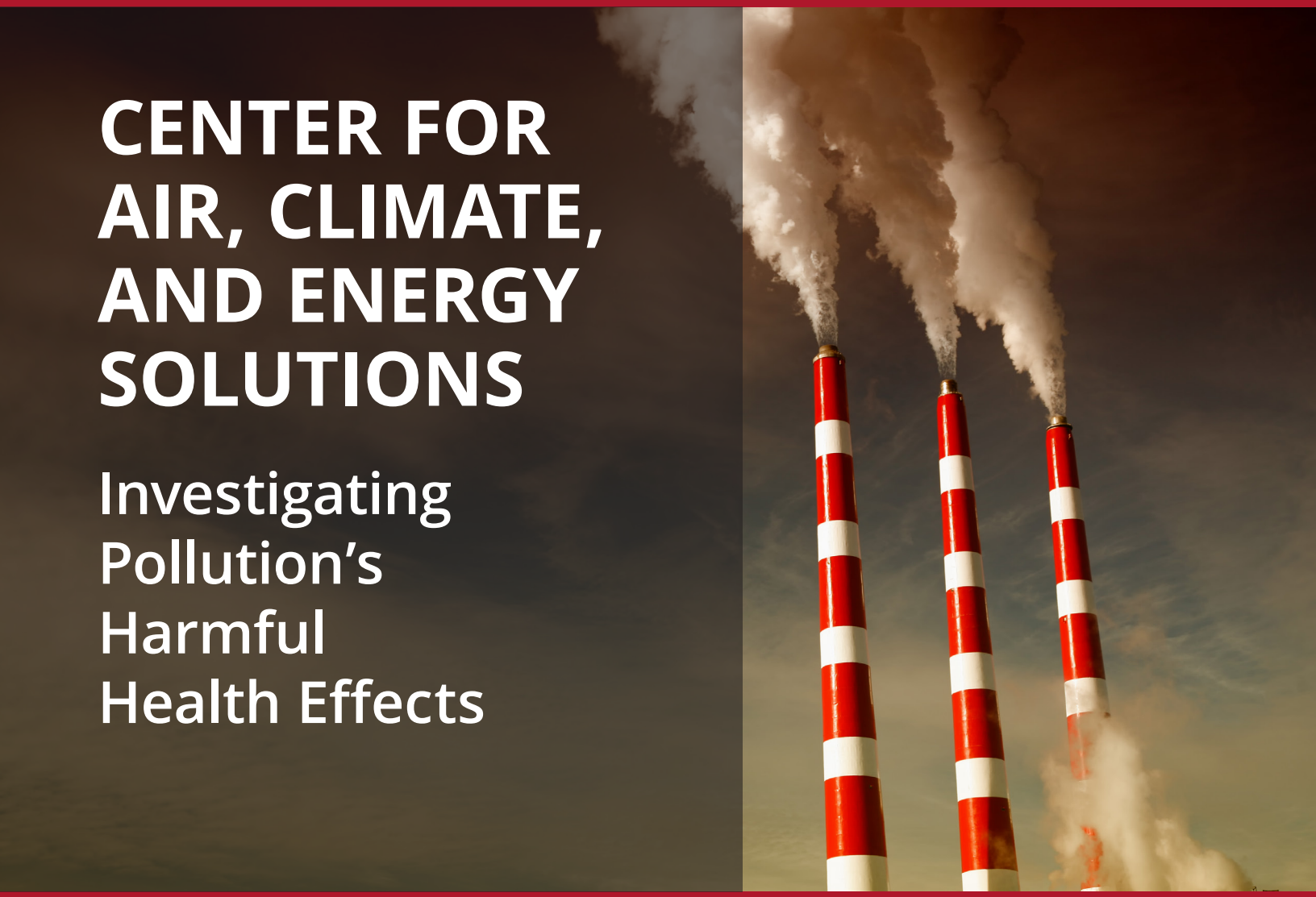
Carnegie Mellon University

CEE NEWS

CMU.EDU/CEE

SUMMER 2017



CENTER FOR AIR, CLIMATE, AND ENERGY SOLUTIONS

Investigating Pollution's Harmful Health Effects

Carnegie Mellon University
Civil and Environmental Engineering

CEE NEWS
Summer 2017

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SOMETHING TO SHARE?
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Please email your news to mmobley@andrew.cmu.edu

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Dear Alumni and Friends,

Research is critical to advancement of the missions of civil and environmental engineering: provision and management of sustainable infrastructure for people and communities, enhancement of quality of life, protection of public health, and protection of the natural resources on which society depends. The research that we conduct in CEE at Carnegie Mellon is motivated by a strong desire to contribute to advancing these missions, and our field.

Our cover story focuses on a large new research center in the College of Engineering, sponsored by the U.S. Environmental Protection Agency, in which Professor **Peter Adams** has a key role, and other CEE faculty members and students are involved: the Center for Air, Climate and Energy Solutions (CACES). Research being conducted in CACES is oriented toward protection of human health. Project areas include measurement of air pollutant concentrations regionally and across the country to protect and improve the health of vulnerable populations; development of tools for scientists, policy makers, and citizens to evaluate the health impacts and social costs of air pollution; and evaluation of the impact of future scenarios for electricity, transportation, and urban development on air quality and human health.

CEE research in mechanics of materials, led by Professors **Amit Acharya** and **Kaushik Dayal**, has yielded important contributions in bridging from atomic to macro scale in regard to material properties and behavior. An overview of the research of recent PhD graduate **Chiqun Zhang**, who was supervised by Professor Acharya, is provided in this issue. Zhang developed mathematical models that predict the influence of defects in crystals on material behavior, providing capabilities that will aid material manufacturing.

Another research contribution highlighted in this issue is the CMU Power Sector Carbon Index developed by Professor **Costa Samaras** and EPP Professor **Inês Azevedo**. The index tracks the CO_2 emissions of the U.S. power sector, as well as the total electricity generated from coal, natural gas, nuclear, and renewables, with data going back to 2001. The index has rapidly gained a large following.

Carnegie Mellon is celebrating Anniversary Weekend at Homecoming, November 10-12. There are special events celebrating the founders who have built the legacy of the university and those who will lead our future. Information about the inspiring weekend program is available at cmu.edu. The CEE Alumni Advisory Council will be meeting on November 10; we look forward to welcoming the council members back to their CEE home.

The faculty, students and staff of CEE thank all of our loyal and generous alumni who support the Department in so many and much appreciated ways. We send our best wishes to all of you.

Dave Dzombak
Hamerschlag University Professor
CEE Department Head

CEE FAST FACTS

2018 RANKINGS

CIVIL
UG 12 // GRAD 10

ENVIRONMENTAL
UG 8 // GRAD 8

Source: U.S. News & World Report

44% of CEE students are women

59% Undergrad Women
39% Graduate Women

OUR FACULTY

14 Full Professors
4 Associate Professors
6 Assistant Professors

5 National Academy of Engineering Members
3 Active
2 Emeritus

AY 2017-18

Bachelors Students	96
Masters Students	197
Doctoral Students	78

$5.89M
Total Annual Externally Sponsored Research

3 FACULTY WITH ACTIVE NSF CAREER AWARDS

EDUCATION & RESEARCH AREAS

Advanced Infrastructure Systems (AIS)
- Smart / Connected Cities
- Intelligent Transportation Systems
- Information & Communications Technologies
- Building Energy Management
- Structural Health Monitoring

Environmental Engineering Sustainability & Science (EESS)
- Air and Water Quality
- Climate Change Adaptation for Infrastructure
- Sustainable Design
- Remediation
- Urban Water Systems
- Energy and the Environment
- Environmental Nanotechnology

Mechanics, Materials and Computing (MMC)
- Modeling & Computer Simulation of Complex Physical Systems & Phenomena
- Practical Application of the Emergent Complex Behavior of Materials
- Design of New, Resilient Materials & Structures

INSIDE THIS ISSUE

Feature Stories

Center for Air, Climate, and Energy Solutions

Investigating Pollution's Harmful Health Effects

Decreased lung function, heart attacks, and even death—air pollution can have serious health impacts. CEE PhD student Marguerite Marks has firsthand experience with health issues linked to air pollution. While Marks was pursuing her PhD, her new baby developed a virus-induced asthma called bronchiolitis; an ailment that can be exacerbated by air pollution.

