CATALYSIS CENTER FOR ENERGY INNOVATION

AN ENERGY FRONTIER RESEARCH CENTER

UNIVERSITY OF DELAWARE

2009 - 2024 SUMMARY REPORT

The Catalysis Center for Energy Innovation (CCEI), an Energy Frontier Research Center funded by the U.S. Department of Energy and hosted at the University of Delaware, operated from 2009 to 2024. This closing summary report celebrates the center's achievements and contributions, and acknowledges the dedicated efforts of all those involved in its journey.

TABLE OF CONTENTS

CATALYSIS CENTER OF ENERGY INNOVATION

Letter from the Director 1
Catalyzing Innovation 4
Revolutionizing Biomass 6
Synergy in Science 9
From Lab to Life 12
Startups 14
By the Numbers 15
Trailblazing Discoveries 18
Partner Institutions 24
People Power 25
Industrial Consortium 30
A Lasting Legacy 31

MESSAGE FROM THE DIRECTOR

DIONISIOS G. VLACHOS

Dear Friends and Colleagues,

As we close the chapter on the Catalysis Center for Energy Innovation (CCEI), I am filled with pride and gratitude for the remarkable achievements we have accomplished together over the past 15 years. Our center was born from a vision to transform biomass into valuable energy resources and chemicals. The collective dedication and ingenuity of our team advanced that goal far beyond our initial imagination.

Reflecting on our journey, I am reminded of the countless challenges we tackled and the innovative solutions we developed. Throughout our funding cycles, we explored uncharted territories. Each scientific breakthrough paving the way for a more sustainable future. The impact of our research has been felt both in academia and industry, and I am proud of how we pushed the boundaries of knowledge in ways that will have lasting significance. Our advances in heterogeneous catalysis, particularly in the development of new zeolites and the use of renewable feedstocks, highlight not only the ingenuity of our researchers, but also the critical role that collaborative science plays in addressing global energy challenges. It has been incredibly rewarding to see our shared passion foster both scientific achievement and deep friendships that will endure beyond the life of the center.

The opportunities CCEI created for postdoctoral researchers, graduate students, and undergraduate interns – who comprised the lifeblood of our center – were particularly fulfilling to witness. They enriched the environment in our laboratories and office spaces, driving innovative research with enthusiasm and creativity. Many of our alumni are already making significant contributions to the field, while others are newly equipped with the education and skills needed to tackle future challenges. I am honored to know that the mentorship and training they received during their time with CCEI empower them to lead the future of energy innovation.

As we close this chapter, I am excited about the future that lies ahead. The knowledge and expertise we have built will continue to resonate in the ongoing efforts to develop sustainable energy solutions. While the CCEI may be concluding, the legacy of our work will endure, inspiring future generations of researchers and innovators. I look forward to seeing the new ventures and discoveries that will move us forward.

Thank you to all those who contributed to this incredible journey. Let us continue to challenge ourselves and each other to push the boundaries of what is possible.

Warmest regards,

D. Vlachos

CATALYZING INNOVATION

THE ESTABLISHMENT OF CCEI

2009

The Catalysis Center for Energy Innovation (CCEI) was established in 2009 as one of the nation's first Energy Frontier Research Centers (EFRCs) – a U.S. Department of Energy initiative.

Building on the University of Delaware's long tradition of pioneering catalytic research, a legacy established by the Center for Catalytic Science and Technology (CCST) since 1978, CCEI brought together a multidisciplinary team of scientists and engineers from various institutions and national laboratories to address critical challenges in energy catalysis. Over its 15 years of operation, CCEI advanced the fundamental science of catalysis enabling a slate of scientific breakthroughs in sustainable energy solutions and priming the market for biomass-based product applications in jet fuel, adhesives, packaging, detergents, plastics, textiles, and more.

REVOLUTIONIZING BIOMASS

CUTTING-EDGE CATALYTIC TECHNOLOGIES

CCEI developed innovative catalytic technologies to efficiently convert biomass – wood, switch grass, and other organic waste – into fuel, chemicals, and advanced materials. CCEI researchers tackled the toughest challenges in energy with ground-breaking science, including catalysis, reaction engineering, and multiscale modeling. The center focused on the primary objectives detailed on the following pages.

