050 and have strong academic programs performing vanguard research and learning in sustainable energy systems and practices.[2,3,4,5,6,7] By leveraging these commitments, the US-Denmark Summer School provides a collaborative research and education model focused on strengthening the intersection of academia, private industry, civil society, and governance to obtain impacts and benefits far beyond what can be achieved individually.[8,9,10] Students and professionals participating in the summer course gain experience working within disparate communities of practice: interdisciplinary, cross-sectoral and diverse teams learn about and tackle real world problems. While experiential and entrepreneurially-minded learning promotes learner efficacy, it is by working intimately within a multi-cultural and multi-disciplinary setting that provides the basis for robust and sustainable solutions. In this proceeding, we present our observations, challenges, and learnings garnered over eight years of hosting the summer school and detail the current program design, which has evolved to reflect lessons learned.

1. The Program

The US-Denmark research and education program, funded for the first three years by the Danish Agency for Science, Technology and Innovation and the following five years by US-NSF PIRE, is a cooperative and collaborative partnership between two US universities: Universities of California, Santa Cruz and Davis (UCSC, UC Davis), and two Danish universities: Aalborg University (AAU) and the Technical University of Denmark (DTU). Each summer, these

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[*] Refer to the webpage for more information on the Summer School: https://pire.soe.ucsc.edu/

universities host an intensive, four week course housed in Electrical Engineering (UCSC, DTU), Biological and Agricultural Engineering (UC Davis), and Energy and Environmental Planning (AAU). The program is open to selected senior undergraduates, graduate students and more recently professionals in any discipline from US and European Institutions; participants are admitted based on their academic qualifications, creativity and commitment to renewable energy and sustainability assessed through the submission of an essay and interview. The bulk of the activity takes place in the summer during a three week, in-person workshop preceded by a week of online preparation where participants utilize digital communication to facilitate interaction between international teams. Each year, the location of the summer school alternates between Denmark and California, though each university ensures core faculty (representing engineering, social and environmental sciences) are present for part or all of the three weeks, while other lecturers participate virtually or for shorter durations.

The Summer School introduces and reinforces a holistic approach to systems thinking by offering access to leading experts in politics, economics, science, technology, business and marketing. In parallel, participants work in multidisciplinary and multinational teams on client-oriented projects. Our objective is to provide experiential yet scaffolded exposure to the larger and more diverse solution space necessitated by sustainable design that targets the learner’s zone of proximal development, thus bolstering learner capacity to contribute to innovation.[11,12] Over the four weeks of the program, participants gain experience in:

- Identifying societal challenges and needs regarding sustainability and renewable energy, and articulating constraints governing robust solutions
- Translating in-classroom theories to real-world design using professional practices
- Engaging institutions, corporations and municipalities to broaden exposure to diverse expertise and strengthen networks
- Sharing knowledge of best practices and limitations
- Expediting contextual research to better understand application and scalability of potential solutions through their implementation in living test-beds.

During the workshop, faculty, mentors, clients and participants interact daily through analysis of real world case studies and their technical, social, environmental, and economic implications. As the three-week session progresses, participants collaborate in diverse teams and apply these learnings to a feasibility study for their respective client. The daily agenda is a mixture of: community and industrial site visits, seminars, interactive workshops and teamwork. Figure 1 below presents a pictorial sampling of these activities. The full three week agenda for the California Summer Program and the complementary Danish version are found in the appendices and depict a current sampling of lectures and field trips. This recommended schedule is resultant of participant survey data and faculty observations spanning the eight years of the program. Each activity and its timing has been carefully considered; some provide benefits beyond simply learning content but serve to bolster team efficacy or broaden network connections.

Figure 1: A sampling of the different activities available during the US-Denmark Summer Program. Image c/o K. Kornbluth

2. The Participants

Participants in the US-Denmark Program come from diverse backgrounds, not just in terms of their disciplinary areas, but also in the cultures and expertise represented. Of the 127 participants over the eight years, roughly 70% were graduate students; 25% undergraduate students; and 5% were professionals (non-student). The program is designed to elicit and build upon prior knowledge in an intensive environment; thus, the summer course is more effectively utilized by experienced participants and graduate student enrollment has become predominant. We find that the interaction between professionals and graduate students promotes a healthy and diverse knowledge base that can be leveraged within projects, often leading to insights illustrative of academic-industry partnerships. In the two years that the program has been open to professional participants, we have had in attendance representatives from international development, governmental and consulting sectors. We hope to increase the percentage of professionals in future years, though the program length can be prohibitive to participation.

Though hosted at Danish and Californian institutions, the program is open to and has enrolled students from outside the core universities in both the United States and Europe. More than a dozen nationalities have participated in the program: USA, Denmark, Italy, France, Spain, Mexico, Columbia, Russia, Brazil, China, Netherlands, Romania, India, Canada, Malaysia, Jordan, among others. In keeping with its multidisciplinary nature, over 30 majors have been represented over eight years (Table 1).

Table 1: List of majors represented over the eight years of the US-Denmark Summer Program and associated number of participants (estimated).

Major	Number of Participants
Electrical Engineering	17
M.A. Business Administration	4
Applied Physics	6
Environmental Studies	16

Sustainable Cities	2
Climate Change Mitigation	1
Wind Energy	4
Ecology	1
Chemistry	3
Renewable Energy Systems	4
Mechanical and Aero Engineering	10
Material Science	2
Environmental Policy	4
Chemical Engineering	3
Sustainable Energy	5
Environmental and Energy Planning	6
Politics	1
Sociology	3
Biochemistry	2
Agricultural and Environmental Eng.	5
Biological Systems Eng./Biotech	6
Computer Engineering/Computer Sci.	3
Civil Engineering	1
Economics	5
Psychology	2
Technology and Information Mgmt.	4
Earth Sciences	1
Biology	3
Applied Math	2
Community Development	1

Program Details with Participant Feedback

While the emphasis of the program has always been renewable energy systems, the content, locations visited, client base, as well as student demographics dynamically vary to parallel prevailing research and political climate. For example, the first years of the program focused on broadening understanding of the life cycle of renewable energy technologies; the 2016 theme, "Intermittency-Friendly Community-Scale Renewable Energy for Micro-Grids," emphasized grid and market level response to distributed energy resources. Core lecture and activity topics, repeated each year, would reiterate foundational knowledge especially important for the multidisciplinary demographic. The particular themes are addressed in supplementary lectures and guest seminars, etc. The sites visited during the summer school also adapt to reflect the changing themes: recent summer schools visit the islands of Samsø and Bornholm in Denmark, as these communities recognized early on that higher penetrations of renewable energy generation have potentially negative impacts on grid reliability as a whole and undertook efforts to understand preferred operating strategies.[13,14] Other site visits, such as the Moss Landing Natural Gas Power Plant in California, remain as valuable learning opportunities in energy system transitions. This natural gas power plant, commissioned in 1950, is currently the highest capacity power plant in California and demonstrates striking differences between California's and Denmark's respective approaches to energy security.