"Not only is it hard to watch your child struggling to breathe, but, over the past two years, I've spent five nights in the hospital, with multiple doctors' visits and medications. He's fine now, but kids with severe asthma whose parents have to do that all of the time, that's a really big toll both emotionally and economically," says Marks, who hopes her current work with the Center for Air, Climate, and Energy Solutions (CACES) will help illuminate the effects of air pollution.

Founded in 2016 with $10 million in funding from the Environmental Protection Agency (EPA), CACES is a five-year collaborative research center at Carnegie Mellon University with a focus on the impacts of air pollution, technology, climate change, and related policies on local air quality and health. Within Carnegie Mellon alone, the students and faculty in CACES represent six departments, including CEE, and over a dozen faculty from outside institutions are involved.

CEE Professor **Peter Adams** is a principal investigator with CACES, and has been involved with the center from its start. "The goal of CACES is to give decision makers better tools to think about energy systems, energy transitions, climate, and health implications, so that they can look at everything holistically and make smarter decisions for the benefit of society," he explains.

Understanding Past Health Impacts

Working with Adams at CACES, Marks is modeling the historical levels of a type of particulate matter called PM2.5, so named for having a diameter of 2.5 microns or less.

While PM2.5 is known to be harmful to our health, few measurements of PM2.5 in the United States were made before 1997, when the EPA first regulated it. Without that data, researchers have struggled to fully assess the health effects of PM2.5.

Marks is working to fill in that data gap back through the 1980s. After Marks prepares and inputs the historical meteorology and emissions data she's collected from the EPA and other sources, she develops estimates for PM2.5 as well as other gaseous pollutants over the specified time period.

"There's a much better history of measuring gaseous pollutants, like NO_2, ozone, and SO_2, so we have several means to test the model's validity for the 1980s," explains Marks. "We can also spot check using some scattered PM measurements that were done at universities in those earlier years."

Once Marks has confirmed the accuracy of the model's estimates, epidemiologists in CACES will analyze her data alongside extensive national health data to improve understanding of the impact of varying PM2.5 exposure levels and compositions on the US population.

"We're certain that it's bad to breathe in pollution, but there are many nuances that are less well understood," she says. "If you're exposed when you're a kid, is that worse long term than if you are exposed as young adult? Or is it worse if there are multipollutant mixtures like ozone in addition to PM and NO_2? Does the pollution source matter? Is it worse to live near a freeway than a factory? We don't know. Combining the detailed health data with comprehensive air-quality data will let us dig into those questions."

tell you, if you emit air pollution here, here, and here, or if you switch from coal to natural gas, or if you replace dirty Pittsburgh diesel buses with modern diesel buses or something even cleaner, what does that do? How many lives does it save? Is it worth the investment? Those are the kind of questions that we want to answer," says Adams.

Currently, the EPA and other researchers study air pollution and health impacts with tools called chemical transport models, or CTMs, typically modeling 12- or 36-km blocks of the country at a time. In CACES, Adams and his team are working to make their models accurate at the 1-km scale.

The goal of CACES is to give decision makers better tools to think about energy systems, energy transitions, climate, and health implications, so that they can look at everything holistically and make smarter decisions

Improving Physical Air-Quality Modeling

While Marks prepares her models, Adams is also working with two Engineering and Public Policy students—**Shayak Sengupta** and **Pablo Garcia**—to develop sophisticated air-quality models that will provide more localized and detailed pollution information than has ever been available.

With these models, organizations will be able to understand better the social costs and benefits, including health impacts, of policy and technology changes.

"There aren't ready-made tools that

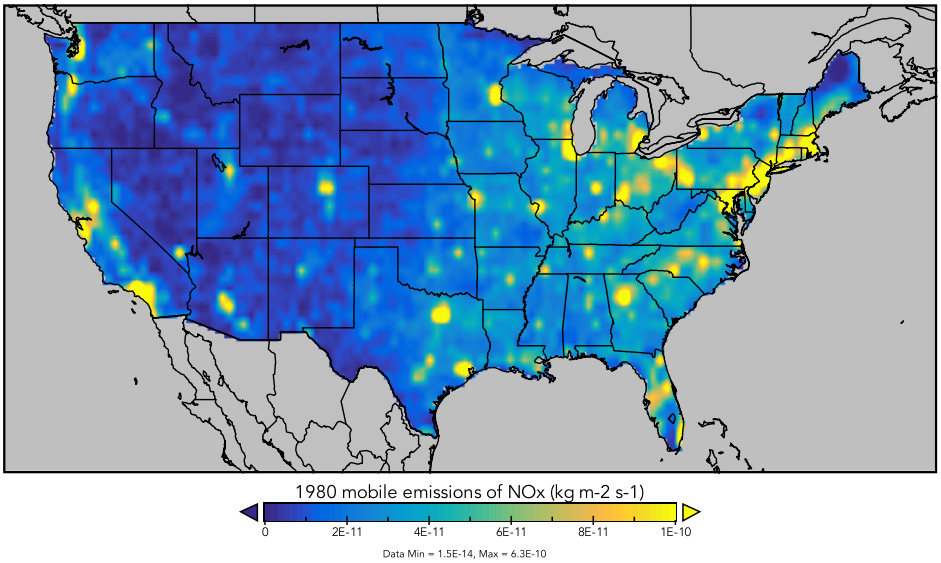
At this scale, Adams and his students expect to uncover localized, potentially harmful differences in air pollution level and composition that would otherwise go overlooked. With 1-km models, they can also see how decisions impact each individual neighborhood—including areas along bus routes or major roadways—and consider questions of environmental justice to determine whether minority groups or people with low socioeconomic status are exposed to higher air pollution levels.

To prepare these models, researchers use meteorology data and emissions estimates from dozens of manmade and natural sources, including plants, cars, restaurants, power plants, and more. Creating a model with a

spatial resolution as high as 1-km requires collecting and estimating this emissions information in great detail across all times of day, days of week, and seasons.

Even at low spatial resolution, CTMs are difficult and time-consuming, and few organizations outside the EPA have the resources or expertise to run them. In particular, state organizations have few tools for deciding how to meet federal regulations—and when those regulations aren't met, the health of state residents is in danger. That's why Adams and his team inside CACES are also building reduced complexity models that are much faster and simpler to use.

Land transportation sector emissions of nitric oxides (NOx as NO)



Estimated level of NOx emitted from traffic in 1980 (source: M. Marks)

Developed by Adams, Estimating Air-pollution Social Impact Using Regression (EASIUR) is one such reduced complexity model that can quickly estimate health damages based on the amount of specified pollutant emitted in a certain location. Closely derived from the gold-standard CTMs, EASIUR gives states, cities, and private organizations the power not only to test individual proposals, but also to compare multiple scenarios for improving air quality, giving them clear, defensible answers on the health impacts of various technologies and policies.

