

Developing a Research Agenda for Utilization of Gaseous Carbon Waste Streams

Committee

David T. Allen

Chair

DR. DAVID T. ALLEN (NAE) is the Gertz Regents Professor of Chemical Engineering, and the Director of the Center for Energy and Environmental Resources, at the University of Texas at Austin. He is the author of seven books and over 250 papers, primarily in the areas of urban air quality, the engineering of sustainable systems, and the development of materials for environmental and engineering education. Dr. Allen has been a lead investigator for multiple air quality measurement studies, which have had a substantial impact on the direction of air quality policies. He directs the Air Quality Research Program for the State of Texas, and he is the founding Editor-in-Chief of the American Chemical Society's journal ACS Sustainable Chemistry & Engineering. The quality of his work has been recognized by the National Science Foundation, the AT&T Foundation, the American Institute of Chemical Engineers, the Association of Environmental Engineering and Science Professors, and the State of Texas. He has served on a variety of governmental advisory panels and from 2012 to 2015 chaired the U.S. Environmental Protection Agency's Science Advisory Board. Dr. Allen received his B.S. degree in Chemical Engineering, with distinction, from Cornell University in 1979. His M.S. and Ph.D. degrees in Chemical Engineering were awarded by the California Institute of Technology in 1981 and 1983. He has held visiting faculty appointments at the California Institute of Technology, the University of California, Santa Barbara, and the Department of Energy.

Mark A. Barteau

Member

DR. MARK A. BARTEAU (NAE) is the Director of the University of Michigan Energy Institute and the inaugural DTE Energy Professor of Advanced Energy Research. He previously served as the Senior Vice Provost for Research and Strategic Initiatives at the University of Delaware. He was elected to the National Academy of Engineering in 2006. Barteau brings extensive experience as a researcher, inventor, academic leader, and consultant for both US and international organizations. His research focuses on chemical reactions at solid surfaces, and their applications in heterogeneous catalysis and energy processes. His research has been funded by the National Science Foundation, the Department of Energy, the Air Force Office of Scientific Research and NASA. Mark received his Masters and Ph.D. in Chemical Engineering from Stanford University in 1977 and 1981, respectively.

Michael Burkart

Member

DR. MICHAEL BURKART is currently a Professor and Vice Chair of the Chemistry and Biochemistry Department at UC San Diego and Associate Director of the California Center for Algae Biotechnology. His research includes natural product synthesis, biosynthesis, and synthetic biology. He has broad experience in renewable fuels, chemicals, and materials. Dr. Burkart's lab pursues interdisciplinary research in the fields of bioorganic and synthetic organic chemistry and chemical biology. The lab is currently involved in the study of algal metabolic pathways with an emphasis on engineering improved biofuel production. Dr. Burkart received his B.A. in chemistry from Rice University in 1994 and his Ph.D. in organic chemistry from Scripps Research Institute in 1999.

Jennifer Dunn

Member

DR. JENNIFER DUNN is the Director of Research of the Northwestern-Argonne Institute of Science and Engineering and a Principal Environmental Analyst at Argonne National Laboratory. She is a Research Associate Professor at Northwestern University in Chemical and Biological Engineering. Jennifer investigates life cycle energy consumption and environmental impacts of advanced transportation and fuel technologies, including biofuels and battery-powered electric drive vehicles. In previous work, Jennifer led life cycle analysis projects in the United States for URS Corporation and supported mobile source emission reduction programs at the U.S. Environmental Protection Agency. She holds a Ph.D. in Chemical Engineering from the University of Michigan.

Anne M. Gaffney

Member

DR. ANNE M. GAFFNEY is the director and laboratory fellow of the Process Science & Technology Division of Idaho National Laboratory. She received her doctorate in physical organic chemistry from University of Delaware in 1981, and a bachelor's in chemistry and mathematics from Mount Holyoke College in 1976. Having worked at ARCO, DuPont, Rohm and Haas, and Lummus in various R&D and leadership roles, she has been a most prolific inventor and an author with 247 patent/patent applications and 99 publications (plus two book chapters and two books edited), as well as 106 presentations or seminars. She has received many awards such as the ACS Award in Industrial Chemistry in 2013, ACS Fellow in 2010, the Tribute to Women in Industry Award in 2007, and the Catalysis Club of Philadelphia Award in 1999. Anne's most recent accomplishment is being the recipient of the 2015 Eugene J. Houdry Award of the North American Catalysis Society.

