



PROGRESS IN SUSTAINABLE ACADEMICS AND RESEARCH AT PENN 2017/18 ACADEMIC YEAR

SUPPLEMENTAL TO THE 2017 STARS REPORT

Below are few highlights of the outstanding work of our faculty, schools, and sustainability professionals have taken to advance sustainability in Academics at the University.

The first section of this document outlines innovative sustainability work organized by themes: advancing innovation, building on faculty strengths, and new programs. The second part lists accomplishments by Schools (Arts and Sciences, Design, Engineering, and Wharton), plus work organized and promoted by Penn's Sustainability Office.

Advancing innovative, interdisciplinary research

- The Vagelos Integrated Program in Energy Research, a dual undergraduate degree in SAS and SEAS, graduated its largest class yet, who began conducting individualized research in the summer of their first year and continued doing so until graduation.
- The Penn Institute for Urban Research organized several events with Perry World House about sustainable urban development around the world and sent a Penn delegation to the UN Conference on Housing and Sustainable Development (Habitat III) in Quito, Ecuador.
- PennDesign is one of four partners in a five-year, \$7.5 million grant from the US Department of Transportation – *Cooperative Mobility for Competitive Megaregions* – that aims to advance research, education, and technology-transfer initiatives to improve the mobility of people and goods in urban and rural communities of megaregions.
- The Initiative for Global Environmental Leadership, based in Wharton, held an international conference on *The Future of Education in Business Sustainability*, part of its mission to bring together interdisciplinary research with business practices to address pressing environmental challenges around the world.

Building and honing faculty strengths

- SEAS appointed five new professors with research in energy and sustainability, especially using nanotechnology to advance sustainable energy storage and energy conversion, who join more than a dozen existing faculty members with strong research programs in these areas.
- The Energy Science cluster in SAS hired three new faculty members, who work across the Departments of Chemistry; Earth and Environmental Science; and Physics and Astronomy.
- In Design, Prof. Richard Weller, Chair of Landscape Architecture, published the widely read and reviewed *Atlas for the End of the World*, a four-year research project using maps and essays to examine the intersection of urban growth and endangered biodiversity around the world, and is now working with the UN Secretariat for the Convention on Biological Diversity to help achieve 2020 global conservation targets.

Developing new educational programs

- The new Penn Program in Environmental Humanities received a multi-million dollar grant from the Mellon Foundation and began to implement a new Environmental Humanities undergraduate minor and graduate certificate, as well as a cluster hire in Environmental Humanities that will work across seven SAS departments.

- SEAS introduced six new or substantially updated courses in energy and sustainability, along with its vibrant Energy and Sustainability minor and undergraduate specialization in Energy Conversion and Storage.
- Wharton offers a significant range of options to meet student demands in this area, including an undergraduate concentration in Environmental Policy and Management, an MBA major in Environmental and Risk Management, and a dual MBA/Master of Environmental Studies degree.
- The School of Design updated the existing Masters of Environmental Building Design program, renaming the program the Master of Science in Design (MSD) with a concentration in Environmental Building Design. Other new along with new Certificates in Environmental Building Design, Ecological Planning, and Energy Management and Policy.

SCHOOL SUSTAINABILITY INITIATIVES

SCHOOL OF ARTS AND SCIENCES

Research and Faculty Recruitment

Abe Nitzan, a member of our Chemistry faculty since July 2015 and recently elected to the National Academy of Sciences, was appointed to the Donner Chair in the Physical Sciences. Dr. Nitzan is a theoretical chemist and a recognized expert on the processes underlying the interaction between light and matter and energy transfer. Physics and Astronomy is working with SEAS to recruit a condensed matter scientist to fill the Greene Chair and Earth and Environmental Sciences is actively recruiting a senior faculty member in climate science.

The Energy Science cluster hire has now made its third faculty appointment, Bo Zhen in Physics and Astronomy. Dr. Zhen is currently a postdoctoral fellow at MIT. His research focuses on the design of novel nanophotonic devices that use light to vastly improve the operating efficiency and energy usage of super computers. Dr. Zhen is the third hire in this SAS cluster previously including Dr. Jessica Anna in Chemistry and Dr. Ileana Perez-Rodriguez in Earth and Environmental Sciences.

The Penn Program in Environmental Humanities (PPEH), originally part of the SAS Strategic Plan, has grown from a small group of faculty focused on eco-criticism to a robust research and education program that just received a multi-million grant from the Mellon Foundation. PPEH received much deserved praise for its highly publicized work on the national data rescue efforts to preserve decades of climate change data. They have just launched a cluster hire in Environmental Humanities involving 7 SAS departments; their search advertisement yield over 500 applications!

Educational Programs

The Vagelos Integrated Program in Energy Research is a dual undergraduate degree between the College and SEAS. It is now in its fourth year and continues to attract the very best applicants to Penn. This year 20 students will matriculate, the highest thus far and the intended yield going forward. All students begin conducting individualized research in the summer of their freshman year and continue doing so until graduation.

The PPEH is nearly completion of an Environmental Humanities minor for undergraduates in the College and a graduate certificate for PhD students. Earth and Environmental Sciences is strengthening its Masters in Environmental Sciences by creating a concentration in environmental health with the Center for Excellence in Environmental Toxicology.

SCHOOL OF DESIGN

1. Introduction

Buildings account for half of the energy used and greenhouse gases produced in the United States. Transportation consumes another 30 percent of energy use and greenhouse gas production. Clearly, buildings, landscapes, and cities—the built environment—play a crucial role in our energy and environmental futures. Accordingly, improving ecological performance, increasing energy productivity, and promoting resiliency and sustainability are central to the curriculum, research and outreach of the School of Design. These aims are supported by each of the School's five academic disciplines, and particularly the departments of architecture, landscape architecture, and city and regional planning, as well as the Center for Environmental Building Design, the Kleinman Center for Energy Policy, the new Ian L. McHarg Center: Urbanism + Ecology, and PennIUR. Through courses, studios, conferences, and publications, the School routinely brings together environmental and social scientists, architects, landscape architects, planners, designers, policy makers, business owners, *and* communities to develop practical and innovative ways of improving the quality of life in communities across the globe, particularly those with high vulnerability to the adverse impacts of climate change.

2. Advancing Strategic Academic Planning Around Sustainability and Energy Research

In the past year, several PennDesign departments, programs, and research centers have launched new master's and certificate programs or courses related to sustainability and energy policy. As a result, students have more tools at their disposal when it comes to addressing these issues in practice.

- The Department of Architecture added a new *Master of Science in Design (MSD)* in Environmental Building Design and a *Certificate in Environmental Building Design* in partnership with the Center for Environmental Building Design, a faculty research center dedicated to improving the environmental future of contemporary buildings and cities. These are in addition to an existing *Certificate in Ecological Architecture* and the *Master of Environmental Building Design*.
- The Kleinman Center—whose mission is to cultivate energy policy innovation and promote its application by creating opportunities for students, researchers, and professionals to debate viewpoints, explore options, and develop agendas for decision and action—further developed a *Certificate in Energy Management and Policy* which was launched in 2015 and enrolled 15 students from 5 schools across the University in 2016-2017.
- The Department of Landscape Architecture began developing a new *Risk and Resilience Certificate*, directed by Matthijs Bouw, Rockefeller Urban Resilience Fellow, and an *Ecological Planning Certificate* (in collaboration with the Department of City Planning). Both certificates will be launched in fall 2018 and will be open to students from the School of Design, Arts and Sciences (especially Environmental Studies and Biology), Fels, Law, and Wharton.

Also in the past academic year, PennDesign introduced new *courses and studios* focused on energy policy, sustainability, and climate change.

- The Kleinman Center rostered *Ideas in Energy Policy*, which explores a collection of ideas and critical debates in contemporary energy policy highlighted in five recent books that have been globally influential. The Kleinman Center and the Department of Landscape Architecture began developing a new interdisciplinary studio focused on energy and design, the first in what is expected to be a 3-year sequence of studios on energy.
- The Department of Landscape Architecture also introduced a new interdisciplinary studio in fall 2016. The 'InterStudio,' as it is known, places students from various disciplines in the midst of complex, real-world situations and asks them to work together to reach design

solutions and planning policies which improve the socio-economic conditions of communities. Last year's Interstudio focused on post-earthquake recovery in Chamangas, Ecuador.

- The Department of City and Regional Planning offered a new course, *CPLN Global Challenges in International Development*, which focused on agreements approved by the United Nations General Assembly between 2015-2016 (2030 Agenda for Sustainable Development, Paris Agreement, New Urban Agenda) that address sustainability. In addition, the Department continues to offer a concentration in Sustainable Transportation and Infrastructure Planning (STIP), which focuses on urban highway, public transit, and non-motorized transportation systems and their connections to sustainable, livable, and economically-productive development forms.

3. Events & Publications Focused on Climate Change, Energy and the Environment (Organized by Academic Unit)

PennDesign, the Kleinman Center, and Penn IUR facilitated numerous contributions to the public dialogue on climate change, energy and the environment this past year.

a) The Kleinman Center

The Kleinman Center completed research on such challenges as fuel economy standards, future utility resiliency, and the sustainable (re)design of the urban transportation sector. Its findings and policy recommendations were published on the Kleinman Center website, and many were covered by national news media (NPR, E&E News, Utility Dive) and disseminated in peer-reviewed journals. In total, Kleinman published 10 papers, 33 policy digests, and 86 blog posts. In addition, in January 2017, the Kleinman Center launched a podcast series, with 14 episodes produced and nearly 6,000 listens to date. The series explores policy issues that define our relationship to energy and its impact on society and the environment. The Kleinman Center also produced 43 events and co-produced additional events with PennIUR, PennPlanning, Perry World House, the Penn Program on Regulation, the Risk Center, and others across campus. A full list of Kleinman Center events from the past year can be found here: <http://kleinmanenergy.upenn.edu/past-events>.

b) PennIUR

Penn IUR organized several events with Perry World House around sustainable urban development and sent a Penn delegation (20 faculty and PhD students) to the UN Conference on Housing and Sustainable Development (Habitat III) in Quito, Ecuador in October 2016. Penn IUR also presented an exhibit, sponsored several talks and published a research digest with Perry World House on Penn-led research on sustainable urbanization: https://global.upenn.edu/uploads/media_items/pwh-research-digest-october-2016.original.pdf

Penn IUR was awarded supplemental funding from Penn Global for its *Land for Public Good* initiative that will support a research colloquium in the coming academic year. Entitled "Responses to Global Agreements, New Theories of Practice and Development in Low Income Countries," it will focus on sustainable urban development, including climate change. This colloquium will be preparation for the UN's 2018 High Level Political Forum (HLPF), the annual convening to measure progress on the 2030 Agenda with respect to the sustainable development goals (SDGs) for water/sanitation, energy, sustainable consumption, cities, life on land, and partnerships.

