



Carnegie Mellon University
Wilton E. Scott Institute
for Energy Innovation

IMPACT

2021-2022 ANNUAL REPORT

New Scott Institute initiatives aim to lead the way towards a decarbonized future

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Looking back on the past decade as the Scott Institute celebrates its 10th anniversary

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Scott Institute fostering innovation at inaugural EnergyTech University Prize

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DIRECTORS' LETTER



Jay F. Whitacre
Director, Wilton E. Scott Institute for Energy Innovation
Trustee Professor in Energy, Materials Science & Engineering and Engineering & Public Policy



Daniel Tkacik
Executive Director, Wilton E. Scott Institute for Energy Innovation

"You and I are breathing the same carbon dioxide right now that was put in the atmosphere during the industrial revolution." That statement of fact, shared by the Scott Institute's inaugural director Granger Morgan on page 42, is an apt way to introduce you to this year's IMPACT report. As the Institute turns 10 this year, we remain steadfast in our mission— arguably even more important than it was a decade ago— of encouraging the development of breakthrough technologies and policies that accelerate the transition to a sustainable, low-carbon future. To Dr. Morgan's point: the longer we wait to decarbonize the energy system, the more carbon enters the atmosphere and will remain there for centuries. The Scott Institute today continues to work towards that goal of decarbonization, and in this year's report, you will get a glimpse of our progress.

Over the past decade, we've invested \$3.1 million into our energy researchers' work via our seed funding program, and those projects have bloomed into over \$17 million in follow-on funding. In the past two years, we've awarded ten seed grants (p 10-13) that span a wide range of topics, from electrocatalysis to environmental impacts to energy equity. Energy startups continue to thrive here, as the Scott Institute has helped grow over 30 different companies in the past 10 years. One in particular — Farm to Flame Energy (p 30), a startup that delivers clean energy to farmers by replacing diesel-powered generators with ones that burn carbon-neutral feedstock — is working with the electric company Georgia-Pacific to deploy their technology.

Decarbonization is not unique to the Scott Institute, which is why it was so important for the Institute to form the University Energy Institute Collaborative, a first-of-its-kind partnership of over 150 U.S. university-based energy institutes formed to collaborate in addressing the critical challenges facing America's energy systems. In May 2022, the Collaborative had its first in-person annual summit since before the Covid-19 pandemic.

Moving forward, in addition to its current and thriving initiatives, one of Scott's larger priorities will be launching a new initiative focused around decarbonization (p 8), which will catalyze a network of energy researchers within the Institute to jump start the necessary acceleration towards a sustainable low-carbon future. As the Institute's first director said in a fascinating Q&A (p 42), we really can't wait any longer.

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New Scott Institute initiatives aim to lead the way towards a decarbonized future.

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Looking back on the past decade as the Scott Institute celebrates its 10th anniversary.

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Farm to Flame Energy

Founded by CMU alumni in 2018, Farm to Flame Energy provides affordable and renewable power.

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Fostering Energy Innovation with Strategic Partnerships

CMU partnered with the DOE for the inaugural EnergyTech University Prize and more.

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Interview with Scott Institute Directors

Jay Whitacre, Granger Morgan and Jared Cohon talk about the Institute's past and future.

HIGHLIGHTS TIMELINE

JANUARY 2021

Zach Ulissi's paper "Methods for comparing uncertainty quantifications for material property predictions" ranks among 2020's top 10 read articles in Machine Learning: Science and Technology

The Sherman and Joyce Bowie Scott Hall received the **2020 Green Good Design Award** from The Chicago Athenaeum

MARCH 2021

Scott Institute and **NREL** collaborate on DOE's American-Made Solar Prize Round 4 Set! Demo Day

JUNE 2021

Scott Institute wins Department of Energy EPIC **\$1 million** award as part of the United States Research Impact Alliance team. The funding gives new resources and critical support to deploy game-changing energy tech

Faculty Affiliate **Baruch Fischhoff** receives the 2021 Sigma Xi's William Procter Prize for Scientific Achievement

NOVEMBER 2021

Scott Institute joined Pittsburgh delegation attending **COP26** climate change summit in Glasgow, Scotland

Carnegie Mellon ranked top PA university in EPA Green Power List for overall annual green power usage

JANUARY 2022

Scott Institute Seed Grants for Energy Research program receives 23 proposal submissions with approximately **\$1.42 million** in requested funding from CMU faculty

MARCH 2022

Scott Institute hosts Department of Energy (DOE)'s inaugural **EnergyTech University Prize** as well as the **American-Made Solar Prize** Round 5 Set! Pitch Showcase during CMU Energy Week 2022

APRIL 2022

Scott Institute's **Anna J. Siefken** joins Office of Technology Transitions at the DOE

JUNE 2022

Scott Institute co-hosts **2022 University Energy Institute Leadership Summit** with Colorado School of Mines Payne Institute for Public Policy

Daniel Tkacik named new Executive Director of the Scott Institute

Carnegie Mellon announces partnership with DOE to co-host the 2022 **Global Clean Energy Action Forum** this September

ENABLING A SUSTAINABLE LOW-CARBON FUTURE

We address the world's most important energy-related challenges by enabling **collaborative research, strategic partnerships, policy outreach, entrepreneurship, and education.**

We support transformative work that strives to optimize energy resources and reduce the environmental impacts associated with energy production and use with social equity. We also seek to encourage the development of breakthrough technologies that will accelerate the transition to a **sustainable, low-carbon energy future.**

TECHNOLOGY

Energy Technologies: Current and Future

- High-Performance Renewables
- Transportation Energy, EVs, Infrastructure and Electrification
- Energy Storage, Batteries, Fuel Cells and Internet of Things (IoT)
- Decarbonization, Carbon Capture, Sequestration and Utilization

EFFICIENCY

Resource Efficiency, Policy and Analysis

- Efficiency of Traditional Fuels and Resource Recovery
- Environmental Monitoring, Sensing and Treatment
- Energy Policy, Economics and Community
- Enhanced Water Resources

COMPUTATION

High-tech Energy and Computational Solutions

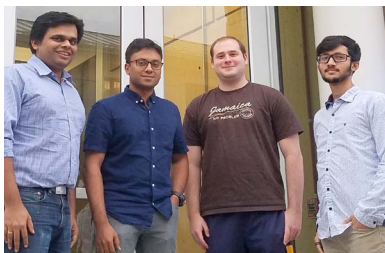
- Grid Modernization, Energy Planning, System Reliability and Resiliency
- Building Performance, Urban Planning, Design and Analytics
- Machine Learning, AI, Autonomous Vehicles and Robotics for Energy Systems
- High-Performance Computing and Data Centers



RESEARCH HIGHLIGHTS



Center for Atmospheric Particle Studies faculty members **Ryan Sullivan** and **Hamish Gordon** have received a new atmospheric research award from the Department of Energy aimed at improving climate change predictions. Sullivan and Gordon's research will incorporate their experimental findings and atmospheric models to better understand how wildfire emissions emit ice nucleating particles that potentially have significant effects on cloud microphysics, precipitation and climate.

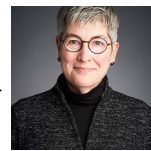


Venkat Viswanathan* (MechE) and CMU Researchers **Matthew Guttenberg** and **Shashank Sripad** developed INCEPTS, a first-of-its-kind software that predicts electric vehicle and aircraft battery charge levels. The technology can make predictions for energy usage based on varying climates and geographies, and then determine ideal charging locations.

A research collaboration led by Mechanical Engineering (MechE) professor **Shawn Litster*** was awarded \$3.2 M from the Department of Energy ARPA-E OPEN 21 program to develop ionomer-free electrodes for ultra-high power density fuel cells. The research team aims to enable low-cost, high-efficiency hydrogen fuel cells for both light- and heavy-duty vehicles. The ARPA-E OPEN 21 program prioritizes funding technologies that support novel approaches to clean energy challenges.



Professor of Materials Science and Engineering, **Elizabeth Holm** and NETL are using computer vision and machine learning to create heat-resistant alloys essential for energy systems. This development is critical in producing reliable electricity supplies while producing fewer emissions and helping meet U.S. decarbonization goals.



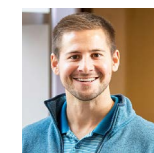
Amritanshu Pandey, **Larry Pileggi** and ECE Ph.D. student **Aayushya Agarwal** introduced an algorithm to quickly facilitate highly accurate simulations and optimizations of power grids, ensuring energy is never found in short supply. Previous methods to locate disturbances in a grid involve reworking their entire mathematical problem from the beginning, and instead, methodology crafted by the



CMU team uses prior information about the grid as a starting point to find the solution, efficiently translating a previously known network configuration into a new one without the disturbance.



Philip LeDuc (MechE) and Ph.D. student **Adam Wood** address one of the biggest problems in the world, water scarcity, with a solution that is more cost-effective and sustainable than current technologies. "Typically, desalination systems are quite expensive.



We're trying to take something that already exists in the world and usually goes to waste and use it to produce freshwater from salty water," Wood said. The unconventional carbon-based electrode is created using bread, suggesting a collaboration with suppliers wherein supplies not sold or disposed could be utilized.