Community stakeholders from local municipalities, the commercial sector, housing associations, utilities (mobility, water, energy, etc.) as well as within the universities, act as a client-base for the projects and thus maintain relevancy. In both California and Denmark, these partnerships have established living-laboratories as diverse test beds for systems level development of sustainable solutions:

- DTU: Nordhavn, Copenhagen; Power-Flex-House, Roskilde; Bornholm Power System
- UC Davis: West Village, UC Davis Campus, the Domes; City of Davis
- AAU: Cloud City, Kildeparken 9220, Stigsborg Harbour Front, Aalborg Municipality; Samsø Energy Island
- UCSC: Santa Cruz Municipal Wharf, UCSC Arboretum, City of Santa Cruz

These sites provide a strong foundation for learning and offer opportunities for continued research into common challenges communities face; challenges while not unique are still highly contextual. Thus the US-Denmark program has a rich pool from which to select projects for the summer workshop, a number of which are able to be continued as masters or doctoral level work.

1. General Participant Feedback

The overall feedback from participants over the eight years of the program has been overwhelmingly positive. What follows is a qualitative discussion of participant feedback data gathered in post-program surveys administered immediately at the end of the summer schools as well as a longitudinal interview where previous participants were contacted. Though Likert scale items were included in the surveys, we find these quantitative data significant only for analysis within program years to compare and contrast the relative value of different program components. These data are difficult to apply across years as participants generally rate the program against their current and past experience in more traditional academic environments; variations in Likert scale items remain within a single standard deviation of the average and are thus not of statistical significance to conclusively analyze inter-year changes. Note that all participant quotes are italicized.

Participants valued the exposure and accessibility of the faculty and mentors, particularly being able to interact and "*mingle*" with professionals in areas of their primary interests as well as partake in discussions of new topics.

> *"The US-Denmark PIRE Program was life changing, and the highlight of my college career. Without a doubt, the professor that led this program made this a truly memorable experience."*

Moreover, participants were better able to define their own career paths, developing confidence for future endeavors.

"I want to work in the energy field, this course help me to define what I am the most interested in, thanks to the field trips but also lectures. Working on solar thermal energy for district heating is relevant for me because it was a topic I did not know a lot about, but now I can consider applying for a job related to it."

"My participation in this program has afforded me the opportunity to experience education in an entirely new way…I feel that it has prepared me for the professional world in a very real way."

Students who have completed this program have gone on to work in the public, private, or non-profit sectors primarily in areas related to sustainability and renewable energy. Some have become professors in academic institutions, business cofounders and CEOs, energy investment consultants, and professional engineers while others are either finishing graduate school, law school or business school.

There certainly have been criticisms and lessons learned over the course of the eight years. The intensity of the agenda becomes exhausting as the weeks progress, which has in some cases impeded project completion. Finding a balance between new content and project work is difficult and requires significant planning and resources to coordinate effectively. In many years' surveys, participants have requested to be better informed of the agenda beforehand so they themselves can be better prepared. Again, this is a reflection of the intense resources needed to organize a binational summer school, which will be discussed in greater detail in the following section.

"The work was intense, and somewhat unrealistic at times for 3 weeks…but ultimately, well worth it. I was fully educated on all matters of renewable energy, but not only that, I now have a very clear understanding of how municipalities implement changes in their energy structure. Excellent workshop. Would go again, 100% satisfied. Thank you for giving me the opportunity to join! More things like this needed around the world."

2. Lectures:

It is interesting to note that while the majority of the participants' academic studies are related to energy and the environment, the lectures voted as the 'best' in post-program surveys are repeatedly on topics to do with market regulation and energy planning from the implementation perspective. A more comprehensive list of current lectures can be found in the 3-week sample agenda in the appendix.

Top three lectures in 2016:

1. "Levelized Cost Accounting and Economic Feasibility"
2. "Microgrids, Energy Generation and Grid Resiliency"
3. Campus Facilities Overview: "Transforming occupants into a low-cost, high-accuracy sensor system"

Post-program reviews of the lectures reveal the importance for participants to hear from diverse and disparate perspectives during the seminars. For instance, instead of simply presenting the "roadmap to carbon neutrality" which conveyed US and Denmark's respective approaches to achieve this goal, these seminars incorporated discussion points with critical analyses of the contexts leading to differences between the two strategies. This approach was considered by participants as "*insightful*" and "*relevant*". However, in some cases there were discrepancies in responses between participants. Students from STEM fields indicated a preference for more detailed discussions of technology, describing lectures as "*too general and more of a basic overview*." On the other hand, participants from non-STEM disciplines felt "*some of the lectures needed a bit more introduction, such as the highly technical ones, but this just made things more challenging, which is great*." Unfortunately, maintaining uniform engagement across such a diverse student body is challenging. By emphasizing contemporary application of sustainable technologies and their context-driven limitations, we can ensure lecture content contains new information for just about every participant. Indeed, the three lectures rated most favorable over others are more nuanced topics relating to market and system implementation. Moving forward, we hope to further tie in the lectures with the current projects through facilitated post-lecture discussions and activities. In general, participants preferred interactive lectures and the ensuing engagement.

3. Site visits:

During the field trips, participants are guided through selected sites by experts who discuss and physically highlight benefits and problems associated with technology implementation. Not only are participants better able to translate theory into real world practice, they are able to identify ensuant challenges perhaps not otherwise obvious (for instance, California and Denmark have different air pollution standards limiting implementation possibilities). These visits are an opportunity to learn intended content by enabling access to practical experts who can pose and answer stimulating questions. Refer to the agendas in the appendix for a more comprehensive list of sites visited.