"Even at the EPA level, instead of evaluating one or two potential decisions, they could look at a whole suite of options and then home in on the ones that seem most promising," adds Adams.

To ensure accuracy, the estimates from all models run by Adams and his team will be evaluated against real air-quality measurements taken by another CACES team. That team is measuring air quality across three test cities, including Pittsburgh, driving around to capture and map data at different times in different neighborhoods as well as placing sensors throughout each city.

Exploring Future Energy Scenarios

In addition to air-quality modeling, Adams is assisting with another CACES project, one focused on assessing future scenarios and policies using the new data and tools from CACES.

"This is where we take these tools on a test drive. It's a way to show that we can pull all of this together into a meaningful analysis of future energy scenarios and transitions," says Adams, who is advising Engineering and Public Policy PhD student **Michael Roth** on his work in CACES.

Roth's goal is to model what the US energy sector and emissions will look like by 2050 under three possible scenarios: a carbon tax, an air pollution tax, and legislation regulating both of those things.

Learn More: The Center for Air, Climate, and Energy Solutions is a collaborative research center at Carnegie Mellon University created through a partnership with the Environmental Protection Agency.

Issues like shale gas development, electric car subsidies, and power plants of the future raise air and climate questions that require integrated thinking. The new Center is bringing together experts to arrive at the best decisions.

bit.ly/learn-more-CACES

"We'll be seeing how social welfare changes under different types of regulations. We want to know if anything can be gained from regulating air pollution emissions and greenhouse gas emissions together or if perhaps they should be treated separately," explains Roth, who will also investigate the possible value of regional and local regulations, and the ways in which having regional air pollution policies might change the national energy system.

Collaboration at the Center of Everything

While regulations and new technology in recent decades have spurred dramatic improvements in US air quality and associated health, nearly 80,000 premature deaths nationwide are still attributed to air pollution every year, and everyone inside CACES realizes there's a lot riding on their work.

To complete each project, constant collaboration is required. "CACES is a unique and interesting place to work because it's so interdisciplinary. It brings together different fields, and it's right in the name—air quality, climate, and energy—it's this nexus of really crucial things right now," says Marks, who knows the epidemiologists are counting on her data. In turn, the results of the epidemiology studies will help CACES researchers more accurately model the health impacts of energy decisions.

As these diverse subject matter experts build tools that will guide decisions about the future of our country and planet, everyone is counting on each other. "CACES is so far from the cliché of a lone scientist working at a lab," says Garcia, who is on the modeling project with Adams. "This way of working is what I have always wanted science to be; a collective enterprise of knowledge building and sharing. I believe the work from CACES is going to have a huge impact on air-quality science and policy for decades."

Looking Back at 20th Century Air Pollution

"We have made a lot of progress, but there are all these facets that still need to be understood about the history and effects of the Clean Air Act," reflects CEE PhD student **Marguerite Marks**, whose focus is on historical air-quality modeling.

Pittsburgh has come a long way from its past as a city of smog. In fact, in 1948, one of the country's worst pollution disasters occurred only 25 miles outside the city, when a five-day smog killed 20 people, sickened 7,000, and left lasting effects on citizen health in Donora, PA. This accelerated efforts in Pittsburgh and other communitiies to improve air-quality.

The Clean Air Act, introduced in 1970, along with later regulations, helped lower emissions from sources like cars and power plants. By 1987, the EPA started regulating particulate matter with a diameter of 10 microns, and within a decade, it revised the cutoff to a diameter of 2.5, with regulations that are still in place.

"They used to figure you could just measure total particulates in the atmosphere," explains Marks. "Only over the last 20 or 30 years have we grown increasingly certain that the harmful effects of air pollution are mostly caused by the smallest bits of particulate matter. It's still a young field with much left to learn."

Downtown Pittsburgh in the 1930s.

Calculating Behavior: CEE Student Builds Mathematical Models to Inform Material Design

Designing new materials is a complicated business, explains **Chiqun Zhang**. He would know—he's spent most of the last five years studying material defects, modeling, and behavior at Carnegie Mellon, earning both a master's degree and a PhD in the Civil & Environmental Engineering Department, as well as a second master's degree in computer science.

For his PhD, Zhang worked closely with CEE Professor **Amit Acharya**, utilizing both his computing and his engineering knowledge to develop mathematical models that predict the influence of topological line defects in solid and liquid crystal on material behavior.

Chiqun Zhang

While an ideal crystal has a perfect lattice throughout its structure, most crystal lattices actually have imperfections that cause stress fields in the materials. These stress fields then interact with other defects in the crystal structure and ultimately change important material properties like strength and ductility (the ability to be stretched without fracturing).

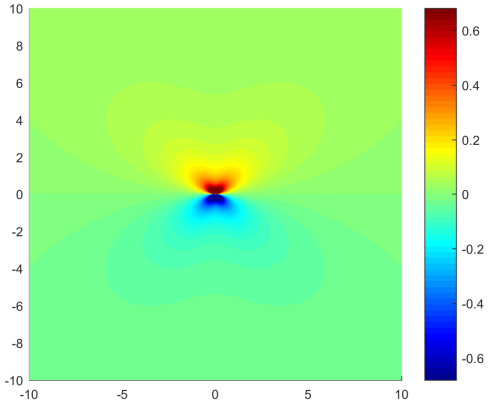
"Understanding stress fields and defect dynamics is especially significant in the material manufacturing industry," explains Zhang. "For example, we want to create alloys for building cars and planes that will have high strength and high ductility, so that the alloy can be shaped without cracking. We also want to optimize liquid crystal to have a long lifetime and good optical properties for displays and biological systems."

Determining how to best create and refine such materials, however, requires using models to predict the material's structure and properties. Unfortunately, with many types of intricate crystalline defect microstructures in existence, researchers have not yet developed a complete theory or model for predicting material behavior under all specified conditions or stresses.

Working with Professor Acharya, Zhang developed theories and models that will help researchers to understand material behaviors specifically related to the reach and impact of disclination defects.

"During the past five years, my advisor and I have extended the generalized disclination theory and applied it to solve defect problems at various grain boundaries and phase boundaries," says Zhang. "Our model as well as our simulations underscore the complementary importance of topology, geometry, and energetics in understanding defect mechanics."

The generalized disclination theory solves the statics and dynamics of line defects involving distortion



Rendering of a dislocation stress field

discontinuity and is critical for studying grain and phase boundaries. Because this theory is used to predict stress and deformation fields of material with these defects, it's particularly valuable for understanding a material's strength for manufacturing and use.

Having completed his PhD in September 2017, Zhang now works at Verdigris as a data scientist, applying machine-learning techniques and numerical analysis for designing smart buildings.

"My current work uses my knowledge from both my master's degrees and my skills in mathematical modeling and numerical simulation that I developed during my PhD," says Zhang, who adds, "CMU prepared me very well for my career. They equipped me with the ability to manage my time and workload and the ability to adapt to any challenges I might face in my future."