B. Reeja Jayan* is part of a project recently awarded a \$7.5M Multidisciplinary University Research Initiative (MURI)

grant from the U.S. Department of Defense. The 5-year project will study the effects of radiation damage on the performance of wide-bandgap electronics. Jayan will lead the CMU team to learn about the effects of various types of energy radiation on electronic materials to potentially identify ways to engineer radiation hardened materials for use in space exploration vehicles.



"ENERGY USAGE IS THE INEQUITY THAT WE SHOULD BE FOCUSING ON, AND THAT CAN'T BE FOUND WITH SOLELY AN INCOME-BASED MEASURE."

Destenie Nock* and team including CMU Ph.D. student **Shuchen Cong** have unveiled a hidden energy poverty often not captured in income-based metrics. Their new measure, termed the "energy equity gap" captures energy-limiting resident behavior to illustrate the divide in safety and comfort from extreme temperatures across income groups.

Rather than a replacement, the energy equity gap is an excellent complement to current income-based metrics, capturing a previously unseen group experiencing energy insecurity without much overlap. Of 4,577 households examined from 2015-2016, the energy equity gap showed 86 energy-poor and 214 energy-insecure households. Only three of these were captured in the 141 households identified as energy-poor by existing income-based metrics, revealing significantly more challenges for energy access than previously known.

* Energy Fellow

Working towards a low-carbon energy future

In 1936, the Carnegie Institute of Technology's Coal Research Laboratory published a paper titled, "The Relation of the Work of the Laboratory to Practical Carbonization." Nearly a century later, the world is working towards solutions of practical de-carbonization, with the Scott Institute leading the way with its support of a wealth of projects and initiatives. Noteworthy Scott Institute initiatives to date include the Power Sector Carbon Index, the University Energy Institute Collaborative, the Battery Storage Initiative and others.

In 2020, the Scott Institute and North Carolina State University received support from the Alfred P. Sloan Foundation to establish the **Open Energy Outlook (OEO)**, a modeling effort which aims to examine different technology and policy pathways across the energy system that achieve deep decarbonization.

"While energy models have been widely used to understand long-term trends in the energy system, there is

a need for open, transparent, and reproducible models that allow for collaborative analysis. The vision of the Open Energy Outlook initiative is to fill the need while using the model to evaluate deep decarbonization pathways for the U.S.," says **Paulina Jaramillo***, a core team member of the OEO.

The OEO examines national energy futures to inform energy and climate policy efforts by applying the gold standards of policy-focused academic modeling, maximizing transparency and building a networked community. Using a framework of questions to address every aspect of deep decarbonization efforts in the energy system, the OEO includes equity, developmental issues and more in the modeling systems.

Another addition to the Scott Institute's key initiatives is the **Laboratory for Energy and Organizations (LEO)**, which aims to understand how governments, businesses and communities can motivate the adoption of technologies and practices to reduce greenhouse gases.

"It is now relatively clear what steps will help us make a clean energy transition — we now need to make sure these steps are pursued in a way that communities perceive as fair and equitable," explains **Valerie Karplus***, an associate professor in the Department of Engineering and Public Policy who leads the LEO team.

Research projects have focused on policies to support industrial decarbonization, how the clean energy transition is affecting communities and jobs, coal power plant responses to environmental regulation, and collective strategies for reducing GHG emissions in global supply chains.

Given the Scott Institute's breadth and depth of work in decarbonization, the Institute is currently in the early stages of developing a new and larger initiative to encapsulate decarbonization at CMU and beyond, called **decarb @ CMU**. This initiative will create a unified identity for decarbonization researchers and link

existing energy work on campus and Scott Institute initiatives, such as OEO and LEO, to create new opportunities for collaboration with the shared vision of decarbonizing our energy future.

"Three to five years down the road, a successful decarb @ CMU initiative will have been instrumental in setting up multiple deeply-supported efforts in decarbonization and developing strong relationships with external partners, leading to real-world impact on the energy landscape locally and regionally," describes **Daniel Tkacik**, Executive Director of the Scott Institute. "Decarb @ CMU will be the Scott Institute's official stake in the ground exemplifying how serious we are about fostering new research collaborations and partnerships that lead to a low-carbon future."

* Energy Fellow

2022 SEED GRANTS

Scott Institute Seed Grant Funding to Advance Five CMU Energy Projects

Carnegie Mellon University research projects exploring green chemistry and reducing greenhouse gas emissions in steelmaking are among the research being supported by the Scott Institute for Energy Innovation's 2022 Seed Grants for Energy Research.

The annual funding program, now in its tenth year, supports the development of new research in areas such as energy sources, production, efficiency, environmental impacts and energy equity. Additionally, researchers can request awards to perform vital equipment repairs. This year, 23 proposals were submitted with requests totaling \$1.42 million as part of this highly competitive process. The Institute awarded \$278,000 to five faculty-led projects.

THE 2022 SEED FUNDING WINNERS:



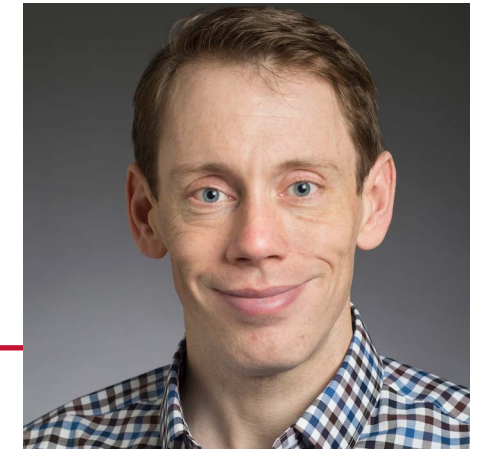
Corey Harper (Civil and Environmental Engineering), will develop a method to quantify need in terms of public EV charging infrastructure for different communities based on parking space availability, grid resiliency and socioeconomic factors. His project is titled, "Combining Transportation and Grid Models to Evaluate the Equity Implications of EV Charging and Grid Infrastructure Deployment Decisions in Emergency Evacuation Scenarios."

P. Chris Pistorius, POSCO Professor of Materials Science and Engineering, will aim to decrease CO₂ emissions from EAF steelmaking, by better understanding the current practice and by potentially carburizing EAF feed with recycled CO₂. His project is titled, "Carbon in electric arc furnace steelmaking: Direct-reduced iron and oxygen use."



Barry Rawn (Electrical and Computer Engineering), will use funds to repair and update an instrument called the Portable Phasor Measurement Unit. This equipment will be used in a project called, "Data-Driven Model Creation for Rwandan Grid Stability - Equipment Repair." It is slated next for use in Rwanda, where it will be installed in a substation with the co-operation of Rwanda Energy Group (REG).

Shawn Litster* (Mechanical Engineering), will use the allotted funds to support assembling an electrolyzer test station to ramp up a new research program in green hydrogen technology and low temperature water electrolysis with his project, "Electrolyzer Test Station for Green Hydrogen Research at CMU."



Assistant Professor of Chemical Engineering **Gabriel dos Passos Gomes**, along with **Zachary Ulissi*** (Chemical Engineering), will aim to make advancements in green chemistry by improving sustainable processes in catalysis science with their project, "Design of Bimetallic Oxide Supports for Organometallic Catalysts to Enable Hydrogenolysis with Clean H₂."

* Energy Fellow

"THIS CELEBRATES THE 10TH YEAR OF THE SCOTT INSTITUTE SEED GRANT PROGRAM. WE ESTIMATE THAT OVER ITS LIFETIME THE PROGRAM HAS FOSTERED THE CREATION OF RESEARCH PROJECTS THAT HAVE SUBSEQUENTLY LED TO AROUND \$17M IN NEW EXTERNALLY FUNDED RESEARCH ACROSS THE UNIVERSITY."

- SCOTT INSTITUTE CO-DIRECTOR ANDREW GELLMAN

2021 SEED GRANTS

Six CMU Researchers Receive Seed Funding to Spur Energy Research

For the 9th round of Seed Grants for Energy Research in 2021, the Scott Institute provided over \$400,000 in support to five CMU faculty projects. These projects explore critical energy research including energy efficiency, electrocatalysis, energy operations models optimization and air quality management in low and middle-income countries.

In 2021, addressing energy equity was added as a new metric for consideration, in alignment with the Scott Institute's interest in DEI-related endeavors.

THE 2021 SEED FUNDING WINNERS:



Tzahi Cohen-Karni, Associate Professor of Materials Science and Engineering (MSE) and Biomedical Engineering (BME), for "ML Accelerated Inverse Design of High-Performance Low-Cost Electrocatalysts." Establishing connections between electrocatalyst processing and performance proves challenging under typical material selection-driven approaches. This work proposes a methodology for coupling electrocatalyst synthesis and performance through machine learning (ML) guided material discovery.



Albert Presto, Associate Research Professor in the Department of Mechanical Engineering (MechE) for "Development of a rapid, high-volume and low-cost method for particle source apportionment in low- and middle-income countries." Air quality planners typically rely on expensive, precise measurements of particulate matter (PM) composition to identify major sources that can then be regulated. This project will support the development of low-cost PM composition analysis methods that will enable source apportionment and, therefore, more informed policymaking.