NOVEL CATALYST DISCOVERY

Synthesis and characterization of new catalysts to enhance efficiency and effectiveness of energy-related reactions and processes

UNDERSTANDING CATALYST FUNCTIONALITY

Investigating catalysts' mechanisms and functionality to improve sustainable, eco-friendly consumer product manufacturing processes

MULTISCALE MODELING

Development and application of computer models to predict catalyst functionality and process outcomes – from nanoscale changes to industrial system-wide impacts

REACTION AND REACTOR EVALUATION

Assessing the performance of chemical reactions and reactors to optimize conversion processes and viability of commercial product production

TECHNOLOGY TRANSFER

Facilitating the adoption of innovative catalytic technologies from research to industrial application

EXPANDING THE ENERGY RESEARCH FRONTIER

Pioneering discoveries and methodologies in catalytic science for energy-related applications and contributing to the scientific literature in the field

UNITING SCIENCE AND INDUSTRY

Bridging the gap between scientific research and industrial application to address industry pain points, accelerate advancements, and increase commercialization opportunities

EDUCATION AND OUTREACH

Training the next generation of scientists and engineers and promoting public understanding of sustainable energy technologies

SYNERGY IN SCIENCE

PARTNERSHIPS AND INDUSTRIAL IMPACT

CCEI exemplified the power of collaboration, forging robust partnerships that spanned academia, industry, and federal agencies. These alliances not only amplified the center's research capabilities but also ensured that its breakthroughs had tangible industrial impacts.

FEDERAL PARTNERSHIP

Support from federal agencies plays a strategic role in bringing scientists and scholars together to conduct transformative research. Since its establishment in 2009, CCEI secured $42.7 million in federal funding from the U.S. Department of Energy. The funding included two 4-year renewals in 2014 and 2019, making it one of the longest-tenured EFRCs established by the U.S. Department of Energy. Of the original 46 EFRCs, CCEI was among the few to receive renewal funding, highlighting CCEI's continued excellence and impact in energy-related catalysis research.

INTERDISCIPLINARY COLLABORATION

The center fostered strong collaborations between researchers from multiple disciplines, academic institutions, and national laboratories across the U.S. in advancing the frontiers of catalysis research for converting biomass into chemicals and fuels. Together, the expertise and synergism of nearly 50 principal investigators from 17 institutions nationwide tackled the challenges and complexities of heterogeneous catalysis.

CCEI's commitment to the multidisciplinary collaboration of chemists, chemical engineers, material scientists, physicists and others brought invaluable strength. The holistic approach allowed CCEI teams to tackle the same challenges from different angles, allowing for diverse solutions, identification of obstacles, and prevention of unnecessary complications.

INDUSTRIAL PARTNERSHIPS

CCEI established partnerships with industry stakeholders enhancing the impact and applicability of its research. Regular discussions with industry partners helped move ideas from drawing boards and proving grounds into the workflow and scale of biorefineries and production.

FROM LAB TO LIFE

INFLUENCE AND OUTREACH

CCEI's influence extended far beyond the laboratory, with its research translating into significant economic, environmental, and educational contributions. The center's prolific output of publications, patents, and public engagement initiatives underscored its role as a beacon of innovation in the field of energy research.

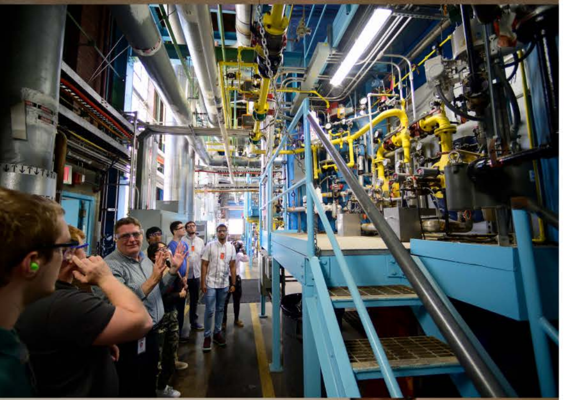
RESEARCH PUBLICATIONS

CCEI's contribution to scientific knowledge and technological advancements was abundant. Over its 15-year operation, CCEI produced 550 peer reviewed publications, was featured on the cover of scientific journal covers 46 times, and saw nearly 35,500 citations of CCEI research papers. On average, CCEI produced 36 research articles each year, with the majority of papers authored by two or more principal investigators.

