



CENTER FOR SUSTAINABLE ENERGY
AT NOTRE DAME

The **kilo** JOULE 2019 ANNUAL REPORT

University Research Center

ENABLING A SUSTAINABLE ENERGY FUTURE FOR ALL



UNIVERSITY OF
NOTRE DAME

| RESEARCH

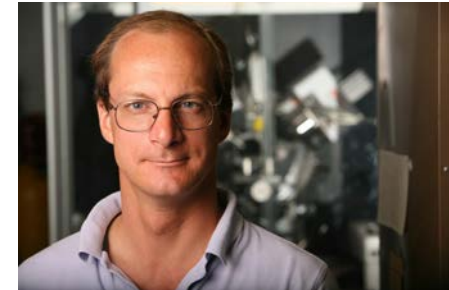
Welcome

April 2, 2020

Dear Friends and Colleagues,

I am writing this letter at a time when our country is being tasked with unprecedented challenges and uncertainties due to the world-wide pandemic of COVID-19. This fatal virus has forced us to adapt to new ways of doing things, including teaching, learning, and working from home. The need to uphold social distancing and still maintain a sense of normalcy is no easy task, **yet because of it, we have made new discoveries and created more opportunities to see the “good” in these very trying times.**

With that said, I am pleased to have the opportunity to share some “good news” with you — our annual report for 2019. This report contains a brief overview of ND Energy and its major accomplishments in research, education, outreach, and community partnerships. It also recognizes the achievements of our faculty, students, and others who have contributed greatly to the mission and vision of ND Energy.



As you read through the report, you will learn about ND Energy’s key areas of business and services along with highlights of major programs and events. This includes an overview of our second annual research symposium that was held in March. We were delighted to have Rachel Kyte, former CEO of SEforALL, as our keynote speaker, along with other invited experts, who filled the day with useful and provocative presentations focused on global sustainable energy issues and topics.

Another new program introduced in the fall was the capstone course for the Energy Studies Minor — **“Puerto Rico: Roadmap to a Renewable Future”**. This course provided classroom instruction to undergraduate students along with a weeklong immersion in Puerto Rico where students gained a deeper **understanding of Puerto Rico’s energy infrastructure and technological challenges**, while considering the cultural, ethical, political, and social aspects unique to this territory.

These are just a few of the highlights in this year’s report. I hope you will enjoy reading the rest in its entirety and joining me in celebrating the achievements of all who have contributed to energy-related research and education at Notre Dame and abroad.

In closing, I want to express my heartfelt gratitude for your continued support of ND Energy and its ongoing endeavors to enable students, faculty, and other professionals to cultivate, innovate, and transform the world toward a more sustainable energy future for all.

Best wishes to you and yours always.

Kindest regards,

A handwritten signature in black ink, which appears to read "Peter C. Burns".

Peter C. Burns

The Henry Massman Professor of Civil and Environmental Engineering and Earth Sciences
Director, Center for Sustainable Energy at Notre Dame (ND Energy)
Director, Actinide Center of Excellence (ACE)



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[energy.nd.edu](#)
[mcf.nd.edu](#)

LOOK FOR REGULAR COMMUNICATIONS

The *milliJoule* (weekly reminders of events, news, and more)

The Joule (biannual newsletter of major accomplishments and initiatives over the past 6 months)

The *kiloJOULE* (annual report—THIS REPORT—covering major accomplishments and initiatives over the past year)

The *kiloJOULE* provides an annual review of major accomplishments and activities in energy-related research, education, and outreach at the University of Notre Dame. This report covers CY2019 and highlights the work of affiliated faculty, associated researchers, students, and key collaborators.

Questions and comments may be directed to Barbara Villarosa, Business and Communications Program Director, at bvillaro@nd.edu or to Ginger Sigmon, Managing Director, at gsigmon@nd.edu.

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Internship * Young Scholars Program * TRIO Programs

Outreach

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History



ND Energy is built upon the foundations laid by the Notre Dame Energy Center, a College of Engineering research center, founded in 2005, and the University-funded Strategic Research Investment (SRI), Sustainable Energy Initiative (SEI), founded in 2010. These two entities were integrated in 2011, which resulted in its current designation as a University research center and naming it the Center for Sustainable Energy at Notre Dame, better known today as ND Energy. Since 2014, ND Energy has broadened its research areas and has become an umbrella organization for energy-related research and education at Notre Dame.

Mission, Vision, and Objectives

ND Energy's mission is to foster and grow energy-related research, support education and community outreach, and influence the national and global discussions of the most pressing energy policy issues and questions of our time.

Essentially, ND Energy enables researchers to make new discoveries, scientific advancements, and technological breakthroughs that empower students and faculty to innovate, educate, and influence the world toward a more sustainable energy future.

This is accomplished through research business development activities, research fellowships for students, the Materials Characterization Facility, the Energy Studies Minor, campus and community outreach programs, community building, and engagements, collaborations, and partnerships with industry, government, and academia.

Our vision is to enable faculty, researchers, scholars, students, and other influencers to create a sustainable energy future for all, especially those in low- and middle-income regions of the world.

ND Energy's primary objectives are aligned with the University's vision and goals to become a preeminent research university with a distinctive Catholic mission and unsurpassed undergraduate education. They are as follows:

- Serve as a focal point for all University-wide energy-related research and education activities.
- Foster and grow inter-college collaborations in energy-related research and education.
- Enhance research development and establish more external collaborations.
- Increase educational opportunities pertaining to energy at the undergraduate and graduate levels.
- Influence the national and global views on energy policy, ethics, and international relations.

Center Leadership

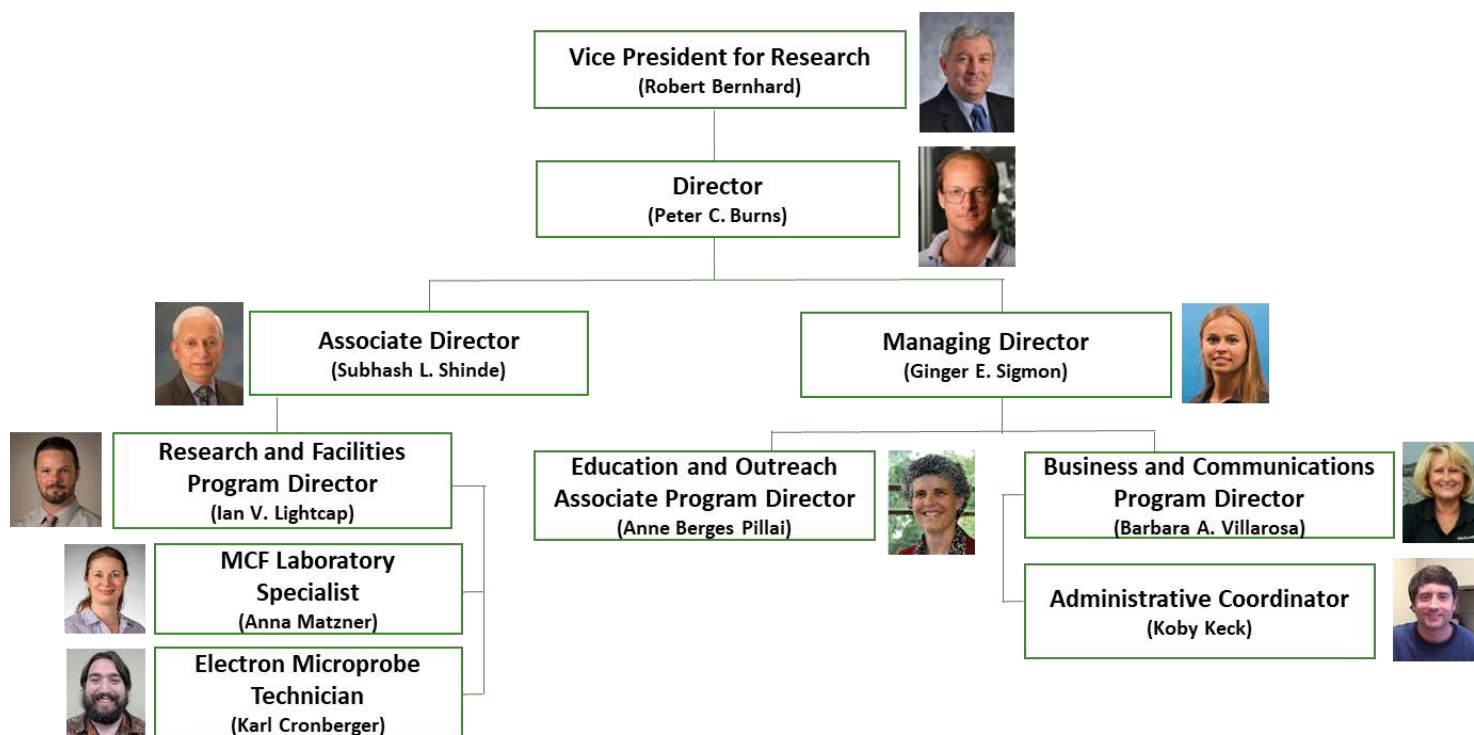
As a University Research Center, ND Energy reports directly to the Vice President for Research, and it has strong connections with all colleges and schools, especially the Colleges of Engineering and Science, where most affiliated faculty and associated researchers reside.

ND Energy's leadership team offers a full menu of research services to faculty and associated researchers to advance research business development and increase external funding in energy at Notre Dame. For example, team members connect and engage industry partners and collaborators on research proposals, gather data and supporting documents, write proposal sections, develop outreach for broader impacts, provide facility services and other resources, and manage grant projects and budgets. The team is well positioned and prepared to support all aspects of research proposal development at Notre Dame. Since 2014, ND Energy's team has assisted in proposal development totaling over \$131.5M in submissions.

Meet Karl Cronberger

Karl Cronberger is the newest member of the ND Energy Leadership Team. He is a recent Ph.D. graduate from the University of Notre Dame and currently operates **and maintains the two Electron Microprobes (EMP) within ND Energy's Materials Characterization Facility**. The EMP is a specialized electron microscope used for chemical analysis with a resolution of up to 1 micron and commonly used to characterize a variety of materials in various fields of studies such as the geology of the Earth, Moon, and meteorites; nuclear forensics, and fuel systems; industrial applications in metallurgy, and battery production; and some biological and environmental applications as well.

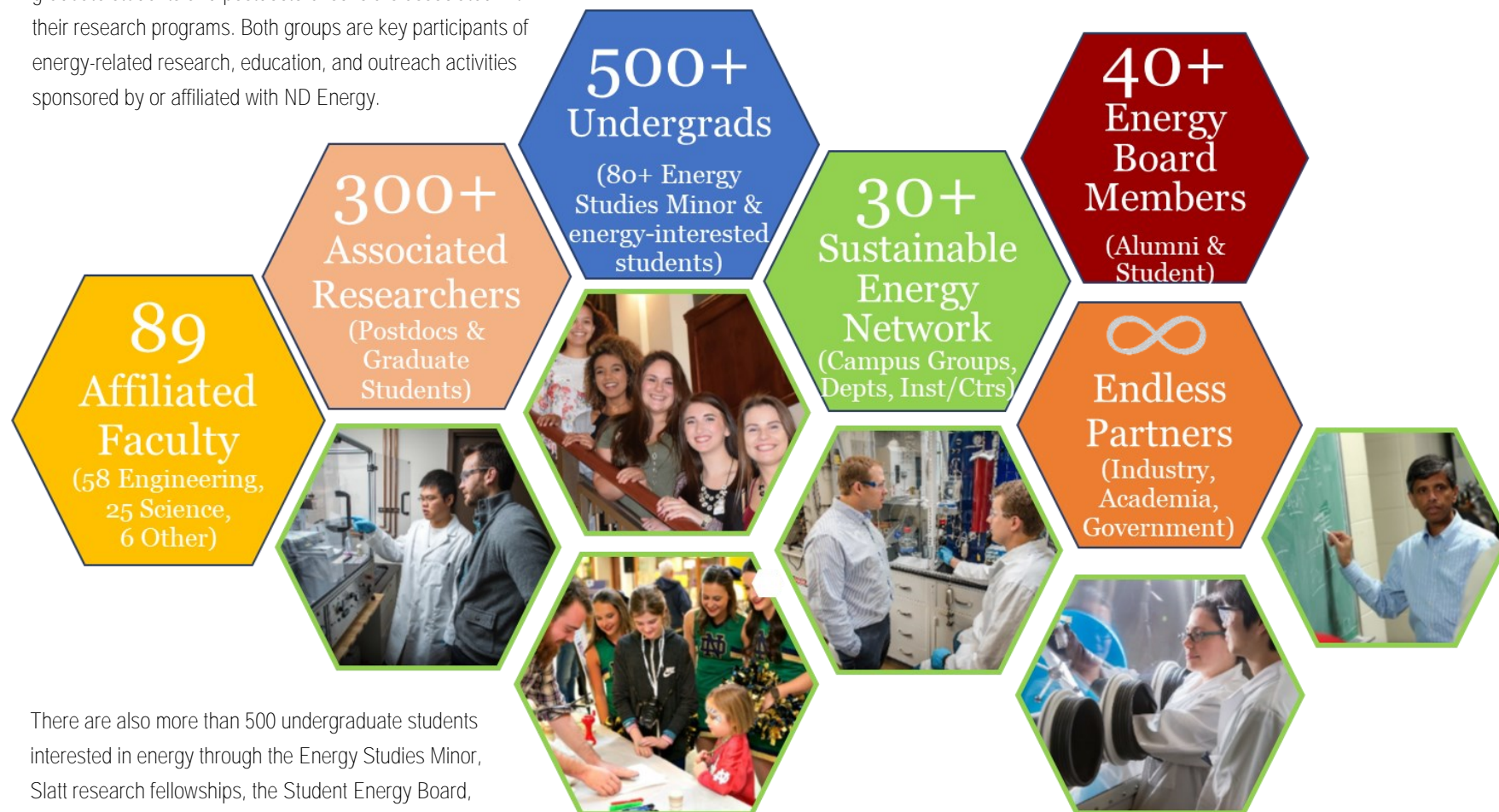
Karl's Ph.D. work at Notre Dame revolved around Lunar Petrology and the origin of the Moon.



Building Community

ND Energy builds and fosters a strong energy community at Notre Dame with faculty, students, administrators, alumni, and external partners contributing to various goals as members of the Alumni Energy Board, Sustainable Energy Network, Student Energy Board and other groups and ad hoc committees. This vibrant network enables us to provide distinct opportunities for regular engagement, including workshops, symposia, lectures, faculty forums, student seminars, professional development programs, and campus and community outreach activities.