Nicola Secomandi, Professor of Operations Management, Tepper School of Business, for "Data-Driven Distributionally-Robust Optimization for Contemporary Merchant Energy Operations Models." This proposal focuses on merchant energy operations, a strategy that models as real options the operational flexibility embedded in the energy (and commodity) conversion assets that form the backbone of energy infrastructure and markets.



Destenie Nock*, Assistant Professor of Civil & Environmental Engineering (CEE) and Engineering and Public Policy (EPP) along with **Costa Samaras*** (CEE) for "Energy Equity in the United States Under Climate Change." This work will uncover hidden energy poverty by creating a more comprehensive assessment of the energy burden in the U.S.



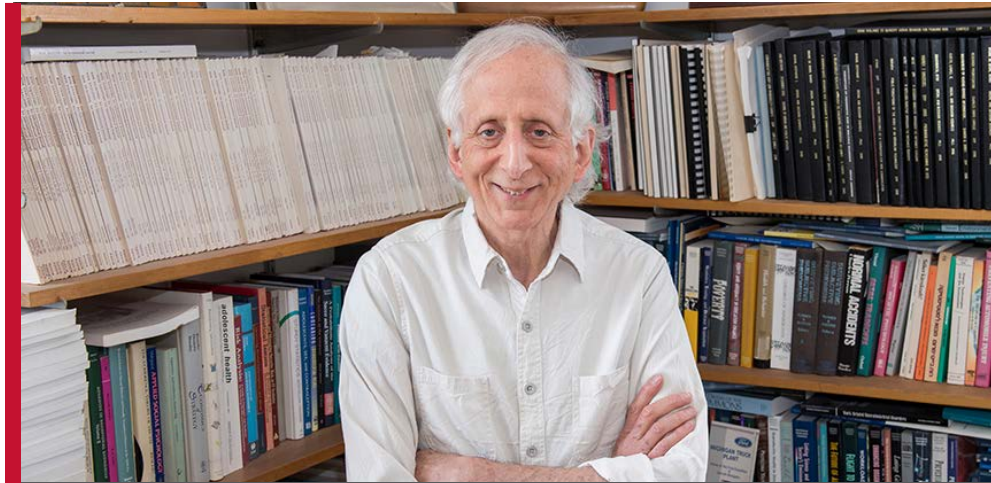
Marc DeGraef, Professor and Co-Director of the J. Earle and Mary Roberts Materials Characterization Laboratory, for equipment repair replacing a PIXcel1D X-Ray Detector on a Panalytical X'Pert PRO MPD powder diffractometer. The Panalytical X'Pert PRO MPD powder diffractometer used for powder and bulk x-ray diffraction measurements is primarily for phase identification and phase quantification.



Daniel Armanios for "Alleviating Organizational and Communication Barriers to Energy Efficiency Programs for More Equitable Access." This project proposes a novel mixed-methods approach that integrates organizational and behavioral approaches to improve the efficacy of programs designed to enhance energy equity.

* Energy Fellow

FEATURED AWARDS & HONORS



Baruch Fischhoff (Heinz) was named a 2021 Fellow of the American Association for the Advancement of Science (AAAS). The lifetime distinction recognizes important contributions to STEM disciplines, including pioneering research, leadership within a given field, teaching and mentoring, fostering collaborations and advancing public understanding of science.

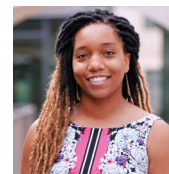


Akshaya Jha* (Heinz) won the United States Association for Energy Economics Young Professional Best Paper Award for his paper, "Start-up Costs and Market Power: Lessons from the Renewable

Energy Transition." Jha's research examines the benefits and costs of economic and environmental policy pertaining to the coal and electricity sectors in the United States and India.



Heartland Forward, a nonpartisan think tank focused on economic renewal in states located geographically in the middle of the United States, recently rated CMU as the nation's top technology transfer institution. Their analysis considered metrics like formal commercialization and tech transfer of intellectual property alongside citations of university articles in patents.



Destenie Nock* (CEE, EPP) received the 2021-22 Wimmer Faculty Fellow Award to evaluate how social justice based active learning activities can impact student learning. This award will help

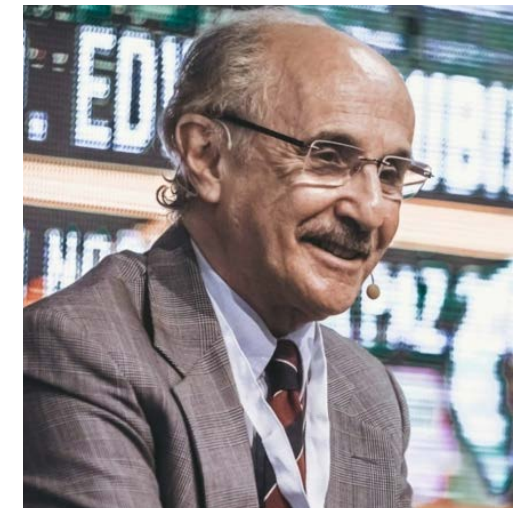
her develop tools to integrate social justice considerations into course materials that will push students to think and design past theory-based lectures.

The **United States Research Impact Alliance** team, which includes The Scott Institute, NETL, BRITE Energy Innovators, RJ Lee, and other regional partners, has been chosen as an awardee of



Energy Program for Innovation Clusters (EPIC)

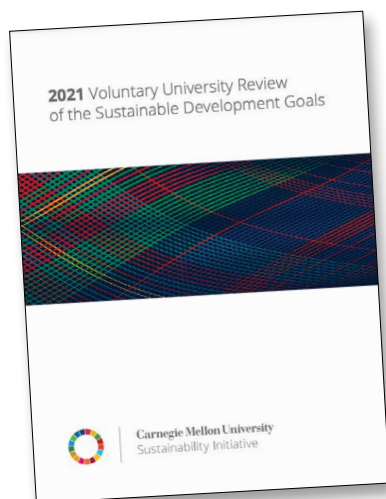
from Department of Energy's Office of Technology Transitions. This funding gives new resources and critical support to deploy game-changing energy tech and supercharge our local energy entrepreneurs and ecosystem.



Ed Rubin* was chosen to receive the 2020 Dixy Lee Ray Award from the American Society of Mechanical Engineers (ASME) in recognition of his extensive career of achievements and contributions to environmental engineering.

Ed Rubin transitioned to emeritus professor in 2022 after 53 years on the Meche faculty. He was also a founding member of EPP where he played a key role in creating the undergraduate double major program & curricula.

* Energy Fellow



CMU's work on the Sustainable Development Goals (SDGs) has been recognized by the **United Nations Foundation**, which notes the creative ways that universities are implementing the 17 goals.

CMU's Sustainability Council, including founding board member **Anna J. Siefken** from the Scott Institute, launched *the world's first Voluntary University Review in 2020*.



Southwest Pennsylvania's Energy Industry: A Case Study Briefing Energy Futures Initiative

In October 2021, President and former Secretary of Energy **Ernest Moniz** and Associate Professor Engineering and Public Policy **Valerie Karplus*** presented the key findings of released a research study on how Southwestern Pennsylvania can thrive during the transition to a future with net zero greenhouse gas (GHG) emissions. This case study, the Roosevelt Project, was initiated by Moniz and takes a multidisciplinary approach to examine the transitional challenges associated with progress toward a deeply decarbonized U.S. economy.

The Southwestern Pennsylvania case study puts forth recommendations for how the regional economy can leverage its existing assets to help meet national and global efforts to address climate change, while creating new jobs and opportunities for existing fossil

energy workers and their communities. "Southwestern [Pennsylvania] has an opportunity to demonstrate how an 'all-of-the-above' strategy can generate jobs, build new industries and secure livelihoods across the region's rural and urban communities, turning headwinds into tailwinds on the path to net zero GHG emissions nationwide," said Moniz.

The findings were presented to energy industry and economic development stakeholders at Bosch Spark Conference Room in Scott Hall. Moniz, who currently serves as president and CEO of Energy Futures Initiative, joined CMU President **Farnam Jahanian**, Congressman **Mike Doyle**, Allegheny County Executive **Rich Fitzgerald**, and former Pittsburgh Mayor, **William Peduto** for the announcement.



From left, J. Michael McQuade, Jay Whitacre, Valerie J. Karplus, Ernest Moniz, Farnam Jahanian, Anna J. Siefken and Rich Fitzgerald

"THERE IS AN OPPORTUNITY FOR REGIONAL LEADERSHIP TO EMBRACE THIS DIVERSITY AS 'THE NEXT BIG THING' — AND TO DEVELOP A BOLD, TARGETED, AND INCLUSIVE REGIONAL STRATEGY AND ONGOING CONVERSATION TO SUPPORT ITS IMPLEMENTATION."

- ASSOCIATE PROFESSOR VALERIE KARPLUS

THE WILTON E. SCOTT INSTITUTE FOR ENERGY INNOVATION FEATURED EVENTS

JULY 22, 2021

Accelerating Innovation – From Bench Scale to Pilot and Commercialization

A panel of four leading innovation experts including **Ryan Dings** (Greentown Labs), **Janine Elliott** (Incubation Programs), **Rick Stockburger** (BRITE Energy Innovators) and **Jeffrey McDaniel** (Innovation Works) considered the critical factors early-stage energy entrepreneurs should consider while working towards getting the first product into the market – with special focus on hardware.