PATENTS AND LICENSED TECHNOLOGIES

CCEI established itself as a vanguard in transformative research, discovering and advancing processes to generate useful products from waste. Throughout its operation, CCEI completed over 50 patent filings and developed more than 10 innovative technologies that were subsequently licensed for commercial use. These successes represent significant advancements in catalytic science, impacting industries from paper to agriculture, and more.






ECONOMIC AND ECOLOGICAL IMPACT

The center's research contributed to sustainability and economic growth with the creation of six innovative startup companies, including Activated Research Company, Lingnolix, RiKarbon, and Sironix which are detailed on the following page.

EDUCATION AND TRAINING

CCEI was proud to offer a vibrant environment to educate and stimulate the next generation of engineers and scientists needed in heterogeneous catalysis and reactors, biorefineries, and renewable energy sectors. The center trained 221 graduate students and postdoctoral fellows, the significant majority of whom have gone on to successful careers in academia, industry, and government. CCEI addition ally focused on engaging future scientists and engineers by supporting research internships for 103 undergraduates and high school students.

PUBLIC OUTREACH AND ENGAGEMENT

CCEI conducted numerous outreach activities to establish community connections, present the center's research activities, and promote awareness of sustainable energy technologies. Outreach efforts included public lectures, professional workshops, research symposiums, student poster sessions, and interactive educational presentations to engage K-12 students.

STARTUPS
BORN FROM CCEI RESEARCH

CCEI

RiKarbon

RiKarbon develops technologies for cost competitive renewable products that use non-conventional and typically unused carbon feedstocks to serve the domestic and international specialty and performance chemicals market.

SIRONIX RENEWABLES

Sironix Renewables transform plants into high-performing, eco-friendly cleaning product ingredients.

arc activated research company

Activated Research Company (ARC) is a leading innovator of LC/GC instrumentation creating award-winning, affordable laboratory solutions that deliver simplified workflow and better results.

lignolix

Lignolix develops novel chemical process technologies for converting lignin in plant waste into ingredients for adhesives, cosmetics, flavors, and fragrances.