There are currently 89 affiliated faculty members with over 300 graduate students and postdoctoral scholars associated with their research programs. Both groups are key participants of energy-related research, education, and outreach activities sponsored by or affiliated with ND Energy.



There are also more than 500 undergraduate students interested in energy through the Energy Studies Minor, Slatt research fellowships, the Student Energy Board, and other programs and outreach activities.



Affiliated Faculty

ND Energy affiliated faculty are key members of the energy community at Notre Dame. Their interests and expertise in energy-related research and education are the foundation of our research focus areas and help to strengthen the educational offerings provided through the Energy Studies Minor. This year, we welcomed six new faculty affiliates.

Faculty who joined ND Energy in 2019 were as follow:

All affiliated faculty may be viewed at: <https://energy.nd.edu/about/affiliated-faculty/>



Christiane Baumeister

Robert and Irene Bozzone Associate Professor, Economics

Interests:
Energy Conversion and Efficiency



Kyle Bibby

Wanzek Collegiate Chair and Associate Professor, Civil & Environmental Engineering & Earth Sciences

Interests:
Sustainable Bio/Fossil Fuels



David Burghoff

Assistant Professor, Electrical Engineering

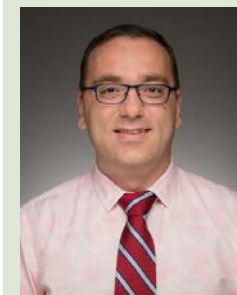
Interests:
Energy Conversion and Efficiency, Transformative Solar



Christopher Hinkle

Bettex Collegiate Chair and Associate Professor, Electrical Engineering

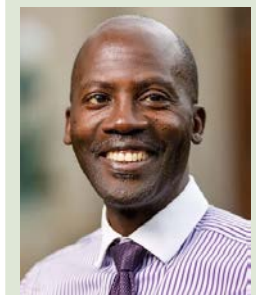
Interests:
Smart Distribution and Storage, Transformative Solar



Khachatur Manukyan

Research Assistant Professor, Physics

Interests:
Sustainable and Secure Nuclear

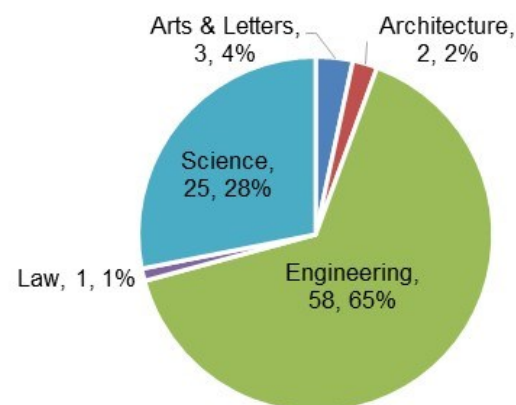


John Onyango

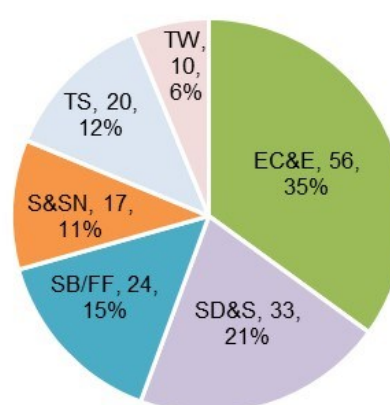
Associate Professor, School of Architecture

Interests:
Energy Conversion and Efficiency

Faculty by College/School



Faculty by Research Areas



EC&E Energy Conversion and Efficiency
Building Energy, Catalysis, Conversion of Energy, Fuel Cells, Hydrogen, Solar to Fuels/Chemicals

SD&S Smart Distribution and Storage
Hydrogen Storage, Smart Grid Technology, Storage of Energy

SB/FF Sustainable Bio/Fossil Fuels
Biofuels, Carbon Sequestration, Fossil Fuels

S&SN Sustainable and Secure Nuclear
Actinide Materials, Nuclear Forensics, Nuclear Physics, Nuclear Structures

TS Transformative Solar
Solar Photovoltaics, Solar to Fuels/Chemicals, Energy Conversion Efficiencies

TW Transformative Wind
Structures, Turbines, Wind Engineering

Energy Boards

The Alumni Energy Board is comprised of Notre Dame alumni who serve as members of the College of Engineering Advisory Council and are leaders in the energy field. They meet annually with ND Energy to provide advice and counsel on strategic initiatives in energy research and education.

2019 members are shown here.

The Sustainable Energy Network is comprised of Notre Dame representatives from various centers and institutes, departments, and student organizations who have similar interests in environmental topics. They meet throughout the academic year to discuss and share current initiatives and events.

2019 members are listed here.

The Student Energy Board is comprised of Notre Dame undergraduate and graduate students from all colleges and schools interested in energy. They meet regularly throughout the academic year to plan and organize outreach activities, including the annual Notre Dame Energy Week.

2019 core leaders are listed below.

Breanna Belz, College of Engineering, 2020
Emily Black, College of Engineering, 2020
Vignesh Chiniyah, College of Engineering, 2020
Amorette Hernandez, College of Arts and Letters, 2021
Emma Kerr, College of Engineering, 2022
Diane Kim, College of Engineering, 2022
Erika Kim, College of Engineering, 2020
Angelo Liu, College of Science, 2020
Erin Ludwig, College of Engineering, 2022
Abigail Martin, College of Engineering, 2021
Abbey McCarthy, College of Engineering, 2021
Chase Miller, College of Engineering, 2020
Kathryn Moran, College of Arts and Letters, 2021
Kelly Moran, College of Engineering, 2021
John Quinlan, College of Science, 2020
Jonathan Reuvers, Mendoza College of Business, 2020
Claire Saltzman, College of Science, 2020
Mackenzie Winton, College of Engineering, 2021

Alumni Energy Board



Anthony F. Earley, Jr.
Pacific Gas and Electric Corp.
(retired)



Edward B. Fitzpatrick, Jr.
P.E. Consulting



John M. Kelly, Jr.
Vanguard Oil and Gas



Michael A. O'Sullivan
FPL Energy



Robert N. Schleckser
ExxonMobil Corporation



Richard L. Stanley
GE Energy

Sustainable Energy Network

Department/Organization	Representatives
Center for Social Concerns	Bill Purcell
Chemical and Biomolecular Engineering	Susan Vissage
Chemistry Department	Brian Baker, Mary Prorok
College of Arts & Letters	Josh Weinhold, Mark Schurr
College of Engineering	Gary Gilot
College of Science	Bill O'Hayer
College of Science Committee on Sustainability	Anthony Serianni
College of Science – Physics	Thomas Loughran
de Nicola Center for Ethics and Culture	Laura Gonsiorek
Energy Engineering Minor	Joseph Powers
Energy Studies Minor	Peter Burns, Anne Pillai
Environmental Change Initiative	Kara Primmer
Facilities Design and Operations – Utilities	Paul Kempf
Flatley Center for Undergraduate Scholarly Engagement	Kati Schuler
GreeND Student Organization	K. Bonnet, G. Champion, J. Roberts, K. Lane, G. Castle, A. Finster
GLOBES	Gary Lamberti
Institute for Advanced Study	Donald Stelluto, Carolyn Sherman
Institute for Flow Physics and Control (FlowPAC)	Thomas Corke
Kellogg Institute	Therese Hanlon, Holly Rivers
Kroc Institute	Anna VanOverberghe
Mendoza Energy & Resources Club	Jonathan George
Mendoza College of Business	Sam Miller
Minor in Sustainability	Alex Hajek, Rachel Novick
ND Research	Joanne Fahey
ND Nano	Heidi Deethardt, Derek Lake
LEAST and ASCENT	Robert Dunn
Office of Sustainability	Caitlin Hodges
Pulte Institute for Global Development	Jennifer Krauser, Tom Purekal
Reilly Center for Science, Technology and Values	Anna Geltzer
Radiation Laboratory	Ian Carmichael, Laura Mortlock-McMinn
School of Architecture	Dennis Doordan, Barbara Panzica
Student Energy Board, ND Energy	Breanna Belz
Student Government	E. Boyle, P. McGuire, J. Kelley, M. Isaac, B. Steiner
Resiliency and Sustainability of Engineering Systems Minor	Kevin Walsh, Consuelo AntonioGuerra

External Partnerships

Over the years, ND Energy has cultivated partnerships and collaborations with individuals, groups, and organizations within academia, industry, and government. This has enabled broader research capabilities, stronger education programs, and unique opportunities for our students, faculty and general constituents. Some major connections are listed below.

American Electric Power	Mishawaka School Corporation
AmeriCorps	MIT Lincoln Laboratory
Argonne National Laboratory	National Energy Technology Laboratory
AT&T	National Renewable Energy Laboratory
Atlanta University Center Consortium	Naval Nuclear Laboratory
Bertrand Farm	Northern Indiana Regional Science and Engineering Fair
Bethel College	Oak Ridge National Laboratory
Boeing	Pacific Northwest National Laboratory
Chevron	Prairie Winds Nature Farm
City of South Bend*	Purdue University
Deloitte	Regional Environmental Action Network, IU South Bend
EDF Energy	Saint Mary's College
enFocus	Sandia National Laboratories
ExxonMobil	Siemens
Food Rescue US	South Bend Community School Corporation
Fund for the Public Interest	St. Adalbert Catholic School
General Electric	St. Joseph County Public Library
Goshen College	Stanford University
IBM	STARBASE Indiana, Department of Defense
Indiana and Michigan Power	Sustainability Office, IU South Bend
Indiana University	Unity Gardens
Inovateus Solar LLC	Universidad del Sagrado Corazon
Invenergy	University of Arizona
Ivy Tech Community College	University of Puerto Rico-Mayaguez
KPMG	University of Texas-Austin
Let's Share the Sun Foundation	University of Virginia
Madison STEAM Academy	Washington State University
Mishawaka Parks and Recreation	Young Southeast Asian Leaders Initiative



Research Areas

Researchers affiliated with ND Energy strive to make new discoveries, scientific advancements, and technological breakthroughs that empower students and faculty to innovate, educate, and influence the world toward a more sustainable energy future for all. This creates an environment conducive to advancing multidisciplinary, innovative research and scholarly initiatives that penetrates all major research areas focused on energy. These areas are highlighted below and the information on subsequent pages reflects the excellence in energy-related research and education at Notre Dame.

Major Research Themes



Energy Conversion and Efficiency



Subcategories
Building Energy,
Catalysis, Conversion
of Energy, Fuel Cells,
Hydrogen, Solar to
Fuels/Chemicals



56
Affiliated Faculty



\$4,369,292
External Awards



Smart Distribution and Storage



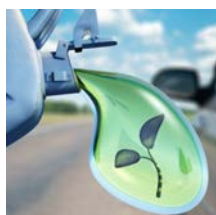
Subcategories
Hydrogen Storage,
Smart Grid
Technology,
Storage of Energy



33
Affiliated Faculty



\$735,822
External Awards



Sustainable Bio/ Fossil Fuels



Subcategories
Biofuels,
Carbon
Sequestration,
Fossil Fuels



24
Affiliated Faculty



\$1,652,865
External Awards



Sustainable and Secure Nuclear



Subcategories
Actinide Materials,
Nuclear Forensics,
Nuclear Physics,
Nuclear Structures



17
Affiliated Faculty



\$3,151,075
External Awards



Transformative Solar



Subcategories
Solar Photovoltaics,
Solar to Fuels/
Chemicals,
Energy Conversion
Efficiencies



20
Affiliated Faculty



\$181,440
External Awards



Transformative Wind



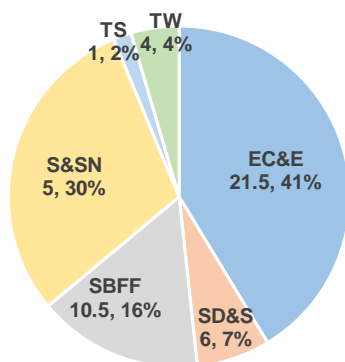
Subcategories
Structures,
Turbines,
Wind Engineering



10
Affiliated Faculty



\$481,042
External Awards



EC&E Energy Conversion and Efficiency
SD&S Smart Distribution and Storage
SBFF Sustainable Bio/Fossil Fuels
S&SN Sustainable and Secure Nuclear
TS Transformative Solar
TW Transformative Wind

TOTAL AWARDS
FOR 2019
48
\$10,571,536

Global Sustainable Development

Aligned with Notre Dame's Catholic mission, Pope Francis's Encyclical *Laudato si'*, and United Nations' Sustainable Development Goal 7, ND Energy has expanded its vision to enable research and other scholarly endeavors well beyond the traditional university laboratory setting. Amidst natural environments, human habitats, and indigenous regions, unique discoveries are made that create a deeper, more comprehensive understanding of technological and systematic challenges, and the economic, political, historical, and ethical issues relevant to particular areas of the world. This is especially true in low- and middle-income countries, where a greater emphasis is placed on the sociological and humanistic aspects of providing sustainable energy solutions.

This year, ND Energy continued its support of the Energy E3: Education, Engineering-design, and Entrepreneurship program, led by Abigail Mechtenberg, assistant teaching professor of physics. Under her direction, students traveled to their home countries in Uganda, Rwanda, Nigeria, and Haiti to implement the E3 curriculum and where energy teams of local technicians and engineers were formed. These teams learned how to prototype, design, build, install, maintain, and create a business venture for renewable energy devices using local materials. These devices, when combined, create micro-grids that produce electricity in **places where it doesn't exist. These devices** include the following: cattle-go-round generator, merry-go-round generator, bicycle generator, hand-crank generator, hydroelectric generator, wind turbines, concentrating solar power generator, thermal electric cook-stove/solar, waste incinerator generator, retrofitted petrol generator (biogas) using anaerobic digester: methane, retrofitted petrol generator (biogas) using urine electrolysis: hydrogen, bio-diesel generator using Ugandan algae: oil.