Top three site visits:

California (2016):	Denmark (2015):
1. CA-Independent Systems Operator (ISO)	1. Samsø 100% Renewable Energy Island
2. Moss Landing Power Plant	2. Avedøre BioFuel Power Plant
3. University of California, Davis Solar Farm	3. Risø Wind Turbines

Witnessing renewable energy generation in action through site visits has consistently been the highlight of the program over the eight years:

> *"The project-based learning style and the fieldtrips were TOP NOTCH. I was impressed all around. I cannot believe we got to go to a powerplant, ISO, motorcycle manufacturer, a passivhaus, and all the rest! I was legitimately in awe the entire time. It is rare to find a project that really exposed students to so many real life situations. The program organizers did a perfect job finding a diverse set of places to visit. THANK YOU! The projects were also a good addition."*

"The field trips were incredibly helpful and were a great strength of the program. Being able to talk to current professionals in the renewable energy field, as well as see in person the strategies used to implement different technologies was priceless. It provided a greater breadth to the course."

In general, participants not only enjoyed climbing a wind turbine in Denmark (Figure 2) or the boat trip to a renewable energy island, but were genuinely engaged by different modes of learning not typically found in academic settings; "*active participation*…(while on the field trip)*…enhanced material retention*." Participants have suggested that these experiences may be improved by including more time to reflect in conjunction with exercises that connect field visits with the current set of projects.

Figure 2: Participants visiting a wind farm and climbing up to the turbine c/o K. Kornbluth

4. The Projects

The program reviews indicate appreciation of the project-based learning style with real world application that engages multiple learning styles. These program features were described as being in contrast with their previous learning experiences at home universities (with Olin College and Roskilde University being the exceptions).

"The project-based learning style of the course was beneficial to a variety of personalities (introvert and extrovert). Overall, this course was extremely beneficial in terms of allowing me to find my own way and think critically."

"This program has been a really unique experience. It will be something to remember, and I hope this program will continue growing and expanding giving even more students the opportunity to experience this."

Below is a sampling of recent project topics:

- "**A Techno-Economic Investigation of the Transition from Liquid Natural Gas to Liquid Biofuel Gas**", for the Danish Municipality of Samso Island.
- "**Carbon Costs at the University of UC Davis**": A Comparison of Renewable Energy and Purchased Offset Approaches to Carbon Neutrality", for the University of California at Davis.

- "**Reducing the Carbon "Pawprint" of the Copenhagen Zoo**", a study of the feasibility of using ground-based heat pumps to provide heat and cooling between the new Arctic penguin facility and the tropical equatorial exhibit of the Copenhagen Zoo.
- "**Energy Efficiency Solutions for Battery Testing in Modern EV Manufacturing**", a study of methods to reduce the energy consumption in the testing of batteries for all electric motorcycles for Zero Motorcycles, Scott's Valley, California.
- "**Can the Santa Cruz Municipal Wharf Become Energy Self-Sufficient?**", a study for the City of Santa Cruz, California of the potential use of renewable energy resources for supplying the energy needs of the Santa Cruz Municipal Wharf.
- "**Residential Energy Consumption Study of the Aalborg East Village**" a study for the Danish municipality of Aalborg.

The clients have expressed a high level of satisfaction overall with the quality of work produced during the summer school. These studies provide insight into opportunities for more sustainable practices that in many cases have been enacted by the target community or manufacturing unit. For example, street lighting on the Santa Cruz Municipal Wharf and in the city of Merced was replaced by more efficient LEDs as a direct result of summer team's study. Furthermore, the Santa Cruz Municipal Wharf study (above) prompted the establishment of the Greenwharf test bed site. In other instances, continued graduate research has produced several theses, journal articles, and conference proceedings. [6,15,16,17,18,19,20,21]

Behind the Scenes: Logistics

The US-Denmark Summer Program is a unique educational initiative offering opportunities for facilitated learning in a global and practicable environment. Participants learn and interact across traditional boundaries, enhancing business, technical, and social acumen needed for professional efficacy in global markets. The key word here is 'facilitated'; each activity throughout the entire program cycle requires scaffolding to create an inclusive learning environment, empowering participants to explore the different lenses of sustainability synergistically, as a team.

Below is a list of targeted learning outcomes, the successful participant is able to:

- Understand and adapt to the global context of grand challenges
- Demonstrate an increased ability to navigate ambiguity and uncertainty
- Employ human-centered design principles
- Work in diverse teams for sustainable development
- Practice critical and complex-systems thinking
- Exhibit professional communication to diverse audiences
- Apply hands-on and real-world experience to contemporary technological solutions

1. Pre-workshop planning

Careful planning and coordination is required to successfully achieve some of these more demanding goals and move away from 'immersive learning' toward 'entrepreneurially-minded learning', the difference being learners actually participate in and take ownership of developing concrete solutions for a client. As shown in the idealized annual program cycle in Table 2, program activities begin rather early in the year; for a participant this means immediately upon acceptance to the program with the pre-course assignment, and even earlier for the staff. From that point on, a series of facilitated meetings between faculty and students and even between the student teams serve to set expectations beyond travel logistics and prepare participants for the intensity of the three week workshop. Teams become acquainted before their arrival, motivated by the required submission of a group pre-course assignment during the online session.

Table 2: The annual program cycle from application to final deliverable. Text in black indicate participant tasks while text in blue refers to program coordinator tasks.

Key Dates	Activity
1-Oct	Applications Open
15-Jan	Applications Close
	List of Municipal, Industry, Faculty clients confirmed
1-Mar	Applicants are notified: Accepted/Waitlisted/Scholarships
	Q&A Sessions via Skype; Send out Project List
1-Apr	Confirmation of Acceptance Due
1-May	Pre-Course Assignment Due: 1st, 2nd, 3rd choice project with Cover Letter
	Pre-program survey administered (content)
15-May	Team Assignments
	Facilitated Team Introduction Session via Skype
1-Jun	Logistics Session via Skype; Establishing expectations
	Virtual team meeting
1-Jul	Logistics Session 2 via Skype; Group Pre-Course Assignment discussion
	Virtual team meeting
4th week July	Online Session: Teams meet regularly; perform literature review with online content
	Summer School Faculty hold regular office hours on Skype
31-Jul	Group Pre-Course Assignment Due: Rough Draft Study with Annotated Bibliography
	Students Arrive
1-Aug	Summer School Begins
	Full agenda is provided in the Appendix
21-Aug	Summer School Ends
	Post-program survey administered (content and program reflections)
1-Dec	Final Draft Feasibility Study Due (for credit or certificate)