BY THE NUMBERS

CATALYSIS CENTER FOR ENERGY INNOVATION

324 STUDENTS & POSTDOCTORAL FELLOWS TRAINED

6 STARTUP COMPANIES

PATENT FILINGS **50+**

17 INSTITUTIONS

35,489 CITATIONS

2 RENEWALS

550 PUBLICATIONS

AVERAGE ANNUAL PUBLICATIONS **36**

47 PRINCIPAL INVESTIGATORS

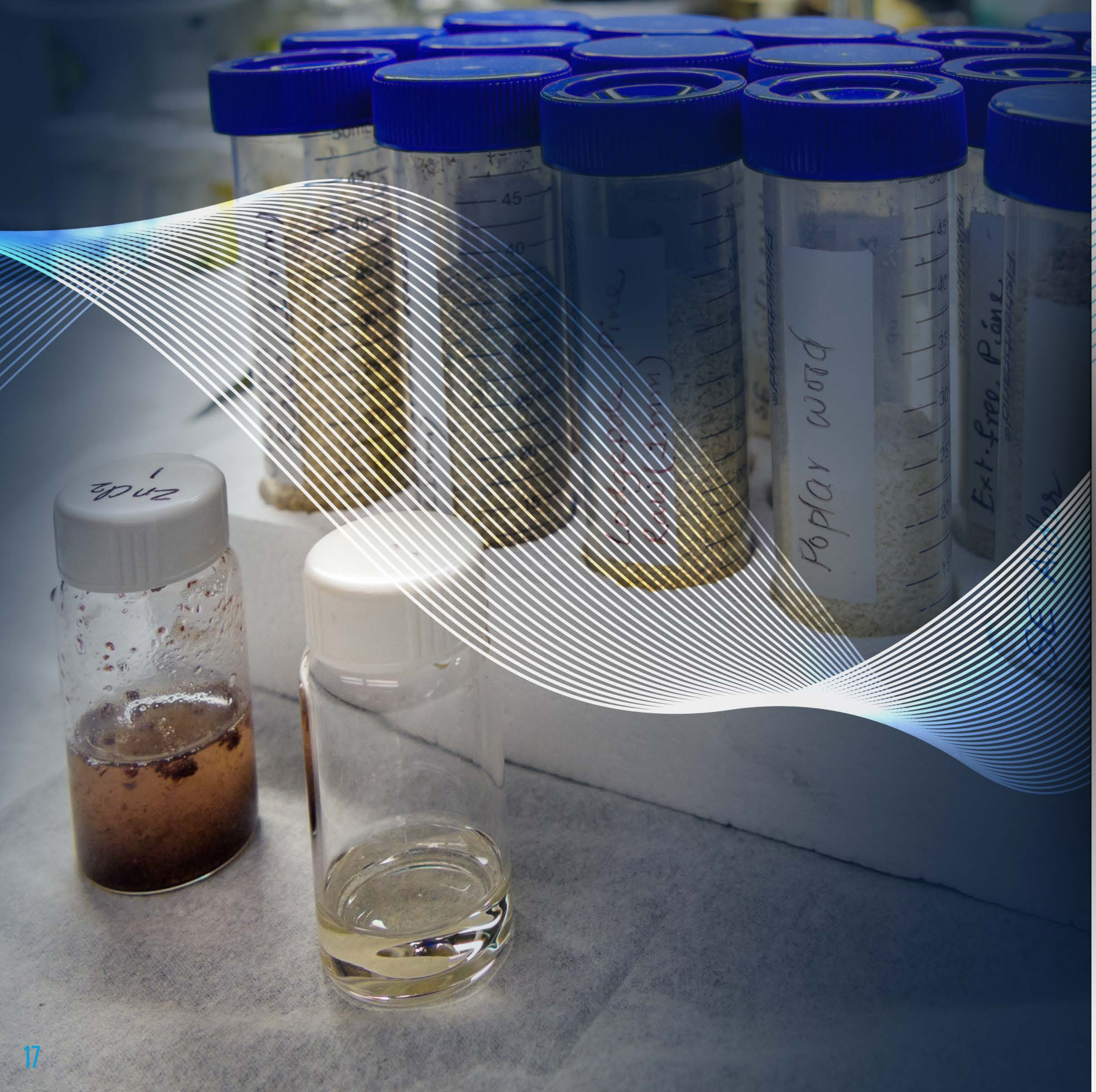
$42.7 MIL FEDERAL FUNDING

JOURNAL COVERS **46**

10+ LICENSED TECHNOLOGIES

15 YEARS OF OPERATION

2009-2024



TRAILBLAZING DISCOVERIES

DEFINING RESEARCH HIGHLIGHTS

The Catalysis Center for Energy Innovation made significant strides in energy catalysis, garnering attention from the scientific community, industry professionals, and the public at large. Several groundbreaking research projects showcased the center's ability to push research boundaries, provide innovative solutions, and contribute to the foundation needed to continue future advancements in the field. Some of CCEI's most notable research publications are highlighted on the following pages, illustrating the breadth and impact of CCEI's work over the years.

2023

OXYGEN INFLUENCE ON CATALYSTS
Optimized carbon-based catalysts and discovered how different forms of oxygen in carbon materials influence catalytic performance, overturning traditional understandings of catalytic chemistry (*Nature Communications*).

2022

FASTER AMMONIA SYNTHESIS
Demonstrated that ammonia - the most highly produced chemical in the world – can be synthesized 10 times faster and under milder conditions using dynamic catalysis. They additionally reported nearly doubling the equilibrium conversion limit at which the building-block molecules, hydrogen and nitrogen, are converted to ammonia from 32% to 52% (*Science Advances*).

RENEWABLE FUELS FROM BIOMASS
Improved the ability of catalysts made from metal-metal oxides to convert leaves, stalks, and cobs leftover after field harvesting into renewable fuels, chemicals and plastics (*Nature Catalysis*).

2020

AL FOR RENEWABLE ENERGY
Developed a high-confidence approach for artificial intelligence-based models applicable to enhance productivity in many fields including renewable energy, battery technology, and climate change mitigation (*Science Advances*).

IMPROVED HYDROGEN FUEL CELLS
Developed new characterization techniques to address challenges in electrochemical storage technologies, such as the hydrogen fuel cells used in transportation vehicles (*Nature Communications*).

NEW BIOMASS CATALYSTS
Discovered a new class of catalysts for converting agricultural biomass, demonstrating that scientists can selectively control the chemical reactions required to convert plant derivatives into potential biofuel (*Nature Catalysis*).

2019

COST-EFFECTIVE METAL OXIDES
Demonstrated that rather than expensive metals catalysts like platinum, cheaper and more stable metal oxides can be efficient, cost-effective alternatives in the production of renewable everyday products like lubricants, adhesives, and soap (*Nature Catalysis*).