2017 COMMENCEMENT

ASCE Outstanding Civil Engineering Student Award
Ahmad Khanzada

H. A. Thomas, Sr. Distinguished Service Award
Stephanie Tjan and Nikita Sharma

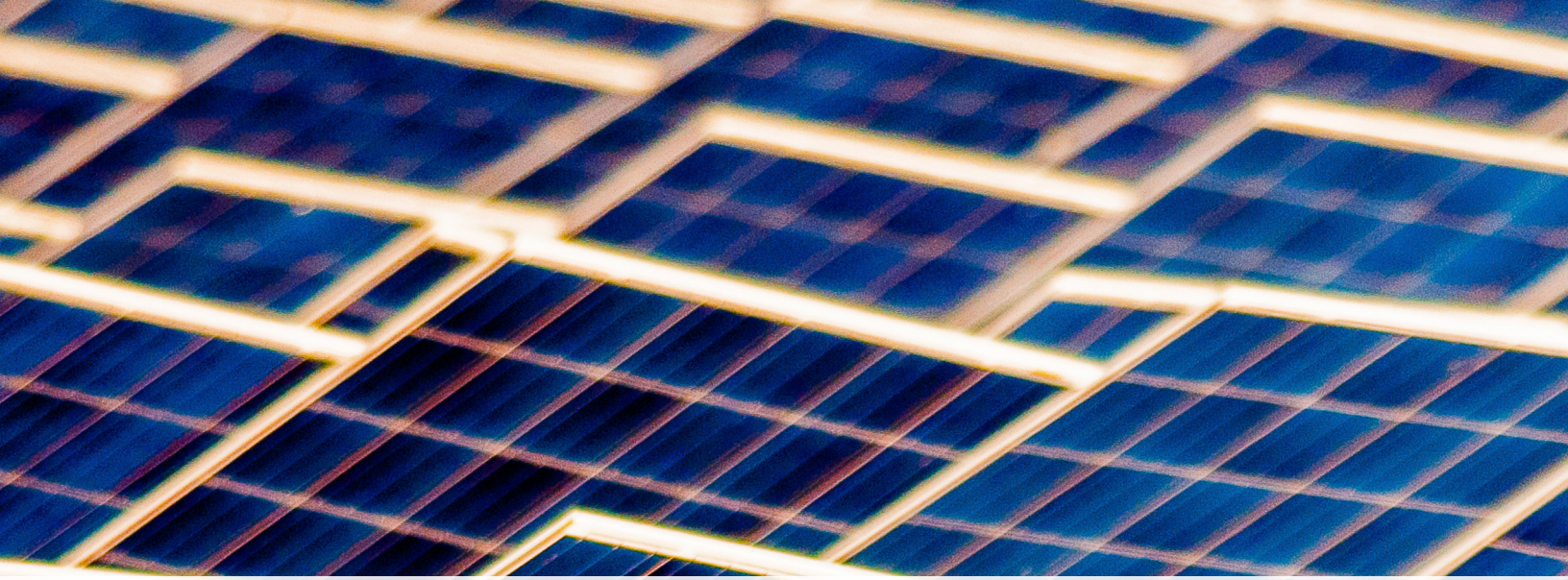
H. A. Thomas, Sr. Scholarship Award
Jun Yi Edmund Lee

James P. Romualdi Civil and Environmental Engineering Award
Johnny Mascaro and Maskana Adedjouman

Outstanding Teaching Assistant Award
Juan Tzoc

Paul P. Christiano Distinguished Service Award
Tania Lopez

Mao Yisheng Outstanding Dissertation Award
Carl Malings



CMU Power Sector Carbon Index

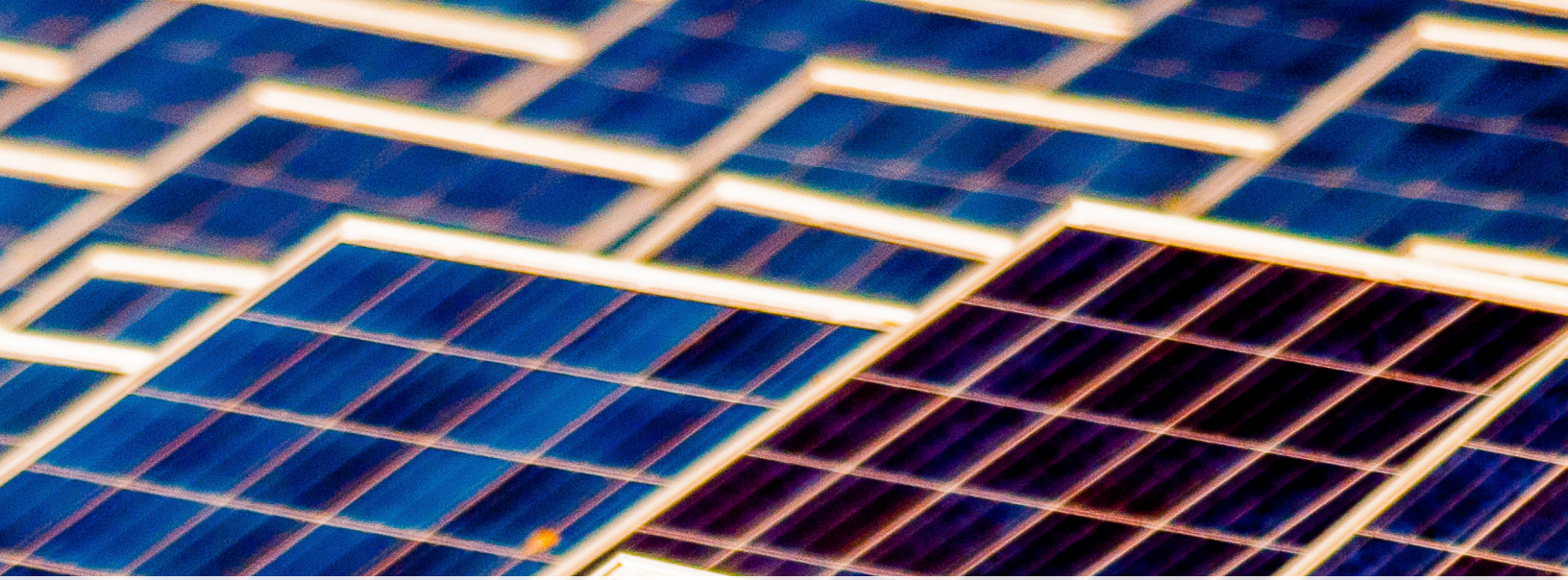
"The public is increasingly concerned about climate change, and they want to be able to do something about it. The index lets them know how the country is doing over time and helps them to understand some of the contributing factors to the climate."

From 2005 to 2017, the CO_2 emissions intensity from US electricity production has decreased nearly 24%, according to the latest update of the Carnegie Mellon Power Sector Carbon Index.

Yet before index co-creators CEE Assistant Professor **Costa Samaras** and Engineering and Public Policy Professor **Inês Azevedo** launched the index earlier this year, such timely insights into CO_2 emissions not only were difficult to obtain, but required time-consuming study and expert analysis.

Automating much of the data collection and analysis, their index now serves as a valuable, transparent resource for tracking the US power sector's CO_2 emissions as well as the total electricity generated from coal, natural gas, nuclear, and renewables, with data going back as far as 2001. Using this information, the index reports on emissions intensity, the ratio between total emissions resulting from electricity production and the total electricity produced in a set period.