Penn IUR has partnered with APEC's [Asian Pacific Economic Cooperation] Energy Working Group on the Energy Smart Communities Initiative (ESCI). This project is associated with the APEC Leaders' (heads of state) 2011 announcement to support a goal of a 45 percent reduction of regional aggregate energy intensity (2005 baseline) by 2035. [APEC measures energy intensity as: the calculation the units of energy over the units of GDP.] Specifically, APEC has funded IUR to undertake a project called "Gaps Assessment on APEC Energy Efficiency and Conservation Work

Toward Fulfilling the Leaders' Energy Intensity Reduction Goal," a landscape study that assesses APEC investments and gaps in investment in energy-conserving projects in order to advise APEC and its economies on needed area for increased attention.

c) The Center for Environmental Building Design

The Center for Environmental Building Design (CEBD) published a new book: Dan Willis, William W. Braham, Katsuhiko Muramoto, Daniel A. Barber, *Energy Accounts: Architectural Representations of Energy, Climate, and the Future* (Routledge, 2016). The book gathers case studies from firms including Kieran Timberlake, SHoP, AMO, Lateral Office, WOHA, and many more, to serve as a resource for professionals and students in architecture, engineering, and urban design.

d) Department of Architecture

In October 2016, the Department of Architecture hosted a one-day symposium, *Under Pressure*, which focused on pressure points affecting urban housing, including changes in lifestyles, domesticity, housing density, and technology – changes that have a direct impact on energy consumption and greenhouse gas production.

In November 2016, Oxford University Press published [*A House in the Sun: Modern Architecture and Solar Energy in the Cold War*](#), a history of solar energy experiments during the Cold War written by Assistant Professor of Architecture Daniel Barber. *This comprehensive review, which includes 136 beautiful illustrations, examines how architecture has engaged with environmental issues and illuminates current debates around energy, architecture, and climate.*

In December 2016, the Chair of the Department of Architecture, Winka Dubbeldam, was featured as a panelist at the Institute for Public Knowledge's working group on Cities, Cultures, and Climate Change. The panel, which included ecologist Eric Sanderson, discussed the new book by architect Vanessa Keith – *2100: A Dystopian Utopia / The City After Climate Change*.

e) Department of Landscape Architecture

On April 21, 2017 (Earth Day), Professor Richard Weller, Chair of the Department of Landscape Architecture, released the results of a four-year research project titled '*Atlas for the End of the World*'. Published online, the *Atlas* consists of hundreds of new maps with supplementary essays that examine the intersection of urban growth and endangered biodiversity worldwide. The *Atlas* has reached over 1,000 unique visitors per day and has been reviewed by *Scientific American*, *National Geographic* and *Artsy* among others. Weller is now working with the United Nations Secretariat for the Convention on Biological Diversity (CBD) to further this work in the run-up to meeting 2020 global conservation targets to which 196 nations are signatory.

In June 2016, the Department of Landscape Architecture hosted the *New Landscape Declaration Summit* in association with the Landscape Architecture Foundation (LAF) to mark the 50th anniversary of the original Landscape Declaration, a statement of environmental concern and action launched on the steps of Independence Hall in 1966 by then Department Chair Ian L. McHarg. The *Summit* brought together over 700 delegates and 70 speakers to inform a declaration which sets out the core values of the landscape architecture profession for the 21st century. Authored by a task force led by Weller, the new *Declaration* has now been translated in to 17 languages.

The Department of Landscape Architecture also launched a public program entitled '*Penn Landscape Dialogues*' in spring 2017 to bring together emerging voices in global landscape architecture. Selected through a competitive process, each of the 16 speakers was chosen based on research into environmental issues.

Also in Landscape Architecture, Associate Professor of Practice David Gouveneur saw his book *Planning and Design for Future Informal Settlements* (Routledge) translated into Spanish. The Department published the latest two issues of *LA+ Interdisciplinary Journal of Landscape architecture*, focusing on simulation and identity. Each issue brings together 20 authors from the sciences, humanities, and design professions to address pressing or persistent environmental concerns.

f) Department of City and Regional Planning

Professor of City and Regional Planning John Landis co-authored “*Intersecting Residential and Transportation CO₂ Emissions: Metropolitan Climate Change Programs in the Age of Trump*” with Assistant Professor Erick Guerra and Assistant Professor David Hsu (now at MIT). Published in the *Journal of Planning, Education and Research* (JPER), the article looks at the potential for local planning initiatives (compact growth and residential retrofit mandates) to reduce CO₂ emissions in light of the likely rollback of fuel-economy standards. Landis’s recent *Housing Policy Debate* article “End of Sprawl? Not So Fast...” (April 2017) raises major sustainability implications of sprawl in US metro areas since 1990.

Also in the Department of City and Regional Planning, Assistant Professor Megan Ryerson has published results from her study *The Dual Relationship between Resilience Planning and Airline Fuel Consumption*, a pioneering investigation of what is known as “excess contingency fuel loading.” Funded through the Kleinman Center, this work establishes how much fuel is burned because airlines carry fuel beyond what is needed for foreseeable contingencies—and a possible means to reduce aviation fuel consumption.

4. Advancing Innovative, Interdisciplinary Partnerships & Research (Organized by Academic Unit)

Various departments, programs and centers within PennDesign engaged in interdisciplinary research and partnerships focusing on energy and sustainability. In addition to other schools at Penn, our partners included national, state, and municipal governments, public utilities, and private industry.

a) The Kleinman Center

- *Comparative Pathways to Regional Energy Transition*: A collaboration between key regional stakeholders (including the City of Philadelphia, PGW, GPEAT, PECO, and several environmental groups), advisors and researchers, the project identified four different policy strategies under review in Philadelphia and translated these strategies into model inputs that can be used to estimate local net benefits over time—a new approach that better captures the real-world constraints and realities of local decision making.
- *Department of Energy Power Grant*: A collaboration with the Pennsylvania Small Business Development Center, the project focuses on businesses and individuals negatively impacted from the downturn in the coal economy to help them become more resilient to withstand potential future disruptions.
- *Society for Decision Making Under Deep Uncertainty*: Based on the above Pathways project, the Kleinman Center was invited by the Society to give a presentation at the 2017 conference at the Oxford Martin School in the U.K. that deals with cities’ adaptation to climate change and local energy systems.
- A partnership with Deloitte and the United States Agency on International Development (USAID) on an indefinite quantity contract looks at providing research and training capacity for designing and implementing new regulatory mechanisms for energy systems in developing countries. The Kleinman Center will facilitate Penn contributions to USAID energy projects around the world.

- *World Urban Forum (WUF) Series*: Collaborating with PennIUR and Perry World House on a fall white paper series in advance of the World Urban Forum in Spring 2018; the series will focus on the implementation of the New Urban Agenda, specifically on several Sustainable Development Goals (SDGs), including relevant topics such as energy, cities, and sustainable consumption. The Kleinman Center will co-author a paper in this series focusing on challenges of and opportunities for implementing innovative ideas in energy policy at the local level. The paper describes a typology of intergovernmental and intersectoral challenges facing the implementation of the Sustainable Development Goal 7 (SDG 7) “Ensure access to affordable, reliable, sustainable, and modern energy for all”, and discusses practices and policies to alleviate these challenges.
- *Kleinman Center Faculty Research Grants Program*: The Center supports faculty and doctoral students across the University on topics that address timely energy policy needs. This past year, projects in five schools and multiple disciplines were funded:
 - Design
 - Stefan Al -- [*Chinese Policy Implications of Urban Form Energy Studies*](#)
 - William Braham (multiple co-authors) -- [*Philadelphia's Energy Transition*](#)
 - Law
 - Shana Starobin – [*Innovating in Isolation: Cuba's Lessons for Sustainable, “Energy Smart” Agriculture*](#)
 - SAS
 - Sara Byala – [*The Multinational as Policy Driver in Africa: A Case Study*](#)
 - SEAS
 - Jorge Santiago-Aviles -- [*Potable Water for the Clinic Serving the Community of Gashora, Rwanda*](#)
 - Shu Yang -- [*Humidity Responsive, Water Harvesting and Self-Cooling Building Envelopes*](#)
 - Wharton
 - Jose Miguel Abito – [*Separate Markets for Externalities: Regional versus State-by-State Implementation of the Clean Power Plan*](#)
 - Arthur van Benthem -- [*How to Improve Vehicle Emissions Policies?*](#)
 - Hongyu Xiao (PhD student) – [*Water Rights, Droughts and Climate Change on the Future of the American Southwest*](#)

b) Center for Environmental Building & Design

The Center for Environmental Building & Design is developing a research program of regional environmental accounting in collaboration with the Delaware Valley Regional Planning Commission (DVRPC) and the EPA, which would provide an energy-based consumption model of the nine-county region. PhD students in Architecture and City Planning are collaborating on the first public presentation of that work, a conference paper entitled “City Building: Concentration of Urban Assets in the Philadelphia Region,” for the Biennial International Workshop: Advances in Energy Studies (BIWAES) in September.

CEBD also has active research collaborations on energy and architecture with the following organizations and labs.