A new initiative this year focused on the aftermath of Hurricane Maria and the devastation it caused to Puerto Rico's energy infrastructure, which started with a newly developed partnership with Casa Pueblo, an award-winning community center in Adjuntas, led by Arturo Massol Deyá and his father Alexis Massol González. This relationship began in fall 2018 when Massol presented a lecture during the 12th annual Notre Dame Energy Week. Since then, ND Energy has visited Casa Pueblo and the Universidad del Sagrado Corazón to discuss ways in which to engage students from Notre Dame and Puerto Rico in research and education programs. This resulted in a new capstone course for the Energy Studies Minor — Puerto Rico: Road Map to a Renewable Future — offered for the first time in fall 2019. Twelve undergraduate students participated in weekly preparatory classes and spent a weeklong immersion in San Juan and Adjuntas, Puerto Rico, during fall break. Students learned about the opportunities and challenges of creating more resilient energy grids, while studying the technological challenges and considering the economic, political, historical, and ethical issues unique to Puerto Rico. This seminar course will be offered again in Spring 2021.

Energy Policy

ND Energy collaborates with researchers and other departments and organizations to provide support and resources for activities leading to new policy developments and other related initiatives. This year, ND Energy partnered with the Pulte Institute for Global Development and hosted Craig A. Hart through the Pulte Institute's Policy and Practice Visiting Associates Program. During Hart's visit, he studied the future of energy in the Midwest and later wrote the following report: *Strategy for the Future: Energy Transition, Competitiveness and the Future Midwest*

The views expressed in this report are those of the author and do not necessarily represent those of ND Energy and the Pulte Institute for Global Development.



Craig A. Hart is the Executive Director of Pace Energy & Climate Center at Pace University's Haub School of Law, a lecturer at Johns Hopkins University's Energy Policy and Climate program, and senior fellow at the Atlantic Council's Global Energy Center. Mr. Hart advises governments, project developers, lenders and investors in conventional energy, renewable energy and carbon management projects and regulation in Asia, the Americas, Africa, and the Middle East.

Hart holds a J.D. and B.A. from the University of California at Berkeley, an M.A. from New York University, and a Ph.D. from the Massachusetts Institute of Technology.

Research Business Development

Research Awards

In 2019, ND Energy affiliated faculty received 48 externally funded awards totaling over \$10.5M. Of this amount, over \$7.5M or 71% was affiliated with ND Energy. Affiliation is the amount of the proposal designated by the lead principal investigator (PI) as attributable to energy-related research. This designation is optional and can be attributed to more than one center/institute. Additionally, of these awards, 24 were new in 2019 totaling more than \$4.8M.

Total Awards: 48 Total Amount: \$10,571,536 Total Affiliation: \$7,519,060 Percent Affiliated: 71% New Awards: 24 totaling \$4,887,075

Research Proposals

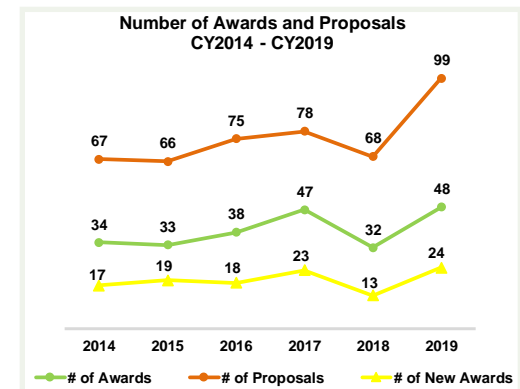
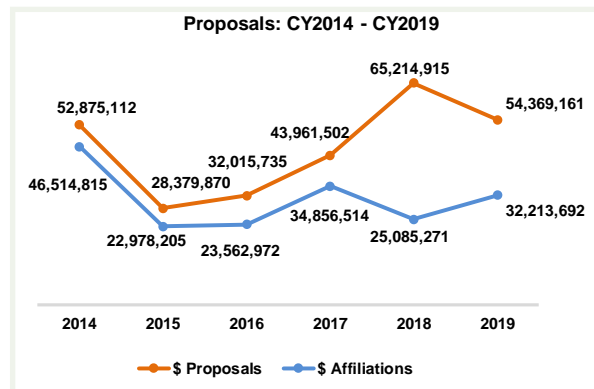
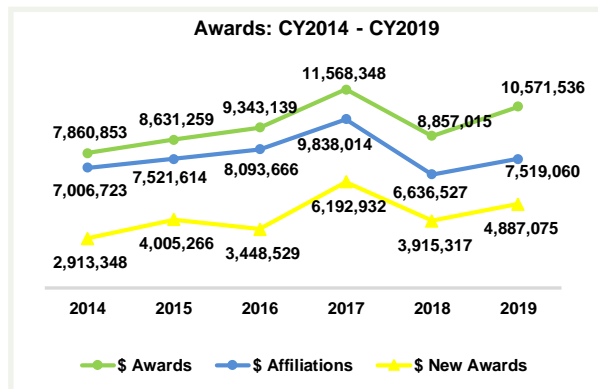
ND Energy supports faculty with proposal submissions by identifying potential funding opportunities; engaging teams in brainstorming activities; fostering relationships and cross-cutting research capabilities; establishing external partnerships and collaborations with academia, industry, and national laboratories; and assisting with proposal preparations. In 2019, ND Energy affiliated faculty submitted 99 proposals totaling more than \$54M. Of this amount, over \$32M or 59% was affiliated with ND Energy. Affiliation is the amount of the proposal designated by the lead principal investigator (PI) as attributable to energy-related research. This designation is optional and can be attributed to more than one center/institute.

Total Submissions: 99

Total Amount: \$54,369,161

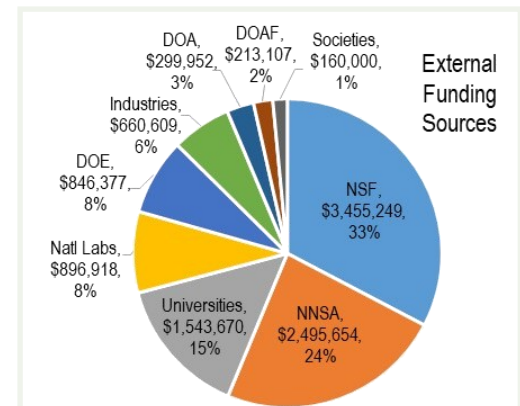
Total Affiliation: \$32,213,692

Percent Affiliated: 59%



Research Funding Sources

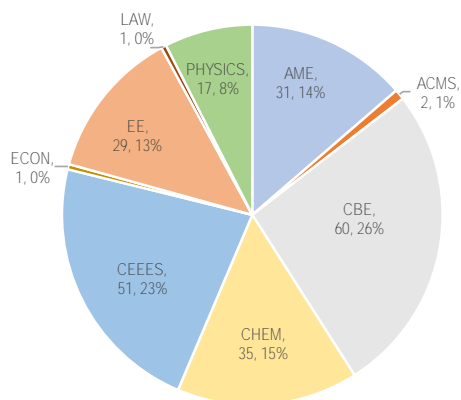
Primary sources of external research funding for energy-related awards in 2019 are shown here. The agencies providing the highest amounts of funding are the National Science Foundation (NSF), National Nuclear Security Administration (NNSA), and other Universities. Other agencies are National Laboratories, Department of Energy (DOE), Industries, Department of Army (DOA), Department of Air Force (DOAF), and Societies.



Research Publications

Sixty-two (62) affiliated faculty members published energy-related journal articles in 2019. Nine (9) faculty members published 6 or more journal articles, representing nearly 39% of total publications. There were 18 faculty with total citations of 100 or more in 2019. Over the past six years (2014-2019), affiliated faculty have published 1,417 energy-related journal articles with citations totaling 34,659.

2019 Journal Articles by Department



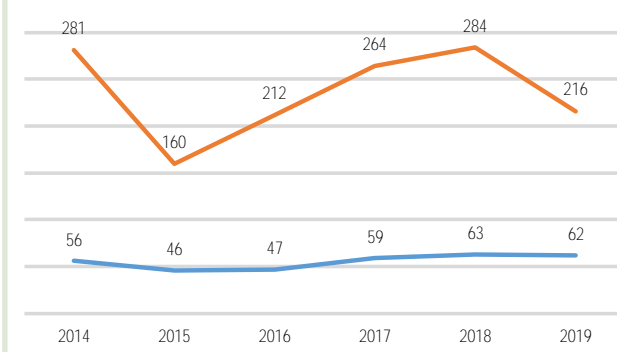
There were 227 energy-related journal articles published in 2019. Eleven of them were in collaboration with other affiliated faculty for a net total of 216.

As shown here, departments with the highest number of publications in 2019 were Chemical and Biomolecular Engineering at 60, Civil & Environmental Engineering & Earth Sciences at 51, Chemistry and Biochemistry at 35, and Aerospace and Mechanical Engineering at 31. Electrical Engineering, Physics, Applied and Computational Mathematics and Statistics, Law, and Economics were other contributing departments.

The total number of energy-related journal articles published from 2014 through 2019 was:

1,417

Number of Publications and Faculty by Year



9 Faculty with = / > 6 Publications in 2019

PI	No.
Peter Burns	18
Suman Datta	17
William Schneider	9
Ruilan Guo	8
Prashant Kamat	8
Tengfei Luo	8
Alexander Mukasyan	8
Masaru (Ken) Kuno	6
Robert Nerenberg	6

88

PUBLICATIONS

18 Faculty with = / > 100 Citations in 2019

PI	No.	PI	No.
Prashant Kamat	1984	Jason Hicks	182
William Schneider	757	Patrick Fay	169
Masaru Kuno	754	Haifeng Gao	165
Tengfei Luo	648	Gregory Hartland	155
Peter Burns	309	Sylvia Ptasińska	144
Ruilan Guo	237	David Go	142
Alexander Mukasyan	229	Vijay Gupta	135
Edward Maginn	194	William Phillip	120
Suman Datta	187	Olaf Wiest	103

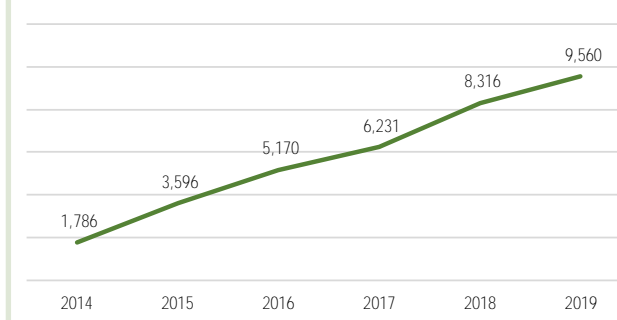
6,614

CITATIONS

The total number of citations on energy-related journal articles published from 2014 through 2019 was:

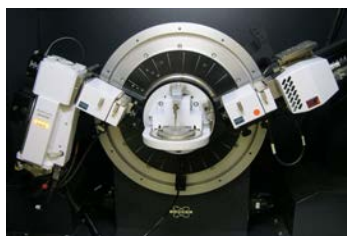
34,659

Number of Citations on Articles Published in 2014-2019



Materials Characterization Facility (MCF)

The Materials Characterization Facility (MCF) delivers state-of-the-art analytical services, expertise, and instrumentation with unique capabilities to resolve some of the most relevant scientific problems facing researchers today. The MCF is managed by Dr. Ian Lightcap, ND Energy's Research and Facilities Program Director, who oversees the following major areas of capabilities within the MCF:



Crystallography

Instruments:

Powder XRD
Single Crystal XRD
High-Res XRD



Electrochemistry

Instruments:

Solar Fuels and
Electrocatalyst Testing Stations



Gas Analysis

Instruments:

Gas Chromatograph with Mass
Spectrometry
GC-FID
GC-TCD
Triple Quad GC-MS



Polymer/Particle Analysis

Instruments:

SEC-MALS
Zetasizer and DLS



Rheometry/DMTA/Tribology

Instruments:

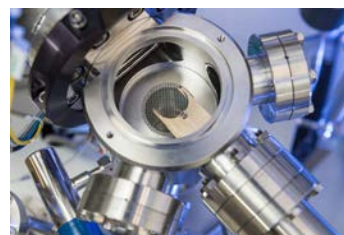
Hybrid Rheometer



Spectroscopy

Instruments:

FTIR
FTIR Microscope
Micro-Raman
Solar Simulators
UV-Vis



Surface Analysis

Instruments:

ASAP 2020 Surface Area and
Porosity Analyzer
Profilometer
AFM Park XE7
Asylum AFM
XPS
SX-100 Microprobe



Synthesis

Instruments:

Microwave Reactor
Thermal Evaporator



Thermal Analysis

Instruments:

DSC
Calorimeter - Drop Solution
Calorimeter - Reaction
TG/DSC
TG/DSC-Mass

External Use

The MCF provides external users customized analytical solutions that range from customer-specified analytical work to sponsored R&D projects involving coordinated use of analytical services across campus with the option to consult with faculty experts in materials areas important to the issues being investigated.

New instruments are added to the MCF when faculty join the University or the need arises for additional capabilities. In 2019, the existing SX-50 electron microprobe was replaced with an upgraded SX-100 electron microprobe through the University's Equipment Restoration and Renewal (ERR) Program.

MCF Outreach



The MCF was one of sixteen facilities on User Facility Row during the Materials Research Society Fall Meeting and Exhibit in December 2019. Drawing thousands of visitors to the Exhibit Hall, facility representatives held one-on-one conversations with participants who were eager to learn about capabilities and expertise available to support their research. Dr. Ian Lightcap and Dr. Subhash L. Shinde represented the MCF.

MCF in Numbers

12 Awards were received by faculty in 2019 who indicated the use of the MCF to achieve their research objectives. Awards totaled \$4,567,057.

35 Proposals were submitted by faculty for external funding who included the use of the MCF in its “facilities and equipment” section to achieve their research objectives.

52 Publications were reported by faculty who used data obtained from MCF instruments.

USERS
62 PIs
12 Departments
333 Researchers

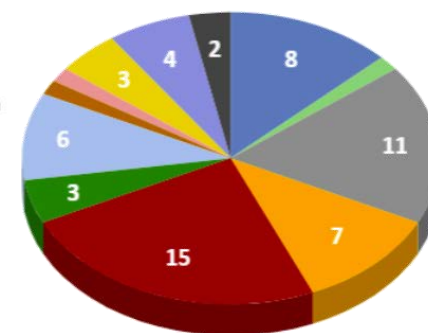
There were 62 principal investigators (PIs) from 12 different departments or centers/institutes whose group members used the MCF in 2019.

The largest number of users by PI were from the Departments of Chemistry and Biochemistry with 15 PIs and Chemical and Biomolecular Engineering with 11 PIs.

There were 333 users of the MCF in 2019.