SEPTEMBER 7, 2021

Distinguished Lecture: Britney J. McCoy

EPA's **Britney McCoy** (EPP '05) discussed transportation mitigation efforts at EPA and the current challenges to reducing CO₂ in the transportation sector. McCoy emphasized the role we all must play in future-focused thinking in advancing clean transportation technology options while reducing GHG emissions for real transformational change.

JANUARY 25, 2022

Endgame: Decarbonization

Energy Fellow **Paulina Jaramillo*** (EPP) and Faculty Affiliate **Jeremy Michalek** (EPP and MechE) joined a panel discussion including **Dr. Javad Mohammadi** (UT Austin) and **Erika Myers** (Global eMobility) for an important conversation on national decarbonization strategies and policy priorities in the transportation sector. The event was co-hosted by the Scott Institute and the Block Center.

MARCH 2, 2022

Virtual Distinguished Lecture: Accelerating Our Path to a Carbon Negative Society

Shashank Samala (Heirloom) explored the engineering and robotics challenges behind scaling a direct air capture technology.

BENEFICIAL ELECTRIFICATION

The Scott Institute co-hosted an event with Duquesne Light in December 2021 bringing together national experts **Alex Laskey** (Opower), **Destenie Nock*** (CEE and EPP), **Jeremy Snyder** (Buro Happold), **Steve Pantano** (CLASP) and **Kevin Walker** (Duquesne Light) to examine the implications of electrification in the built environment, and specific ways that it can help accelerate the energy transition in communities.



From left, Jeremy Snyder, Steve Pantano, Destenie Nock and Alex Laskey

APRIL 27, 2022

Special Virtual Distinguished Lecture: Jay Hakes

Jay Hakes, Presidential and Energy Historian, Author, and former Administrator of the U.S. Energy Information Administration discussed U.S energy policy during a special lecture livestreamed from the UEIC Annual Summit.

JUNE 13-14, 2022

The Northeast Workshop on Energy Policy and Environmental Economics

The workshop organized by **Karen Clay*** and others aims to assemble a set of papers on a variety of topics, reflecting the latest advanced in energy and environmental economics. Event was hosted by the Heinz College with support from the Scott Institute, the Steinbrenner Institute, the Tepper School of Business and the University of Pittsburgh.

Watch events online at cmu.edu/energy

* Energy Fellow

FEATURE



10 YEARS OF IMPACT



The construction of Scott Hall in 2015

One walking the streets of Pittsburgh today might spot an electric bus passing a decommissioned steel mill covered in photovoltaics, sights that seemed impossible at a time when Pittsburghers once walked through veils of smoke that darkened the daylight, a hazy byproduct of the coal that was so important to Pittsburgh's development. Pittsburgh's history with energy is rich and storied; the energy industry took off here, fueling the massive demands of Andrew Carnegie's mills. And while Carnegie's mills polluted the region's air and waterways, his educational institution — which would eventually become Carnegie Mellon University — was crucial in leading the development of clean energy technologies and policies.

Since 2012, the Wilton E. Scott Institute for Energy Innovation has built upon this foundation of energy

history and leads the way in energy innovation in both Pittsburgh and beyond. When Joyce Bowie Scott and Sherman Scott each received their CMU diplomas — hers in 1965 from the College of Fine Arts and his, a year later from the College of Engineering — they never imagined their names would be engraved into the walls of one of the University's most iconic buildings nearly 50 years later. Named after Sherman's father, a passionate geologist and energy industry leader, the Wilton E. Scott Institute for Energy Innovation has captured Wilton Scott's enthusiasm for discovery in the energy field.

The Scott Institute has become one of the premier energy institutions in the country, having recently been named one of the American Energy Society's "Energy Elites." From the beginning, its mission has been to support energy research and technology

to create a more sustainable, equitable, accessible and efficient future, and through various initiatives, funding opportunities, events and more, the Scott Institute has supported and advocated for the work of top researchers and developers in the energy field. In addition to bringing at least \$60M in energy research funding from public and private funding sources, the Scott Institute has helped launch over 30 energy and cleantech startup companies.

"The Scott Institute has become a leader at forging relationships between different disciplines to develop responses to the most complex questions in the energy field," says Jay Whitacre, director of the Scott Institute. "Over the past decade, the Scott Institute has championed projects and collaborations to make a lasting impact on the world."

One of the most instrumental initiatives of the Scott Institute has been the Seed Grants for Energy Research which began in 2013 with the first round of funding. "It has been very impactful and valuable for the faculty . . . Faculty make tremendous use of it. It has been leveraged into many millions of dollars, outside support," says Dr. Jared Cohon, director of the Scott Institute from 2014 to 2017. Since its establishment, the seed grants have distributed \$3.1 million to fund seventy research teams and leading to faculty receiving about \$17 million in external funding for their projects.



From left to right: Claire Ruge Bertucci, John Bertucci, James Garrett, Subra Suresh, Joyce Bowie Scott and Sherman Scott

"The Scott Institute has become a leader at forging relationships between different disciplines to develop responses to the most complex questions in the energy field," says Jay Whitacre, director of the Scott Institute. "Over the past decade, the Scott Institute has championed projects and collaborations to make a lasting impact on the world."

In 2019, the Scott Institute established the University Energy Institute Collaborative (UEIC), a coalition of energy institutes across the US. Bringing together over 150 institutions and energy experts to catalyze connections and new innovations, this program is the first of its kind and fuels collaborative efforts to achieve the member institutes' shared vision of a lower carbon future. Members of the UEIC convene annually to exchange ideas, inspire meaningful research, engage scholarship, inform regional and national policy, impact decision-making and re-imagine energy education to be ready to create the future of energy systems.

CMU is home to many talented faculty and students, and the Institute not only provides support for their research, technology and other relevant endeavors, but also offers them with the chance to connect with others. Graduate students from programs such as the Energy Science Technology & Policy (EST&P) program can intern with the Scott Institute as well, contributing to the opportunity to build on their experiences and industry reach. "I think my internship



Group image of University Energy Institute Collaborative (UEIC) during the 2019 annual summit hosted by Carnegie Mellon University

with Scott institute has amplified my experience by working with such a dynamic group of energy professionals. During my internship, I have learned more about exciting research opportunities by talking to Scott Institute affiliates," says Prathit Dave, a current EST&P student and Scott Institute intern.

Expanding beyond the CMU community, the Scott Institute has hosted the annual CMU Energy Week, which was launched in March 2016 and has brought approximately 1,000 attendees to campus each year. During Energy Week, the Scott Institute brings together academics, professionals, students, and other leaders of the energy sector for a series of forums, panel discussions and unique events to engage industry, students, faculty, staff,

government officials and innovators in technology and the public on the future of research, policy and education. Energy Week has included something for everyone—career fairs, hackathons, panels on

current research and the future of energy featuring top researchers, industry leaders, and more. Past participants have included former Department of Energy Deputy Secretary Elizabeth Sherwood-Randall, former Pittsburgh mayor William Peduto, Congressman Conor Lamb, co-founder of Lyft, Raj Kapoor and many others.

Over the course of a decade, the Scott Institute has forged relationships between external contributors, but also within the university itself. "The Scott Institute plays a role . . . both inside the university and outside, both regionally and nationally, as the convener of other institutes," according to Dr. Cohon. The Scott Institute has forged multiple partnerships of all shapes and sizes—from working with industry to partnering with Department of Energy to help organize and run the American Made challenges and the EnergyTech University Prize, hosting both programs' national competitions during Energy Week 2022.

The Scott Institute will continue to support all kinds of research, technology and development of innovations in the energy sector that help create a lower-carbon outlook. By continuing to add initiatives, expand outreach and push to support the innovators in the energy sector, the Scott Institute aims to maintain their mission and achieve an equitable and sustainable energy future.

People may have once said that "coal is the rock upon which Pittsburgh was built," but the Scott Institute hopes to prove that **clean energy innovation will be that upon which Pittsburgh grows.**

Exterior of Scott Hall



A panel discussion at Energy Week 2019

POLICY OUTREACH



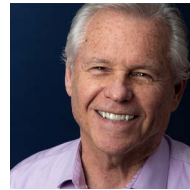
Lester and Judith Lave Professor of Economics, Engineering, and Public Policy, **Nicholas Muller*** launched a new index, the ESG Index, to serve as the go-to resource for accurate data in monetary pollution. The index relies on monetized damage from pollution emissions and aggregates damages across eight pollutants to provide stakeholders with a complete measure of companies' environmental impact.



Engineering and Public Policy professor **Destenie Nock*** published a paper focusing on how sociodemographic data is used

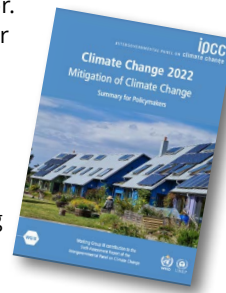
to determine energy goals and future planning which includes "Ten Steps for the Standardization of Sociodemographic Data Practices".