- Ackoff Collaboratory, SEAS. “Gaming the sustainable city (and region).”
- Shu Yang Group, SEAS. “Smart windows & envelopes.”
- Energy Coordinating Agency (ECA). “Monitoring row house weatherization”

c) Department of Architecture

- *Climatic Effects: Architecture, Media, and the Great Acceleration*. Assistant Professor of Architecture Daniel Barber received a University Research Foundation (URF) grant in spring

2017 to explore images of the design methods and strategies used by various architects from the 1930's to the 1960's – just as HVAC was developing – to manage seasonal climatic changes or to provide comfortable living and working conditions in extreme locales. Meteorologists, economists, biologists, physiologists, insurance agents, and many others developed climate knowledge in relation to architectural images. What emerges is a media-architecture history of the Great Acceleration.

d) **Department of Landscape Architecture and Regional Planning**

- *The Ian L. McHarg Center: Urbanism + Ecology.* In 2017, PennDesign launched the Ian L. McHarg Center, named after the longtime (1920-2001) Professor and Chair of Landscape Architecture and Regional Planning, and arguably the most important environmental planner and landscape architect of the 20th century. The Center is ramping up to a public launch with an international symposium in Philadelphia in 2019 celebrating the 50th anniversary of McHarg's *magnum opus* 'Design With Nature'. In alignment with the United Nations' Sustainable Development Goals, the McHarg Center's mission is to bring environmental and social scientists, landscape architects, planners, designers, policy makers, *and* communities together to develop practical and innovative ways of improving the ecological performance and quality of life in places with high vulnerability to the adverse impacts of climate change.
- *SITES Rating System.* PennDesign Dean Frederick Steiner helped develop the SITES Rating System with the Lady Bird Johnson Wildflower Center, the American Society of Landscape Architects, and the US Botanic Garden. SITES was designed to be the outdoor equivalent to the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) system. SITES is now administered by the Green Business Certification Inc. In November 2016, he became one of the first SITES Accredited Professionals.
- *Collaborative Research Project for Urban Sustainability.* Dean Steiner is also a member of the NSF-funded Collaborative Research Project for Urban Sustainability and co-editor of the 2016 book *Nature and Cities: The Ecological Imperative in Urban Design and Planning*, published by the Lincoln Institute of Land Policy.
- *Rockefeller Resilience Fellow at PennDesign* Matthijs Bouw is currently working on the 'Big U,' a 10-mile sea-level barrier around the southern tip of Manhattan. Senior Lecturer Nick Pevzner won the 2017 Maeder York Fellowship, a 3-month residency at the Gardener Museum in Boston to study the effects of methane leaks in the city of Boston.
- *Atlantic Highlands Eco-Region Research and Design.* Two faculty members in the Department of Landscape Architecture—Associate Professor Chris Marcinkoski and Adjunct Associate Professor Ellen Neises—and the design practices they lead were selected by the Regional Plan Association (RPA) to develop design strategies for the 1.85 million acre Highlands Region of New Jersey, New York and Connecticut. The work was commissioned following a design competition linked to RPA's Fourth Regional Plan for the development of the New York metroregion over the next 25 years, which will be released in October 2017. Neises and Marcinkoski collaborated with conservation organizations in New Jersey and New York, Rutgers University sciences faculty, and climate and conservation research teams working for the U.S. Forest Service research teams to understand the challenges to climate adaptation of the forests, wetlands, farms, reservoirs, lakes and the rivers that provide drinking water, food, and habitat for the metroregion.
- *Slate Lands Studio Research.* Fifty-four second-year graduate students and four faculty working with Adjunct Associate Professor Ellen Neises advanced the Department's collaboration with the Lehigh Valley Planning Commission by developing project proposals for climate and energy resilience connected with rural economic development. With input from local ecologists, planners, developers, mayors and community leaders, and Penn's Historic Preservation and Natural Systems faculty, students contributed to the early visioning stage of a Long-Term Comprehensive Plan for the 22-square mile Slate Belt. A traveling

exhibition of student work, has been presented in multiple venues in the Lehigh Valley since May, is contributing to the regional conversation.

e) Department of City and Regional Planning

PennDesign's City and Regional Planning Department is a leader in the area of sustainable transportation research and infrastructure planning; a number of its current multi-university initiatives are focused on improving the resilience of intercity transportation networks as well as decreasing greenhouse gas and improving air quality.

- *Cooperative Mobility for Competitive Megaregions (CM2)*. PennDesign is one of four consortium partners in a five-year, \$7.5 million grant from the US Department of Transportation – *Cooperative Mobility for Competitive Megaregions (CM2)* – that aims to advance research, education, and technology-transfer initiatives to improve the mobility of people and goods in urban and rural communities of megaregions. The grant was awarded in fall 2016 and is led by Dean Frederick Steiner and Professor John Landis, former Chair of the Department of City and Regional Planning. Projects funded through this initiative focus on the development and comparison of alternative transportation investments in the Northeast mega-region, including rail transit, high-speed rail, autonomous freight, and increased bicycle use—all of which have much greener and more sustainable profiles than the default (highway expansions).

Adapting to Climate Change. In partnership with the University of Tennessee, the University of Maryland, and Mosaic ATM, and with funding from the Federal Aviation Administration, Assistant Professor Megan Ryerson has developed mathematical algorithms and data-driven spatial models to study how airlines/shippers choose to divert their flights in the event of an abrupt hub outage resulting from natural disasters, among other incidents. Results have been published or are forthcoming in peer-reviewed journals.

- *Quantifying Greenhouse Gas Emissions (GHG) from the Intercity Transportation System*. Assistant Professor Ryerson's research focuses on the change in environmental emissions of transportation associated with a new mode, a new airport, or a new airspace procedure and the impact on the entire transportation system. Funded by *Mobility21*, a \$14 million, five-year transportation research grant to Penn and Carnegie Mellon University awarded by the U.S. Department of Transportation to develop and deploy solutions that will fuel the economy, keep drivers safe, and deliver efficient and reliable transportation, Professor Ryerson examines whether a new airport will cause people from neighboring towns to drive further to access new air service, thereby increasing emissions, how the airspace will be impacted by a new airport, and what the human health impacts will be of the new emissions and noise. Professor Ryerson developed frameworks and data-driven models of Greenhouse Gas Emissions and Local Air Pollutant Emissions from aviation, rail, and auto that go beyond the tailpipe. She also studies how trends and changes in the aviation industry as a whole will change the Greenhouse Gas emission footprint of the entire intercity transportation system. Ryerson's research findings have been published or are forthcoming in several books and peer reviewed journals; a TedxPenn Talk [available at TEDxPenn YouTube Station](#) (April 1, 2017); and in "The Airline Industry Eyes Its Carbon Footprint," [Energy Policy Now Podcast of the Kleinman Center](#) (January 23, 2017).

5. Addressing Penn's Direct Environmental Impact

For the past ten years, PennDesign's Center for Environmental Building Design (CEBD) has partnered with Facilities and Real Estate Services (FRES) to improve building performance and reduce energy consumption across the Penn campus. The Center also prepared the first Carbon Footprints for the University of Pennsylvania Health System, the Morris Arboretum, and the New Bolton Center. In last two years, CEBD has conducted six studies for FRES.

- *Enhancing the Use of Building Energy Data*, 2016-2017.
- *Building Energy Reporting and Performance Analysis*, University of Pennsylvania, 2015-2016.
- *Carbon Footprint*, New Bolton Center, University of Pennsylvania, 2015-2016.
- *Carbon Footprint*, Morris Arboretum, University of Pennsylvania, 2014-2016.
- *Carbon Footprint*, University of Pennsylvania Health System (UPHS), 2014-2016.
- *Energy and Carbon Accounting*, University of Pennsylvania, 2014-2015.

Professor Bill Braham, Director of the CEBD, also co-chaired the Utilities Subcommittee of the Environmental Sustainability Advisory Committee, which has overseen the development of the university's carbon action plan.

SCHOOL OF ENGINEERING AND APPLIED SCIENCE

New Faculty Hires with Current Research in Energy and Sustainability

Eric Detsi, Assistant Professor, Materials Science and Engineering

Eric's primary research interests involve the novel design and synthesis of metal-based 3D nanostructured materials with enhanced properties for structural and functional applications. His approach is to apply the natural sciences, primarily physics and chemistry, to solve engineering problems. In particular, Eric exploits the crystal structure of multiphase non-precious metal alloys to engineer nanoporous materials with hierarchical porosity after selective leaching. More importantly, micro and mesopores are needed to accommodate the large volume changes taking place in high-capacity alloy-type battery anodes during their alloying reactions with alkali or alkaline-earth metals. Eric also takes advantage of state-of-the-art thin film deposition techniques such as plasma-enhanced atomic layer deposition, combined with his expertise in top-down nanofabrication by selective leaching, to engineer novel 3D nanocomposites for critical energy applications.

<https://detsi.seas.upenn.edu/>. Detsi (joined Penn in August 2016) reworked our course MSE 455 to go beyond "corrosion" to include materials design for energy applications. This course also includes active learning.

Manfred Morari, Distinguished Faculty Fellow, Electrical and Systems Engineering

Morari's research focuses on model predictive control (MPC) of the electric power grid as well as green buildings. MPC is a promising alternative to standard strategies for building control. It uses a mathematical model of the building and predictions of disturbances (e.g., ambient temperature) over a given prediction horizon (e.g., two days) for defining an optimization problem that is solved such as to maintain thermal comfort for the occupants while minimizing some objective (e.g., energy use or monetary cost). This makes it possible to integrate all available actuators and their interactions as well as predictions of weather, internal gains and electricity prices into a coherent, mathematical control framework that can handle constraints on control inputs and room temperatures. MPC relies on having a model of the building dynamics. Morari is a member of the National Academy of Engineering.

James Pikul, Assistant Professor of Mechanical Engineering and Applied Mechanics.