As mentioned earlier in this paper, the efficacy of the US-Denmark Program is a result of incorporating lessons learned over the eight years. For example, the submission date for the individual pre-course assignment, a cover letter where the participant "applies" to their first choice project and indicates their 2nd and 3rd preferences, has been continually pushed earlier in the year after assessing the preceding cycle. This assignment's purpose is to allow faculty to understand the participants' motivation and skillset; its submission just after acceptance to the program enables earlier team formation. We find this necessary for the following reasons:

- Teams can become more familiar with their topic and begin collecting data and resources beforehand
- Teammates gain familiarity with the social and work related particularities of their team before commencing the three week session (where there is not much free time for socializing and team building)
- Difficulties associated with international teaming are elucidated earlier and can be overcome sooner
- Teams establish a clear means of communication that works well for their team before the summer session begins (Skype, WhatsApp, Google Hangouts, etc.)†

Table 3 in the appendix outlines changes made in managing team formations over the eight years of the Summer School.

In program assessments, participants have requested more time early-on to interact and develop as a team: "*jumpstart the team bonding and the rest falls into place easier.*" The first few days of the workshop are generally reserved for establishing a crucial common knowledge base and introducing projects; we elect to be proactive about team cohesion even before the participants meet in-person by providing multiple faculty-supported virtual sessions over the spring/summer. This time spent working together beforehand better prepares groups to confront the non-stop pace of the summer workshop with more resources at their disposal.

A clear consequence of this decision, however, is that projects must be selected and ready to go at an earlier date. This task is made much easier by tying the program topics in with the larger research agenda between the universities and their local communities through living laboratories. Thus, discrete projects can be anticipated well in advance, making it possible for the summer session to act as a catalyst into multinational, twinned research for longer term exchanges and/or degree theses. Furthermore, advanced planning of project themes allows for more targeted lecture content and site visits.

The teams are responsible for the completion of a pre-course assignment, due at the end of the online session: a rough draft 'Introduction' for their feasibility study with annotated bibliography. This group-level activity is used to ensure team interaction and individual completion of the online readings. Each group is assigned articles and background information that directly relates to their project in addition to core readings. Yet, the time committed by each participant during the online session has varied widely over the years, even though the readings were considered 'mandatory'. We anticipate that the group assignment with faculty (virtual) office hours helps to focus efforts during the online week.

Finally, by having both the participants and faculty better prepared, more time can be spent digesting and reflecting on the content and experiences of the workshop. We recognize that three weeks with a packed schedule leaves insufficient time for full assimilation of content such that it may be effectively and efficiently applied to the project. Final feasibility studies are due three months after the end date of the summer session and are required for program credit.

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† Mention of specific tradename does not constitute an endorsement by the universities

2. Summer Workshop

The first week of the three week, in-person session is shown in Figure 3 for reference; this schedule has also been optimized for team building, project framing, and participant engagement in response to feedback from past participants and faculty observations. Note that the top three rated field trips and lectures are emboldened in the Figure. Some critical points:

Structured social time in the beginning of the in-person session is observed to be highly beneficial and expedites team synergy. From the instructors' perspectives, social participation within the local community helps to better contextualize local practice while highlighting cultural norms and differences early on. Furthermore, **changing the venue** halfway into the program provides a secondary sample set, exemplifying the importance of localized context when implementing renewable energy systems. At the same time, the move allows participants with somewhat of a fresh start in a new location. The program committee considers that these positive outcomes outweigh the logistical difficulties and added cost.

Participants appreciate getting to know faculty and have requested more time "**mingling with staff and participants**." Coffee breaks and social activities allow participants time to reflect on lectures, ask questions one-on-one, learn more about relevant (or non-relevant) research, and network. We also encourage past participants to join in these events, promoting continuity and an alumni 'community of practice' mindset.

Maintaining clarity of the project objectives has been a challenge for many teams, even with frequent contact with the client. In response, we have initiated **scaffolded project activities** to help guide articulation of project objectives and scopes of work, in conjunction with intermediate deadlines and feedback. In short, the transition from divergent thinking toward convergent project tasks is made more efficient. Without this regimented approach, participants are generally ill prepared to accommodate the intensity of the course, resulting in decreased productivity and a stressful final few days.

Variety in content and its presentation helps maintain engagement during such long days while **addressing different modes of learning**. When planning the agenda, we try to include four distinct activity types each day if possible: lectures, project work, field trips, and interactive workshops. Additionally, it is beneficial to include a level of interactivity in each activity: site visits may be accompanied by a worksheet, lectures incorporated with a problem set or calculation, etc. Working interactively is instrumental in enabling participants from multidisciplinary and diverse backgrounds to **effectively communicate and contribute.**

Early in the workshop, the lectures and activities serve to establish a **common knowledge base** and problem solving tools. While this is not possible for all disciplines, fundamental knowledge of electricity and energy is required to succeed in this course. For example, many participants initially cannot articulate the difference between power and energy (kW vs kWh). Though this topic is assigned during the online session, the inclusion of a hands-on workshop where we use Kill-a-Watt (P3) energy usage monitors to disaggregate household energy consumption while measuring both power and energy helps to cement this knowledge and prevent confusion later in the course.