Overall, the results appear positive. The impressive 24% CO_2 decline from peak 2005 emissions has been aided by the rise of renewable energy, with renewables accounting for 19% of



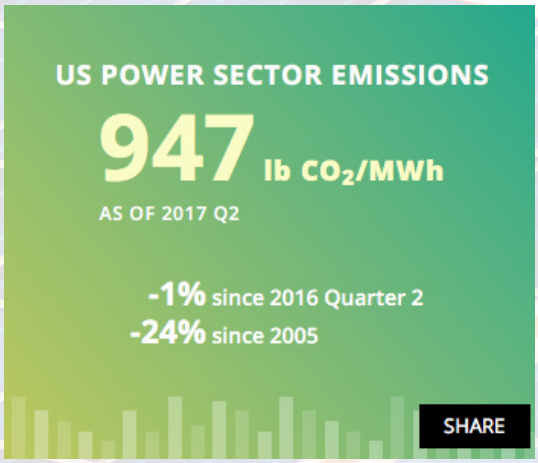
electricity generated in the first three months of 2017. An even bigger driver behind the lowered carbon emissions intensity has been an increased usage of natural gas, with 2016 being the first year in which the US generated more electricity from natural gas than coal.

Yet, from October 2016 to March 2017, coal has grown to again take the lead as our primary electricity source, resulting in carbon emissions intensity increasing slightly over this period. As coal and natural gas prices fluctuate and remain in direct competition, which energy source will win out in the long term remains to be seen, with CMU's index allowing careful observation of any trends that take shape.

Published through the Scott Institute for Energy Innovation and supported by Mitsubishi Hitachi Power Systems, the index has benefits that extend far beyond the CMU community. For policy makers and regulators, having a current understanding of the power sector's contribution to climate change and their de-carbonization progress can enable improved decision-making.

Likewise, utility companies can use the index to compare their CO_2 reductions with national trends—and Samaras and Azevedo expect the index to soon incorporate regional data as well.

"With every update we post, new insights arise that are of high relevance to the nation's energy leaders and policy makers, enabling them to assess the level of effort still needed for deep de-carbonization activities in a timely manner," says Azevedo, who also notes that the index will highlight the consequences of various changes in energy markets and policies.



The Power Sector Carbon Index provides an estimate of the carbon dioxide (CO2) intensity of the US power sector using publicly available data sources. Carbon intensity is measured in pounds of CO2 per Megawatt-hour (MWh) of electricity.

To learn more about this tool, visit: emissionsindex.org

"Even everyday citizens can find value in the index," says Samaras. "The public is increasingly concerned about climate change, and they want to be able to do something about it. The index lets them know how the country is doing over time and helps them to understand some of the contributing factors to the climate."

To maximize the impact of the index, the underlying code, figures, and data are all available for download and public use at emissionsindex.org.

"Having these pieces out in the open is essential for the future of energy analysis, so that other people can build on this work that we started," Samaras says. "For us alone to become experts on carbon emissions doesn't help anybody. That wouldn't advance knowledge or impact climate change, but we believe this index will. Those are the most important goals of our work."

FACULTY NEWS

SARAH CHRISTIAN

Assistant Teaching Professor

Wimmer Faculty Fellowship

Eberly Center

Sarah Christian was recently selected as one of five 2017- 2018 Wimmer Faculty Fellows at the Eberly Center for Teaching Excellence and Educational Innovation.

Christian will redesign the junior-level core course, Materials Lab, by developing laboratory experiences to encourage students to "think like engineers" by making them more open-ended and inquiry-based. She will also create a rubric to measure the extent to which this approach enhances students' comprehension of fundamental concepts and ability to apply them to real-world engineering problems encountered in the field.

MITCHELL SMALL

Heinz Professor

Barbara Lazarus Award

CMU

Mitchell Small was awarded the Barabara Lazarus Award at the CMU Celebration of Education event, which celebrates Carnegie Mellon's distinguished faculty members and educators for their outstanding contributions to the university and their devotion to and effectiveness in teaching.

The Barbara Lazarus award is named after a beloved member of the Carnegie Mellon community and celebrates those who foster an inviting and nurturing environment for graduate students and young faculty at the university.

During his 34-year career at CMU, Small has served as the associate department head for graduate education in Engineering & Public Policy (1992-2015).

Among his many awards and accomplishments, Small is an elected fellow of the Society for Risk Analysis and received its Distinguished Educator Award in 2013. He was the first recipient of the CMU College of Engineering Faculty Outstanding Mentoring Award in 2016.

JEANNE VANBRIESEN

Duquesne Light Professor

Professor **Jeanne VanBriesen** has joined a nine-member task force that will will review lead sources, risks and data; assess the impact of universal lead screening; and make recommendations to help with the prevention of lead exposure in the Western Pennsylvania region.

Faculty Awarded SEED Grants

Three CEE faculty members were named as 2017 recipients of the Scott Institute's annual Seed Grants for Energy Research, which support CMU faculty research in the areas of energy, environment, and policy.

CEE Professor **Constantine Samaras** with Professors Jeremy Michalek (MechE and EPP) and Inês Azevedo (EPP) will examine the impact of autonomous taxis and shared mobility services such as Uber and Lyft on energy consumption, vehicle use, and greenhouse gas and criteria air pollutant emissions.

Professors **Athanasios Karamalidis** (CEE) and Newell Washburn (CHEM) will conduct research necessary to develop a continuously operating, small-scale field-ready separation system that can be deployed at sites that produce waste water—such as gas operations, geothermal utilities, coal power plant effluents, and more—and extract rare-earth elements from the water produced. These elements are necessary for the development of green energy technologies.

Professors **Meagan Mauter** (CEE and EPP) and Jay Whitacre (EPP) will create a Concurrent Assessment and Design of Systems (CADS) platform for assessment of the complex intersections between policy, technology, and human responses to system perturbation in climate change mitigation and adaptation.

CMU signs MOU on Smart Infrastructure

Representatives from Carnegie Mellon's College of Engineering, including Dean **James Garrett**, CEE professor and head, **Dave Dzombak**, and CEE professors **Mario Berges** and **Pine Liu** traveled in early September to the City of Chengdu, Sichuan Province, China, as part of a delegation to sign a Memorandum of Understanding (MOU) for the establishment of a smart cities research partnership with the Chengdu High-Tech Development Zone (CDHT) and The Lab Ventures, LLC.

The next step is to develop a formal, five-year agreement, focused on applied research and validation of existing research by the Smart Infrastructure Institute of Carnegie Mellon (SII), in collaboration with CDHT and The Lab Ventures. The MOU documents the intent to develop research and educational cooperation between the CDHT, The Lab Ventures, and the SII.

The MOU is a preliminary step in this effort, with all parties agreeing to begin discussions of potential future collaborations on: research in smart infrastructure technology and systems; engagement with universities for technology programs, short-term executive programs, seminars, and symposia; research facilities in Chengdu and/or Pittsburgh; commercialization of research findings and technologies in Singapore-Sichuan Hi-Tech Innovation Park (SSCIP); and management of intellectual property rights and publications resulting from joint research activities.

Honoring Dr. Mao

In July CEE hosted 25 Chinese high school students and their teacher chaperones on campus. The visit was sponsored by the Mao Yisheng Foundation; a representative accompanied the group. The students held a ceremony honoring Dr. Mao at the statue outside of Baker Hall. Dr. Mao was the first PhD graduate ever from Carnegie Mellon (Carnegie Tech), in 1921, in Civil Engineering.

STUDENT NEWS

NYLA KHAN
Masters Student

Best Poster
Annual Shale Gas Innovation Contest

Nyla Khan and her research team were recently awarded a Best Poster prize at the 6th Annual Shale Gas Innovation Contest.