Pikul's research group seeks to make transformative advances in sustainable energy storage, energy conversion, and multifunctional materials by understanding and exploiting characteristics of materials at the micro and nano scales. James is a new hire and he has not taught yet but his hire is a large investment by SEAS in sustainable energy research. His lab is in the Singh Center for Nanotechnology. <https://pikul-lab.seas.upenn.edu>

Aaswath Raman, Assistant Professor, Electrical and Systems Engineering

Incoming faculty member, Aaswath Raman, is working on using nanotechnology for energy applications. In a recent breakthrough, he has shown how light and heat can be controlled and better used to enable new technological possibilities for next-generation approaches to energy, information processing, sensing, displays and communication systems. An important recent development in his work on radiative cooling was [published in Nature](#). As a first step to harnessing this resource, he demonstrated that sub-ambient radiative cooling to the sky can — counterintuitively — be achieved during the day, even under direct sunlight. Funded by a \$3M award from the U.S. Department of Energy's Advanced Research Projects Agency (ARPA-E), his team is now working to both scale and integrate this technology to improve the efficiency and capabilities of conventional cooling and air-conditioning systems. For a high-level summary you can hear a [Nature podcast interview](#) with him and read the [official Stanford news release](#). Other media coverage includes [The](#)

[Economist](#), [CNN](#), [The Guardian](#), [IEEE Spectrum](#), [MIT Technology Review](#), [Ars Technica](#), [Stanford Report](#), and [Christian Science Monitor](#). His technology is now part of a startup he co-founded call SkyCool Systems.

Aleksandra Vojvodic, Assistant Professor, Chemical and Biomolecular Engineering

Aleksandra's research focuses on theoretical and computational-driven materials design. The lab uses computational frameworks to obtain fundamental understanding of surface and interface properties of complex materials that can be used to develop theoretical models for chemical transformations and energy conversion. These models have, for example, been used to predict new catalyst materials for several chemical reactions which have been experimentally synthesized and tested, validating the desired properties of the computationally predicted catalyst material. Aleks developed our new course, **CBE 544 - Computational Science of Energy and Chemical Transformations**.

<http://www.seas.upenn.edu/directory/profile.php?ID=220>

Faculty with Current Research In Energy and Sustainability

Mark G. Allen works on nanotechnology for energy applications such as power supply on a chip. Nanostructured magnetic materials are being exploited to create energy storage and conversion elements of very high compactness that can operate at high frequency in electronic switching converters. By use of electrodeposition and advanced nanofabrication techniques, sequential stacked sheets of highly laminated magnetic material can be produced which allow for very high saturation flux densities while suppressing the eddy current losses common to these otherwise high quality alloys. Such devices can be used either to create ultracompact or higher efficiency voltage converters, for applications ranging from LED lighting to portable electronics to battery management. A new Penn spinoff company, Enachip, has just been funded to commercialize this technology.

<http://mems.seas.upenn.edu/homepage.php>

Igor Bargatin's group is part of a large research project in thermionic energy conversion, a sustainable, non-fossil fuel energy conversion technology, funded by ARPA-E. Recently, his group made new components that their collaborators used to demonstrated >10% efficiency of energy conversion from heat to electricity, which exceeds the efficiencies available from thermoelectric systems. The final goal of the ARPA-E program is to demonstrate record 25% efficiency.

<http://bargatin.seas.upenn.edu>

Rob Carpick studies the origins of friction, lubrication, and wear at the nanoscale. One of his main goals is to develop ways to reduce and overcome friction and wear, thus reducing energy consumption and material waste in applications from vehicles to manufacturing processes.

<http://carpick.seas.upenn.edu>

I-Wei Chen's interests span several aspects of nanomaterial research. He investigates magnetic and fluorescent smart colloids for molecular imaging, primarily MRI; nanograin ceramics, which deals with multilayer ceramic capacitor (MLCC), specifically sintering and dielectric/ferroelectric properties of barium titanate; and thin film nanometallic electronic devices for resistance random access memory (RRAM). Chen is also studying energy materials, such as zirconia, thermoelectrics and transparent electrodes. <http://www.seas.upenn.edu/~iweichen/>

Russel Composto is involved in polymer science and biomolecular engineering research. His interests extend to polymer surfaces and interfaces, adhesion and diffusion, and nanocomposite polymer blend and copolymer films. Russ's biomaterials work centers around manipulating the surface of polymers to elicit control over protein adsorption, as well as cell adhesion, orientation, and function, and he has an active research program at the interface of polymer science and biomolecular

engineering, which combines block copolymer self-assemble as a basis for orienting stiff biological molecules. <https://polymer.seas.upenn.edu/>

Raymond Gorte's current research focuses on electrodes for solid oxide fuel cells (SOFC) and on oxidation catalysis using mixed-oxides. With SOFC, his lab has developed a method to synthesize electrodes with unprecedented control over composition and nanostructure, fabricating high-performance cells that are able to operate on hydrocarbon fuels. In oxidation catalysis, his group has developed methods to measure the thermodynamic, redox properties of mixed oxides and then determine the effect changes in redox properties have on catalytic properties. His overall research interests lie in fuel cells, energy and catalysis.

Cherie Kagan's research is focused on studying the chemical and physical properties of molecular and nanostructured assemblies and thin films and their integration in electronic and optoelectronic devices. In particular she has been a leader in the use of nanostructured materials for solar cells. <http://kagan.seas.upenn.edu/>

Daeyeon Lee's vision is to develop deep understanding of the interactions between soft materials (e.g., polymers, colloids and biologicals, etc.) near or at interfaces. His group seeks to extend the obtained knowledge to enable the assembly of nano-/micro-scale materials into macroscopic structures that have designed properties and functionality. The major research efforts in the lab include understanding the behavior of Janus particles at fluid interfaces, understanding and improving the assembly and mechanical properties of nanoparticle films, the generation of hierarchical structures using emulsions and bubbles as templates, and development of catalytic systems for biomass conversion. <http://www.seas.upenn.edu/~leegroup/index.html>

Noam Lior research interests are in heat transfer and fluid mechanics, thermodynamics, energy conversion, solar energy, combustion, membrane distillation, flash evaporation and water desalination, destruction of hazardous wastes by photocatalysis and supercritical oxidation, scientific sustainability analysis, and heat treatment.

Jennifer Lukes works on nanoscale thermal transport, which has many applications in sustainable technologies include for thermoelectrics and thermal management in electronics. <http://www.seas.upenn.edu/directory/profile.php?ID=59>

Rahul Mangharam's group has been using ideas from control systems and machine learning over internet of things for intelligent energy use. His work has resulted in innovation prizes including the Allegheny Region Cleantech University Prize (CUP) Collegiate Competition in 2016. <http://www.seas.upenn.edu/~rahulm/group/index.html>

Chris Murray - Bridging boundaries between chemistry and materials science, Chris researches the synthesis characterization and integration of nanostructured materials, with an emphasis on the exploration of finite size effects in nanoscale magnets and semiconductors. His seminal contributions include the development of nanocrystalline materials, the creation of artificial atoms (nanocrystals or quantum dots) that self assemble into devices with completely new multi-functionalities. Chris is exploring self-organizing phenomena for applications in information processing, communication, and storage. <http://web.sas.upenn.edu/cbmurray/>

CJ Taylor and Vijay Kumar work on applying computer vision, machine learning and robotics technologies in problems in precision agriculture. Specifically, they are working on yield prediction (by estimating fruit count in the beginning of the season), canopy measurements, modeling the vigor of plants, and the thermal profile to improve the efficiency of food production and the efficiency in the use of water for irrigation. Their work is funded by USDA.

John Vohs' research programs focus on efficient and renewable methods for energy conversion and generation. Current projects in the group include the development of highly-efficiency, fuel-flexible, fuel cells for the generation of electricity, fundamental studies of structure-activity relationships for supported metal catalysts that are used to facilitate reactions required for the conversion of renewable biomass into more useful fuels and chemicals, and the development of photocatalysts for the photochemical production of fuels. <http://www.seas.upenn.edu/directory/profile.php?ID=101>

Karen Winey's group designs and fabricates polymer nanocomposites containing carbon nanotubes and metal nanowires with the aim of understanding how to improve their mechanical, thermal, and especially electrical properties. More recently Karen has expanded her work to include simulations of electrical conductivity and polymer dynamics in the presence of nanoparticles. Karen pioneered the use of HAADF STEM to probe the nanoscale morphology in ion-containing polymers. Now, her group focuses on correlating the structures in these materials, including block copolymers, with transport properties. <http://winey.seas.upenn.edu/>

Shu Yang is interested in developing new methodologies for the controlled synthesis, fabrication and characterization of materials with specific and unique structures and functionalities inspired by biology. Special interests include preparation of functional (co)polymers and investigation of their self-assembled nanostructures; understanding the self-organization process at surfaces and interfaces; development of novel responsive materials and non-conventional approaches for nano- and micropatterning of complex 2-D and 3-D structures; controlling wetting, adhesion and biofouling on polymer thin films.

<http://www.seas.upenn.edu/%7Eshuyang/>

Climate Change, Energy and Environment-Related Research Activities

Materials Science and Engineering

Faculty	Agency	Grant Title
I-Wei Chen	DOE BES	Electric-loading Enhanced Kinetics in Oxide Ceramics: Sintering, Pore Migration and Grain Growth
Karen Winey	ARO	Rapid Screening of New Precise Copolymers: Morphology and Ionic Conductivity
Karen Winey	NSF DMR	Precise Copolymers and Ionomers: Conductivity in Layered and Percolated Morphologies and Mechanical Properties
Karen Winey	DOE Sandia Nat'l Lab	Understanding Transport and Aging Mechanisms to Optimize Sandia's Ion-Conducting Polymer Electrolytes for Energy
Russ Composto	NSF PIRE	PIRE: Research and Education in Active Coatings Technologies (REACT) for the Human Habitat
Chris Murray	NSF CBET	Collaborative Research: Ultrafast Carrier Dynamics in Semiconductor Nanocrystal Solar Cells
Chris Murray	University of Delaware	Rational Design of Innovative Catalytic Technologies for Biomass Derivative Utilization
Chris Murray	Los Alamos Nat'l Lab	Advanced Electro-Catalysts Through Crystallographic Enhancement
Chris Murray	NSF	Collaborative Research: Directing Charge and Energy Flow in Discrete Nanocrystal-Dendrimer Hybrids and in Their Assemblies

Shu Yang	Kleinman Center	Humidity responsive, water harvesting and self-cooling building envelopes
Alison Sweeney (PI), Shu Yang (co-PI)	NSF/INSPIRE	INSPIRE Track 2: Discovery and Development of optimized Photonic systems for high volume, low surface area solar energy harvesting: learn from giant clams
Daeyeon Lee (PI), Shu Yang and others (co-PIs)	NSF CBET	SNM: Scalable Manufacturing of Nanostructured Membranes for Fracking Wastewater Treatment
Xiaoming Mao, Univ. Michigan (PI), Shu Yang and others (co-PI)	NSF- EFMA	EFRI NewLAW: Topological acoustic metamaterials for programmable and high-efficiency one-way transport
Reto Giere (PI), Shu Yang and others (co-PI)	URF RODG	Phase 1 for Energy Sustainability Symposium and for Energy, Sustainability and Environment Working Group meeting
Jianbo Shi (PI), Shu Yang (co-PI)	Penn China Research and Engagement Fund	Symposium and summer school, "Personalized Intelligent Living: Human, Robot and Nature"
Jennifer Lukes (PI), Shu Yang (co-PI)	Penn - URF	Multiscale Measurements of Dropwise Condensation on Micro/Nanopatterned Surfaces

Engineering Led Courses Related to Energy and Sustainability

New courses or those whose curriculum has been revamped in last two years are highlighted.