Steven Quick (School of Architecture) and **Diane Turnshek** (Department of Physics) advised on the City of Pittsburgh "Dark Sky" initiative. The city will be the first city of its size to adopt the new values-centered guidelines of the International Dark Skies Association, which will mean a substantial decrease in energy consumption by streetlights, parks and several larger facilities.



Paulina Jaramillo*, Professor of Engineering and Public Policy served as coordinating lead author of

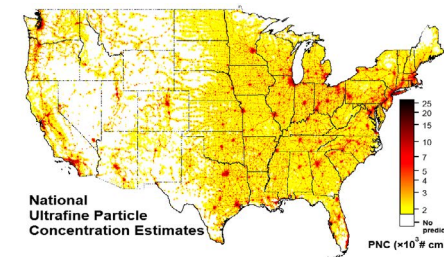
the transportation section of the newly released Intergovernmental Panel on Climate Change (IPCC) report for climate-policymakers. As one of three coordinating lead authors for Chapter 10, Transportation, Jaramillo led more than a dozen fellow experts in evaluating the state of knowledge about mitigation options for the sector. Reducing demand for transport services, increase low-carbon technologies and reducing emissions from shipping and aviation were among the strategies highlighted.



Director of the Scott Institute and Trustee Professor in Energy **Jay Whitacre**, Associate Professor of Engineering and Public Policy **Valerie Karplus*** and Mechanical Engineering (MechE) professor **Shawn Litster*** presented to top-level executives and academics from around the region at the inaugural **H2 SUMMIT: FUELING THE FUTURE**. The event brought together key stakeholders to stimulate discussion and action towards securing a hydrogen hub for the Western Pennsylvania region.



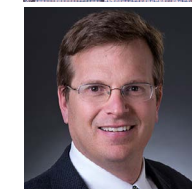
From left: Jay Whitacre, Rick Beuttel (Bloom Energy), Ken McQueen (Kenergy Consulting), Shawn Litster (CMU), Goetz Vesper (University of Pittsburgh)



National ultrafine particle concentration estimates

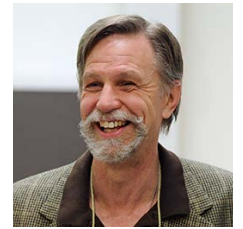


As part of the Center for Air Climate and Energy Solutions (CACES), a team led by Research Professor of Mechanical Engineering, **Albert Presto** and CMU-Africa Director **Allen Robinson** developed the first national model estimate for airborne ultrafine



particle (UFP) concentrations. The model will ultimately lead to a better understanding of UFP's effects on health and hopefully one day impact air pollution policy.

A new model published by Carnegie Mellon's **Jeffrey Anderson**, **David Rode**, and Professor of Engineering and Public Policy, **Paul Fischbeck**, together with **Haibo Zhai** from University of Wyoming shows utilities and policymakers how technologies like carbon capture and storage (CCS) can be used to reduce CO₂ emissions from existing and new power plants while minimizing costs.



* Energy Fellow



Building the Energy Experts of the Future

In a room just down the hall from the Scott Institute, students can often be found debating about energy policies, collaborating on class projects or discussing the many intricacies of today's energy issues. These students are master's students in CMU's Energy Science, Technology and Policy (EST&P) program, and just over a decade ago, these kinds of students didn't even exist. In 2010, the EST&P program became one of the world's first interdisciplinary degree programs focused on energy, offering four different Master of Science degrees situated at the intersection of engineering, economics and public policy.

"There's a real need for interdisciplinary energy experts and there aren't many programs out there," says Dr. Paul Salvadore, Director of the EST&P program. "Our program gives students a customized education and experience to develop into top experts in the field."

The program requires four energy core mini-courses and begins by introducing students to topics that cover every aspect of the energy field—energy conversion and supply; energy transport and storage; energy demand and utilization; and energy policy and economics. Energy

faculty, most of which are Scott Institute affiliates, teach the core classes and introduce students to the program, other energy faculty and their projects at CMU and prepare them for applying their energy expertise. The program provides students with the opportunity to engage with experts and learn more about the possibilities after graduation and helps students create their own trajectory in the program.

Students tailor their own education, taking classes in multiple disciplines that fit their interests and goals. EST&P's program is unique, allowing students to fully customize their specialty and pursue their passions in the energy field, whether it's sustainability, batteries, storage, renewable energy—there's always space for students' innovation in their academics.

After the program, EST&P alumni can be found in a wide variety of sectors and positions. "Our students are making impact over wide ranges—from going on to PhDs to the NGO sector to governmental sectors to industrial pursuits, consulting pursuits. It's hard to find a slice where our students aren't making an impact," says Dr. Salvadore. Many different sectors need experts

that can understand various intertwined aspects of the energy field, he says, and EST&P prepares students to fill that gap.

Since its inception, the Scott Institute has had a growing relationship with the EST&P program, providing students the opportunity to get involved through seminars, networking events and other opportunities.

"Scott really brings on an element of dynamism to the hallway that we couldn't possibly do," says Dr. Salvador. "That level of dynamism is something in the energy space that our students identify with. The flexibility, the interdisciplinarity the Scott Institute has—our students have essentially identified the Scott Institute as their own."

Alexandra Kramer, an EST&P alum and former Scott Institute intern spent several years taking advantage of the Scott Institute's offerings. "My internship at the Scott Institute deeply enhanced my experience in the EST&P program by providing me with a broader look at energy-related research happening at CMU, giving me opportunities to apply what I was learning in the classroom to real-time initiatives, and allowing me to engage with important industry speakers

and VIPs," explains Kramer.

"My exposure at EST&P has been extremely rewarding because of challenging academic courses, being able to participate in numerous events outside classes and the platform it provides to become an energy professional," says Prathit Dave, a current EST&P student and Scott Institute intern.

As the EST&P program and the Scott Institute continue to grow, so will the relationship between them. "We do want to grow the program, we do want to have more interaction with the Scott Institute. It's a symbiotic relationship," explains Justin Puglisi, EST&P Assistant Director and Academic Advisor. "We both benefit each other, from our students...or it's skilled individuals who work in the energy field. They're going to want to do great things with the Scott Institute."

The EST&P program has created and continues to expand opportunities for students and faculty to pursue advancements in the energy field. The program is vital to the Scott Institute's mission, and together EST&P and the Scott Institute will push for interdisciplinary approaches to forming a lower-carbon and sustainable future.

STUDENT NEWS



1



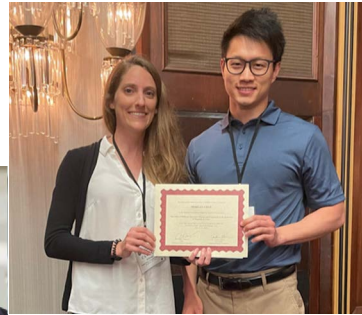
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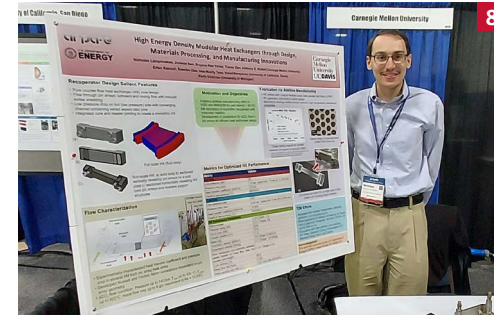
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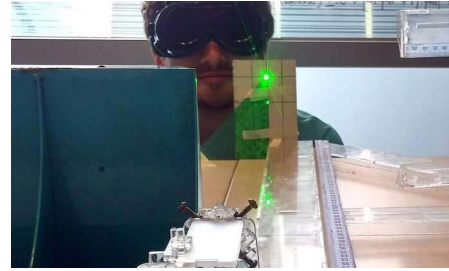
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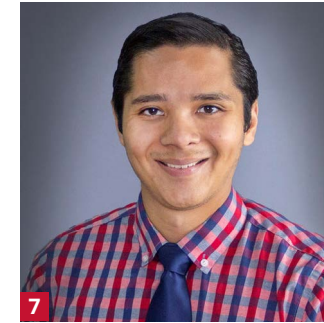
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9

1 Ph.D. student **Aaron Burns** (Engineering and Public Policy) and undergrad students **Tahaseen Shaik** (Electrical and Computer Engineering/Robotics), **Ashima Sharma** (Civil and Environmental Engineering), **Shruti Prasanth** (Communication Design) took first place in the inaugural NASA Gateways to Blue Skies competition for their project titled: "Sustainability and Connected Autonomy: A New Era for Aviation." The team was advised by faculty affiliate **Sebastian Scherer**.

2 **Alexandra Kramer** in the Energy Science, Technology and Policy (EST&P) program attended the U.S. DOE Research Experience in Carbon Sequestration (RECS) program, an annual instructional summit for graduate students and early career in carbon capture, utilization, and storage (CCUS) in December 2021. Kramer also presented as a part of the ARPA-E Student Pitches at the 2022 Energy Innovation Summit with a presentation titled "Long-Duration, High-Capacity Thermal Energy Storage with Skibo Energy TES."