Total Number of PIs by Department



MCF Location

The MCF is located at 146 and 147 Stepan Chemistry Hall as pictured here. Trainings, workshops, and individual or group tours are available by contacting Dr. Ian Lightcap.



More information about the MCF can be found at: <https://mcf.nd.edu/>

Faculty Forums

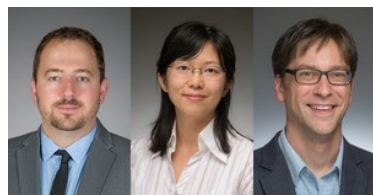
ND Energy's research business development enables new relationships and synergies across interdisciplinary lines, creating broader research areas and cross-cutting collaborations. Engaging faculty in monthly forums to discuss specific research topics, share ideas, and consider upcoming or anticipated external funding opportunities is key to advancing energy-related research at Notre Dame. The following topics were presented by faculty and discussed openly during the 2019 faculty forums.



January 24

*Big Picture Ideas in
Energy-Related Catalysis*

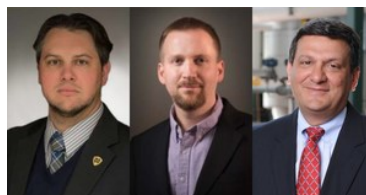
By William Schneider



February 14

*Biomolecular Materials,
Molecular and Synthetic Biology,
and BioPolymer*

By Matt Webber, Na Wei, and
Jonathan Whitmer



March 14

*Electrical Grid Modernization in
Presence of Distributed
Resources*

By Joshua Cameron,
Aaron Striegel, and Paul Kempf



April 12

*Opportunities and
Challenges for Metal
Halide Perovskites*

By Prashant Kamat



May 23

*Next Generation
Computing*

By Suman Datta



August 28

*De-polymerization of
Plastics*

By Thomas Degnan



September 24

*Directional Solvent Extraction
Desalination Using Low Grade
Waste Heat*

By Tengfei Luo

*Nanoscale to Macroscale
Engineering of Thermoelectric
Energy and Sensor Systems*

By Yanliang Zhang



October 29

*Biofilms and Energy:
New Approaches to
Avoiding 'Bad' Biofilms
and Harnessing 'Good'
Ones*

By Robert Nerenberg



November 19

*BioEpiNet approach in
determining thermal
comfort and energy
reduction potentials - The
case of Guttu Traditional
houses of South Canara*

By John Onyango



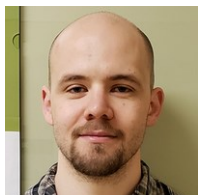
December 11

*Probing Surface
Redox Chemistry of
Semiconductor
Nanocrystals*

By Emily Tsui

Engaging Associate Researchers

Graduate students and postdoctoral scholars associated with ND Energy affiliated faculty presented the following research topics during monthly forums to facilitate cross-disciplinary collaborations and provide an opportunity for researchers to gain a better understanding of the energy-related research programs at Notre Dame.



January 16

Intercalation of Uranyl Peroxide Nanoclusters into Pillared Layered Double Hydroxides, by Samuel Perry, third-year graduate student (Burns Lab), Department of Civil & Environmental Engineering & Earth Sciences



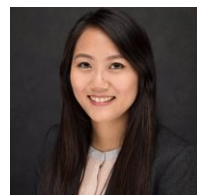
January 16

Investigation of Urine Electrolysis for Nitrogen Removal by Andrew Schranck, fifth-year graduate student (Doudrick Lab), Department of Civil & Environmental Engineering & Earth Sciences



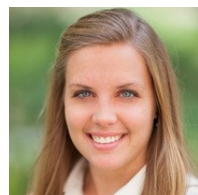
February 20

Dual-Functionalized Nanofiltration Membranes Exhibit Multifaceted Anti-Fouling and Ion Rejection Performance by John Hoffman, third-year graduate student (Phillip Lab), Department of Chemical and Biomolecular Engineering



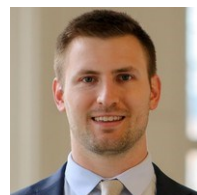
February 20

Bimetallic Phosphide Catalysts for Biomass Upgrading Reactions by Yolanda Bonita, fourth-year graduate student (Hicks Lab), Department of Chemical and Biomolecular Engineering



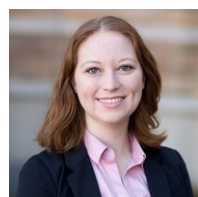
April 17

Rare Earth Element Interactions with Uranium Oxides by Rebecca Carter, fourth-year graduate student (Hixon Lab), Department of Civil & Environmental Engineering & Earth Sciences



April 17

Design of Intrinsically Microporous Iptycene-based Polymers for Enhanced Gas Separation Membranes by Tanner Corrado, third-year graduate student (Guo Lab), Department of Chemical and Biomolecular Engineering



May 15

Interfacial Charge Transfer between Excited CsPbBr₃ Nanocrystals and TiO₂: Charge Injection versus Photodegradation by Rebecca Scheidt, fourth-year graduate student (Kamat Lab), Department of Chemistry and Biochemistry



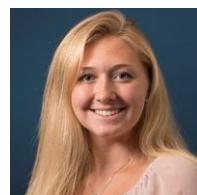
October 16

Radiation Effects of Solid Uranyl Peroxides by Melissa Fairley, postdoctoral scholar (LaVerne Lab), Radiation Laboratory



October 16

A Flexibility Market-Based Approach to Increase Penetration of Renewables in the Power Grid by Nayara Aguiar, fourth-year graduate student (Gupta Lab), Department of Electrical Engineering



November 20

Patterns and Mechanisms of Plio-Pleistocene Climate Change in Southeastern Africa by Audrey Taylor, third-year graduate student (Berke Lab), Department of Civil & Environmental Engineering & Earth Sciences

Summaries of 2019 seminars can be viewed at: <https://energy.nd.edu/about/associated-researchers/2019-seminars/>

Student Research Fellowships (page 1 of 4)

An elite group of students were selected to advance energy-related research at Notre Dame through the Eilers, Forgash, and Slatt student research fellowship programs. The 2019 recipients and their research projects are highlighted below.

The Patrick and Jana Eilers Graduate Student Fellowship for Energy Related Research

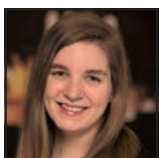
The Eilers research fellowship supports graduate student stipends ranging from \$4,000 to \$10,000 each over a one-year period. Since its inception in 2012, there have been 25 awards made to students totaling nearly \$219,000. Funding for the Eilers fellowship is made possible through the generosity of **Patrick ('90) and Jana Eilers; The Fitzpatrick Endowment for Excellence for the Center for Energy**, established in 2008 by Edward Fitzpatrick, Jr. ('54); and The Michael A. O'Sullivan Endowment for Excellence in Energy Research, established in 2014 by Michael A. O'Sullivan ('82).



Nayara Aguiar, third-year student in the Department of Electrical Engineering, collaborated with Prof. Vijay Gupta on her project entitled *Electricity Market Design to Increase Integration of Renewables in the Power Grid*, which focused on the design of a new market structure using flexible energy resources and renewables to gain additional economic and sustainable benefits.



Michael Brennan, fourth-year Inorganic/Materials Chemistry major, collaborated with Prof. Masaru Kuno on his project entitled *Compositionally Insensitive Size-Dependent Stokes Shifts in CsPbX₃ (X = Cl, Br, I) Nanocrystals*, which focused on understanding the origin of a size-dependent Stokes shift, providing significant insight into the photophysics and electronic structure of all-inorganic/hybrid lead halide perovskite nanostructures and thin films for applications in solar cells.



Laura Merrill, fourth-year student in the Department of Chemical and Biomolecular Engineering, collaborated with Prof. Jennifer Schaefer on her project entitled *The Role of Morphology and Electrochemical Interface on the Electrodeposition/Dissolution Efficiency of Magnesium Batteries*, which focused on the study of magnesium electrodeposition for propelling magnesium battery technology to be a viable option for electrical vehicle or grid-scale energy storage solutions.



Samuel Perry, third-year student in the Department of Civil and Environmental Engineering and Earth Sciences, collaborated with Prof. Peter Burns on his project entitled *Intercalation of Uranyl Peroxide Nanoclusters into Synthetic Layered Double Hydroxide Clays*, which focused on the study of several aspects of uranium compounds that could provide useful applications in the nuclear fuel cycle during geologic disposal of used nuclear fuels and remediation of contaminated sites.



Qinnan Zhang, fifth-year student in the Department of Chemical and Biomolecular Engineering, collaborated with Prof. Ruilan Guo on her project entitled *Toward a Better Understanding of Iptycene-based Polyimide Membranes: Structure, Microporosity and Gas Separation Performance*, which focused on developing new microporous polymer membranes for energy efficient applications to address the permeability-selectivity tradeoff of current polymer gas separation membranes.

Student Research Fellowships (page 2 of 4)

The Forgash Fellowship for Solar Energy Research

The Forgash research fellowship provides a \$5,000 award to an undergraduate or graduate student interested in conducting solar energy research. Since its inception in 2009, 10 students (6 undergraduates and 4 graduates) have received awards ranging from \$1,500 to the current amount of \$5,000, totaling \$24,000 to-date. Funding for the Forgash fellowship is made possible through the generosity of John ('00) and Karla Forgash.



Amal Sebastian, second-year graduate student in the Department of Physics, collaborated with Prof. Sylwia Ptasińska on his project entitled *Atmospheric Pressure Plasma: A Novel Tool for the Synthesis of Efficient Photocatalytic Materials*, which focused on using a novel deposition method to engineer new functional materials that can be used to capture solar radiation.

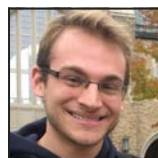
The Vincent P. Slatt Fellowship for Undergraduate Research in Energy Systems and Processes

The Slatt research fellowship supports multiple awards annually in the amount of \$5,000 each to undergraduate students interested in creating new technologies and advancing energy systems globally. Since its inception in 2006, 130 students have received awards totaling more than \$613,000. Funding for the Slatt fellowship is made possible through the generosity of **Christopher ('80) and Jeanine Slatt in honor of Vincent P. Slatt, Notre Dame Class of 1943.**

The following Notre Dame students received awards to conduct research during the academic year.



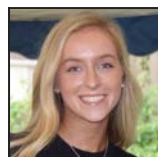
Emily Doyle, sophomore, majoring in chemical engineering, collaborated with Prof. Jennifer Schaefer on her project entitled *Magnesium-Sulfur Battery Production*, which focused on understanding the speciation of polysulfide anions within the battery cell, thereby giving insight into the design requirements for improving its capacity retention and life-cycle.



Jack Gorman, junior, majoring in aerospace engineering, collaborated with Prof. Hirotaka Sakaue on his project entitled *Application of Microfiber Coatings to Aerodynamic Surfaces*, which studied the use of microfiber coatings on transportation devices to reduce drag and noise in an attempt to decrease energy consumption.



Seancarlos Gonzalez, sophomore, chemical engineering major, collaborated with Prof. Jennifer Schaefer on his project entitled *Developing Carbon Cloth Interlayer Cathodes with Tungsten Disulfide Catalysts for Magnesium Sulfur Batteries*, which focused on developing the best cathode for magnesium sulfur batteries to prevent the migration of polysulfides and thus improving the effectiveness.



Kimberly Riordan, sophomore, chemistry major, collaborated with Prof. Emily Tsui on her project entitled *Targeting a Trigonal Pyramidal Sulfur Radical for Battery Applications*, which studied hypervalent sulfur radicals of novel geometry and electronic structure to identify new properties that could lead to the development of new lithium-sulfur batteries.

Student Research Fellowships (page 3 of 4)

A second group of undergraduate students were selected to conduct energy-related research during summer 2019, receiving Slatt fellowships to support their research projects. The students selected for ND Energy's Summer Research Program are highlighted below.

The Vincent P. Slatt Fellowship for Undergraduate Research in Energy Systems and Processes

The following summer Slatt scholars from Notre Dame collaborated with Dr. Abigail Mechtenberg, assistant teaching professor in the Department of Physics, to continue implementing the Energy E3 program in low- and middle-income countries.



Janaya Brown, junior, aerospace and mechanical engineering major and energy studies minor, collaborated with Ugandan partners on her project entitled *Empowering Ugandans to Power Uganda: Analyzing the Mechanical Properties and Various Impacts of Novel Weaved Wind Turbine Blades*.



Henri Francois, junior, computer science and engineering major, collaborated with Haitian partners on his project entitled *Empowering Haitians to Power Haiti: Restoring Energy Production Capacity to Haiti: Energy Generation Systems and Microgrid Optimization*.



Kalule Guwatudde, junior, management consulting major, collaborated with Ugandan partners on his project entitled *Evaluating Pay-as-you-go Systems for Energy Devices in Uganda*.



Perfect Mfashijwenimana, junior, electrical engineering major, collaborated with Rwandan partners on his project entitled *Empowering Rwandans to Power Rwanda: Model Predictive Control for Noise Characteristics in Locally Built Devices*.



Musodiq (Tolu) Ogunlowo, junior, electrical engineering major, collaborated with Nigerian partners on his project entitled *Empowering Nigerians to Power Nigeria: Understanding the Relationship Between Demand and Capacity Shortage to Design Multiple Energy Source Input Charge Controller with Locally Built Systems*.

The following summer Slatt scholars from universities in Puerto Rico worked on research projects with ND Energy affiliated faculty.



Marrero Cabrera, junior, biotechnology/chemistry major at the Universidad del Sagrado Corazon, collaborated with Prof. Na Wei, assistant professor in the Department of Civil & Environmental Engineering & Earth Sciences, on a project related to biofuels.



Norbert Xavier Ramos Lopez, junior, chemical engineering major at the University of Puerto Rico-Mayaguez, collaborated with Prof. Jason Hicks, associate professor in the Department of Chemical and Biomolecular Engineering, on a project related to biofuels.



Erick Mendez Rios, junior, chemical engineering major and project management minor at the University of Puerto Rico-Mayaguez, collaborated with Prof. Edward Maginn, Dorini Family Professor of Energy Studies and Department Chair in the Department of Chemical and Biomolecular Engineering, on a project related to energy storage.