EAS 301/505 Climate Policy and Technology

EAS 306/506 Electricity and Systems Markets

EAS 401/501 Energy and Its Impacts: Technology, Environment, Economics, Sustainability

EAS 402/502 Renewable Energy and Its Impacts: Technology, Environment, Economics, and Sustainability

EAS 403/503 Energy Systems and Policy

EAS 501 Energy and its Impacts: Technology, Environment, Economics, Sustainability

ENGR 250 Energy Systems, Resources and Technology

ENGR 503 Engineering in Oil, Gas and Coal, from Production to End Use

CBE 375 Engineering and the Environment

CBE 543 Sustainable Development of Water Resource Systems

CBE 544 Computational Science of Energy and Chemical Transformations

CBE 545 Electrochemical Energy Conversion and Storage

CBE 546 Fundamentals of Industrial Catalytic Processes

ESE 518 Battery and Super-Capacitor Systems

ESE 519 Real-Time Embedded Systems

ESE 521 The Physics of Solid State Energy Devices

ESE 526 Photovoltaic Systems Engineering

MEAM 203 Thermodynamics

MEAM 502 Energy Engineering

MEAM 503 Direct Energy Conversion: from Macro to Nano

MEAM 561 Thermodynamics: Foundations, Energy, Materials

MEAM 572 Micro/Nanoscale Energy Transport

MEAM 580 Electrochemistry for Energy, Nanofabrication and Sensing

MEAM 504 Tribology

MEAM 537 Nanotribology

MSE 250 Nano-scale Materials Lab

MSE 393 Materials Selection (sustainability and societal impact are criteria)

MSE 401 Energy and Its Impacts: Technology, Environment, Economics, Sustainability

MSE 455 Electrochemical Engineering of Materials

MSE 530 Thermodynamics and Phase Equilibria

MSE 545 Materials for Energy and Environmental Sustainability

[Minor in Energy and Sustainability](#)

MSE Undergraduate Degree Specialization in [Energy Conversion and Storage](#)

Academic Programs Related to Energy and Sustainability

New Service Learning Courses:

EAS 097: Spring 2017 Embed Controlled Gardening

A course intended to integrate concepts of basic physics, biology, electronics and systems engineering for the benefit of Penn engineering students, teachers and students from two minority-centered community public schools in West Philadelphia and North Philadelphia. The course engaged the participants in the design and implementation of indoor cultivating systems using photo-voltaic technology (solar power) to energize LED emulating the needed solar radiation for plant growth, a liquid nutrient distribution system, sensors/actuators capable of selecting the harvestable plants and keeping track of overall system parameters.

EAS 296: Spring/Summer 2017 The Rwanda Gashora Program

The SEAS Rwanda Gashora Program explores the use of solar energy and information communication technology (ICT) in low-resource communities in developing countries. The course

provides students with an opportunity to understand the challenges around technology use and energy production in these settings, and includes substantial hands-on work in designing and implementation in low-income country settings. This year the students completed a water filtration project that is completely powered by solar power. The students installed solar panels for water purification systems that pump water from Lake Rumira (approx.. a kilometer away from the village) enabling the entire community to have ready access to clean water.

Student Extracurricular Activities

Penn Electric Racing

Penn Electric Racing team and its goals and accomplishments are very clear on the connection between the team and the sustainability goal of electric transportation. Here are quotes from their About Us page (<http://www.pennelectricracing.com/about-us>):

“Bringing the Next Generation of Engineers and Leaders Together - Penn Electric Racing is the University of Pennsylvania's Formula SAE Electric Team. Each year, we build award-winning electric race cars on a mission to prove that electric vehicles are the future of transportation.”

“Our mission is simple: Penn Electric Racing aims to educate students and give them practical experience working on a large-scale engineering project. Our club is open to students of all levels and backgrounds and exists as a microcosm of a large, diverse organization. By promoting a focus on the most current clean vehicle technologies and by allowing students to gain real-world professional experience in their area of interest, we give Penn students a competitive advantage when entering the workplace.”

This extracurricular activity receives significant support from SEAS (space, staff support, facility access, funding, publicity, etc). This year they won the Formula SAE electric vehicle competition and have multiple other championships over the last few years. We are the top school for student-designed electric vehicles. PER also points out that 8% of the School of Engineering's undergraduates are team members. The team has evolved over the years from solar cars, battery powered full-sized cars and electric motorcycles to the current, highly competitive, electric race car program.

WHARTON SCHOOL

Programs, Research, and Teaching Related to Climate Change, Energy, and the Environment

A. Research

1. Energy Economics and Finance Seminar (organized by BEPP Faculty and hosted by Kleinman Energy Center). <https://bepp.wharton.upenn.edu/research/energy-economics-finance-seminar/>.
2. Penn Wharton PPI Briefs and Papers.
<https://publicpolicy.wharton.upenn.edu/search/?q=energy>.
<https://publicpolicy.wharton.upenn.edu/search/?q=environment>
<https://publicpolicy.wharton.upenn.edu/search/?q=sustainability>
3. Penn Wharton PPI Data Sources (including energy and environment resources).
<https://publicpolicy.wharton.upenn.edu/data-resources/us-fiscal-policy/>.
4. Risk Management and Decision Processes Center.
 - a. Research areas include Chemical Safety, Climate Change, Critical Infrastructure, Flood Resilience, Extreme Events, South Florida Water-Sustainability and Climate.
<https://riskcenter.wharton.upenn.edu/areas-of-research/>.
 - b. Publications: Papers, books, newsletters, and issue briefs.
<https://riskcenter.wharton.upenn.edu/publications/>.
5. Knowledge@Wharton. Wharton's online business analysis journal.
Energy: <http://knowledge.wharton.upenn.edu/?s=energy>.
Climate: <http://knowledge.wharton.upenn.edu/?s=climate>.
Fossil fuels: <http://knowledge.wharton.upenn.edu/?s=fossil+fuel>.

B. Conferences

1. PPI hosted Marvin Odum, President of Shell Oil Company (with Kleinman Center for Energy Policy). <https://publicpolicy.wharton.upenn.edu/live/news/1198-event-recap-marvin-odum-president-of-shell-oil>.
2. IGEL Conferences.
 - a. Annual Conferences. See 2017 Agenda for "The Future of Education in Business Sustainability." <https://igel.wharton.upenn.edu/2017-conference/>.
 - b. Sponsored Conferences. <https://igel.wharton.upenn.edu/research/conference/>.
3. Wharton Energy Conference. One of the largest energy conferences in the Northeast, organized by MBA students. For 2016 agenda, see <http://www.whartonenergyconference2016.com>.

C. Academic and Co-curricular Programs

1. Academic majors, minors, and undergraduate concentrations.
<https://igel.wharton.upenn.edu/education/>.
 - a. University Minor in sustainability and environmental management (Business Economics and Public Policy (BEPP) with Initiative for Global Environmental Leadership (IGEL)).
 - b. Wharton concentration in Environmental Policy and Management.
 - c. Dual Degree MBA/Master of Environmental Studies.
 - d. MBA Major in Environmental and Risk Management.
2. Penn Wharton Public Policy Initiative (PPI).
 - a. Public Policy Research Scholars. Interdisciplinary certificate program which includes an energy and environment track. <https://publicpolicy.wharton.upenn.edu/for-students/public-policy-research-scholars/admissions/>.
 - b. Wharton Undergraduate Industry Exploration.
<https://publicpolicy.wharton.upenn.edu/for-students/academic-options/public-policy->

- [sector/](#). Travel to DC with faculty for interactions with public policy researchers, including at the World Bank (Global Sustainability) and World Resources Institute (sustainable natural resource management).
- c. Infrastructure case competition on water-related issues (such as Flint, Michigan crisis). <https://publicpolicy.wharton.upenn.edu/live/news/1184-case-competition-winners-go-to-the-us-department>.
 - d. DC Internships funding (e.g. EPA; DOE; World Bank (Global Sustainability area). About 12 per year are funded, including cosponsored internships with Kleinman Center for Energy Policy. <https://publicpolicy.wharton.upenn.edu/live/files/260-penn-wharton-ppi-annual-report-2015-2016>: See page 19.
 - e. Student Blog (includes energy, environment, and other topics). <https://publicpolicy.wharton.upenn.edu/for-students/blog/>.
3. Wharton Energy Club. <http://www.whartonenergyclub.org>.
 4. Russell Ackoff Fellowships. Doctoral student fellowships to pursue research in areas such as Managing Environmental, Health and Safety Risks. <https://riskcenter.wharton.upenn.edu/russell-ackoff-doctoral-student-fellowships/>.