RENEWABLE LUBRICANT BASE OILS
Created renewable lubricant base oils efficiently from non-food biomass and fatty acids. This was one of the first attempts to make renewable lubricants from abundant raw materials resulting in a high-performance material with tunable properties (*Science Advances*).

2018

ELECTROCHEMICAL CATALYSTS
Discovered that vanadium nitride can be used as a catalyst to electrochemically produce ammonia at close to room temperature from nitrogen in the atmosphere (*Journal of the American Chemical Society*).

ADVANCED TANDEM CATALYSIS
Advanced tandem catalysis, where multiple catalysts are used together to produce even faster and more efficient reactions, that could also reduce the environmental footprint of common industrial chemical processes (*Journal of the American Chemical Society*).

BIO-BASED OILS FOR LOTIONS

Engineered bio-based oils from plant scraps and natural oils to be used as a renewable alternative to typical petroleum-based resources used in skin lotions and sunscreens.

SUSTAINABLE ADHESIVES

Invented a novel process to make high-performance adhesives from inexpensive, plentiful, and sustainable material discarded by pulp and paper manufacturers. The adhesive preforms as well as commercially-available products (*ACS Central Science*).

2017

BIOBASED AVIATION FUEL

Developed processes to accelerate the production of bio-based aviation fuel (*ACS Catalysis, ACS Catalysis, ChemSusChem*).

RENEWABLE BUTADIENE PROCESS

Designed a process to make butadiene – a molecule essential to the production of synthetic rubber and plastics – from renewable resources (*ACS Sustainable Chemistry and Engineering*).

ONE-STEP SUGAR EXTRACTION

Invented a novel, one-step process for extracting sugars from wood chips, corn cobs and other organic waste which could serve as a less expensive, sustainable substitute for petroleum used to manufacture consumer goods (*ChemSusChem*).

2016

RENEWABLE SOAP MOLECULES

Created a new soap molecule made from renewable sources that could dramatically reduce chemicals in cleaning products and their impact on the environment (*ACS Central Science*).

2014

QUANTITATIVE CARBON DETECTOR

Invented the Quantitative Carbon Detector (QCD) a revolutionary device for chemical analysis, significantly reducing the time required to identify and quantify chemical compounds in complex mixtures that is now being produced commercially (Lab on a Chip), is now being developed commercially.

2013

CATALYTIC TRANSFER HYDROGENATION

Introduced the catalytic transfer hydrogenation technology to selectively convert furans into reduced ones and enable integration of processes from sugars to p-xylene.

2012

HIGH-YIELD BIOMASS p-XYLENE

Developed a new process to produce high yield (greater than 90 percent) p-xylene, used to make plastic bottle, from biomass rather than petroleum.

2010

GLUCOSE TO FRUCTOSE CATALYST

Introduced the first heterogeneous catalyst, Tin-Beta, to convert glucose into fructose. This is the first step in the production of a large number of targeted products including biofuels and biochemicals.

PARTNER INSTITUTIONS

A NETWORK OF EXCELLENCE

CCEI was built on the strong foundation of its partner institutions, which included leading universities and national laboratories. The collaborations brought together diverse expertise and resources, enabling CCEI to push the boundaries of research and innovation.

University of Delaware
Brookhaven National Laboratory
University of Minnesota
UMass Amherst
Stony Brook University
Rutgers
University of Maryland
UC Santa Barbara
Caltech
Columbia University
Penn University of Pennsylvania
UConn
Johns Hopkins University
Georgia Tech
Princeton University
Carnegie Mellon University
Lehigh University

PEOPLE POWER

THE HEART OF CCEI'S SUCCESS

At the core of CCEI was a community of dedicated individuals whose collective efforts powered its many achievements. From the seasoned expertise of principal investigators and advisory board members to the fresh perspectives of graduate students and postdoctoral researchers, CCEI's success was a testament to the passion and creativity each member brought to the table.

Under the leadership of CCEI's co-directors, Dr. Dion Vlachos, Dr. Jingguang Chen, and Dr. Paul Dauenhauer, research groups across 17 institutions worked in concert, blending unique skills and expertise to tackle complex energy challenges. This commitment to interdisciplinary collaboration and shared goals created a dynamic environment that encouraged collaborative innovation and advanced sustainable energy technologies.