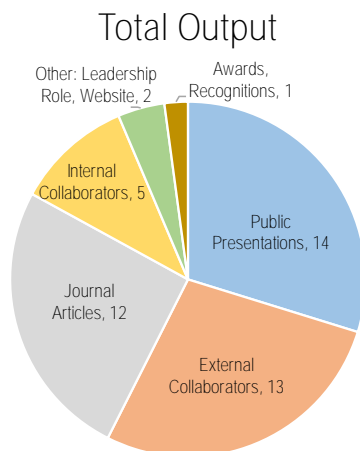
More information about current and past fellowship recipients, including project descriptions, can be found at:

<https://energy.nd.edu/research/fellowships/>

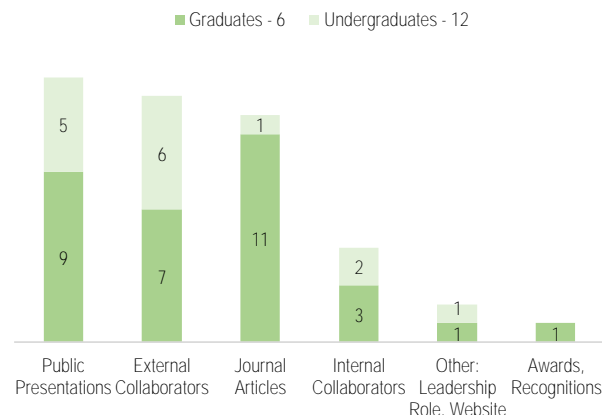
Student Research Fellowships (page 4 of 4)

2019 Output

Based on final progress reports, the following output was achieved in 2019 by graduate and undergraduate students receiving Eilers, Forgash, and Slatt research fellowships. This represents responses from 18 students, 6 graduates and 12 undergraduates. As shown, the highest output area was public presentations with 14 total, 9 by graduates and 5 by undergraduates. The next two highest areas were nearly tied with 13 external collaborations and 12 journal articles.



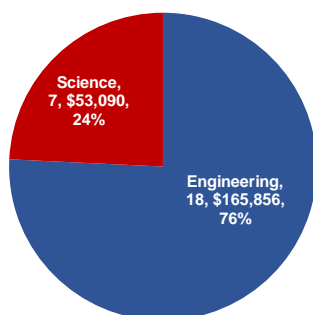
Output by Student Group



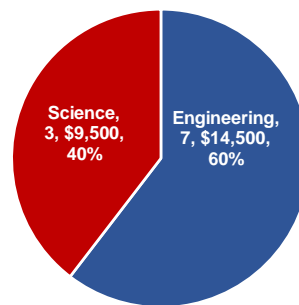
Overall Impact by College

The following pie charts show the distribution of student research fellowship awards by college with the total number and amounts since programs began.

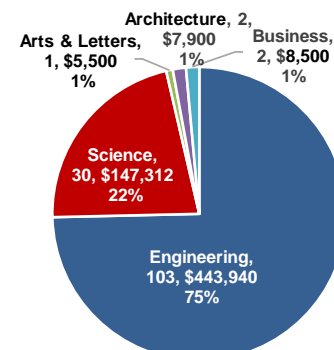
Eilers Fellowships by College 2012-2019 (Total = \$218,946)



Forgash Fellowships by College 2009-2019 (Total = \$24,000)



Slatt Fellowships by College 2006-2019 (Total = \$613,151)



Summer Programs for Undergraduate Student Researchers



Summer undergraduate researchers participated in professional development and social events organized by REU/ Fellowship programs in the Colleges of Engineering and Science, The Graduate School, ND International, and ND Research. All activities, including weekly brown bag luncheons, provided opportunities for students to network with peers, interact with faculty, learn about other research programs, and prepare for the Summer Undergraduate Research Symposium designed for students to present their research projects to a broader campus audience at the end of their research experience.

Program participants were Biological Sciences REU, Center for Research Computing REU, CBE Research Opportunities for Undergraduates, The Graduate School REU and Summer Programs, ND International iSURE, ND Energy Slatt Fellowships, NDnano NURF, Physics REU, and Wireless Institute REU.

2nd Annual ND Energy Research Symposium



Since 2018, ND Energy has hosted an annual research symposium for the purpose of bringing together researchers, scholars, students, and sustainability professionals from academia, industry, and government to talk about some of the greatest challenges and opportunities in sustainable energy research and development facing the world today. The second annual research symposium, held March 20, 2019, focused on Global Transformation: Ensuring Access to Affordable, Reliable, and Sustainable Energy for All with topics centering on the United Nations' Sustainable Development Goal #7: Affordable and Clean Energy. [VIEW KEYNOTE ADDRESS ON YOUTUBE](#)

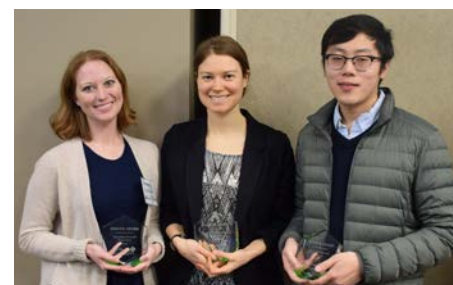
Duly featured was keynote speaker Rachel Kyte, (former) Chief Executive Officer of Sustainable Energy for All (SEforALL), Special Representative of the UN Secretary-General for Sustainable Energy for All, Co-Chair of UN-Energy, and Professor of the Practice of Sustainable Development in The Fletcher School of Law and Diplomacy at Tufts University. In her address, *Cooling, Cooking,*

Moving and Manufacturing: The Challenges and Opportunities in Limiting Warming to 1.5 Degrees and Ensuring Everyone has Access to Sustainable Energy, Kyte argued that the pace at which we decarbonize our energy systems must increase dramatically. While Kyte acknowledged the political and institutional challenges that may slow us down, she struck a more optimistic tone about the opportunities that new technologies and business models provide.

Other presentations were *The Notre Dame Global Adaptation Initiative (ND-GAIN)* by Patrick Regan, Associate Director of the Notre Dame Environmental Change Initiative (ND-ECI), who examined measurements and implications of climate vulnerability assessments at country and city levels using the Notre Dame Global Adaptation Initiative (ND-GAIN) suite of tools. *Energy E3: Education, Engineering-design, and Entrepreneurship* was presented by Abigail Mechtenberg, ND Energy International Sustainable Development Researcher and Assistant Teaching Professor of Physics, who discussed the Energy E3 program that unites collaborators with local technicians and engineers on prototyping, designing, building, installing, maintaining, and creating a business venture for renewable energy devices, using local materials and resident technical expertise, in Uganda, Rwanda, Nigeria, and Haiti. *The United Nations Millennium Development Goals and Beyond*, presented by Vijay Modi, Professor of Mechanical Engineering at Columbia University, highlighted how the combination of small-scale generation, mobile telephony, digitization and finance are providing a nuance understanding of how we can best serve the small emergent consumer. *Understanding the Water-Energy-Food Security Nexus*, presented by Shelle Miller, Jonathan W. Bulkley Collegiate Professor of Sustainable Systems at the University of Michigan, considered a holistic approach to the sustainable development goals by explaining the food-energy-water nexus and the interdependencies of those systems. *Renewables as a Solution to Water for Energy (W4E) in Drought-prone Regions and Access to Energy as Means to Achieve Social Equality for Developing Countries* was presented by Luciano Castillo, Kenninger Professor of Renewable Energy and Power Systems in Mechanical Engineering at Purdue University, who shared his proposal to create a US-Mexico 'energy-water corridor' in lieu of a border wall, encompassing a consortium of 28 scientists as outlined in the white paper, "Future Energy, Water, Industry and Education Park (FEWIEP): A Secure and Permanent US-Mexico Border Solution." *Micro-hydropower for Powering Rural African Communities: Opportunities, Challenges, and Lessons*, presented by Jun Chen, Associate Professor of Mechanical Engineering at Purdue University, covered the work of the Purdue Global Engineering Program in Africa that is developing a low-cost micro-hydropower system for providing basic electricity needs in rural communities.

At the end of the day, a networking reception and poster session was held for Notre Dame graduate students and postdoctoral scholars to discuss their research projects with symposium participants. Awards were given to the following top three presenters:

- Feng Gao, *Elucidating Effects of Pattern Geometry on Ion Transport through Charge Patterned Membranes* (Phillip Lab)
- Sara Gilson, *Synthesis and Characterization of Neptunium Metal-Organic Frameworks* (Burns Lab)
- Rebecca Scheidt, *Interfacial Charge Transfer between Excited CsPbBr₃ Nanocrystals and TiO₂: Charge Injection versus Photodegradation* (Kamat Lab)

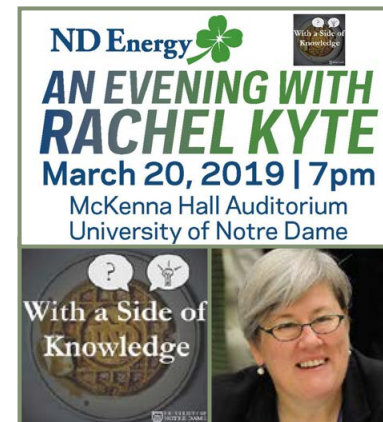


Rebecca Scheidt, Sara Gilson, and Feng Gao

2nd Annual ND Energy Research Symposium (cont.)

The research symposium continued into the evening with a companion event for the entire Notre Dame and surrounding communities. Ted Fox, executive administrator in the Office of the Provost and podcast host of *With a Side of Knowledge* (provost.nd.edu/podcast), led a conversation with Rachel Kyte that focused on the work of SEforALL and the United Nations' Sustainable Development Goal #7 (SDG7), which calls for "affordable, reliable, sustainable and modern energy for all" by 2030. Kyte highlighted the three core targets for achieving SDG7: (1) ensure universal access to affordable, reliable and modern energy services; (2) increase substantially the share of renewable energy in the global energy mix; and (3) double the global rate of improvement in energy efficiency. Kyte also shared her views on how to reach these targets.

[VIEW THE CONVERSATION ON YOUTUBE](#)



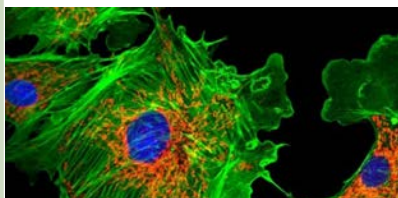
Other Symposia and Workshops

ND Energy supported other symposia and workshops throughout 2019 that were sponsored by Notre Dame departments, student groups, faculty, national associations, and community partners. These programs are highlighted below.



Materials Research Society Spring Meeting and Exhibit

The Materials Research Society (MRS) held its spring meeting and exhibit on April 22-26 in Phoenix, Arizona. Over 30 members of the Notre Dame research community presented and many more attended. Subhash L. Shinde, associate director of ND Energy, served as an invited co-chair and helped to develop 60 symposia, including leading the organization of Symposium X – Frontiers of Materials Research, featuring topics at the forefront of research on materials science and engineering.



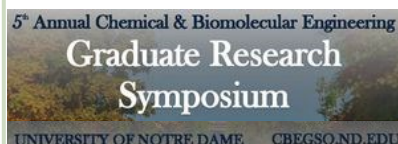
6th Annual Midwest Imaging and Microanalysis Workshop

Hosted by the Notre Dame Integrated Imaging Facility (NDIIF), this annual workshop was held on May 6 and enabled leading experts to present topics on new trends in in-situ and high resolution microscopy for nano-technology, materials, and bio-sciences.



EdTech in the Bend e-Learning Conference

Organized by the South Bend Community School Corporation, this annual event was held on August 2 for area teachers to demonstrate new and improved ways to use computer technology in the classroom. ND Energy has participated and supported this effort since its inception in 2016.



The 5th Annual Chemical and Biomolecular Engineering (CBE) Graduate Research Symposium

The CBE's Graduate Student Organization held its annual, day-long research symposium on September 19 at Notre Dame. Students presented their research to a diverse audience of peers, faculty, alumni, and guests, covering a broad range of disciplines, including energy and sustainability, nano- and micro-fluidics, simulation and theory, systems engineering, materials science, nanotechnology, and bioengineering.



Notre Dame-Purdue Symposium on Soft Matter & Polymers

This one-day symposium was held on September 21 at Purdue University and attracted over 110 participants with 11 invited speakers and 40 contributed poster presentations. A variety of broad ranging topics were presented from general synthesis, characterization of synthetic soft materials, to their broad applications.

Education

Offering an unsurpassed undergraduate education that nurtures the formation of mind, body, and spirit is one of Notre Dame's primary goals and a key component of ND Energy's mission. It is the cornerstone of preparing the next generation of students to lead our country and ensure a sustainable energy future for all. Education programs administered by ND Energy include the Energy Studies Minor, Mishawaka High School Internship, and CISTAR's Young Scholars.

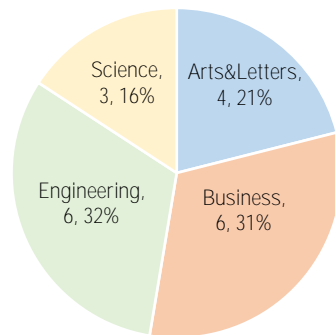
Energy Studies Minor (ESM)

Since 2012, ND Energy has administered the Energy Studies Minor (ESM). The minor is open to undergraduate students in all majors and colleges at Notre Dame and is intended to prepare students to become successful leaders who understand the complexities of global energy challenges and can help move our country and the world toward a more sustainable energy future.

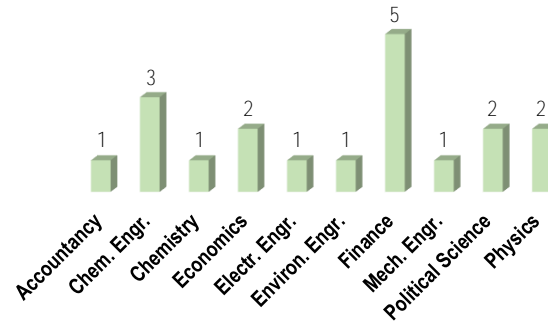
Minor requirements include the successful completion of three required courses focused on energy and society, the business of energy, and a capstone that encompasses the understanding of several major elements in energy. In addition, students are required to successfully complete three, 3-credit electives from an approved list of technical and non-technical courses.

The charts below show the 2019 ESM graduates by college and major, and the number of graduates from 2012 to 2019.