D. Faculty.

1. Eric Gilje, Assistant Professor of Finance.
Research: <https://fnce.wharton.upenn.edu/profile/gilje/#research>.
2. In the News: <https://fnce.wharton.upenn.edu/profile/gilje/#news>. Howard Kunreuther, James G. Dinan Professor (OID).
Research: <https://oid.wharton.upenn.edu/profile/kunreuth/#research>.
In the News: <https://oid.wharton.upenn.edu/profile/kunreuth/#news>.
3. John Paul MacDuffie, Professor of Management.
Research: <https://mgmt.wharton.upenn.edu/profile/macduffi/#research>.
In the News: <https://mgmt.wharton.upenn.edu/profile/macduffi/#news>.
4. Eric Orts, Guardsmark Professor (Legal Studies and Business Ethics).
Research: <https://lgst.wharton.upenn.edu/profile/ortse/#research>
In the News: <https://lgst.wharton.upenn.edu/profile/ortse/#news>.
5. Arthur Van Benthem, Assistant Professor (BEPP).
Research: <https://bepp.wharton.upenn.edu/research/>.
In the News: <https://bepp.wharton.upenn.edu/profile/arthurv/#news>.

E. Courses

1. BEPP 261/761/961 (also cross-listed with Operations, Information and Decisions (OID) and Electrical and Systems Engineering (ESE)): Risk Analysis and Environmental Management. Undergraduate, MBA, and PhD students.
Enrollment = 324 over four semesters offered (Spring of 2014-2017).
2. BEPP 263/OIDD 263: Environmental and Energy Economics. Undergraduates.
Enrollment = 56 over two semesters offered (Spring of 2015 and 2016).
3. BEPP 763/OIDD 763: Energy Markets and Policy. MBAs.
Enrollment = 124 over two semesters offered (Spring of 2015 and 2016).
4. Finance (FNCE) 756: Energy Finance. MBAs.
Enrollment = 202 over three semesters offered (Spring of 2015-2017).
5. Wharton Executive Education, Energy and Transportation Program. Non-credit course for business professionals. <https://executiveeducation.wharton.upenn.edu/for-organizations/energy-and-transportation>.

F. Sustainability Programs at Wharton. <https://www.sustainability.upenn.edu/sustainability-programs-wharton>.

PENN SUSTAINABILITY OFFICE – ACADEMIC COLLABORATION

Sustainability Academics collaboration between Students, Faculty, and the Penn Sustainability Office

A. Integrating Sustainability across the Curriculum

This program assigns student to work with faculty on updating existing courses or designing new courses to introduce sustainability themes. Since its launch in 2012, the ISAC program has paired 24 students with 48 faculty, bringing sustainability content to 41 new or updated courses. The table below lists participating students along with the courses they worked on and the supervising professors. For more information, see

<https://www.sustainability.upenn.edu/participate/staff-and-faculty/integrating-sustainability-across-curriculum>

Student Research Assistants	Course	Professors
2012 (nine courses)		
Elise Jun	LALS 233: History of Coca to Cocaine	Ann Farnsworth
Lauren Kaufman	ENVS 667: Sustainable Goods	Jim Hagan
	Comm 123: Critical Approaches to Pop Culture	Felicity Paxton
Mary Tsai	URBS 290: Metropolitan Nature	Michael Nairn
	ARCH 431: Construction I	Franca Trubiano
Meg Schnieder	ENVS 400: Landscape Sustainability	Doug Jerolmack
	CHEM 012: Environmental Chemistry	Marsha Lester
Sam Hougie	ECON 001: Introduction to Microeconomics	Rebecca Stein
Tyler Hall	COML209, ENGL275, , STSC368: Sustainability & Utopianism	Bethany Wiggin
	Sustainability in Schools	Liz MacKenzie
2013 (twelve courses)		
Luke Saputelli	SEAS 301, SEAS 505: Climate Policy & Technology	Andrew Huemmler
	ENVS327: Principles of Sustainability	Alain Plante
Rosemary Santos	Sustainability in Practice (PennDesign Coursera)	Mark Alan Hughes
	UBS 417: Cities & Sustainability	Ariel Ben-Amos
2014 (eight courses)		
Kensey Miller	Architecture in the Antropocene	Daniel Barber
	HSSC 272, ENVS 272: Energy in American History	Ann Greene
Jesse Yoder	EAS 403 :Energy Systems and Policy	Andrew Huemmler
	UBS 417: Cities & Sustainability	Ariel Ben-Amos
Michael Steele	Legal Studies 612: Responsibility in Professional Services	Sarah Light, Eric Orts
	Legal Studies 215/815: Environmental Management, Law and Policy	Sarah Light
Katherine Dalton	Microbial Fuel Cells Investigation	Karen Hogan
	ENVS 494: Toward Sustainability at Penn	Dan Garofalo
2015 (six courses)		
Julia Levitan	Legal Studies 215/815: Environmental Management, Law and Policy	Sarah Light
	HSPV 572 - Preservation Through Public Policy	David Hollenberg
Riad Hammadeh	Chemistry 101	Ivan Dmochowski
	CHEM 251 – Principles of Biochemistry	Jeffrey Saven

Mary-Katherine McMullen	Energy in American History	Ann Greene
	Dynamics 615 - Global Pennovation	Steve Finn
2016 (six courses)		
Samuel T. Sanders	Legal Studies LGST 299: <i>Environmental Ethics and Business</i>	Brian Bekey
	GRMN 150/ENVS 150 Water Worlds: Cultural Responses to Sea Level Rise & Catastrophic Flooding	Simon Richter
Cody E. Clouser	MEAM 514 Design for Manufacturability	Mark Kim
	MEAM 203: Thermodynamics I	Igor Bargatin
Gabriel E. Solomon	Shifting Sustainability	Dan Garofalo / Kim Quick
	The ENV S301: Environmental Case Studies	Jane Dmochowski
2017 (eight courses)		
Octavia Sun	ENVS100: Introduction to Environmental Science	Alain Plante
	EcoFeminism	Dan Garofalo / Felicity Paxton
Nafissatou Ba	Sustaining Safe Drinking Water in Philadelphia	Richard Pepino
	Urban Water Systems	Howard Neukrug
Mary Cerulli	Slower Schuylkill River Symposium	Bethany Wiggan
		Nikhil Anand
Miranda Mote	ANTH 440, Plants and Society	Chantel E. White
	ANTH 415, Archaeology of Animals	Katherine M. Moore
Albert Chen	Architecture Summer Abroad Studio	Rebecca Popowsky
Katlyn Cotton		Fritz Steiner
		Laurie Olin
		Randall Mason

B. Ben Franklin Scholars Course Design Grants (<https://www.sustainability.upenn.edu/news/call-proposals-ben-franklin-scholars-course-design-grants-0>) provide funding for faculty to create a new undergraduate seminar that uses innovative approaches to the theme of sustainability. Since the launch in 2012, three new courses have been created. After a two-year hiatus, the *Course Design Grants* will be available to faculty again in 2018. Recipients of the Course Design Grants are listed below.

2013: David Graziani, Associate Professor of Sociology, received a Ben Franklin Scholars (BFS) Course Design Grant for the seminar, *Where the Wild Things Aren't: Zoos, Science Museums, and the Culture of Nature*. *Where the Wild Things Aren't* was offered in Fall 2014. David Graziani’s proposal demonstrated “a creative way to explore human understands non-human creatures. Since much of what we do to orient ourselves toward questions of sustainability requires a trans-human-centric perspective, this course promises to contribute to the deep tissue sort of work that is required to make advances in this area.”

2012: Eric Orts, Professor of Legal Studies and Business Ethics and Management in Wharton, and Director of the Initiative for Global Environmental Leadership (IGEL) received the BFS Course Development Grant for the development of a seminar version of *Environmental Management Law and Policy*.

2011: Dr. Alan Kelly and Dr. James Ferguson received a BFS Course Design Grant to create BENF225, *Global Food Security*. Drawing on his years as the Dean of the School of Veterinary Medicine and as a noted animal physio biologist, Dr. Kelly created his first course for undergraduates on food supply, scarcity, and security.

C. Penn Undergraduate Climate Action Plan Grants administered by the *Center for Undergraduate Research Fellowships* and funded by the facilities division, provide students an opportunity to work alongside doctoral candidates under the supervision of a Penn professor on research projects related to sustainability and climate change.

Recent grant recipients are listed below, along with their faculty advisors and research topics. For more information, see (<https://www.curf.upenn.edu/content/penn-undergraduate-climate-action-grant>)

2017 (eight grants)

- Ana Alonso (COL 2018): "The Transitioning Traditional: Using Cards as a Vehicle for Traditional Ecological Knowledge Transmission"
- Madeleine Andrews (COL 2018): "Effects of salivary cortisol on frequencies of self-directed behaviors"
- Amy Chen (COL 2018): "Sustainable Peru: The Impact of Textile Design on Profits, People, and the Planet"
- Hailey Dougherty (COL 2018): "The adaptive capacity of traditional agro-economic systems to extreme drought and flooding events in the Cordillera Blanca"
- Sarah Haber (COL 2018): "Urban Road Dust: A comparative study of anthropogenic inputs in Freiburg, Germany"
- Jisoo Kim (COL 2018): "21st Century Conservation of Paraguayan Fauna"
- John San Soucie (COL 2018): "Southern Ocean Deep Convection and Global Climate Teleconnections"
- Cynthia Wang (COL 2018): "E-Waste Management Internship/Research"

2016 (three grants)

- Lauren Brunsdale (COL 2017): "Monitoring Landscape and Vegetation Change in Ventura River Watershed, California Using Remote Sensing" [Mentor: Jane Dmochowski, Earth and Environmental Sciences]
- Harry Smith (COL 2018): "Creating a Novel, Phytoplankton Size-Dependent Ocean Ecological Model" [Mentor: Irina Marinov, Earth and Environmental Sciences]
- Mauricio Tassano (SEAS 2017): "The Thermodynamic Stability of Corner and Edge Sharing, Inorganic CsPbI₃ Surfaces" [Mentor: Andrew Rappe, Chemistry]

2015 (seven grants)