3 **Ian Gray** (Tepper), **Sean Irvine** (Tepper), **Keitaro Iwasa** (Tepper) and **Alexandra Kramer** (EST&P) won 2nd place in the

Pacific Northwest National Laboratory (PNNL) Division of the DOE's inaugural Solar District Cup. The team's project, guided by Scott Institute Systems Scientist **Panayiotis (Panos) Moutis**, aimed to maximize resiliency for solar yield and storage solution for the PNNL campus.

4 In November 2021, EST&P students **Adrielle Cailipan**, **Sabrina Curtis**, **Pranav Gupta**, and **Alexandra Kramer** won the Edison Energy Challenge at the MIT Energy-Hack. Their 'Tartan Method' solution compared qualitative objects and prioritize climate impact, cost and societal co-benefits for any renewable energy project. Their project referenced research on holistic multi-criteria decision analysis from Scott Institute Energy Fellow **Destenie Nock**.

5 **Morgan Chen** (Mechanical Engineering) was awarded Best Oral Presentation in the Student Competition of the 56th Annual Microwave Power Symposium. Chen's work, "The Effect of Different Microwave Powers and Frequencies in the Reduction of Magnetite to Iron," was a collaboration with the National Energy Technology Lab.

6 Mechanical Engineering Ph.D student **Andrés Arias-Rosales** alongside Scott Institute Faculty Affiliate **Philip LeDuc** (Mechanical Engineering) published research working to use shadow modeling to calculate urban setting light levels for designing the most efficient solar panel placement. The technique has the potential to be used for other applications such as urban farming and heat levels for building design.

7 **Elvin Vindel**, a Ph.D. student in civil and environmental engineering, led the creation of a model that can help cut emissions from buildings and improve the overall efficiency of the grid. The model for demand flexibility in heating, ventilation and air conditioning (HVAC) systems offers solutions in energy demand management for building managers and grid operators alike. The paper was co-authored by Vindel's advisers, **Mario Bergés** and **Burcu Akinci**, both professors of civil and environmental engineering.

8 **Nicholas Lamprinakos**, a Ph.D. student at CMU, presented research titled "High Energy Density Modular Heat Exchangers through Design, Materials Processing, and Manufacturing Innovations" at the

2022 ARPA-E Energy Innovation Summit Technology Showcase. Lamprinakos works on a team led by Faculty Affiliate **Tony Rollett** that received a \$2.4M grant from ARPA-E as one of 18 high-temperature materials projects.

9 A team of researchers led by **Turner Cotterman**, an engineering and public policy Ph.D. student, has shown that sustainably decarbonizing our energy system by 2050 will require us to change the way we model energy transitions and account for the role of public opinion. In a decarbonization scenario that does not consider public acceptance, nuclear energy would make up 73% of total energy generation, with renewables contributing most of the rest, and costs would increase by 9%. However, factor in social acceptance and nuclear energy's share drops to just 3%, requiring about 97% of our energy to come from renewables in order to reach full decarbonization, and costs increase by 11%. Cotterman and his co-authors argue that public policy and the energy sector in general must begin to orient toward the public's concerns, rather than omitting them from a situation in which they have a considerable impact.

FARM TO FLAME ENERGY

Farm to Flame's mobile fuel processor

Providing affordable and renewable power

Farm to Flame was founded in 2018 by **Will McKnight** (CRO) and **Kwaku Jyamfi** (CEO). The company began as a means to commercialize a combustion process that McKnight's grandfather and uncle patented. In 2020, Jyamfi asked fellow Carnegie Mellon alumnus **Stefano Alva** (CFO) to join the team.

After receiving funding from a variety of sources including Carnegie Mellon University, Syracuse University, and the United States Environmental Protection Agency, Farm to Flame is providing affordable and renewable power to areas around the globe.

Farm to Flame's combustion process allows several agricultural and food wastes to burn without smoke or odor, transforming the waste into accessible, reliable and affordable biomass with low emissions. Locations like farms

and sawmills that produce plant waste can utilize Farm to Flame's fuel processor to turn the waste into energy. Traditional energy technology that utilizes biomass relies on burning wood chips. This produces a lot of ash, leading to down time and maintenance. Farm to Flame's safe powder burns much cleaner than wood (smokeless-odorless) and can provide a cleaner energy alternative to those who rely on biomass for power. This can mean a solid backup to the grid, or a reliable source of energy on its own for places where there is no reliable power grid.

Their success is underscored by the array of grants and competitions that they have won. In 2021, they secured a Small Business Innovation Research (SBIR) grant for \$100,000 from the EPA. Additionally, they received \$75,000 from the New Jersey Commission on Science, Innovation and



"WE SEE PROVISION OF RENEWABLE POWER GENERATION AS THE MOST IMPORTANT PROBLEM TO SOLVE IN OUR MODERN TIME. PROVIDING CARBON-NEUTRAL ELECTRICITY TO THE WORLD IS CRITICAL FOR OUR SUSTAINABLE DEVELOPMENT."

- Kwaku Jyamfi, CEO

Technology (CSIT).

Most recently, in 2022 they have won \$50,000 from the Cisco Global Problem Solver's Challenge and another \$50,000 from the Capitol Innovator's Fund. They have also received an award from Clean Energy Trust and a \$200,000 investment from the Richard King Mellon Foundation.

The technology has been installed in a few locations in Pennsylvania and New Jersey, and Farm to Flame has partnered with the University of Calabar to install their fuel processors in Nigeria. Fuel can be created from materials like wood, grain waste, and yard trimmings. As their technology is installed, users can expect to see less pollution, more reliable energy production,

and lower costs.

"We see provision of renewable power generation as the most important problem to solve in our modern time. Providing carbon-neutral electricity to the world is critical for our sustainable development."

LEARN MORE ABOUT FARM TO FLAME ENERGY AT FTFENERGY.COM AND JOIN THEIR CAMPAIGN AT WEFUNDER.COM/FARM.TO.FLAME.ENERGY

Read more about CMU's energy startups at cmu.edu/energy/research-innovation/energy-innovations/startups.html



ABOVE IMAGE: Farm to Flame Generator

INNOVATION NEWS



CorePower Magnetics, led by alumni **Samuel Kernion**, **Paul Ohodnicki** and CMU Professor **Michael McHenry** (MSE), have launched their soft magnetics technology start-up, accelerating grid and EV modernization processes through lighter, more efficient components. The startup was also awarded funding from the Department of Energy through the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR).

CMU spinout **Gecko Robotics**, a Pittsburgh-based technology company started by several CMU students, announced the close of its \$73 million Series C funding round. It marks the largest funding round for a Pittsburgh startup so far in 2022. The startup also continued its growth with 70,000 sq. foot office at Nova Place on Pittsburgh's North Side.

Venkat Viswanathan* and CMU Alumni **Greg Houchins** have recently launched **Chement**, a start-up company based on Houchins' research in an energy efficient, zero-emissions process for the production of cement. Houchins was also named a Breakthrough Energy Fellow for the inaugural 2021 cohort. The fellow program identifies and supports the best and brightest individuals and teams across the globe working to develop, scale, and commercialize technologies.

Hyllion, founded by CMU alumni **Thomas Healy**, signed an agreement with building materials producer Holcim for heavy-duty trucks with an electric drive combined with a natural gas generator to charge the battery. Holcim plans to replace its existing diesel trucks in Texas and Oklahoma with the Hyllion trucks with a range of 1,000 miles.

Arieca, a CMU spinoff, received a \$6.5 million Series A funding round co-led by Nissan Chemical Corporation and 412 Venture Fund, with participation from ROHM Co. Ltd., Monozukuri Ventures, Mountain State Capital, Innovation Works and Carnegie Mellon University. Arieca also an agreement with ROHM, a leading provider of power semiconductor devices for the xEV market. The partnership is to develop next-generation Thermal Interface Materials (TIM) using Arieca's Liquid Metal Embedded Elastomer Technology.

SparkMeter, started by CMU alumni **Daniel Schnitzer**, is a provider of grid management services, equipment and software solutions. The company raised an additional \$10M led by Accurant International with participation from existing investors Breakthrough Energy Ventures and Clean Energy Ventures. The funds totaling \$22M will enable its growth in global markets, including enabling access to reliable electricity in underserved communities across Africa, Asia and the Americas.



* Energy Fellow

162
FACULTY
AFFILIATES
ACROSS 28 CMU CENTERS
AND DEPARTMENTS

15
ENERGY
FELLOWS
FROM VARIOUS DISCIPLINES

272 
GRADUATES
OF ENERGY SCIENCE,
TECHNOLOGY AND POLICY
MASTER'S DEGREE PROGRAM
SINCE 2011

70
SEED GRANT
PROJECTS
SUPPORTED
SINCE 2013

ATTENDEES
AT 23 EVENTS

AWARDED
\$3.1 MILLION
RESULTING IN

\$17
MILLION

IN FOLLOW-ON
FUNDING

NEARLY

200

ENERGY
RELATED
COURSES
AT CMU

OVER 400
PHD THESES
WITH AN ENERGY FOCUS
SINCE 2012



EnergyTech University Prize Mid-Atlantic Competition in February 2022

Fostering Energy Innovation with Strategic Partnerships

The Scott Institute has partnered with the Department of Energy’s Office of Technology Transitions for the **EnergyTech University Prize (UP)** to serve as a Regional Convener for the mid-Atlantic region. EnergyTech UP launched in October 2021 with 180 teams from 113 schools competing throughout the United States. The Scott Institute also held the inaugural national pitch event during 2022’s Energy Week on March 24, where nine teams were selected as winners.