Khan's poster, "Cold Energy Recovery from LNG Regasification," discussed the comparison between regasification solutions and their impact on savings and recovery. The team focused on the cold energy that is lost to a heat sink when liquefied natural gas (LNG) is regasified to natural gas at the receiving terminal.

The team compared two different thermodynamic cycle technologies for recovering LNG regasification cold energy, the Direct Expansion Cycle (DEC) and the Combined Cycle and found that the amount of LNG regasified has the highest impact on saving, and that DEC is optimum for small-scale recovery while the Combined Cycle is better for large -scale recovery.

TESSA WEEDEN
Undergraduate Student

Tessa Weeden attended a Graduate Application and Fellowship Boot Camp at Duke University. This competitive program gives undergraduates an opportunity to explore various options for graduate study as well as how varied engineering research can be.

"The trip really opened my eyes to the possibility of grad school, which I wasn't considering beforehand," says Weeden. "I still have not decided what I want to do once I graduate, but it's comforting to know that even if I decided to enter industry for biomedical engineering or become a practicing civil engineer, the opportunity to get a PhD never goes away. I think it's important to realize the value in different career paths and this workshop helped me to understand that better."

Recent PhD Theses

BANDAR ALMUTAIRI - *Statistical Models for Characterizing and Reducing Uncertainty in Seasonal Rainfall Pattern Forecasts to Inform Decision Making* - Advisor: Small

XIAOJU CHEN - *Uncertainty Estimation in Matrix-Based Life Cycle Assessment Models* - Advisor: Matthews

YIMING GU - *Bayesian-Based Traffic State Estimation in Large-Scale Networks Using Big Data* - Advisor: Qian

COREY HARPER - *Transitioning to a Connected and Automated Vehicle Environment: Opportunities for Improving Transportation* - Advisors: Hendrickson, Samaras

CARL MALINGS - *Optimal Sensor Placement for Infrastructure System Monitoring Using Probabilistic Graphical Models and Value of Information* - Advisor: Pozzi

JEFFERY SONG - *Making Sense of the Noise: Statistical Analysis of Environmental DNA Sampling for Invasive Asian Carp Monitoring Near the Great Lakes* - Advisor: Small

CEE Professor and Department Head Dave Dzombak with students at the College of Engineering Honors Convocation in May.

Pictured (left to right): Shyama Sadashiv, John Mascaro, Stephanie Tjan, Ahmad Khanzada, Julie Kim, Maskana Adedjouman, Dave Dzombak, Carol Qu, and Edmund Lee

Drew DeLong in front of Washington Monument

CEE Undergrads Land Political Internships in DC

The change of any political administration is prone to much discussion and debate—when a government changes hands, many of its inner workings are revealed and scrutinized in great detail. What better time could there be, for an intern in the Washington DC, political sphere, to gain practical experience than at the change of an administration?

Two CEE undergraduates recently had the opportunity to utilize their engineering skills in this uniquely significant political setting. Seniors **Drew DeLong** and **Tyler Kohman** received internships in Washington DC during the Spring 2017 semester. These internships were established through Carnegie Mellon University's Washington Semester Program offered by the Dietrich College.

Kohman, who is double majoring in engineering and public policy (EPP), spent the first half of his internship with the House Committee on Transportation and Infrastructure (T&I), and spent the second half of his internship working directly with Congressman Bill Shuster of Pennsylvania's 9th District, the chairman of the T&I Committee. While Kohman was with the committee, he designed analytical tools to compile committee records, photographed congressional hearings, and attended hearings and briefings for research on subjects such as the Federal Aviation Administration (FAA) modernization, supersonic flight, autonomous vehicle implementation, and other infrastructure funding methods and policy.

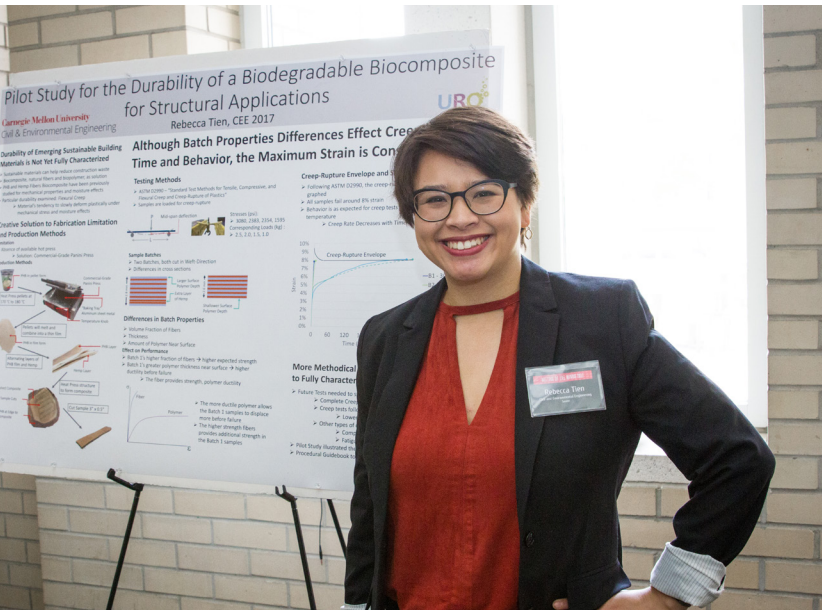
"My career ambitions are to work on the qualitative side of engineering," says Kohman, "specifically on integrating emerging transportation technologies into existing infrastructure and developing policy that creates a safe, efficient, and seamless environment for all modes of transportation."

DeLong's internship took place in the office of Paul Ryan, the speaker of the U.S. House of Representatives, which is located within the Capitol Building itself. DeLong spent much of his internship attending congressional hearings on technical topics such as infrastructure and clean water technology, as well as giving guest speakers tours of the Capitol Building. DeLong notes that he was able to attend some significant events during his internship: for example, he was working in the Capitol Building the night of the State of the Union address, and he was able to attend the second hearing of former FBI Director James Comey.

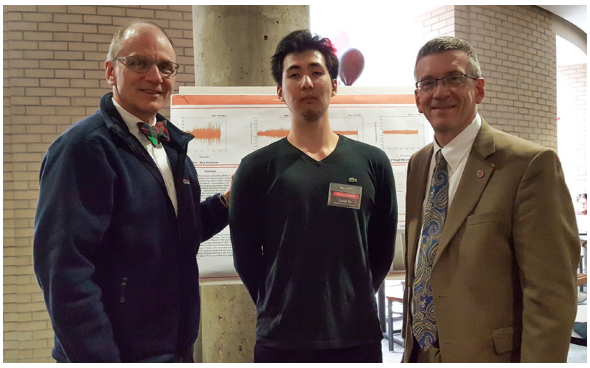
"The number one thing that having a CEE undergrad in that space gives, is a strong foundation into the policy," says DeLong. "Having an undergraduate in civil engineering really provided a strong foundation and insight into the basic principles of what goes into the types of infrastructure projects they spoke about. You have a different foundation going into the Hill, and working on the Hill, having a civil engineering degree: a very logical, structured undergraduate experience fueled by what we learn at Carnegie Mellon—the problems, the tests, the design classes—and how you approach problems."

Tyler Kohman behind podium at the Pentagon

Both DeLong's and Kohman's experiences in Washington DC were so positive that they decided to continue their involvement in politics. Kohman has teamed up with Congressman Bruce Westerman of Arkansas's 4th District to create a new internship program designed to recruit more engineers to Capitol Hill, and DeLong hopes to return to Washington for additional internships in the future.