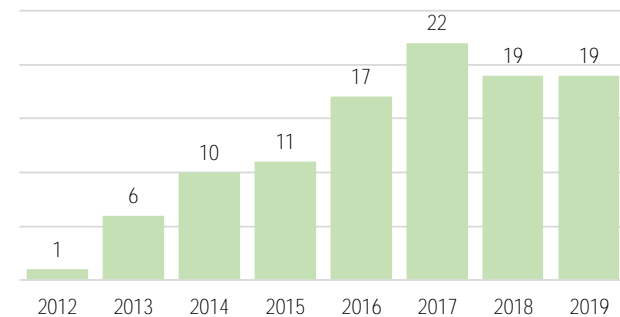
2019 ESM Graduates by College



2019 ESM Graduates by Major



Total ESM Graduates by Year



New ESM Capstone Course

The ESM offers several options for students to meet the capstone requirement, including a one-week, energy-focused seminar through the Center for Social Concerns; a semester-long course led by ND Energy focused on a broad range of energy topics that culminates into a comprehensive final report and presentation; on-campus collaborations with laboratories and researchers; summer internships; and voluntary and credit-based learning experiences.

In fall 2019, ND Energy offered another capstone option for students, a new course entitled *Puerto Rico: Road Map to a Renewable Future*. Twelve students participated in the inaugural course, consisting of weekly classes and a fall break immersion in Puerto Rico. Students learned about the opportunities and challenges faced by communities when attempting to reduce their carbon footprint, as well as the technological challenges that exist while considering the economic, political, historical, and ethical issues unique to Puerto Rico.

New ESM Capstone Course (cont.)

While in Puerto Rico, students spent the first part of the week in San Juan, meeting with other college students, professors, industry leaders, government officials, and politicians to gain a better understanding of the current infrastructure, political landscape, and culture. Toward the end of the week, students traveled to the small mountain town of Adjuntas, where they met with leaders of Casa Pueblo, an award-winning community organization leading an effort for energy independence in Puerto Rico. Students also visited residents in a remote area to gain a better understanding and interpretation of the specific challenges that small communities face each day, long after the devastation of Hurricane Maria in 2017. While there, students also completed a service project by installing a solar powered street lamp on a dangerously dark corner.

When students returned to Notre Dame, they continued their journey by completing a final project that encompassed everything they learned and more.



More information about the Puerto Rico course can be found at: <https://energy.nd.edu/minor/puerto-rico-experience/>.

ESM Certificate Ceremony

A certificate ceremony and reception for ESM graduates and their family and friends was held the Friday before Commencement. This event has become an annual tradition and **serves to recognize graduates for their achievements with a signed “Certificate of Completion” by the Dean of Engineering and the Director of ND Energy.** The 2019 graduates are listed below.

2019 Graduate	Major/Minor	2019 Graduate	Major/Minor
Alexander Baumann	Accountancy	James Irving	Chemical Engineering
Matthew Chamberlain	Chemical Engineering	Michael Kay	Electrical Engineering
Kevin Clancy	Finance	Elisabeth Kerns	Chemistry, Glynn Family Honors Program
Edgar Duffy	Finance	Brady McLaughlin	Physics in Medicine, Glynn Family Honors Program
Kelly Fischer	Finance	Kylie Minor	Economics, Theology Minor
John Fitzsimmons	Finance	Eduardo Peres	Economics
Grace Georgi	Political Science, German Minor	Kelly Prussack	Mechanical Engineering
Cameron Gorsak	Physics, Catholic Social Traditions Minor	Marisa Ross	Environmental Engineering
Jared Hendrick	Finance	Nicholas Waytula	Political Science, Business Economics Minor
Kevin Hottinger	Chemical Engineering		

ESM Alumni Network

All ESM graduates are invited to join the ESM Alumni Network to stay apprised of current initiatives in energy and activities at Notre Dame. Members also receive ND Energy's biannual newsletter, annual report, notices of major events, such as the annual Notre Dame Energy Week and ND Energy Research Symposium, and opportunities to promote the minor through various means and activities.

More information about the network can be found at: <https://energy.nd.edu/minor/energy-studies-minor-alumni-network/>.

Mishawaka High School Internship Program

The Notre Dame-Mishawaka High School Internship Program began in 2013 in an effort to engage high school students in energy-related scholarly activities. Between 10-15 junior and senior college-bound students enroll annually in one or both semesters to learn about critical topics in energy and experience working in a laboratory.

Students earn high school credits each semester while conducting research and participating in seminar-style group classes. **Students come to Notre Dame's campus twice a week** to conduct energy-related research in an ND Energy affiliated laboratory under the mentorship of a graduate student or postdoctoral scholar. Group classes are held regularly at Mishawaka High School to discuss energy-related topics and other college preparatory topics of interest.

The main goals of the program are for students to:

- Experience conducting research in a laboratory;
- Gain a deeper understanding of STEM topics not regularly taught in classrooms or learned from textbooks;
- Become more aware of the complexities of global energy issues by studying topics such as geopolitics of energy, renewable energy and economics, and energy policy;
- Develop skills that will help them succeed in college.

2019 Interns

The following students successfully completed their internship during the 2019 spring semester and discussed their research experience during a poster session held on Notre Dame's campus on **May 20 in the Atrium of Stinson-Remick Hall**.



Logan DeSchepper

Synopsis of Plasmons and Their Applications to Solar Energy

Advisor: Gregory Hartland, Professor of Chemistry and Biochemistry



Elizabeth McKesson

Morphology of Actinide Oxides Under Controlled Storage Conditions

Advisor: Amy Hixon, Assistant Professor of Civil & Environmental Engineering & Earth Sciences



Elizabeth Harvey

Sol-gel Synthesis and Sorption of Rare Earth Elements

Advisor: Amy Hixon, Assistant Professor of Civil & Environmental Engineering & Earth Sciences



Taylor Stanton

Nanoporous Charge-Patterned Mosaic Membranes with Controlled Interfacial Packing Enhance Electrolyte Support

Advisor: William Phillip, Associate Professor of Chemical and Biochemical Engineering



Alicia Katzelis

Leaching of Noble Metal Catalysts

Advisor: Svetlana Neretina, Associate Professor of Aerospace and Mechanical Engineering



Joy Thompson

Using Big Data Network Analysis to Examine Uranium Mineral Associations

Advisor: Peter Burns, Henry Massman Professor of Civil & Environmental Engineering & Earth Sciences

More information about the internship can be found at: <https://energy.nd.edu/outreach/community-outreach/mhs-internship/>.

CISTAR Young Scholars Program

The CISTAR Young Scholars Program enables high school students to spend six weeks in the summer on Notre Dame's campus, engaged in full-time research and educational activities. Students work alongside CISTAR Fellows in the laboratories, explore career options in chemical engineering, and participate in lectures about ethics, communications, laboratory safety, and other relevant topics. Young scholars also attend social and professional development events for summer undergraduate researchers and participate in the annual Summer Undergraduate Research Symposium to present their research.

2019 Young Scholars

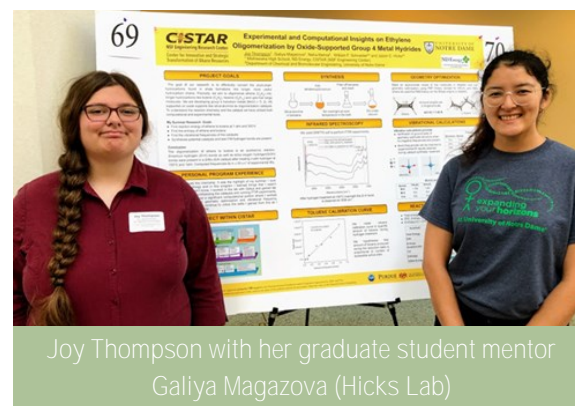
Abigail Donaldson from Riley High School in South Bend and Joy Thompson from Mishawaka High School participated in the Young Scholars Program during summer 2019. They are pictured here, presenting their research poster during Notre Dame's Summer Undergraduate Research Symposium.

What is CISTAR?

The Center for Innovative and Strategic Transformation of Alkane Resources (CISTAR) is a National Science Foundation (NSF) Engineering Research Center (ERC) that brings together researchers from lead institution, Purdue University, and partner institutions Northwestern University, University of New Mexico, University of Notre Dame, and University of Texas at Austin. Joining with industry and government, this center cultivates engineering discovery and education to develop innovative process designs for economic production of liquid chemicals and transportation fuels from shale gas hydrocarbons. Researchers also explore novel approaches for converting methane to chemical intermediates, which can then be used as a feedstock for conversion to liquid fuels.

Now in its third year, CISTAR has 29 industrial partners and 13 innovation partners to accelerate the commercialization of new technologies and workforce development. Notre Dame's principal investigators are professors in the Department of Chemical and Biomolecular Engineering, Thomas Dignan, Alexander Dowling, Ruilan Guo, Jason Hicks, and William Schneider. Graduate students associated with the center are Yoonrae Cho, Jerry Crum, Alejandro GarciadiegoDelRio, Kaniskha Ghosh, Zihan Huang, Jeonghyun Ko, Si Li, Galiya Magazova, Neha Mehra, Jessica Muhlenkamp, and Joshua Wright.

More information about CISTAR can be found at: <https://energy.nd.edu/research/research-centers/>.



Joy Thompson with her graduate student mentor Galiya Magazova (Hicks Lab)

TRiO Programs

ND Energy signed a letter of intent with the U.S. Department of Education's TRiO Programs hosted by the University of Notre Dame to support their efforts to ensure equal educational opportunity for all Americans, regardless of race, ethnic background or economic circumstance. TRiO's college preparatory programs - Talent Search and Upward Bound - assist low-income families and first-generation college students as they progress from middle school to high school and beyond.

ND Energy conducts outreach activities for TRiO program participants and also draws from their student pool when recruiting high school students for CISTAR's Young Scholars Program.

Outreach

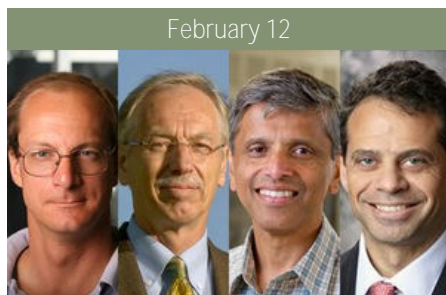
ND Energy organized the following outreach events, engaging students, faculty, and staff in discussions related to major topics in energy. These programs also supported affiliated faculty and their research programs by engaging the broader community in learning about energy in general and demonstrating the impact their research has on society.

Distinguished Lectures

Distinguished lectures bring nationally recognized experts from academia, industry, and government to Notre Dame to discuss research, technological advancements, and policy developments with students, faculty, and sustainability professionals.

Lectures held in 2019 are highlighted here.

More information about Distinguished Lectures can be found at: <https://energy.nd.edu/outreach/campus-outreach/distinguished-lectures/>



February 12

ND Energy Bouts: Fighting for Renewable Energy

Moderated by:

Khalil Shalabi ('88), Executive Vice President for Strategic Initiatives and Transformation, Lower Colorado River Authority (LCRA)

Representing nuclear:

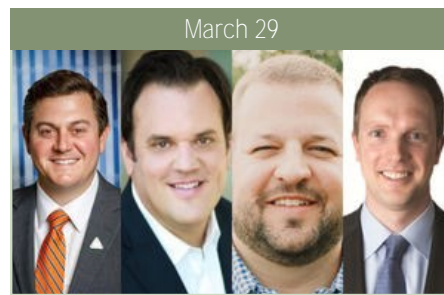
Peter C. Burns, Massman Professor, Department of Civil & Environmental Engineering & Earth Sciences; Director, ND Energy; Director, NNSA Actinide Center of Excellence

Representing wind:

Thomas Corke, Clark Chair Professor, Department of Aerospace and Mechanical Engineering; Director, Hessert Laboratory; Director, Institute for Flow Physics and Control

Representing solar (winner):

Prashant Kamat, Zahm Professor of Science, Department of Chemistry and Biochemistry and Radiation Laboratory



March 29

Climate and Business Summit: Future of Distributed Energy

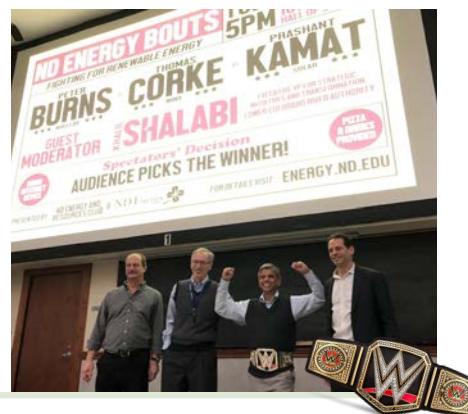
TJ Kanczuzewski, Chairman and Co-Founder, Inovateus Solar

Joel Link, Vice President, Origination & Development, Tenaska

Chris McKissack, Chief Operating Officer, GlidePath

Luke Lewandowski, Director of Americas Power & Renewables Research, Wood Mackenzie,

Co-sponsored with Net Impact



The winner of the first-ever ND Energy Bouts — Prashant Kamat for SOLAR!



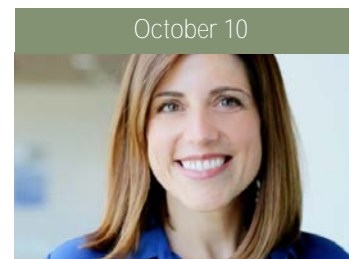
September 30

Perovskite Solar Cell Stability: From Cells to Modules

Jeffrey Christians ('15)

Assistant Professor of Engineering
Hope College

Co-sponsored with Kamat Lab



October 10

The Future of Energy – the promise of renewable energy and critical needs for our future energy system

Danielle Merfeld
VP and Chief Technology Officer
GE Renewable Energy

Notre Dame Energy Week

Sponsored by ND Energy and its Student Energy Board, Notre Dame Energy Week is an annual event designed to create awareness and educate the Notre Dame and surrounding communities about current energy-related issues and a broad range of topics related to energy and the environment. The 13th annual Notre Dame Energy Week was held September 9-16, 2019 and included the following distinguished lectures, as well as other energy-related events described below.

Students, faculty, and staff toured the Notre Dame power plant where they learned about the ways in which the University provides power to campus, including several renewable energy sources. Other tours included the Materials Characterization Facility, where tourists saw first-hand the state-of-the-art instrumentation that supports faculty research. In addition, graduate student Jeffrey DuBose (Kamat laboratory) provided a brief presentation on solar power before leading small groups to see the solar panels on the rooftop of Stinson-Remick Hall.