- Jordan Doman (COL 2017): "Developing emerging biosensor technology" [Mentor: Ivan Dmochowski, Chemistry]
- Annie Liu (COL 2016): "Intersections of Spirituality and Sustainability: a Critical Examination of Healthcare and Healing in Auroville" [Mentor: Andrew Lamas, Urban Studies]
- Elizabeth Schwartz (COL 2016): "Implementing an expanded science curriculum to students at Philadelphia Freedom Schools" [Mentor: Andrew Schiera, Urban Studies]
- Alisa Shargorodsky (COL 2016) "Reducing single use waste outputs that burden the urban metabolism" [Mentor: Amy Hillier, Design]
- Harry Smith (COL 2018) "Contrasting the ecological responses to climate change in the Arctic and Southern Oceans" [Mentor: Irina Marinov, Earth & Environmental Sciences]
- Khadija Tarver (COL 2016) "Climate change risk perception in West Santo Domingo, Dominican Republic" [Mentor: Jane Dmochowski, Earth & Environmental Sciences]
- Siyuan Wu (COL 2016) "Analyzing Potential for Carcinogenic Ptaquiloside Exposure in Danish Groundwater Sources" [Mentor: Alain Plante, Earth & Environmental Sciences]

2014 (six grants)

- Leah Davidson (WH 2016): "The Significance of Color in Environmental Art" [Mentor: Bethany Wiggin, Germanic Languages and Literatures]

- Minsik Jun (EAS 2015): “Sr_{0.55}Na_{0.45}SiO_{2.775} for solid oxide fuel cells” [Mentor: John Vohs, Chemical and Biomolecular Engineering]
- Gabriella Meltzer (COL 2015): “The Hidden Bodies Behind E-Waste: A Case Study of Accra, Ghana” [Mentor: Andria Johnson, History and Sociology of Science]
- Charity Migwi (COL 2015): “A Sustainability Impact Study of the Sahara Forest Project Using Selected Indicators of Sustainability” [Mentor: Kristen Hughes, VIPER]
- Angela Perfetti (COL 2016): “The Response to Asbestos: Medical Decision-Making” [Mentor: Fran Barg, Anthropology]
- Kyra Reumann-Moore (COL 2015): “The Effects of Hydraulic Fracturing on Drinking Water Quality in the Denver-Julesburg Basin” [Mentor: Richard Pepino, Earth and Environmental Science]

2013 (eight grants)

- Mariah Deters (COL 2014): “The Future of Sustainable Energy in Modern China” [Mentor: Yuhua Wang, Political Science]
- Lingbin Cai (EAS 2016): “Impact of Climate Change on the Tropical Oceans” [Mentor: Irina Marinov, Earth and Environmental Sciences]
- Shabnam Elahi (COL 2014): “Mapping Risk: Environmental Exposure to Asbestos in Ambler, PA” [Mentor: Frances Barg, Anthropology]
- Kim Gordon (COL; EAS 2014): “Environmental Behavior in Argentine Society” [Mentor: Joseph Sun,]
- Hoon Kim (COL; WH 2013): “A Political Analysis of Japan's post-Fukushima Alternative and Nuclear Energy Policy” [Mentor: Frederick Dickinson, History]
- Jessica Mangin (COL 2014): “Redefinition | Form in Sustainable Design” [Mentor: Daniel Barber, Architecture]
- Mark Pantano (COL 2014): “Ecological Memory: Environmental Adaptation and Representation in Islamic Domestic Architecture” [Mentor: Renata Holod, Art History]
- Gerard Salter (COL 2014): “Equilibrium Channel Geometry of Suspended Load Streams: Experimental Study” [Mentor: Douglas Jerolmack, Earth and Environmental Sciences]

2012 (eight grants)

- Kensey Berry (COL 2013): “Cost, Carbon, and Social Responsibility: A Multifaceted Analysis of Penn's Policy of Purchasing Renewable Energy Credits” [Mentor: Dr. Craig Calabria, Earth and Environmental Science]
- Adriel Koschitzky (COL; WH 2014): “Green Synthesis of Boronic Acids” [Mentor: Dr. Gary Molander, Chemistry]
- Hyejung Lee (COL 2013): “Recent Trends in Floodplain Carbon: Paradigm Case or Bias?” [Mentor: Dr. Jane Willenbring, Earth and Environmental Science]
- Shirley Leung (COL; LPS 2013): “North-South Assymetries in the Responses of Ocean Ecology and Biogeochemistry to Global Climate Change” [Mentor: Dr. Irina Marinov, Earth and Environmental Science]
- Katherine Oberwager (COL 2012): “Mexican and Puerto Rican Immigrant Urban Agriculture in the United States” [Mentor: Dr. Domenic Vitiello, City and Regional Planning]
- Mark Pantano (COL 2014): “Life in the Quarry: Gaudi and the Search for Art Nouveau Environmentalism” [Mentor: Dr. Lothar Haselberger, History of Art]
- Pallavi Podapati (COL 2013): “Appalachian Water Watch” [Mentor: Dr. David Barnes, Health and Societies]
- Meg Schneider (COL 2013): “Nudges Toward Sustainability: Digital Shower Timers in Dorms” [Mentor: Dr. Jason Dana, Psychology]

2011 (five grants)

- Bianca Datta (EAS 2014): Nanocrystals for Solar Energy Conversion

- Joanna Karaman (COL 2012): Defining Sustainable Use of Building Materials
- Shirley Leung (COL; LPS 2012): Using ¹⁰Be to Understand Anthropogenic Influences on Soil Erosion Rates
- Claire Masteller (COL 2012): Vegetation Stability and Climate Change: A case study at White Sands National Monument, NM
- Douglas Miller (COL 2012): Sustainable Behavior Inducement

2010 (six grants)

- Zachary Bell (COL 2012A): Nonprofit Sustainability Management Model
- Rachel Gittelman (COL 2011A): The Role of ALDH3A1 Variation in Climatic Droplet Keratopathy in the Mapucha Indians of Argentina
- Maura Goldstein (COL 2011A): Penn Garden Development and Outreach
- Rachel Margolis (COL 2011A): Studying Relative Sea Level on Georgia Coast
- Claire Masteller (COL 2012A): Examination of the evidence for sea level rise through proxy data; Georgia, United States
- Kirstin Washington (COL 2011A): The Geochemistry of Limestone Cave Waters and Its Implications for the Development of New Methods for Studying Paleoclimate

D. Penn Undergraduate Research Mentorship (PURM) grants dedicates funding for sustainability-related undergraduate summer research projects from the facilities department as part of a campus-wide Power Down Challenge energy conservation program. Recipients in 2017 and 2016 are listed below. For more information see: <https://www.curf.upenn.edu/content/penn-undergraduate-research-mentoring-program>),

2017:

- Hannah Sanders (COL 2019): "Characterization of Anthropogenic Dark Earth soils" [Dr. Alain Plante, EARTH AND ENVIRONMENTAL SCIENCE, Arts and Sciences]
- Amy Goldfischer (COL 2019): "Community-Based Ecology in the Galápagos Archipelago" [Dr. Michael Weisberg, PHILOSOPHY, Arts and Sciences]

2016:

- Beidi Hu, Fangjian Hu (COL 2019): "Global Sustainabilities" [Dr. Simon Richter, GERMAN, Arts and Sciences]
- Jonathan Schiff (COL 2019) / Robin Zhang (EAS 2019): "Satellite Data Analysis for Ocean Sciences" [Dr. Irina Marinov, EARTH AND ENVIRONMENTAL SCIENCE, Arts and Sciences]
- Sophie Bodek, (COL 2019) "Luquillo Critical Zone Observatory (LCZO), Sediment Transport and Exports of Luquillo Streams [Dr. Douglas Jerolmack, EARTH AND ENVIRONMENTAL SCIENCE, Arts and Sciences]

E. Penn Summer Sustainability Fellowships. Since the summer of 2015, Penn's Division of Facilities and Real Estate Services has partnered with academic offices to develop summer research fellowships at Penn, Philadelphia-area sustainability nonprofits, and with the City of Philadelphia. Partner academic offices include:

- Department of Urban Studies, School of Arts and Sciences
- Department of Earth and Environmental Science, School of Arts and Sciences
- Department of Germanics, School of Arts and Sciences
- Department of Chemical & Biomolecular Engineering (CBE), School of Engineering & Applied Science
- Department of Teaching, Learning, and Leadership, Graduate School of Education
- Department of City and Regional Planning, School of Design
- Department of Architecture, School of Design
- Department of Historic Preservation, School of Design
- The Kleinman Center for Energy Policy, School of Design

- Penn Praxis, School of Design
- Liberal and Professional Studies, Masters of Environmental Studies
- The Netter Center for Community Partnerships

The table below lists participating students along with the agencies for which they worked on and the supervising professors.

Student Research Assistants	Department / School	Organization / Project	Supervisor
2017 (eight research fellowships)			
Chloe Qu	City and Regional Planning / School of Design	Philadelphia City Planning Commission (PCPC) / Sustainable Guidelines	Gary Jastrzab, Executive Director
Haley Jordan	Masters of Environmental Studies / Liberal and Professional Studies	Zero Waste, City of Philadelphia	Nic Esposito, Zero Waste and Litter Director
Brandon Burke	Masters of Environmental Studies / Liberal and Professional Studies	City of Philadelphia's Energy Office / ESCO development	Amanda Byrne, Energy Analyst; Richard Freeh
Mary Cerulli	Earth and Environmental Studies / School of Arts and Sciences	Bartram's Garden / Oral History Project - Eastwick	Tyler Holmberg, Bartram's Farm Manager
Bailey Smith	Masters of Environmental Studies / Liberal and Professional Studies	PHS Tree Tenders / Tree Checkers / PHS Plant One Million	Dana Dentice, PHS Plant One Million Manager
Mitchel Gainer	Business Economics & Public Policy / Wharton Graduate MBA program	Penn Water Center, Department of Earth & Environmental Science	Howard Neukrug, Director of the Penn Water Center
Ivan Sandoval	History and Sociology of Science / School of Arts and Sciences	Ben Franklin Technology Partners / Strategy Arts / ImpactPHL	Scott Wheeler Managing Director, Strategy Arts
Starr Herr-Cardillo	Historic Preservation / School of Design	Bartram's Garden / Woodlands / Curatorial Research	Joel Fry, Bartram's Curator Jessica Baumert, Woodlands ED
2016 (nine research fellowships)			
Mukete, Asinty	Masters of Environmental Studies / Liberal and Professional Studies	Philadelphia Office of Sustainability / Kleinman Center	Christine Knapp, Philadelphia Sustainability Director
Suresh, Adithya	Mechanical Engineering (Graduate) / School of Engineering and Applied Science	Philadelphia Energy Office / Efficiency Analysis	Amanda Byrne, Energy Analyst; Richard Freeh, Office Director
Byerly, Jackson	City and Regional Planning / School of Design	Philadelphia Parks & Recreation Department / Waste Management	Nic Esposito, Parks Director
Rigell, Laura	City and Regional Planning / School of Design	Philadelphia Energy Authority / Solar Schools Project	Emily Shapira, Executive Director
Miller, Kinsey	Earth and Environmental Science / School of Arts and Sciences	Urban Forestry (PHS) / Urban Canopy Research	Dana Dentice, PHS Director
Gutarez, Xelba	Masters of Environmental Studies / Liberal and Professional Studies	Neighborhood Gardens Trust	Jennifer Greenberg, PHS Director
Manley, Adiga	City and Regional Planning / School of Design	City Harvest Program	Nancy Kohn, PHS Director
Arthur Rempel	Chemical & Biomolecular Engineering / School of Engineering and Applied Science	SEAS Energy Curriculum	Robert Carpick, Department Chair / Andy Huemmler, Senior Lecturer
Clay Gruber	Architecture / School of Design	Penn Praxis	Julie Donofrio, Penn Praxis Managing Director