US/Denmark Summer School Schedule				Red font: Activity	**Bold: Rated top three**	Field Trip	Project work
All activities subject to change				Interactive Workshop	Social Activity	Lecture	Misc. Logistics
Date:	**Sunday, Day 1**	**Monday, Day 2**	**Tuesday, Day 3**	**Wednesday, Day 4**	**Thursday, Day 5**	**Friday, Day 6**	**Saturday, Day 7**
Location	**Location 1**						
7-8 AM						Breakfast:	
8-9 AM		Breakfast:	Breakfast:	Breakfast:	Breakfast:	**Field Trip: Moss Landing Power Plant**	Breakfast:
9-10 AM	Arrival: Location 1 Check-in	Course Overview and Introductions	**Campus Facilities: "Transforming occupants into a low-cost, high-accuracy sensor system"**	Sustainable Buildings Professional Series: Passive Architectural Design	Professional Series: Siemens "Development of the Renewable Energy Sector-CA/Dk"		
10-11 AM							Project Framing: Brainstorming Activity Evaluative Matrix
11-12 PM		Project Expectations and Milestones	Coffee Break Engineering Efficacy: The Four Lens Analytic Framework	Field Trip: Midori Haus	Coffee Break Project Check-in: Objectives		
12-1 PM							
1-2 PM		Lunch:	Lunch:	Lunch:	Lunch:	Picnic Lunch	Lunch
2-3 PM		Group Introductions: Elevator Pitch Activity	Field Trip: Zero Motorcycles + Joby Aviation	The Demand Side: Consumer Behavior Practicing Energy in CA	HOMER Pro: Modelling the Bornholm Grid	Field Trip: Blume Biodistillery and Whiskey Hill Farms BONUS: Watsonville Wastewater treatment	Facilitated Project Work Elevator Pitch Activity Indicators and Metrics
3-4 PM							
4 - 5 PM		Coffee Break Project Proposals: Problem Statement		Coffee Break Kill-a-Watt Interactive Workshop: Energy vs Power	Coffee Break Hybrid Grid Modeling Interactive Workshop		
5-6 PM							
6- 7 PM	Dinner:	Welcome Dinner: BBQ	Dinner:	Dinner:	Dinner:	Dinner:	Dinner:
7-8 PM	Post Dinner Social Hour		Project Work: Annotated Bibliography Due	Project Work	Project Work:	Project Work: Problem Statement and Project Objectives Due	Group Social Activity: Beach Bonfire
8-9 PM							

Figure 3: The first week agenda of the summer workshop when held in California; including a sampling of site visits, lectures, workshops and project work. This is an example of a more recent schedule, with a streamlined resulting from eight years of assessment. The full agenda is included in the appendix.

Lessons Learned

This course is designed as a mechanism to translate didactic and classroom learning into applied practice through heavy interaction with and analysis of real world scenarios, at both post- (site visits and case study analyses) and pre-implementation stages (feasibility study for a client). The benefits of problem-based learning are well understood and documented: enhanced collaboration and conflict resolution strategies, familiarity with iterative design, effective application of reasoning, and improved retention of content and process knowledge.[22,23] The US-Denmark Summer Program expands on these outcomes by applying this pedagogy in a global context and incorporating client-based, entrepreneurial practice.

1. Creating Value: Transition from immersive experience to professional practice

The US-Denmark Summer Program's shift towards an entrepreneurially-minded pedagogy within the global economy encapsulates the necessary ingredients for impactful innovation. Innovation has been described as a method of problem solving addressed through group interaction; by drawing on diverse perspectives and backgrounds, ideas are allowed to recombine for new insights.[24] We subscribe to a slightly different definition: innovation is the emergent outcome of a socio-evolutionary process where creative and fit ideas replace less optimal ones.[25,26] Regardless, it is precisely this multidisciplinary, multicultural and cross-sectoral cooperation and collaboration that decreases homogeneity in design thinking, leading to holistic understanding of the global challenges of sustainability and a larger resource pool from which to innovate.

In previous work,[26] we explored four constitutive processes as operational in supporting learner contribution to innovation, summarized below:

Choice: This is defined as **ownership** over a project or project task and is exemplified by the decision-making process that leads to desired outcomes. In the summer school, participants select their own projects and work to create value for their clients.

Challenge: A key component of professional development, challenge describes the difficulties associated with navigating uncertainty and **ambiguity** inherent in real-world and human-centered design. While the faculty in the summer program act as resources for participants and provide project scaffolding, the participants themselves must develop their own strategies with which to progress.

Accountability: A key tenet of entrepreneurship is to solve a real-world problem and create value for a **client**, where the solution is subjective and governed by constraints. Projects undertaken during the summer program hold real value for a client, whether that person represents community, industry, or academic stakeholders (or all of the above). This creates a scenario with real-world consequence.

Cross-disciplinary Sympathy: Defined as the sympathetic accumulation of knowledge as a result of **peripheral participation across sectors** that formulate the T-shaped individual.[27] Emergent innovation directly reflects team cohesion, a state in which teams perceive diversity as requisite to project success and employ effective communication signifying legitimate interdisciplinary engagement. The US-Denmark Program is an opportunity to improve proficiency: multidisciplinary and multinational teams work intimately over several weeks or beyond.

The real-world nature of the course and self-reported data from assessment surveys confirm program learning outcomes satisfy ABET-specified student outcomes, namely the ability to: apply STEM principles, analyze and interpret data, assess feasibility of a design, function on multidisciplinary teams, understand professional and ethical responsibility, communicate effectively, use tools necessary for engineering practice, comprehend contemporary issues, identify value and participate in life-long learning, and understand the impact of solutions in a global context.[28] Moreover, the US-Denmark Summer School's defined learning outcomes align with desired traits of the successful future engineer. The National Academy of Engineering acknowledges and even emphasizes the role of globalization on shaping these necessary traits, among which are: the ability to work within the framework of sustainable development, live and work as global citizens, develop and implement complex systems, communicate, understand ethics and social responsibility.[29]

The value of the US-Denmark Summer Program lies in its careful facilitation of learners in a complex space in conjunction with tangible consequence. Problem-based learning is effective due to extensive scaffolding associated with the pedagogy, allowing learners to navigate complex domains by reducing cognitive load.[23] By moving toward entrepreneurially minded learning, the summer program includes real world application with accountability, offering a unique opportunity to accelerate and hone the development of process skills and practice of the global professional. The end result is enhanced efficacy in self-directed navigation of the new global environment.

This structure is in stark contrast to unguided discovery learning pedagogies, where the learner must construct their own strategies to accumulate knowledge. These more open-ended approaches have been criticized in the literature as ineffective and inefficient.[23,30] Traditional immersive study abroad or exchange programs can be viewed as unguided learning with respect to professional development; there is no expectation beyond academic success. But by scaffolding interactions and activities, the US-Denmark Program complements such programs by making the complexities of global and multidisciplinary interaction more tractable, allowing for enhanced cross-cultural and entrepreneurial learning by bringing tasks within the learner's zone of proximal development.