Rebecca Tien



Dave Dzombak, Daniel Ha, and Dean James Garrett

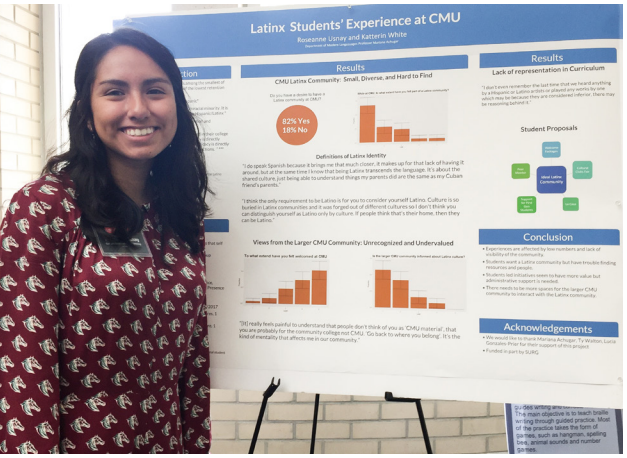
CEE at the 2017 Meeting of the Minds

As the Spring 2017 semester came to an end, three CEE students presented their research at the annual Meeting of the Minds, a university-wide research symposium sponsored by the Undergraduate Research Office.

Durable Biodegradable Construction Materials

Rebecca Tien (pictured above), advised by CEE Professor **Sarah Christian**, presented her research on a biodegradable biocomposite, which is an alternative to traditional construction materials. This alternative would combat the issues behind traditional construction materials that are nonrenewable (or slowly renewable) and generate millions of tons of construction waste that fill US landfills.

"The durability research of the biocomposite is essential to understanding its feasibility in structural applications," explains Tien. "My research into the pilot study provided an amazing experience in learning fabrication and creative problem solving. I loved every moment of it!"



Roseanne Usnay

Designing a Consumer-Grade Acoustic Dampening System

Daniel Ha worked with Professor **Petrus Pistorius** (Materials Science and Engineering) to design and develop a portable and affordable acoustic dampening system.

By using data collected from testing various sound-dampening materials using sensors, Ha used MATLAB to design a soundproofing system that would appeal to consumer-level customers for in-home use. He then built and tested the system.

Connecting Cultural Experiences on Campus

Roseanne Usnay explored ways to strengthen cultural visibility of minority groups among campuses. Her project, advised by Modern Languages Professor **Mariana Achugar**, aimed to explore the experiences of Latinx students, who make up 7.1% of the undergraduate population.

Her project included execution of surveys to explore the academic, emotional, and social experiences of the CMU undergraduate Latinx community. Based on what Usnay and her research partner found, they will look for opportunities to raise the visibility and engagement of the Latinx community at CMU.

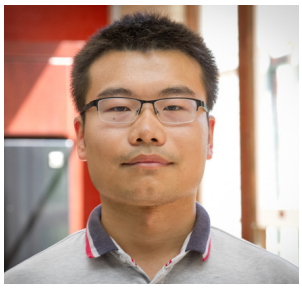
In Their Words: Summer Internships

MENGXI TAN - Masters Student
Greenpeace East Asia - Detox Campaign - Water Team

"I think the whole experience was very eye-opening and challenging. I had never worked a manufacturing job before, and seeing how much work that the environmental engineers put into understanding the plant and the manufacturing process really showed me how well-rounded environmental engineers have to be to work in whatever field they're in."

EMMETT HORTON - Undergraduate - Class of 2018
Wiss, Janney, Elstner Associates - Forensic Engineering

"Last summer I was working in more of a design office setting. I was mostly sitting at a computer, and working with people on the same project. I think that being exposed to this environment – where there are a lot of different projects, they're shorter in time span, and you get to visit the projects in the field – has helped shed some light what I want my future career path to look like."



ZHONGYUAN LI - Masters Student
Turboroto - LiDAR Start-Up

"During this internship, I have been able to develop a better understanding of the LiDAR system and how to utilize those data. It is a lot of fun to think more about how LiDAR can work with structures.

"The ecosystem in Silicon Valley and my second MS program for technology ventures has taught me more about how to set up a start-up. I hope to start my own company and use BIM technology in the civil industry for my future career."

SAKHI SHAH - Masters Student
Sherwood Design Engineers - Planning Team

"I worked in a more traditional engineering firm before and this made me realize it can be different. You can have a lot of innovation and flexibility within civil engineering. It has made me reevaluate things a little bit and see a whole new side to engineering, which is really nice.

"I have done work with water systems and here I have been able to see it in a different light. It's something I can explore going forward."

CARLOS MEJIA - Masters Student
Allura - Project Engineering

"I worked on small projects from the science phase up to the execution. Besides that, based on my knowledge in building information modelling, I suggested some ideas about how to apply building informational modeling for the simulation. I looked at the pipeline from unloading rail cars to the storage silos and performed a 3D modeling that showed the benefits of supervising the work in a different way and how we can keep track at each stage of the project to better handle the contractors and better manage the time frame of the project."

Professor Mitch Small with students observing the 2017 Solar Eclipse

Bowling party - Graduate Student Appreciation Week

First-year undergraduate ice cream social

PhD student in Hauck Environmental Lab

Graduate research poster session

Class of 2017 - undergraduates - Gateway Clipper riverboat cruise graduation dinner

CEE finals week pancake breakfast

Driven to Succeed: CEE Alum Excels at Tesla Motors Gigafactory

When CEE alum **Sophie Grodsinsky** (BS '13) joined Tesla Motors as a mechanical, electrical, and plumbing construction engineer in 2016, she'd never worked a day in construction in her life. The first years of her career had been spent as a field engineer in environmental engineering.

Yet, Grodsinsky was drawn to Tesla's place at the forefront of innovation and she was confident that her time spent studying both Civil & Environmental Engineering and Engineering & Public Policy at CMU had prepared her with the foundation to adapt quickly to this new challenge.

Her assignment was construction project management at Tesla's Gigafactory 1—a factory spreading over one million square feet and home to the production of lithium ion batteries, motors, and drive units for the Tesla Model 3.

With design, construction, and operation occurring simultaneously inside the factory, Grodsinsky managed the budgets, schedules, distribution of design packages, field coordination, and commissioning of six electrical subcontractors. The work was outside her comfort zone, but Grodsinsky didn't let that slow her down, drawing on problem-solving and collaboration skills she'd built at CMU, including in her CEE senior design course.

"My CEE senior project experience was hugely fundamental in determining how I approach problem solving for things I've never seen before. From the organizational skills to how to work with a diverse group, that course was one of the most useful tools I was given throughout my four years at CMU," she says.

At Tesla, Grodsinsky quickly found a mentor to advise her on the complexity of managing teams with competing scopes of work, as well as several construction managers and engineers willing to provide guidance and feedback. "I made my own support network. I reached out to anybody who had a bit of spare time and built my way up," she says.

Building her way up is exactly what she did, and Grodsinsky is now the sole construction manager within the entire factory. "I do everything from mechanical, electrical, plumbing, controls, commissioning architectural work, light, safety, concrete, carpet. You name it, whatever's going on in that million square feet I'm managing," she says.

Grodsinsky credits the interdisciplinary nature of CMU's curriculum as preparing her to work with colleagues across such a wide variety of fields. She also adds that her CEE research experiences have proven greatly valuable, including research she did with Professor **Kelvin Gregory** on rare-earth element recycling, something that's also being worked on at Tesla.