September 9—13



September 9

An Energy Corridor on Our Southern Border
Luciano Castillo, Kenninger Professor of
Renewable Energy and Power Systems,
Purdue University

September 10

Notre Dame Moves Toward Decarbonization
Paul Kempf, Assistant Vice President for
Utilities and Maintenance,
University of Notre Dame

September 11

*Modular Reactors: The Next Generation of
Nuclear Power Plants*
Youssef Ballout, Director of the Reactor
Systems Design & Analysis Division,
Idaho National Laboratory

September 12

Bringing Power to Native Americans
Sandra Begay, Director of Environmental
Health, City of Albuquerque

September 13

***Paths and Pitfalls: Albuquerque's Move
Toward 100% Renewable Energy***
Timothy Keller, Mayor,
City of Albuquerque

Khalil Shalabi, Executive Vice President,
Lower Colorado River Authority



More information about Energy Week can be found at:
<https://energy.nd.edu/outreach/campus-outreach/energy-week/>



Sustainability Expo

Held this year in spring and fall 2019, the annual Sustainability Expo connected Notre Dame graduate and undergraduate students with researchers, educators, community leaders, and employers to discuss professional development opportunities in the areas of energy, the environment, and sustainability studies. The following exhibitors participated in this event, sharing information about their research, academic and experiential learning programs, internships, job openings, and other professional resources.

Exhibitor	Exhibitor	Exhibitor
Be Green Packaging	Goshen College	ND Energy
Berke Research Group	GreeND	NDnano
Burns Research Group	Gupta Research Group	Notre Dame Initiative for Global Development
C-Club	Hixon Research Group	Notre Dame Office of Sustainability
Center for Career Development	IDEA Center	Ptasinska Research Group
Center for Civic Innovation	Inovateus Solar LLC	Resiliency and Sustainability of Engineering Systems Minor
Center for Innovative and Strategic Transformation of Alkane Resources (CISTAR)	John J. Reilly Center for Science, Technology, and Values	South Bend Green Corps
Crossroads Solar	Kellogg Institute for International Studies	St. Joseph County Parks
Energy Studies Minor	Keough School of Global Affairs	Student Energy Board
enFocus	Lightcap Research Group	Student Government Sustainability Department
Environmental Change Initiative	Marathon Capital, LLC	Sunrise Movement
Environmental Sciences Major	Mechtenberg Research Group	UCapture
Food Rescue	Minor in Sustainability	UNDERC
GE Renewable Energy	MoonTree Studios	

Nearly 100 students attended the Expo in February and more than 140 students attended the program in September. The Expo is sponsored by the Center for Nano Science and Technology (NDnano), Center for Sustainable Energy (ND Energy), John J. Reilly Center for Science, Technology, and Values, Meruelo Family Center for Career Development, Minor in Sustainability, and Notre Dame Environmental Change Initiative (ND-ECI).



For more information about the Sustainability Expo, visit: <https://energy.nd.edu/outreach/campus-outreach/sustainability-expo/>

What's it Really Like?

The What's it Really Like?

program allowed students to meet with professionals in small group settings to learn about their careers, career paths, the current climate in their fields, and insights into the future.

These professionals met with students in 2019.



April 17 — Leesa Duckworth, University Relationship Manager of Pacific Northwest National Laboratory (PNNL) and National Nuclear Security Administration (NNSA) Graduate Fellowship Program



October 11 — Michael Grady ('77), Owner/Manager of Eireann Emerald Solutions; Consultant for Innergex Renewables with First Nations in Canada and Native American Tribal Governments



November 15 — Jennifer Carr, Operations Support Engineer of Peak Reliability; Notre Dame Graduate in Philosophy; Portland State Graduate in Electrical Engineering; mother of seven children

ND for the Environment

Throughout the year, ND Energy partnered with the Notre Dame Alumni Association and other groups and departments to engage visiting alumni and their families in the following programs:

ND For the Environment was showcased during Football Fridays. Designed to demonstrate the initiatives on campus to reduce carbon emissions, conserve energy, and address the effects of climate change on the environment, this program is represented by ND Energy, the Minor in Sustainability, and the Office of Sustainability. One of the main attractions this year was the introduction of Notre Dame's new **Grind2Energy** system that will help create one of the first food-waste free lunches on campus.

ND Explores STEM was held during Reunion Weekend with displays filling every floor of McCourtney Hall, showcasing research laboratories, education programs, and other initiatives within Notre Dame Research, the College of Engineering, and the College of Science that focus on STEM research and education.

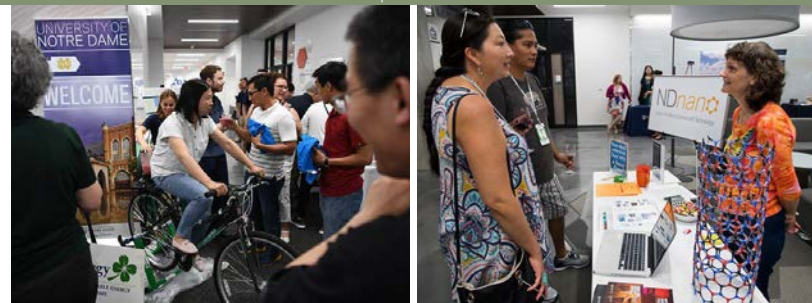


The largest green roof in Indiana is more than 79,000 square feet on top of the Joyce Center.



Other green roofs on campus are at the Morris Inn (shown here), Corbett Family Hall, Duncan Student Center, and O'Neill Hall.

ND Explores STEM



ND for the Environment

The University stopped burning coal at its power plant more than a year ahead of schedule.



The new East Plant's five geothermal heat recovery chillers with capacity of 1,350 tons provide both heating and cooling.



Solar energy arrays at the Kenmore Warehouse in South Bend reduce carbon dioxide emissions by more than 680,000 pounds annually.



Through a partnership with the city of South Bend, the University will capture 7% of its power from the energy of falling water on the St. Joseph River through a hydroelectric generation facility scheduled to be completed in 2021.

K-12 Programs and Partnerships

While promoting and developing curricula in support of STEM education, ND Energy also has developed some long-term partnerships with area schools and other organizations. These collaborations have enabled both institutions to work toward achieving the national goals of increasing advanced training and careers in STEM fields, expanding the STEM-capable workforce, and increasing scientific literacy among the general public.

Art2Science Summer Camp

This annual camp is sponsored by the Joint Institute for Nuclear Astrophysics, Center for the Evolution of Elements (JINA-CEE) and is designed to ignite stellar imaginations through an integrated STEAM approach to learning. Participants, ages 8-12, learn about science, technology, engineering, and science through creative hands-on artistic projects.

This year, ND Energy and affiliated graduate students led a project using coffee filters, markers, and a cup of water to teach students about separations and the importance of separating the good stuff from the bad in order to have clean water and cleaner gasoline.



Madison STEAM Academy

Student Energy Board members Breanna Belz, Rory Burke, Cameron Gorsak, and Bobby Wellendorf spent a morning at Madison STEAM Academy manning stations to demonstrate energy concepts in an interactive way.

In addition, for his capstone project, John "Jack" Feger, senior student in the Energy Studies Minor, worked with fourth grade teacher Ashley Boege on "Details Matter," which is a program designed to help students become more observant with a greater attention to detail; an essential skill for learning.



Northern Indiana Regional Science and Engineering Fair (NIRSEF)

The Northern Indiana Regional Science and Engineering Fair (NIRSEF) was held at Notre Dame and showcased the work of middle and high school students from Elkhart, Fulton, Marshall, and St. Joseph counties. Student Energy Board members Breanna Belz, Emily Black, Kelsey Farr, Francie Fink, Talia Harb, Amorette Hernandez, Emma Kerr, Diane Kim, Sylvia Kolda, Erin Ludwig, Dan Mikovits, Kelly Moran, Loyal Murphy, and Mackenzie Winton served as ND Energy judges and interviewed several young researchers to determine who would win a solar powered charger for their knowledge of energy and the originality of their questions and methods.

Junior division winners were seventh graders Evan Brenneman and Kyle Umbaugh from Lincoln Junior High School in Plymouth for their project on wind turbines and how the size of turbine blades affect rotational speed. They constructed a mini-turbine using cardboard, the shaft of an arrow, and a sand-filled water bottle.

Senior division winner was senior Nicholas Good from John Adams High School in South Bend. His experiment "*Enhancing the Growth Rate of Algae Using Heat Recycled from a Computer Undergoing Calculations*" demonstrated a significant increase in the growth rate of Spirogyra by creating a warmer environment using waste heat from a working computer.



ScienceAlive!

Science Alive brings the local community together to create enthusiasm for STEM education and provides a unique opportunity for people of all ages to interact with researchers, educators, and community leaders to learn about innovative projects taking place in the South Bend area.

This year's event included Slinkies, slime, Sudoku puzzles, Legos, Alka Seltzer, balloons, and a plasma globe to demonstrate the basics of energy-related research involving nanoparticles, catalysis, polymers, and plasma. Posters were also used to connect the hands-on activity to the work being done within each of laboratories represented by the following faculty groups: Kyle Doudrick, Alex Dowling, David Go, Jason Hicks, Marc Muller, Jennifer Schaefer, William Schneider, Emily Tsui, Jonathan Whitmer, and Sangpil Yoon. Other participants included members of the ND Energy Student Energy Board.



St. Adalbert Catholic School

As part of an ongoing relationship between Assistant Professor Emily Tsui and the junior high students of St. Adalbert Catholic School, the eighth grade class visited campus in January to learn about life as a scientist and to tour the Tsui laboratory. Postdoc Greg Kortman, graduate students Moises Ballesteros and Keith Schival, and undergraduate students Robby Gipson, Madison Mettey, and Kimberly Riordan demonstrated various techniques and equipment and answered a wide range of questions about what it is like to be a chemist.

Afterwards, students toured the Materials Characterization Facility (MCF) to learn about some of the advanced instruments found at a research university. Dr. Ian Lightcap, ND Energy's Research and Facilities Program Director, and Dr. Allen Oliver, research professor in the Department of Chemistry and Biochemistry, translated the complexities of materials characterization into simpler terms for the student participants.



St. Joseph County 4H Fair

ND Energy and two of its affiliated laboratories participated in an outreach event during the 2019 St. Joseph County 4H Fair. Prof. Alexander Dowling and graduate students Bridgette Befort and Alejandro Garciadiego demonstrated how computational frameworks can optimize energy technologies by challenging participants to maximize the number of cookies they could make from one square of playdough. They also used Sudoku puzzles to explain how computers help us solve complex problems.

Graduate students Sunho Moon and Sunhoon Rho and postdoctoral scholar Azahar Ali from Prof. Sangpil Yoon's laboratory amplified ultrasound waves to create a miniature water fountain and used Slinkies to provide a hands-on model of energy and wave motion. They also used black lights and fluorescent materials to demonstrate invisible energy.



Marketing Communications

A major component of ND Energy's mission is marketing communications. By using various marketing channels, such as the World Wide Web, Facebook, Twitter, Linked-In, and Email, ND Energy promotes the initiatives and accomplishments of affiliated faculty, associated researchers, students, and other partners in support of energy-related research and education at Notre Dame. Our efforts feature topics surrounding research, education, policy, ethics, social justice, and economics and include promotions of news articles, journal publications, key metrics, and events that are distributed to a broad audience of energy-interested individuals, groups, and national and international organizations and partners.

2019 News Articles (Page 1 of 6)



Prashant Kamat named Highly Cited Researcher for 2019

Prashant Kamat, The Rev. John A. Zahm, C.S.C., Professor of Science, has been named a Highly Cited Researcher for 2019 by Clarivate Analytics.



Steven Corcelli appointed Associate Dean

Steven A. Corcelli, Professor of Chemistry & Biochemistry, has been appointed the College of **Science's first Associate Dean for Interdisciplinary Studies and Faculty Development.**



Researchers develop novel computer learning method for faster AI

A novel one-shot learning method allows computers to draw upon already learned patterns more quickly and efficiently, using less energy, while adapting to new tasks and data.



Burghoff Receives Air Force Young Investigator Award

The Air Force Office of Scientific Research has recognized David Burghoff, assistant professor of electrical engineering, with a Young Investigator Research Program award.



Notre Dame students study energy challenges and opportunities during an immersion in Puerto Rico

The Energy Studies Minor provides undergraduate students with a holistic understanding of the opportunities and challenges surrounding our rapidly-changing global energy environment.



Zhang named among "rising stars" in materials chemistry
research for energy and sustainability

Assistant Professor Yanliang **Zhang's work on additive manufacturing** for functional materials and devices was featured in a recent themed issue of the Journal of Materials Chemistry A titled Emerging Investigators 2019.



Researchers are the first to observe electron-beam induced plasmonic Fano interferences

In a paper published in Physical Review Letters, Jon P. Camden and collaborators used a combination of electron spectroscopy and theoretical modeling to observe the first direct detection of Fano resonances, or Fano interferences.



Real-time observations and measurements during separation processes could help reduce carbon footprint

Casey O'Brien, assistant professor of chemical and biomolecular engineering, and his team have developed a novel method to see and measure carbon dioxide on the molecular level, providing details of how the gas moves across polymeric FTMs.



Notre Dame ceases to burn coal, a year ahead of schedule

Because of combined efforts laid out in the **University's Comprehensive Sustainability Strategy**, Notre Dame has achieved a 50 percent reduction in carbon emissions per gross square foot based on 2005 levels.



Sakaue named AIAA Associate Fellow

Hiroataka Sakaue, associate professor in the Department of Aerospace and Mechanical Engineering at Notre Dame, has been named an Associate Fellow of the American Institute of Aeronautics and Astronautics.

2019 News Articles (Page 2 of 6)



The Insider Project: Sustainable performance in heritage architecture

Julio Cesar Perez-Hernandez, Associate Professor of the Practice, School of Architecture, led the trip to Cuba. During fall break of 2018, ten undergraduate students and three **faculty and staff from Notre Dame's College of Engineering and School of Architecture** traveled to Cuba as part of the Insider Project, funded by Notre Dame International.



Similarities in biology and technology inspire novel approach in mobile robotics and prosthetics for spinal cord injuries

A team led by Suman Datta, the Stinson Professor of Nanotechnology and director of the Applications and Systems-driven Center for Energy-Efficient Integrated Nano Technologies (ASCENT) and the Center for Extremely Energy Efficient Collective Electronics (EXCEL), is using novel bio-inspired hardware to mimic the way the CPG works.