2. Implicit and Explicit Challenges

Participants in the US-Denmark program are better positioned to tackle grand challenges as a direct result of working with teammates and experts in different fields with which they would not normally interact in an academic setting. However, the practice of doing so presents inherent difficulties. As anticipated, cultural, language and disciplinary barriers initially inhibit team cohesion and synergy; it is through overcoming these barriers that allows for professional development among participants and lays the groundwork for emergent innovation. Providing this opportunity to such a diverse student population itself presents a substantial challenge. In this section, we will discuss logistical barriers to organizing the summer program that have not yet been fully surmounted. A table outlining the changes employed over the eight years to address these challenges is presented in the appendix (Table 3).

Scheduling

Scheduling the US-Denmark Program with its intended spring and summer virtual meetings, online session, and intra-workshop deadlines has presented numerous logistical difficulties. Program length poses a challenge to the principal faculty and to a lesser degree students and professionals. Individuals in the workforce cannot easily take three weeks away, making professional participation less likely without a professional certification or other such recognition. While we have tried both shorter and longer programs (see Table 3 in the appendix), we find three weeks gives optimal balance of human resources and time for reflection and information synthesis.

European and American institutions have very different academic approaches and calendars. The Danish calendar follows a semester system (as opposed to the quarter system subscribed to by the California host institutions) with limited expectation for students to work or study over the vacations, though this is changing. Some Danish universities do not even offer a summer session; we have had to align our program with DTU's three week session in August. Even among US institutions, the fall academic term begins anywhere from mid-August to late September. Thus, these scheduling conflicts preclude participation of students from many US institutions. The host US and Danish institutions have worked together diligently to accommodate differences in academic schedules. As a result, we have been able to accept participants from universities around the country(ies), though the hard deadlines spread throughout the annual program cycle have sometimes had to be softened as organizing virtual sessions, for instance, requires not insignificant coordination. Program success relies on setting clear expectations of work for all participants and staff early on.

Cost

We have implemented a variety of cost-models over the eight years to balance two conflicting objectives: 1) to create buy-in and move away from the concept of 'free trip to Europe/USA' and 2) to enable inclusive participation by not allowing costs to inhibit participation from students from different socio-economic groups. As revealed in post-program assessments, roughly 85% of participants stated that receiving financial aid was a critical factor in their decision to attend. The direct participant cost to attend the summer program for **twenty participants** is approximately $90,000 USD per year, not including salary for faculty or program/research coordinators nor honoraria for lecturers. In fact, faculty and staff time is largely donated in an effort to make the summer course more affordable because of its perceived value to participants. The cost breakdown is as follows: Lodging 40%; Transportation 25%; Course Fees 20%; Food and Incidentals 15%. Note that these figure do not vary significantly between the Denmark and US locations.

A more insightful way of looking at this is the average cost per student. The base cost is approximately $2,500 USD without tuition or travel to the course location. The course has been offered for 7 units of quarter credit (5 units of semester credit); a $2,000 USD fee that comprises 30% of the associated cost directly subsumed by the participant. Here, cultural differences present another challenge: European students do not pay tuition. More than 60% of participants state that receiving course credit was not important to them; that they were after the experience alone. In the future, we hope to offer alternative options for participating in the summer course, including professional certification.

Opportunities for financial scholarships are necessary to create an environment of inclusion and maintain the diversity of the program, though it is our view that the number of these available be limited to a standard defined by academic performance and financial need. In the past, setting this standard has been challenging due to the disparate expectations of students coming from Europe and those from American institutions. The issue of 'fairness' comes up; participants are very aware that they may not be paying the same fee for the same program. We have yet to implement a successful and equitable funding model and have ultimately resorted to covering all costs for US student participants. We are looking to incorporate grant writing sessions into next year's pre-course program to help students solicit scholarships from external sources.

We have spent much time looking into a viable financial model to continue this program beyond funding from the US or Danish federal governments. In the end, it appears that if this program is to be available to all students of every socio-economic class, the institutional sponsor must provide financial support through philanthropic means and public/private contracts and scholarships. We are currently looking into such possibilities.

Conclusions

The US-Denmark Program is a unique opportunity for entrepreneurial-minded learning in today's global marketplace, preparing learners to address the grand challenges of sustainable design. By partnering with local clients while engaging across disciplinary and national boundaries, the program introduces challenges typically experienced in professional practice. We find that it is specifically the multidisciplinary and multicultural nature of these challenges that position leaners for innovation at the global scale. The program's value is in its highly scaffolded learning environment which renders project tasks and synergistic collaboration attainable. However, enabling learner efficacy in a globalized setting requires significant logistical and organizational resources beyond normative costs and learner-faculty ratios. We regard the accelerated professional development, experientially-learned content and process knowledge, connections made, and exposure to complex systems-thinking and value creation offered by the program as being well worth the extra effort and institutional costs. Participants of the program represent a community of practice at the forefront of developing holistic and impactful innovation.

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Appendices

Appendix 1: Progression of program changes

Table 3: Summary of changes made to program components over the eight years of the Summer Program and their results for: approach to project assignment, program duration, and participant funding model.

PROGRESSION OF CHOICE OF PROJECT ASSIGNMENTS		
	APPROACH	RESULT
Year 1-2	Students chose their own topics during the summer school and form their own teams	Projects not well defined; takes too much time; less diverse teams; project ownership
Year 3-4	Students pick from an assortment of pre-assigned topics and form their own teams	Teams still homogeneous in terms of discipline and culture
Year 5-8	Students pick from an assortment of pre-assigned topics and indicate choice preference from 1-3. Instructors form the teams based upon interests and skill sets	Multidisciplinary and multicultural teams formed while maintaining student ownership over project;
PROGRESSION OF IN-PERSON SUMMER SESSION DURATION		

Year 1-3	4 weeks in-person session; no online component	Significant time sink for faculty and costly; difficult to keep up pace for duration
Year 4-7	3 weeks in-person plus online preparation	Time and cost still significant; reduced project time and less room for error
Year 8	2.5 weeks in-person plus online preparation	Cost reduced; really insufficient time for project completion/work scope difficult to define for time
PROGRESSION OF PARTICIPANT FUNDING MODELS		
Year 1-3	Student pays for airfare, food, lodging + tuition	Limited socio-economic diversity from US students; tuition discrepancies
Year 4-5	Fee: 2100USD+flight; FAFSA recipients eligible for aid; tuition covered for all students	More (yet limited) representation from underserved groups of US students; Tuition discrepancies between US and Denmark addressed
Year 6-7	Partial to full scholarships awarded for room, board, flight (up to $2100); tuition covered	Better socio-economic diversity; high program costs
Year 8	US students receive full awards for travel, tuition, room and board	Better socio-economic diversity, but reduced buy-in from US students (free-trip); high program costs