The EnergyTech UP competition asks student teams to develop and present a business plan to solve challenges with potential energy technologies. Teams of students must identify an energy technology, assess its market potential and create a commercialization business plan. Post-secondary students of all levels can compete, having the chance to earn cash prizes for their work. The tasks are interdisciplinary and ask the students to apply their abilities to learn, collaborate

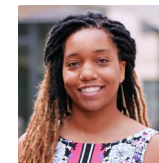
and lead while being both creative and analytical.

In the first phase of the competition, students must research business and energy technology opportunities, presenting their findings at an Explore Event hosted by 11 regional convening organizations including CMU’s Mid-Atlantic event. Regional winners are awarded \$2,500 each and are provided with exclusive mentorship and access to DOE materials. Semifinalists are then selected by the DOE technology offices, awarded \$2,000 and then advance to the Refine and Pitch Phase in the national competition alongside the Regional Winners.

In 2022, CMU hosted the national finals competition during **Energy Week 2022**. Nine teams were selected as the 2022 national winners and technology bonus prize finalists. CMU plans to serve again as a partner for the 2023 EnergyTech UP competition.



The Scott Institute was selected for an **IN² 2022 Channel Partner Strategic Award** to fund Civil and Environmental Engineer Assistant Professors



Destenie Nock* and **Corey Harper**. The project will examine how the deployment of EV charging infrastructure will impact disaster response performance metrics across low and high-income communities in emergency evacuation scenarios. This effort will help ensure equitable resilience while communities transition to a fully electrified transportation system.

IN² is a \$50 million clean technology program funded by the Wells Fargo Foundation and co-administered by the National Renewable Energy Laboratory (NREL). The program supports cleantech startups looking to scale and commercialize low-carbon innovations that have beneficial social, economic and climate outcomes. One of seven awardees, the Scott Institute will be given between \$100,000 and \$175,000 of funding for this project.

IN² has also selected CMU start-up **CorePower Magnetics** to demonstrate its patented high-performance electric motors, inductors and transformers with Eaton, which can extend electric vehicle ranges and improve grid efficiency. CorePower Magnetics will receive \$250,000 in non-dilutive funding and support for its program from NREL and Wells Fargo.

The Scott Institute is partnering with U.S. Department of Energy’s National Renewable Energy Laboratory (NREL) to again facilitate and grow the **American-Made Solar Prize** as one of 16 Power Connectors. Power Connectors are organizations essential to the contest’s diversity and inclusivity and are involved in execution, recruitment and support throughout the competition.

Funded by the DOE’s Department of Solar Energy Technologies Office, the American-Made Solar Prize is a multi-million dollar competition designed to spark innovation in the U.S. solar manufacturing sector through three levels of contests supported by a diverse and powerful network that leverages various resources and stakeholders across the country. As competitors advance through the stages, teams can win \$50,000 to \$500,000 alongside vouchers to further develop and test technologies at national laboratories and facilities.

The American-Made Solar Prize allows competitors to build their network, collaborate and meet with national labs, incubators, investors, and various industry leaders and mentors. The Scott Institute plays a vital role in supporting and executing the American-Made Solar Prize contests and further supporting creative advances in the energy field.

Learn more about becoming a partner at cmu.edu/energy/get-involved/partner

* Energy Fellow

FACULTY IN THE MEDIA



Vivian Loftness* discussed the importance of net zero buildings with the **CHICAGO TRIBUNE**.



Venkat Viswanathan* discussed what it will take to get electric planes off the ground with **WIRED**.



Shawn Litster* described the growth of the hydrogen generator market at General Motors and other companies in **AP News**.



Scott Institute Director **Jay Whitacre** explained the varying storage capacity and powering abilities of grid-scale lithium-ion batteries in **THE DAILY BEAST**.



Rahul Tongia commented that the impact of net-zero commitments and the overall effect on climate change mitigation from corporations is complex, as told to **ABC NEWS**.



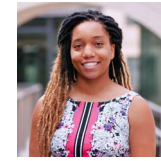
Paulina Jaramillo* discussed how vehicle electrification is crucial to meeting climate mitigation targets on **90.5 WESA**.



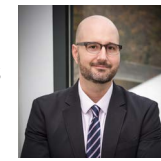
Scott Institute Director Emeritus **M. Granger Morgan** discussed vulnerabilities and hurdles facing officials who are responsible for maintaining and improving the U.S. electrical grid on CBS's **60 MINUTES**.



Destenie Nock's* research on energy equity and COVID-related impacts on residential energy customers was featured by the **PITTSBURGH POST-GAZETTE**.



Costa Samaras* highlighted his study on energy use and life cycle greenhouse gas emissions of drones for commercial package delivery in **TIME MAGAZINE**.



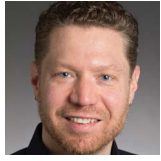
Kate Whitefoot* addressed economic and societal effects on EV adoption and impact EVs can have on cleaning up the electrical grid with **THE DISPATCH**.



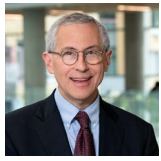
Erica Cochran Hameen wrote an op-ed featured on equity, design justice and the role of mentoring in **ARCHITECT MAGAZINE**.



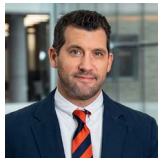
Jeremy Michalek discussed electric cars' impact on the environment with **NEWSWEEK**.



Jay Apt discusses with **E&E NEWS** the role carbon capture can play in reaching net-zero emissions. Renewables can only make up about 80% of electricity production in the U.S., so flexible resources are necessary for the remaining 20%.



Nick Muller* was quoted by **THE HILL** on how pollution disproportionately affects certain racial and ethnic groups, especially older Black and Hispanic individuals.



Chris Pistorius was mentioned by **THE NEW YORK TIMES** about the environmental impact of a stainless steel knife.



* Energy Fellow

ALUMNI NEWS



Joseph DeCarolis (Engineering and Public Policy 2004) was confirmed Administrator of the U.S. Energy Information Administration (EIA). He will oversee a wide range of statistical, analytical, and dissemination activities and will serve as a primary spokesperson for the agency.



Scott Institute Board of Advisor **Kathryn Jackson** (Engineering 1990) was elected to the National Academy of Engineering (NAE). She joins an elite group of more than 60 members of the extended CMU community who have been honored with membership in the NAE, an organization that promotes the technological welfare of the nation by marshaling the knowledge and insights of eminent members of the engineering profession.



Jake Ward (EPP and MechE 2020) had two chapters of his Carnegie Mellon doctoral thesis on the impacts of ridesourcing systems featured in a lead editorial in The New York Times alongside his CMU advisors Jeremy Michalek and Costa Samaras.



A new discovery by alumnus **Mingyi Wang** (Mellon College of Science), with collaboration with a number of world-renowned climate scientists, including Faculty Affiliates Hamish Gordon and Neil Donahue, sheds light on a new way particles are forming in the upper troposphere. Published in Nature, the study's findings suggest that in addition to carbon dioxide, there are other compounds in need of immediate attention and regulation.



“THE NEXT STEP AFTER THE SILENT HUSTLING IS TO TAKE THE INITIATIVE TO CONNECT THE DOTS AND TELL THE STORY OF YOUR ABILITIES TO SOLVE REAL PROBLEMS. AND AFTER THAT YOU LET YOUR SUCCESS MAKE THE NOISE.”

- **SAKSHI MISHRA** (ENERGY SCIENCE, TECHNOLOGY & POLICY 2015) DELIVERED THE KEYNOTE SPEECH AT THE EST&P DIPLOMA CEREMONY FOR THE 2020, 2021 AND 2022 GRADUATING CLASSES.

ENERGY FELLOWS

The Scott Institute Energy Fellows Program incentivizes, promotes and rewards Carnegie Mellon University's most dedicated tenure track energy faculty. Each fellow receives funding, resources and membership in the Scott Institute Fellow Council. We are grateful for their contributions to the energy field.