LEADERSHIP

Dion Vlachos
Director (2009-2024)

Current Affiliation:
Unidel Dan Rich Chair in Energy
Professor of Chemical and Biomolecular Engineering
University of Delaware

Jingguang Chen
Co-director (2009-2014)

Current Affiliation:
Thayer Lindsley Professor of Chemical Engineering
Columbia University

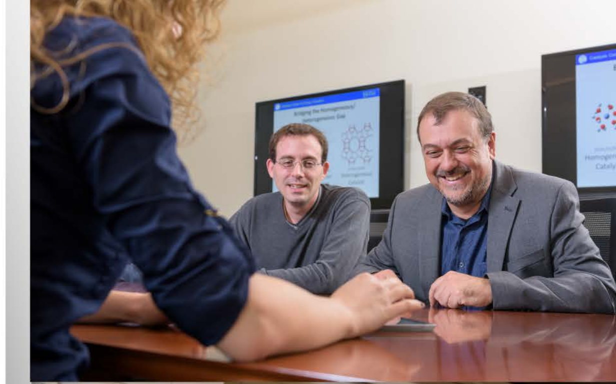
Paul Dauenhauer
Co-director (2014-2024)

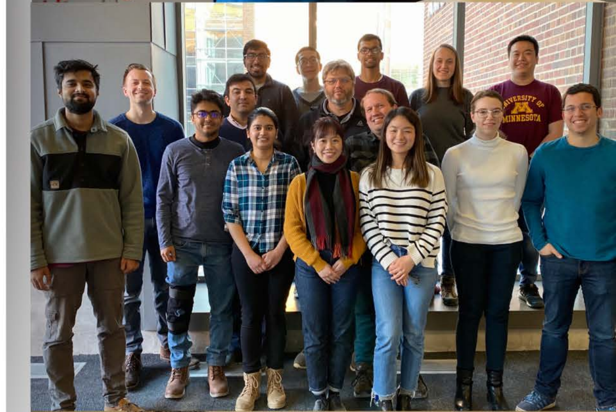
Current Affiliation:
Distinguished McKnight University Professor of Chemical Engineering and Materials Science
University of Minnesota

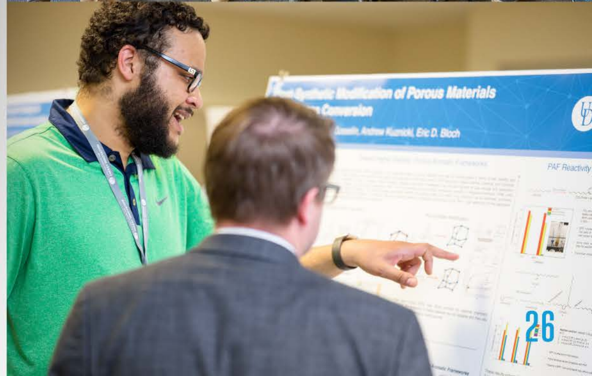
ADVISORY BOARD

Mark Barteau - Texas A&M
Nazeer Bhore - Exxon Mobile
William Borghard - Rutgers
Juben Chheda - Shell International
Avelino Corma Canós - IT Química
Robert Davis - University of Virginia
James Dumesic - UW-Madison
Robert Farrauto - BASF Corporation
Maria Flytzani-Stephanopoulos - Tufts Univ.
Bruce Gates - UC Davis
Javier Guzman - ExxonMobil
Prasanna Joshi - Exxon Mobile
Chung Law - Princeton University
Angeliki Lemonidou - Univ. of Thessaloniki
Charles Peden - PNNL
Carmo Pereira - DuPont
Daniel Resasco - University of Oklahoma
Jose Rodriguez - Brookhaven NL
Lanny Schmidt - University of Minnesota
Susannah Scott - UC Santa Barbara
Shekar Shetty - Air Liquide
Jeffrey Siirola - Carnegie Mellon University
Paris Tsobanakis - Cargill, Inc.
Kurt VandenBussche - UOP-A Honeywell