Appendix 2: Sample California agenda for the three-week summer workshop

US/Denmark Summer School Schedule

All activities subject to change

Red font: Activity	**Bold: Rated top three**	Field Trip	Project work
Interactive Workshop	Social Activity	Lecture	Misc. Logistics

Date:	Sunday, Day 1	Monday, Day 2	Tuesday, Day 3	Wednesday, Day 4	Thursday, Day 5	Friday, Day 6	Saturday, Day 7
Location	Location 1						
7-8 AM						Breakfast:	
8-9 AM		Breakfast:	Breakfast:	Breakfast:	Breakfast:	**Field Trip: Moss Landing Power Plant**	Breakfast:
9-10 AM		Course Overview and Introductions	**Campus Facilities: "Transforming occupants into a low-cost, high-accuracy sensor system"**	Sustainable Buildings Professional Series: Passive Architectural Design	Professional Series: Siemens "Development of the Renewable Energy Sector-CA/Dk"		
10-11 AM							Project Framing: Brainstorming Activity Evaluative Matrix
11-12 PM			Coffee Break Engineering Efficacy: The Four Lens Analytic Framework	Field Trip: Midori Haus	Coffee Break Project Check-in: Objectives		
12-1 PM		Project Expectations and Milestones					
1-2 PM		Lunch:	Lunch:	Lunch:	Lunch:	Picnic Lunch	Lunch
2-3 PM		Group Introductions: Elevator Pitch Activity	Field Trip: Zero Motorcycles + Joby Aviation	The Demand Side: Consumer Behavior Practicing Energy in CA	HOMER Pro: Modelling the Bornholm Grid	Field Trip: Blume Biodistillery and Whiskey Hill Farms BONUS: Watsonville Wastewater treatment	Facilitated Project Work Elevator Pitch Activity Indicators and Metrics
3-4 PM							
4 - 5 PM	Arrival: Location 1 Check-in	Coffee Break Project Proposals: Problem Statement		Coffee Break Kill-a-Watt Interactive Workshop: Energy vs Power	Coffee Break Hybrid Grid Modeling Interactive Workshop		
5-6 PM							
6- 7 PM	Dinner:	Welcome Dinner: BBQ	Dinner:	Dinner:	Dinner:	Dinner:	Dinner:
7-8 PM	Post Dinner Social Hour		Project Work: Annotated Bibliography Due	Project Work	Project Work:	Project Work: Problem Statement and Project Objectives Due	Group Social Activity: Beach Bonfire
8-9 PM							

Date:	Sunday, Day 8	Monday, Day 9	Tuesday, Day 10	Wednesday, Day 11	Thursday, Day 12	Friday, Day 13	Saturday, Day 14
Location	Location 1			Transport Day	Location 2		
7 - 8 AM							
8 - 9 AM	Breakfast:	Breakfast:	Breakfast:	Breakfast:	Breakfast:	Breakfast:	Breakfast:
9 - 10 AM		**Levelized Cost Accounting and Economic Feasibility**	**Microgrids, Energy Generation and Grid Resiliency**	Pack up and Check Out	Associate VP: Role of UCOP and Carbon Neutrality in the UC System	Field Trip: **University Solar Farm** and Energy Efficiency Center; Cogeneration Plant and Biodigester	Project Work
10 - 11 AM	Optional Leisure Activity						
11- 12 PM		Coffee Break Economic Calculator of Generic Revenue Interactive Workshop	Coffee Break Economic, Real Time Energy Management	Transport to Second Location	Coffee Break Carbon Neutrality and Zero Net Energy		
12 - 1 PM							
1 - 2 PM		Lunch:	Lunch:	Picnic Lunch:	Lunch:	Lunch:	Lunch:
2 - 3 PM		Facilitated Project Work	Project Scoping: 7-10 min. team presentations	En route Field Trip: Tesla Motors, Makani Power, Altamont Pass Wind Substation, SSJID Hydropower and PV water treatment	Smart Meter Lab Interactive Workshop	Smarter Cities: US and Dk Energy Efficiency in the Transportation Sector	Facilitated Project Work Statement and Framing Methods Results
3 - 4 PM							
4 - 5 PM		Coffee Break Facilitated Project Work	Field Trip: GreenWharf			Coffee Break Facilitated Project Work	
5 - 6 PM							
6 - 7 PM	Dinner:	Dinner:	Dinner: Optional on Wharf	Dinner:	Dinner: BBQ	Dinner:	Dinner:
7 - 8 PM	Project Work	Project Work:	Optional: Boardwalk	Project Work: Scope of Work and Outline Due		Project Work	Project Work
8 - 9 PM							

Date:	Sunday, Day 15	Monday, Day 16	Tuesday, Day 17	Wednesday, Day 18	Thursday, Day 19	Friday, Day 20	Saturday, Day 21
Location	Location 2						
7 - 8 AM							
8 - 9 AM	Breakfast:	Breakfast:	Breakfast:	Breakfast:	Breakfast:	Breakfast:	Breakfast:
9 - 10 AM		Smart Energy Systems: "Combining Energy Efficiency and Renewable Energy"	Methods of Calculating Performance of Selected Power Systems	Professional Series: The role of the municipality in achieving Post Carbon Society	Project Work: Check in	Facilitated Presentation Prep	
10 - 11 AM	Optional Leisure Activity: Monticello Dam and Lake Berryessa; Napa Valley						
11- 12 PM		Coffee Break Facilitated Project Work	Coffee Break Facilitated Project Work	Field Trip: Dixon Ridge Farms			
12 - 1 PM							Check out
1 - 2 PM		Lunch:	Lunch:	Lunch:	Lunch:	Catered Lunch:	Lunch:
2 - 3 PM		**Field Trip: CA-ISO**	Life Cycle Analysis and Cradle to Cradle Design	Project Work	Facilitated Project Work	Feasibility Study Presentations	Optional Leisure Activity
3 - 4 PM							
4 - 5 PM	Project:		Coffee Break Unbuild It: Interactive Workshop			Coffee Break Speed Dating Activity/Networking	
5 - 6 PM							
6 - 7 PM	Dinner:	Dinner:	Dinner:	Dinner:	Dinner:	Celebration Dinner:	Project Work: Final Feasibility Study with Recommendations Due Dec. 1
7 - 8 PM	Project:	Project Work	Project Work	Project Work:	Project Work: Draft Feasibility Study Due		
8 - 9 PM							