SENIOR FELLOWS

Karen Clay
Professor of Economics and Public Policy, Heinz College
Tepper School of Business (Courtesy),
Department of Engineering and Public Policy (Courtesy)

Vivian Loftness
University Professor,
School of Architecture

Larry Pileggi
Coraluppi Head and Tanoto Professor, Electrical and Computer Engineering

FELLOWS

Stefan Bernhard
Professor of Chemistry
Director, Bernhard Research Group

Paulina Jaramillo
Arthur Hamerschlag Career Development Professor of Engineering and Public Policy
Co-Director,
Green Design Institute (Engineering 2004, 2007)

B. Reeja Jayan
Associate Professor of Mechanical Engineering, Chemical Engineering (Courtesy), Electrical and Computer Engineering (Courtesy) and Materials Science and Engineering (Courtesy)
Principal Investigator, JLAB

Akshaya Jha
Associate Professor of Economics and Public Policy,
Heinz College

Soumya Kar
Professor of Electrical and Computer Engineering (Engineering 2010)

Valerie Karplus
Associate Professor of Engineering and Public Policy

Shawn Litster
Professor of Mechanical Engineering, Materials Science and Engineering (Courtesy)

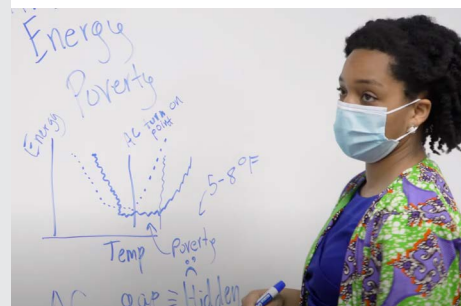
Nicholas Muller
Lester and Judith Lave Associate Professor of Economics, Engineering and Public Policy in the Department of Engineering and Public Policy and Tepper School of Business
Co-Director, Green Design Institute

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Venkat Viswanathan
Associate Professor of Mechanical Engineering, Physics (Courtesy), Materials Science and Engineering (Courtesy) and Chemical Engineering (Courtesy)

Katie Whitefoot
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LEADERSHIP & STAFF

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Materials Science and
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(Courtesy), Materials Science
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A special thanks to our interns
Cody Januszko, Olivia Luk,
Prathit Dave and Manish
Sainani.

FACULTY ADVISORY COMMITTEE

The Scott Institute's internal
faculty advisory committee
offers general strategic advice
and guidance to the Institute.
Committee members serve
terms of one to three years
and are chosen to provide
disciplinary diversity and
representation of faculty
members across the university.
The Institute is grateful
to the following members:

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School of Architecture
(Fine Arts 2014)

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Institute for Politics and Strategy

Shawn Litster
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Materials Science and
Engineering

Nikolaos Sahinidis
College of Engineering,
Chemical Engineering
(Engineering 1990)

Nicola Secomandi
Tepper School of Business,
Operations Management

Venkat Viswanathan
College of Engineering,
Mechanical Engineering,
Materials Science and
Engineering,
Chemical Engineering

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The Scott Institute Board of Advisors offers general
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is thankful for the following members' continued support.

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UK Energy Programme

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(Engineering 1985)

Susan Tierney
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Carol A. Williams
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(Engineering 1980)





INTERVIEW WITH THE DIRECTORS

"It's hard to believe it's been 10 years."

Those words, uttered by Dr. Granger Morgan, who served as the first Director of the Wilton E. Scott Institute for Energy Innovation, carry a lot of weight and can be interpreted in multiple ways. On one hand, one embedded deep in the Scott Institute may feel like the past decade has flown by. On the other hand, a lot has happened (did he mean that it's hard to believe it's been only ten years?). Since its inception, the Scott Institute has been led by three talented directors paving the way to success—**Dr. Granger Morgan** (2012-2014), **Dr. Jared Cohon** (2014-2017), and **Dr. Jay Whitacre** (2017-present). They each have their own perspectives looking at the history, impact and future of the Scott Institute. Here, they each share their unique perspective as the Institute turns ten.

WHAT DREW YOU TO JOIN THE SCOTT INSTITUTE?

Dr. Cohon: The overall concept of it was very exciting and it still is, which is that Carnegie Mellon has tremendous resources in energy—every aspect of it. From the basic science of it to policy and everything in between. But there was no central home for it, it was very distributed. So having a center that both would be a landing point, if you will, for people outside the university looking to find out what Carnegie Mellon did was exciting.

Dr. Whitacre: I first moved my office over here to Scott Hall in 2016 to be closer to other energy researchers and in so doing got a good sense of what was going on at the Institute. When the director position opened up in 2017, I was encouraged to submit my name for consideration, and was subsequently selected. I thought it would be incredibly interesting and gratifying to work in a cross-cutting way with people all over campus who work in a broad "energy" space, and I was not wrong. It is a great experience to explore and support all the different energy related projects going on here at CMU.

ARE THERE ANY SCOTT INSTITUTE INITIATIVES UNDER YOUR DIRECTION THAT YOU WOULD LIKE TO HIGHLIGHT?

Dr. Whitacre: I am particularly proud of the University Energy Institute Collective, which we started here at CMU in 2019 and are continuing to grow such that it becomes a national home for university energy institute leaders. We are also in the process of launching "decarb @CMU" which is going to be a great.

ENERGY ISSUES HAVE EVOLVED A LOT OVER THE PAST DECADE. HOW WOULD YOU DESCRIBE THIS EVOLUTION AND HOW HAS THE SCOTT INSTITUTE ADAPTED TO CHANGES AND DEVELOPED A DEEPER UNDERSTANDING OF ENERGY ISSUES?

Dr. Cohon: I think the biggest change has been the shift in the energy supply makeup with

renewables playing a much bigger role than they did 10 years ago. I would have to say the Scott Institute had their fingers in all of that. Certainly, Jay Whitacre's work on storage, Shawn Litster's work on fuel cells—this is leading, cutting edge, and if anything, it's even more important now than it was ten years ago...We've moved along with and, in a lot of cases, helped that movement to happen, as the energy/carbon decarbonization trajectory has occurred.

Dr. Morgan: Energy has of course become increasingly central. Even at the time that the Scott Institute came into existence, it was widely understood in technical communities that energy was at the heart of addressing the climate problem and decarbonizing. The energy system was absolutely critical and that was going to take both technical issues and policy issues. The urgency of decarbonizing the energy system has clearly become more widely understood over the course of the last decade.

THERE ARE UNIVERSITY-AFFILIATED ENERGY INSTITUTES ACROSS THE US AND AROUND THE WORLD. WHAT MAKES THE SCOTT INSTITUTE SPECIAL? WHAT'S ITS SECRET SAUCE?

Dr. Cohon: We're affiliated with a leading university with a great reputation and that gives us an advantage. There's the unique importance of Western Pennsylvania in the broader southern and northern Appalachian region—in energy, it's been pointed out, especially by the Allegheny Conference, that Pittsburgh may be unique in being the only place where every major form of energy is well represented, from nuclear to coal, all the renewables.

Dr. Morgan: We're much more effective at working across departmental and disciplinary boundaries than most places. We have much deeper and longer involvement in the policy aspects of energy issues in a way that understands the technology.

Dr. Whitacre: The Scott Institute is best in class at bringing together researchers from very different disciplines to answer complex questions that require input from a range of competencies and stakeholders. We routinely create environments (and seed work) where CMU faculty and students from policy departments, basic sciences, engineering,

and architecture can interact and forge new collaborations. These often to long term successful project that have tremendous impact.

THERE HAVE BEEN A LOT OF CHANGES OVER TEN YEARS, BUT IS THERE ANYTHING THAT THE SCOTT INSTITUTE HAS REMAINED CONSISTENT WITH, IN TERMS OF MISSION OR HOW IT WORKS TOWARDS ITS GOALS? IS THERE SOMETHING THAT STICKS OUT AS THE GREATEST REAL-WORLD IMPACT THE SCOTT INSTITUTE HAS MADE OVER THE PAST 10 YEARS?

Dr. Cohon: There are some clear successes that stand out. One is, we continued the seed grant program, which it started before I came, and expanded it somewhat. That's been very impactful and valuable for the faculty...We developed a visiting professor program which allowed faculty to apply for and receive funding to support a visitor for a year.

WHAT DO YOU FORESEE THE SCOTT INSTITUTE DOING IN THE NEXT TEN YEARS?

Dr. Cohon: The Scott Institute will be an enabler of a few big initiatives. I see signs that one is in the area of a decarbonization policy, with a focus on this region and how can Western Pennsylvania, in the broader region, decarbonize in a way that is also positive for the economy.

Dr. Morgan: I think the Scott Institute needs to be going aggressively after some large sources of external support, in particular things that will allow groups of faculty across the campus to be working together.

To close out the Q&A with the directors, Dr. Morgan put the Scott Institute's future into perspective:

"You and I are breathing carbon dioxide right now that was put in the atmosphere during the industrial revolution back in Great Britain," he said. "What most Americans do not understand is we have to decarbonize the energy system. And the longer we wait to do that, the more CO₂ we put in the atmosphere and that CO₂ is going to stay there for centuries, continuing to warm the planet."

The directors agree that the Scott Institute will continue to march forward in its mission—continuing to educate and support decarbonization efforts, technology and research for the benefit of the entire planet.

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Thank you to our generous supporters.

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Mitsubishi Power








Sherman and Joyce Bowie Scott

The legacy of Wilton E. Scott, oil and gas geologist and energy industry leader, lives on through the Wilton E. Scott Institute for Energy Innovation. His son Sherman (Engineering 1966) and wife Joyce Bowie Scott (Fine Arts 1965) — pictured at left — established the Institute in 2012, providing support along with the Richard King Mellon Foundation to house it in the Sherman and Joyce Bowie Scott Hall.



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On the covers: 4,784 solar panels were installed on the roof of Mill 19 at Hazelwood Green, making it the largest installation on a sloped surface in the United States. Mill 19 is a discovery workspace where Carnegie Mellon innovators partner with industry pioneers to apply digital innovation, advanced manufacturing technology and human intelligence to the production of the future. Photos courtesy of Corey Gaffer Photography & RIDC.