**Affiliations listed reflect institution at time of collaboration with CCEI*







PRINCIPAL INVESTIGATORS

Omar Abdelrahman - UMass Amherst
Scott Auerbach - UMass Amherst
Mark Barteau - University of Delaware
Aditya Bhan - University of Minnesota
Eric Bloch - University of Delaware
Anibal Boscoboinik - Stony Brook University
Douglas Buttrey - University of Delaware
Stavros Caratzoulas - Univ. of Delaware
Jingguang Chen - Columbia University
Phillip Christopher - UC Santa Barbara
Prodromos Daoutidis - Univ. of Minnesota
Paul Dauenhauer - Univ. of Minnesota
Mark Davis - Caltech
Doren Douglas - University of Delaware
Wei Fan - UMass Amherst
Anatoly Frenkel - Stony Brook University
Raymond Gorte - University of Pennsylvania
Song-I Han - UC Santa Barbara
George Huber - UMass Amherst
Marianthi Ierapetritou - Univ. of Delaware
Friederike Jentoft - UMass Amherst
Feng Jiao - University of Delaware
Yan Jin - University of Delaware
Christopher Jones - Georgia Tech
Michael Klein - University of Delaware
Bruce Koel - Princeton University
Dongxia Liu - University of Maryland
Raul Lobo - University of Delaware
Giannis Mpourmpakis - Univ. of Delaware
Christopher Murray - Univ. of Pennsylvania
Vladimiros Nikolakis - Univ. of Delaware
Marat Orazov - University of Delaware
Basudeb Saha - University of Delaware
Stanley Sandler - University of Delaware
Susannah Scott - UC Santa Barbara
Ilja Siepmann - University of Minnesota
Mark Snyder - Lehigh University
Klaus Theopold - University of Delaware
Michael Tsapatsis - Johns Hopkins University
Dion Vlachos - University of Delaware
John Vohs - University of Pennsylvania
Ioulia Valla - University of Connecticut
Lynn Walker - Carnegie Mellon University
Donald Watson - University of Delaware
Weiqing Zheng - University of Delaware
Bingjun Xu - University of Delaware
Yushan Yan - University of Delaware

**Affiliations listed reflect institution at time of collaboration with CCEI*

POSTDOCTORAL SCHOLARS

Omar Abdelrahamn
Alex Ardagh
Peng Bai
Rameswar Bhattacharjee
Sourav Biswas
Ying Chen
Hongje Cho
Jeffrey Christianson
Jinlei Cui
Viktor Cybulskis
Siddharth Deshpande
Phuong Do
Mattheus Dorneles de Mello
Saikat Dutta
Konstantinos Goulas
Rajamani Gounder
Qiang Guo
Emmanuel Haldoupis
Yulin Huang
Glen Richard Jenness
Pavel Kots
Jake Kruger
Pawan Kumar
Wen-Sheng Lee
Denis Lee
Marta Leon-Garcia
Chris Lew
Zhe Li
Qiang Li
Sha (Lisa) Li
Shizhong Liu
Peng Lu
Sibao Lui
Jing Luo
Tianyi Luo
Marcella Lusardi
Evangelos Miliordos
Samir Mushrif
Dae Sung Park
Sunghwan Park
Lu Peng
Nafiseh Rajabbeigi
Limin Ren
Prahlad Routh
Sounak Roy
Sunitha Sadula
James Sheehan
Jain Sheetal
Boris Sheludko
Sagar Sourav
Pahari Swagata
Raghuram Thyagarajan
Georgios Tsilomelekis
Despoina Tzoulaki
Subramanian Vaitheeswaran
Vibin Vargheese
Efterpi Vasileiadou
Prasad Vegendla
Qi Wang
Zhuopeng Wang
Cong Wang
Shengguang Wang
Yunzhu Wang
Ruichang Xiong
Xiaofang Yang
Won-Cheol Yoo
Weiqing Yu
Weiqing Zheng

GRADUATE STUDENTS

Sydney Alter
Erha Andini
Abhay Athaley
Samantha Ausman
Sau Praneet Batchu
Ricardo Bermejo-Deval
Himaghna Bhattacharjee
Stephen Kramer Brand
Chun-Chih Chang
Jian Chang
Han Chen
Tso-Hsuan (Eric) Chen
Yu-Ting Cheng
Ziwei Cheng
Hsu Chiang
Hong Je Cho
Chen-Yu Chou
Vinit Choudhary
Matt Christiansen
Timothy Courtney
Jinlei Cui
Gerald Decker
Robert DeJaco
Steven Denny
Vicky Doan-Nguyen
Paul Dornath
Elvis Ebikade
Amani Ebrahim
Menjie Fan
Andrew Foster
Jiayi Fu
Jie Fu
Stephen Giles
Matthew Gilkey
Tejas Goculdas
Eric Gosselin
Nicholas Gould
Sara Green
Daniel Gregory
Jason Gulbinski