Three Indiana research universities to collaborate with industry to solve critical measurement science challenges in new NSF-funded center

Powering everything from the development of new drugs and medical devices to the detection of dangerous chemicals, measurement science is a multi-billion-dollar industry that is key to both U.S. and international economies. With a grant from the National Science Foundation (NSF), researchers from the University of Notre Dame, Indiana University, and Purdue University have formed a new center that will work to solve ongoing and emerging industry-relevant challenges in measurement science.



New collaboration led by Notre Dame leverages Data Revolution to solve current challenges in chemistry

Olaf Wiest, professor in the Department of Chemistry and Biochemistry, will direct The Center for Computer-Assisted Synthesis (C-CAS). **"This will significantly accelerate progress in drug discovery and materials science where such molecules are critical to fundamental research," Wiest said.**



Innovative energy solutions also require innovations in energy storage

Jennifer L. Schaefer, assistant professor in the Department of Chemical and Biomolecular Engineering at the University of Notre Dame, and her research team are working to address the critical needs for energy storage in both developed and developing markets.



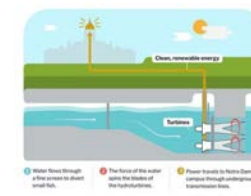
A new fall course offers students a deep-dive into the energy landscape of Puerto Rico

After Hurricane Maria hit Puerto Rico in 2017, the island's energy infrastructure was destroyed. The lack of electricity in rural areas for months following the storm contributed to thousands of post-hurricane deaths. As the island rebuilds, there are calls for replacing the fossil-fuel based centralized grid with renewable microgrids, making use of abundant solar, wind, and water resources. A new 1-credit course for fall 2019, Puerto Rico: Road Map to a Renewable Future, will explore the intricacies of such a seemingly obvious solution.



Maginn named Fellow by AIChE

Edward J. Maginn, the Dorini Family Professor of Energy Studies and chair of the Department of Chemical and Biomolecular Engineering in the College of Engineering at the University of Notre Dame, has been named a Fellow of the American Institute of Chemical Engineers (AIChE).



Hydroelectric plant groundbreaking moves Notre Dame closer to sustainability goals and Seitz Park renovation

The facility, which will be primarily underground, is expected to generate about **7 percent of the University's electrical needs** and offset nearly 9,700 tons of carbon dioxide annually.

2019 News Articles (Page 3 of 6)



Notre Dame announces significant growth in research funding

Researchers from the University of Notre Dame have received \$180.6 million in research funding for fiscal year 2019 — \$100 million more than 10 years ago and a more than 27 percent increase from last year.



Schaefer selected as Toyota Young Investigator Fellow

The program seeks to recognize and encourage young scholars in pursuit of research in green energy technology, specifically those areas that promote the development of next-generation vehicles capable of using alternative fuels.



Notre Dame researcher at the leading-edge of actinide research

Actinides have unique characteristics that are vital to health and medicine, energy and the environment, and national security and public safety. At Notre Dame, Amy E. Hixon, assistant professor in the Department of Civil & Environmental Engineering & Earth Sciences and an ND Energy faculty affiliate, is making great strides to advance fundamental knowledge on the actinide elements.



Sustainable Energy for All event aims to overcome energy accessibility, affordability and reliability

In 2014, the United Nations (U.N.) set a number of sustainable development goals to meet by 2030. One of those goals was intended to ensure access to affordable, reliable, sustainable, and modern energy for all.



Vijay Gupta receives the 2018 Antonio Ruberti Young Research Award from IEEE Control System Society

Vijay Gupta, professor of electrical engineering and an ND Energy faculty affiliate at the University of Notre Dame, has received the 2018 Antonio Ruberti Young Research Award from the IEEE Control Systems Society.



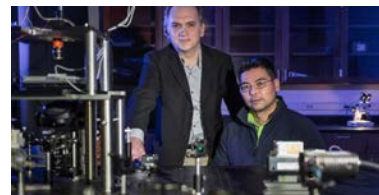
Notre Dame student research aims to address wealth, health, and energy disparities

At Notre Dame, the Energy and Sustainable Development with Design (ESDD) Research Lab looks at different ways to empower people from developing countries.



Notre Dame faculty receive nationally competitive awards

The National Science Foundation (NSF) has recognized three Notre Dame faculty members for their excellence in research with Early Career Development (CAREER) Awards. CAREER awards are the **NSF's most prestigious grant** available to early career faculty.



Research into laser cooling of semiconductors should continue, study finds

New research led by a team of scientists at Notre Dame has called into question the validity of a past study suggesting semiconductors cannot be cooled optically with lasers, and suggests that the elusive quest to cool a semiconductor using lasers should continue.



Paul Kempf appointed assistant vice president for utilities and maintenance

Paul Kempf, senior director of the **University of Notre Dame's utilities and maintenance departments**, has **been appointed the University's** assistant vice president for utilities and maintenance



Notre Dame president co-signs climate change accords with energy and investor executives at Vatican summit

Executives from among the world's leading energy producers and investors concluded two days of Vatican-sponsored dialogue on energy transition with most signing statements of support for carbon pricing and disclosures on climate change risk.

2019 News Articles (Page 4 of 6)



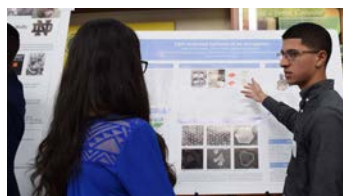
Hildreth appointed to national high energy physics advisory panel

Michael Hildreth, professor of physics and associate dean for research and graduate studies, has been appointed to the national High Energy Physics Advisory Panel (HEPAP).



Doctoral students receive fellowships to study waterways, clean energy, and more

Nine students from Notre Dame have received Center for Environmental Science and Technology (CEST) Predoctoral Research Fellowships. The CEST program provides students with a semester-long fellowship in any area of environmental science or engineering.



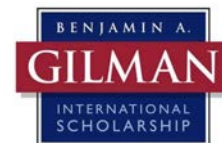
Summer programs are in full swing for undergraduate students at Notre Dame

Several National Science Foundation (NSF)-funded REUs and Fellowship programs at Notre Dame have welcomed undergraduate students to campus this week from across the country and around the world to collaborate with faculty and their associated researchers this summer.



BRIDGES program builds strong foundations for life

A partnership between Notre Dame's Kinetic Structures Laboratory and Riley High School, BRIDGES targets girls, grades 9-12, who are enrolled in the technology and engineering magnet at Riley.



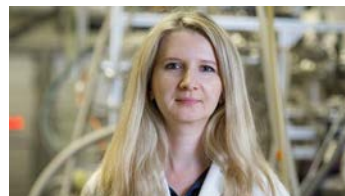
Six students receive summer Gilman Scholarships to study abroad

Sophomore Daniel Mikovits, of Spring Arbor, Michigan, will study in Dublin through **Notre Dame International's** (NDI) Dublin Summer Program. Mikovits is an electrical engineering major with a minor in energy studies. He is a Grand Challenges Scholar.



Study aims to improve capturing wind power for energy production

Scientists have released the first of several reports outlining major results that could help wind industry officials manage wind power facilities more efficiently and increase renewable energy production.



Physics researchers study reasons for biomolecule fragmentation from radiation

Sylwia Ptasinska, associate professor of physics, published research in Physical Review Letters that begins to explain how low-energy electrons cause damage to DNA and proteins, molecules of life.



Faculty awards honor undergraduate teaching and advising

Twenty University of Notre Dame faculty members have received Rev. Edmund P. Joyce, C.S.C., Awards for Excellence in Undergraduate Teaching, and three have been honored with Dockweiler Awards for Excellence in Undergraduate Advising.



Leading energy storage researcher Esther Takeuchi, Ph.D., to deliver the Graduate School Commencement address

The Graduate School is proud to announce that Dr. Esther Takeuchi, Distinguished Professor of Chemistry and Material Science and Engineering at Stony Brook University, will address **graduates at the Graduate School's** annual Commencement Ceremony.



Notre Dame awarded transformational Lilly Endowment grant to accelerate regional innovation and workforce and economic development

The University of Notre Dame announced Friday (April 26) a \$42.4 million grant from Lilly Endowment Inc. to form the Labs for Industry Futures and Transformation (LIFT) Network, which will enhance and link cutting-edge expertise, technologies, workforce development programs and innovation-based facilities throughout the broader South Bend-Elkhart region.

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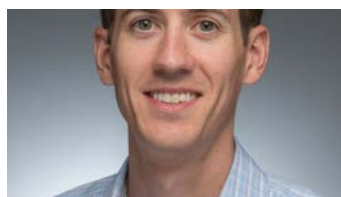
26 students and alumni win NSF fellowships or honorable mentions

The National Science Foundation (NSF) recently announced the winners of its 2019 Graduate Research Fellowship Program (GRFP), with 14 University of Notre Dame students and alumni winning the highly coveted award and another 12 receiving honorable mentions.



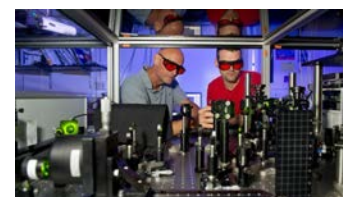
Notre Dame supports spring 2019 meeting of Materials Research Society

Faculty and researchers from the University of Notre Dame are attending the 2019 Materials Research Society (MRS) Spring meeting in Phoenix, AZ the week of April 22–26. Over 30 members of the Notre Dame research community are presenting MRS research.



Doudrick a Recipient of the 2019 Fulbright Global Scholar Award

Assistant Professor Kyle Doudrick was awarded a 2019 Fulbright Global Scholar Award by the Commission Franco Américaine.



2019 Kobayashi Travel Fund and Equipment Restoration and Renewal awardees announced

Fourteen researchers from Notre Dame have received internal grants from Notre Dame Research. Eight faculty have received Equipment Restoration and Renewal awards and six faculty have received Francis M. Kobayashi Travel Fund grants.



Bonus episode of podcast highlights bold proposal for U.S.-Mexico border

With a Side of Knowledge is a podcast produced by the Office of the Provost at Notre Dame. The show released a special bonus episode on Sunday, **April 7, titled “A Bold Proposal for the U.S.-Mexico Border” and featuring Luciano Castillo, Kenninger Professor of Renewable Energy and Power Systems at Purdue University.**



Podcast releases live show episode featuring SEforALL CEO Rachel Kyte

The 12th episode of season two, “On Energy and Not Throwing Spaghetti Against the Wall,” was released Thursday, April 4, and features Rachel Kyte, chief executive officer of Sustainable Energy for All (SEforALL), special representative of the UN secretary-general for Sustainable Energy for All, and co-chair of UN-Energy.



New system to tackle nonconsumable food waste, contribute to clean energy needs of local farm

A new food waste system at the University of Notre Dame is poised to reduce nonconsumable food waste on campus by more than 2,000 pounds per day while contributing to the clean energy needs of a local farm — thanks, in large part, to the hard work of several Notre Dame students.



Notre Dame engineers part of consortium proposing US-Mexico ‘energy-water corridor’ in lieu of border wall

Engineering professors at Notre Dame have joined a consortium of 28 scientists, researchers and engineers in a proposal to build an extensive energy- and water-producing industrial corridor along the U.S.-Mexico border as an alternative to a border wall.



ND Energy welcomes Rachel Kyte, a world-renowned advocate and expert in sustainable energy

The Center for Sustainable Energy at Notre Dame (ND Energy) will host its 2nd annual research symposium on Wed., March 20, with keynote speaker Rachel Kyte who leads the world-wide charge towards access to affordable, reliable, and sustainable energy for all.



Student Energy Board selects top energy-related projects at Northern Indiana Science and Engineering Fair

Notre Dame was once again the site **for this spring’s Northern Indiana Regional Science and Engineering Fair (NIRSEF)**, showcasing the work of students from Elkhart, Fulton, Marshall, and St. Joseph counties.

2019 News Articles (Page 6 of 6)



US remains stagnant in climate change vulnerability and readiness, new data show

For the fourth year in a row, the United States has ranked 15th in the **University of Notre Dame's Global Adaptation Initiative (ND-GAIN)** Country Index. The annual index ranks 181 countries on vulnerability to extreme climate events such as droughts, superstorms and other natural disasters.



Students explored a broader range of career development opportunities during the 2019 Sustainability Expo

Nearly 100 students turned out for the annual Sustainability Expo on **Feb. 11. This year's event marked an** expansion for the expo, offering resources about career opportunities in energy, the environment, and sustainability studies for both undergraduate and graduate students.



Kamat wins the title for solar in the first-ever ND Energy Bouts: Fighting for Renewable Energy

The first-ever *ND Energy Bouts: Fighting for Renewable Energy* drew a huge crowd in Jordan Hall of Science on Feb. 12 with fans eager to see who would take the win.



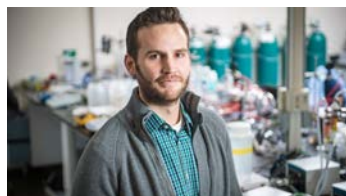
ASCENT: One Year In

The foundational multi-disciplinary Applications and Systems-driven Center for Energy-Efficient Integrated Nano Technologies (ASCENT) has now been in operation for a year. ASCENT is one of only six research centers funded by the Semiconductor **Research Corporation's (SRC) Joint University Microelectronics Program (JUMP).**



Elite group of students selected to advance research in energy at Notre Dame

The Center for Sustainable Energy at Notre Dame (ND Energy) has selected 11 students to receive 2019 fellowships in energy research at the University of Notre Dame.



Anfiro, Company Founded on Notre Dame and Purdue Technology, Announces Formation of Advisory Board

Anfiro, an innovator in water and separation technologies, today announced the formation of its Advisory Board with the appointment of industry leaders Craig Beckman, Matthew Nordan and Jean-Marc Pandraud as its initial members.



Researchers make important **discovery for 'smart' films and encapsulation**

A study from the University of Notre Dame has found that the properties of a material commonly used to create conductive or protective films and encapsulate drug compounds – and the conditions in which this material will disassemble to release that medication – may be different than initially thought.

Marketing Channels

ND Energy uses various marketing channels to share relative news articles, events, and major accomplishments in energy-related research, education, and outreach at Notre Dame.



View full news articles at:

<https://energy.nd.edu/news-events/news/archives/2019/>

Follow us on social media and contact us to learn more about energy-related research, education, and outreach programs and services at Notre Dame.



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ND Energy

Center for Sustainable Energy at Notre Dame

115 Stinson-Remick Hall

Notre Dame, Indiana 46556

Est. 2005



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