"Learning how to do research as a student—seeing what it's like to have that responsibility, not getting too worked up or nervous, and learning how to perform under pressure—that was really helpful," she says. "I'm super grateful for the CEE department. It has very much shaped my professional career and my life."

Overseeing the Nation's First Offshore Wind Farm

As vice president of operations and engineering at Deepwater Wind, CEE alum **Paul Murphy** (MS '04) has a job unlike any other in the United States. That's because Murphy is in charge of operating the nation's very first commercial offshore wind farm, Block Island Wind Farm, a 30-megawatt wind farm with five turbines located about 16 miles offshore of Rhode Island.

Murphy describes his role throughout the project as doing whatever was necessary to keep everything moving—work he describes as both challenging and rewarding. "Being the first offshore wind farm in the US, there was no model to follow. There wasn't a supply chain of companies to support building it. There wasn't a supporting infrastructure: ready-made ports or the right kind of vessels," says Murphy. "We had to solve first-of-a-kind problems on each phase of the project."

During the project's earliest stages, Murphy gathered information through marine surveys and scientific studies. Later, he focused on details like cable routes and supporting real estate agreements and permits, before transitioning to hiring and managing contractors to design and install the project's foundations, cables, and turbines. In December 2016, after nearly seven years of development and construction, Block Island Wind Farm began commercial operation.

Historically, Block Island had ferried in around one million gallons of diesel fuel every year to generate power for the island's inhabitants. Since the project's completion, the island runs primarily on wind power and no longer relies on diesel imports, with excess wind power delivered to the mainland via a newly installed undersea cable.

With larger projects already in development near Long Island and Maryland, Murphy is optimistic about the potential of offshore wind as a valuable energy source.

Murphy has always been drawn to tackling tough problems, and earning his MS in Civil and Environmental Engineering at Carnegie Mellon in 2004 gave him a solid foundation for doing so. "CMU helps you develop a strong analytical skill set that gives you a way to think about the world and about big, important, interesting problems," he says.

Beyond his classes, school organizations and research allowed him not only to dive further into his studies, but also to build leadership skills and become adept at communicating with and working alongside diverse audiences.

Reflecting on his professional success, Murphy explains, "What's been most useful to me is seeking out challenging problems and throwing myself into finding meaningful solutions for those problems. I really believe in what we're working towards at Deepwater Wind—that this could be a viable new source of energy for the US Northeast, help to upgrade our coastal infrastructure, and potentially create thousands of regional jobs. Knowing there are so many positive things you're working towards makes every day meaningful and pushes you to do your absolute best."

Remembering Distinguished Alum Dr. Melvin Ramey

Dr. **Melvin R. Ramey**, an esteemed Carnegie Mellon CEE alumnus, a passionate educator, and an accomplished researcher, passed away on June 28, 2017.

Ramey was a professor emeritus of Civil and Environmental Engineering at the University of California at Davis, where he taught for 37 years.

As a researcher, Ramey's interests spanned the areas of structural design, structural testing, fiber reinforced concrete, and biomechanics. Notably, his biomechanics research—which included using high-speed videography to analyze the physics of the long jump—led him to become a track and field expert for US Olympic athletes.

Ramey earned both his masters and PhD degrees in Civil Engineering from Carnegie Mellon, in 1965 and 1967, respectively. His PhD research advisor was Professor James Romualdi. Following his graduate studies, Ramey stayed in contact with the university and the CEE department, including serving on a presidential advisory board review of the CEE department in the early 1990s.

In 2015, Ramey was recognized by Carnegie Mellon's CEE Department with the Distinguished Alumni Award.

At Spring Carnival we welcomed our Alumni Advisory Council. (Left to right, front row: Deb Lange, Todd Dominick, Jeanne Hoey, Linda Kaplan, Adam Bowland. Back row: Stephen Hinson, Todd Wilson, Russel Jones, Seth Pearlman, Dave Dzombak.)

Clark Construction Group, LLC once again gathered many of the CEE summer interns for an end-of-summer happy hour with CEE alumni in DC.

Thanks to Michelle Cousté for keeping the tradition going! #BlueTartans — with Connor Smith, Michelle Cousté, Steph Emore, Courtney Crystian, Taylor Casserly, Jenny Young, Casey Caslin, and Pierce Sinclair.

Corinne Clinch (CEE/BME BS '14) was honored at the inaugural Pittsburgh Business Times' 30 Under 30 Awards for her work as CEO and co-founder of Rorus, Inc.

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We want to hear from you!

Tell us about your news or share a photo of yourself on your latest project.

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STAFF NEWS

Ron Ripper Keeps Research Running Smoothly

As the director of laboratories and facilities in the Civil and Environmental Engineering Department, **Ron Ripper**'s responsibilities include instituting and ensuring adherence to lab safety policies, maintaining equipment and assisting with purchasing new equipment.

"Overall, I help PhD students keep their research running smoothly in the lab," Ripper said.

Ripper is also responsible for the appearance and maintenance of the department's offices, classrooms, meeting areas and common areas.

"The best thing about this job is the constant exposure to new and exciting ideas and people," Ripper said. "I enjoy working with faculty and staff to implement policies and changes that will enhance their experience, working with students who are intelligent and engaged, and seeing research that could impact the public and the environment."

His work also provides opportunities to work with Carnegie Mellon's experts in green practices and sustainability.

"I have learned so many things with regard to respecting and protecting the earth and our environment," he said. "There are things that we all can do that do not require much effort. I appreciate CMU's commitment."

Alumni AWARDS
April 20, 2018

Please join us at Spring Carnival for the annual CEE Alumni Awards

Call for nominations: 2018 CEE Alumni Awards

Know someone who is deserving of an honor? Submit your nomination by February 15, 2018 for one of the following categories:

- Distinguished Alumni Award
- Outstanding Alumni Service Award
- Lt. Col. Christopher K. Raible Distinguished Public Service Award
- Recent Alumni Achievement Award

For award criteria and nomination instructions, please visit: cmu.edu/cee/alumni/events/alumni-award-criteria or email Deb Lange: dlange@cmu.edu

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Office of Gift Planning

BE A VISIONARY

Daniel Streyle (BS '75) sets his focus on the future.

As project manager, he facilitated the build of the University of Phoenix Stadium and worked to create an impressive structure that will stand the test of time.

At Carnegie Mellon, Dan created a lasting legacy through a gift in his estate plan that will benefit undergraduate engineering research, spurring innovation for generations to come. Learn how easy it is to achieve your philanthropic vision through a planned gift.

Contact the Office of Gift Planning at 412-268-5346 or visit giftplanning.cmu.edu to start building your legacy at CMU today.

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Give Where Your Heart Is

CEE is a remarkable department where faculty, students, alumni, and staff feel connected to each other and the work being done here. Visitors notice the visible signs of our strong community, and new students quickly realize that they are part of someplace special. Our flexible undergraduate and graduate curricula and access to cutting-edge research opportunities allow CEE to continue to graduate classes of creative thinkers and doers.

We are able to provide an engaging, enriching, and encouraging environment because of the support of our donors. Giving to CEE is a vote of confidence in our program and helps keep us competitive with other world-class programs.

Gifts at all levels are needed and appreciated from alumni and friends. Undergraduate alumni participation rates also influence our national rankings in publications such as U.S. News & World Report.

Find details at bit.ly/cee-giving

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