GRADUATE STUDENTS (CONT'D)

Na Guo
Qianying Guo
Kaivalya Gwande
Justin Hopkins
Yung Wei (Jessie) Hsiao
Renjing Huang
Sheetal Jain
Ashay Javadekar
Abhimanyu Jayakumar
Mi Young Jeon
Yichen Ji
Kristeen Joseph
Tyler Ray Josephson
Ali Kamali
Doyoung Kim
Jae Kim
Maura Koehle
Kyle Korman
Shih-Chieh Kung
Mi Jen Kuo
Mark LaFollette
Joshua Lansford
Ajibola Lawal
ChoongSze Lee
Jechan Lee
Jennifer Daneen Lee
Seungyeon (Lina) Lee
Steven Lee
Jennifer Lewis
Junying Li
Xinyu Li
Vinson Liao
Zhaojia Lin
Zhexi Lin
Yang Liu
Bill Lonergan
Song Lou
Jing Luo
Eyas Mahmoud
Elizabeth Mallon
Justin Marlow
Jesse McManus
Matt Mettler
Alexander Mironenko
Myat Myint
Ankita Naik
Stan Najmr
Hannah Nguyen
Nima Nikbin
Angela Norton
Hakan Olcay
Marat Orazov
Ryan Edward Patet
Ji Qi
Xiaoduo Qi
Srinivas Rangarajan
Rajiv Ranjan
Hui Ren
Channing Richter
Natalia Rodriquez-Quiroz
Daniel Rosen
Sanket Sabnis
Taha Salavati-Fard
Michael Salciccioli
Emily Schulman
Bryan Sharkey
Huibo Sheng
Daming Shi
Zachary Smith
Sanjana Srinivas
Eric Steinman
Taylor Sulmonetti
Jonathan Sutton
Theodore Dallas Swift
Tarnuma Tabassum
Sherya Thakkar
Zheng Tian
Ana Ines Torres
Sarah Tupy
Vassili Vorotnikov
Weiming Wan
Cong Wang
Haodong Wang
Lan Wang
Xiaoling Wang
Yuran Wang
Christopher Williams
Jon Wilson
Lea Winter
Alfred Worrad
Wei Wu
Yurong Wu
Yuxiao Wu
Shuting Xiang
Ke Xiong
Dandan Xu
Sen Yang
Shengsong Yang
Mingchun Ye
Zixing Ye
Jingye Yu
Weiting Yu
Hongseok Yun
Xueyi Zhang
Yuan Zhang
Zhigiang Zhang

INDUSTRIAL CONSORTIUM

CCEI

PARTNERSHIPS AND INDUSTRIAL IMPACT

CCEI exemplified the power of collaboration, forging robust partnerships that spanned academia, industry, and federal agencies. These alliances not only amplified the center's research capabilities but also ensured that its breakthroughs had tangible industrial impacts.

Air Liquide creative oxygen
Anellotech
arc activated research company
BRIDGESTONE
DOW
DUPONT
ExxonMobil
imperium renewables
INVISTA
LanzaTech
MICROMIDAS
Plant PET Technology Collaborative
P&G
RjKarbon
SIRONIX RENEWABLES
virdia

A LASTING LEGACY

THE ENDURING IMPACT OF CCEI

The Catalysis Center for Energy Innovation leaves a lasting impact on the field of energy catalysis. Its scientific and technological contributions have advanced the understanding and application of catalytic processes in sustainable energy production. The center's interdisciplinary approach, collaborative efforts, and commitment to education and outreach set a benchmark for future research in this area.

As CCEI concludes its operations, its legacy will live on. It will be reflected in the continuing work of CCEI alumni, the ongoing use of CCEI's developed technologies, and the foundational knowledge CCEI contributed to the field. The spirit of innovation and collaboration fostered will persist, and the work of CCEI will remain a cornerstone of progress in the quest for efficient and sustainable energy solutions. Researchers at the University of Delaware and its partner institutions remain committed to advancing energy-related catalysis and will continue to build on the strong foundations laid during CCEI's 15-year tenure. The ongoing efforts will ensure that sustainable energy solutions continue to evolve and drive future scientific advancements.

ccei.udel.edu