F. *The Student Eco-Rep Program* is Penn's environmental leadership program. The focus is on educating, empowering, and supporting students in an effort to raise awareness of environmental issues and impact the behavior of individuals across campus. Select students develop educational events, activities, and campaigns aimed at supporting the University's *Climate Action Plan*.

Twelve to fifteen students are paid to work three to five hours per week during the school year. The projects undertaken not only lead to improved environmental performance across campus, but they provide practical educational experiences for the participating students – real time, real world experiments that provide understanding of environmental campaigns that are hard to replicate in a classroom. The student program may only last a semester or academic year, but the lessons last a lifetime.

Research activities vary from year to year, but include waste audits, energy conservation outreach and recycling campaigns, educating peers about sustainable dining and consumer habits, organizing community service projects for environmental organizations, and more.

2016 projects included eight projects:

- Replacing Recycling Bags. Michael Shu (SAS '17) worked on assessing the potential for replacing recycling bags provided to students living on campus with recycling bins. Overall, survey results point to students favoring the use of recycling bins over the bags.
- Residential Composting. Sophia Leporte (SAS '19) and Tiffany Yung (WH '18) conducted research on and developed proposals for a residential composting pilot program to test strategies for removing food waste from Penn's landfill stream.
- Outdoor Recycling. Karen Chi (SAS & WH '19) and Helen Dai (SAS '19) evaluated strategies to improve signage and the physical appearance of outdoor recycling bins near College Hall and the High-Rises to increase recycling rates and decrease contamination rates.
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- Sustainability Workshops. Soomin Shin (SAS & WH '19) and Maddie Tilyou (SAS '19) worked on researching sustainability and green event guides at other universities. They also designed and presented sustainability workshops to various student groups on campus.
- Campus Ecology Tours. Carol Chen (WH '19), April Huang (WH '19), Emma Shenton (SAS '19), and Danielle Swanson (SEAS '19) conducted research on the environmental features of Penn's landscape and architecture and designed a tour and guide to raise awareness.
- Penn Community Garden. Brigitte Baella (SAS '19) and Artemis Tiburcio (WH '18) worked on promoting the garden to the Penn community, encouraged participation in cleaning it up, and picked up basic gardening skills to help maintain it.
- Drying Racks. Michael Shu (SAS '17) also introduced drying racks to every laundry room in Harnwell College House and worked on developing a private rental rack system in Rodin. After collecting data, he estimated savings of \$62.72 and 520Wh per month.

G. *Living Green Living Certification* at Penn is an on-line educational and awareness program that helps students identify their personal environmental impacts. The survey walks students through all aspects of environmental impacts: energy use, waste generation, resource conservation, consumer habits, travel and transportation choices, dining and diet, and peer engagement. Starting with a series of pre-requisites for that introduce smart resource management, students

learn about and commit to a series of environmentally responsible practices, from using durable, reusable products to avoid waste generation to adopting a low-carbon diet. Incentives are provided for pledging to maintain these habits over the course of the year, helping to build practices that last a lifetime. See more at

<https://www.sustainability.upenn.edu/participate/students/green-living-certification>

H. Penn Green Pre-orientation Program is an intense, four-day education program for incoming freshmen that introduces them to all aspects of Penn's and the region's environmental initiatives and accomplishments. Led by upperclassmen and coordinated by the Penn Sustainability Office, students meet with Penn professors and area environmental leaders, take tours of key campus and city environmental sites (recycling plants, compost yards, waterworks, urban farms, etc) and learn about ways that they can contribute to the region's environmental improvement. Each year's student cohort get a jump on understanding the goals of Penn's Climate Action Plan, and become leaders in Penn's student environmental extra-curricular groups. See more at <https://www.vpul.upenn.edu/osa/preprog/pgdesc>

I. Penn Sustainability Offices offers **Quaker Days Sustainability Tours** for admitted students to learn about the *Climate Action Plan*, Penn's sustainable campus, and environmental initiatives even before matriculating. For students interested in environmental studies or one of Penn's many environmental science dual degrees or minors, the tours offer an insight into opportunities at Penn. The tours include information on:

- College Green, Shoemaker Green, and Penn Park / Penn's ArbNet Arboretum Accreditation
- Singh Center for Nanotechnology (LEED Gold)
- Weiss Pavilion (LEED Gold)
- Hutchinson Gymnasium (LEED Gold)
- Music Building (LEED Gold)
- New College House (LEED Gold)
- Golkin Hall, Law School (LEED Gold)
- Van Pelt Library
- The ARCH (LEED Gold)
- Steinberg-Dietrich Hall (LEED Gold)
- Wharton's Joe's Café (LEED Gold)
- Huntsman Hall
- The Perelman Center for Advanced Medicine (LEED Silver)
- The School of Medicine's Smilow Center for Translational Research (LEED Gold)

For more information and a description of the sustainable features of each tour stop, see

<https://www.sustainability.upenn.edu/resources/tours/walking-tours>

J. Seasonal Engagement Campaigns: Penn's Sustainability Office manages and promotes environmental educational campaigns for the entire campus community several times a year, including the *Power Down Challenge*, *ReThink your Footprint*, *30x30*, *Move-In Green*, and *PennMOVES*. During each campaign, the Sustainability Office works to educate, support, and empower students, staff, and faculty in pursuit of Penn's *Climate Action Plan* goals.

In support of Penn's educational mission, the Sustainability Office co-sponsors symposia, lectures, and public events during these campaigns to help drive home the message. Partners have included the Perry World House, the Penn Humanities Forum, VPUL's Cultural Resource Centers, the Kelly Writer's House, Wharton's Institute for Global Environmental Leadership, EnerFRONT, and Penn's Institute for Environmental Studies.

For more information, see:

- <https://www.sustainability.upenn.edu/participate/penn-community/power-down-challenge>
- <https://www.sustainability.upenn.edu/participate/penn-community/rethink-your-footprint>
- <https://www.sustainability.upenn.edu/participate/penn-community/30x30-challenge>
- <https://www.sustainability.upenn.edu/news/penn-moves-puts-donations-good-use>
- <https://www.sustainability.upenn.edu/news/welcome-students-move-green-start-school-year>

K. *Facilities Internships.* Penn's Division of Facilities and Real Estate Services has been accepting summer interns since the early 2000s, as part of its mission to integrate Penn's academic mission into the planning, design, and operations of campus. Over the last five years, the Division has employed an average of 20 Penn student interns per year, with five working specifically in the Sustainability Office on campus environmental improvements.

The students are afforded real-world learning opportunities, working alongside experienced professionals in the fields of architecture, sustainability, planning, landscape architecture, construction management, space planning and documentation, graphic design, information technology, and all the building trades. In the summer of 2017, interns were placed in each of the following positions.

- City Code and Permitting
- Summer Turnaround (Housekeeping & Operations)
- Pennovation Market Survey
- Lean Workflow Process (Trades)
- Energy Engineering (O & M)
- Ecosystem Landscape Services
- Human Resources
- Project Management & Closeout
- Lock Shop Data Transfer Assistant
- Penn Garden Student Manager
- Engineering Support (Building Systems Analysis)
- Housekeeping Lean Process
- Operations Control Center (Energy Management and Fault Detection)
- Graphic Design
- Facility Condition Database Coordinator
- Stormwater Management
- Special Projects Assistant Manager
- Sustainability Communications
- Waste Minimization & Campus Engagement
- Penn Tririga Data and Drawing Load
- Assistant Trades and Utility
- Plant Explorer (Landscape Management)
- Safety Assistant
- Accounting Co-op
- Penn Park Orchard
- Sustainability Outreach
- Move In Coordination

L. *Staff & Faculty Eco-Reps.* The Staff & Faculty Eco-Reps programs cater to self-selecting members of the Penn community who wish to learn more about campus environmental issues and serve as peer mentors on sustainability. The Eco-Reps engage with extensive educational programs and events, with the intent to enable them to make a difference in their offices, labs, and classrooms at Penn.

M. Penn's *Green Office Certification* has been adopted by over 120 offices in fifteen Schools and Centers. As part of the certification, offices receive training in best sustainability practices for purchasing, waste minimization, and energy conservation as part of an introduction to Penn's *Climate Action Plan*. The certification is good for two years, after which recertification is required. The current certifications of 94 offices represent over 1600 staff at Penn who have received training in sustainable operations.

For a full listing of offices, see the chart below, and for more information, see <https://www.sustainability.upenn.edu/participate/staff-and-faculty/green-office-program>

Participating School / Center	Total Number of Green Offices	Number of people in office
Schools		
Annenberg	2	80
Dental	0	0
Design	0	0
Law	14	126
Nursing	17	115
PSOM	1	45
SAS	11	200
SEAS	10	103
SP2	0	0
Wharton	4	50
Vet	0	0
Centers		
Alumni Relations	1	80
EVP	19	627
President's Center	3	33
Office of the Provost	12	194
Total	94	1653