Appendix 3: Sample Denmark agenda for the three-week summer workshop

US/Denmark Summer School Schedule

All activities subject to change

Red font: Activity	**Bold: Rated top three**	Field Trip	Project work
Interactive Workshop	Social Activity	Lecture	Misc. Logistics

Date:	Sunday, Day 1	Monday, Day 2	Tuesday, Day 3	Wednesday, Day 4	Thursday, Day 5	Friday, Day 6	Saturday, Day 7
Location	Location 1						
7-8 AM						Breakfast:	
8-9 AM		Breakfast:	Breakfast:	Breakfast:	Breakfast:	**Samsø: 100 % Renewable Energy Island**	Breakfast:
9-10 AM		Course Overview and Introductions	Smart Solutions in Urban Development Sustainable Buildings	Professional Series: Siemens "Development of the Renewable Energy Sector-CA/Dk"	Introduction to Samsø: 100 % Renewable Power Generation		
10-11 AM							Project Framing:
11-12 PM		Project Expectations and Milestones	Coffee Break Engineering Efficacy: The Four Lens Analytic Framework	Field Trip: Siemens Turbine Manufacturing	Coffee Break Project Check-in: Objectives		Brainstorming
12-1 PM							Evaluative Matrix
1-2 PM		Lunch:	Lunch:	Lunch:	Lunch:	Picnic Lunch	Lunch
2-3 PM		Group Introductions: Elevator Pitch Activity	Field Trip: Østerild National Wind Turbine Test Center	The Demand Side: Consumer Behavior Practicing Energy in CA	HOMER Pro: Galapagos Energy System	Samsø visit continued through weekend	Facilitated Project Work Elevator Pitch Activity
3-4 PM							Indicators and Metrics
4 - 5 PM	Arrival: Location 1 Check-in	Coffee Break Project Proposals: Problem Statement		Coffee Break Kill-a-Watt Interactive Workshop: Energy vs Power	Coffee Break Hybrid Grid Modeling Interactive Workshop		
5-6 PM							
6- 7 PM	Dinner:	Welcome Dinner: BBQ	Dinner:	Dinner:	Dinner:	Dinner:	Dinner:
7-8 PM	Post Dinner Social Hour		Project Work: Annotated Bibliography Due	Project Work	Project Work:	Project Work: Problem Statement and Project Objectives Due	
8-9 PM							

Date:	Sunday, Day 8	Monday, Day 9	Tuesday, Day 10	Wednesday, Day 11	Thursday, Day 12	Friday, Day 13	Saturday, Day 14
Location	Location 1			Transport Day	Location 2		
7 - 8 AM							
8 - 9 AM	Breakfast:	Breakfast:	Breakfast:	Breakfast:	Breakfast:	Breakfast:	Breakfast:
9 - 10 AM		**Levelized Cost Accounting and Economic Feasibility**	**Microgrids, Energy Generation and Grid Resiliency**	Pack up and Check Out	Roadmap to 2030: 100% Renewable Energy Denmark	Field Trip: Risø Wind Farm	Project Work
10 - 11 AM	Optional Leisure Activity	Coffee Break	Coffee Break	Transport to Second Location			
11- 12 PM		Economic Calculator of Generic Revenue Interactive Workshop	Professional Series: Neas Energy Balance and Electricity Markets		Coffee Break Strategic Energy Planning		
12 - 1 PM							
1 - 2 PM		Lunch:	Lunch:	Picnic Lunch:	Lunch:	Lunch:	Lunch:
2 - 3 PM		Facilitated Project Work	Project Scoping: 7-10 min. team presentations	Field Trip: Dong Energy Power Plant	Smart Meter Lab Interactive Workshop	Smarter Cities: US and Dk	Facilitated Project Work
3 - 4 PM						Carbon Neutrality and Zero Net Energy	Statement and Framing
4 - 5 PM		Coffee Break Facilitated Project Work	Field Trip: Hanstholm Wave Energy Center			Coffee Break Facilitated Project Work	Methods
5 - 6 PM							Results
6 - 7 PM	Dinner:	Dinner:	Dinner:	Dinner:	Dinner: BBQ	Dinner:	Dinner:
7 - 8 PM	Project Work	Project Work:	Project Work:	Project Work: Scope of Work and Outline Due		Project Work	Project Work
8 - 9 PM							

Date:	Sunday, Day 15	Monday, Day 16	Tuesday, Day 17	Wednesday, Day 18	Thursday, Day 19	Friday, Day 20	Saturday, Day 21
Location	Location 2						
7 - 8 AM							
8 - 9 AM	Breakfast:	Breakfast:	Breakfast:	Breakfast:	Breakfast:	Breakfast:	Breakfast:
9 - 10 AM		Smart Energy Systems: "Combining Energy Efficiency and Renewable Energy"	Kalundborg Symbiosis	Professional Series: The role of the municipality in achieving Post Carbon Society	Project Work: Check in	Facilitated Presentation Prep	
10 - 11 AM	Optional Leisure Activity: Copenhagen						
11- 12 PM		Coffee Break Facilitated Project Work	Coffee Break Facilitated Project Work	DTU Skylab			
12 - 1 PM							Check out
1 - 2 PM		Lunch:	Lunch:	Lunch:	Lunch:	Catered Lunch:	Lunch:
2 - 3 PM		Avedøre BioFuel Power Plant	Life Cycle Analysis and Cradle to Cradle Design	Project Work	Facilitated Project Work	Feasibility Study Presentations	Optional Leisure Activity
3 - 4 PM							
4 - 5 PM	Project:		Coffee Break Unbuild It: Interactive Workshop			Coffee Break Speed Dating Activity/Networking	
5 - 6 PM							
6 - 7 PM	Dinner:	Dinner:	Dinner:	Dinner:	Dinner:	Celebration Dinner:	Project Work: Final Feasibility Study with Recommendations Due Dec. 1
7 - 8 PM	Project:	Project Work	Project Work	Project Work:	Project Work: Draft Feasibility Study Due		
8 - 9 PM							

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