Raghubir Gupta

Member

DR. RAGHUBIR GUPTA is the Senior Vice President of the Energy Technology Division at RTI International. Dr. Gupta obtained his B.Tech. degree in Chemical Engineering from the Indian Institute of Technology, New Delhi, India and his Ph.D., also in Chemical Engineering, from the Illinois Institute of Technology, Chicago. Dr. Gupta's technical expertise ranges from coal/biomass gasification, synthesis gas (syngas) cleanup and utilization, syngas conversion into fuels and chemicals including Fischer Tropsch chemistry, hydrogen production and storage, carbon capture, utilization, and sequestration, desulfurization of hydrocarbon fuels, production of cellulosic biofuels and industrial water reuse. Dr. Gupta has presented his research work in a number of national and international conferences, published in a number of reputed journals, including a paper in Science, and holds more than 20 U.S. and foreign patents. Dr. Gupta is also a visiting research fellow at the Lenfest Center for Sustainable Energy at Columbia University in New York.

Nilay Hazari

Member

DR. NILAY HAZARI is currently a Professor of Chemistry at Yale University. He received a B.Sc. (2002), majoring in chemistry, and a M.Sc. (2003) in inorganic chemistry working with Professor Leslie D. Field at the University of Sydney. He then completed a D. Phil in inorganic chemistry (2006) at the University of Oxford as a Rhodes Scholar. His doctoral supervisor was Professor Jennifer C. Green. He finished his formal education by working for three years (2006-2009) as a postdoctoral scholar under the supervision of Professor John E. Bercaw and Dr. Jay A. Labinger at the California Institute of Technology. In 2009 he started his independent career at Yale. His primary research focus is the mechanism-based design of homogeneous transition metal catalysts for the synthesis of fine and commodity chemicals. A growing interest involves the design and synthesis of small molecules for use in photovoltaics. His approach to developing new catalysts involves detailed experimental and theoretical studies of reaction mechanisms. These studies provide guidance on how to modify current catalysts and design new catalysts, which are more active and selective for existing and novel transformations. To date his group has developed state-of-the-art catalysts for the hydrogenation of carbon dioxide to formic acid, the dehydrogenation of formic acid and methanol to carbon dioxide and hydrogen, and palladium and nickel catalyzed cross-coupling. His precatalysts for palladium catalyzed cross-coupling are commercially available from a number of companies on both research (gram) and industrial (kilogram) scales. Professor Hazari has received a number of awards including the American Chemical Society Harry Gray Award for Creative Work in Inorganic Chemistry by a Young Investigator (2017), the Arthur Greer Memorial Prize for Outstanding Scholarship by Junior Faculty Members in the Social Sciences and Sciences at Yale University (2015), the Camille and Henry Dreyfus Teacher Scholar Award (2014), and the National Science Foundation Career Award (2012). In 2013 he was named an Alfred P. Sloan Research Fellow and in 2012 an Organometallics Fellow from the American Chemical Society Journal Organometallics.

Matthew Kanan

Member

DR. MATTHEW KANAN is an associate professor of chemistry at Stanford University. Dr. Kanan develops new catalysts and chemical reactions for applications in renewable energy conversion and CO₂ utilization. His group at Stanford University has recently developed a novel method to create plastic from carbon dioxide and inedible plant material rather than petroleum products, and pioneered the study of “defect-rich” heterogeneous electro-catalysts for converting carbon dioxide and carbon monoxide to liquid fuel. Dr. Kanan completed undergraduate study in chemistry at Rice University (B.A. 2000 Summa Cum Laude, Phi Beta Kappa). During doctoral research in organic chemistry at Harvard University (Ph.D. 2005), he developed a novel method for using DNA to discover new chemical reactions. He then moved into inorganic chemistry for his postdoctoral studies as a National Institutes of Health Postdoctoral Research Fellow at the Massachusetts Institute of Technology, where he discovered a water oxidation catalyst that operates in neutral water. He joined the Stanford Chemistry Department faculty in 2009 to continue research into energy-related catalysis and reactions. His research and teaching have already been recognized in selection as one of Chemistry & Engineering News’ first annual Talented 12, the Camille Dreyfus Teacher-Scholar Award, Eli Lilly New Faculty Award, and recognition as a Camille and Henry Dreyfus Environmental Mentor, among other honors. The Kanan Lab addresses fundamental challenges in catalysis and synthesis with an emphasis on enabling new technologies for scalable CO₂ utilization. The interdisciplinary effort spans organic synthesis, materials chemistry and electrochemistry.

Paul Kenis

Member

DR. PAUL J.A. KENIS is the William H. & Janet G. Lycan Professor and Head of the Chemical and Biomolecular Engineering Department at the University of Illinois at Urbana-Champaign. Dr. Kenis received his B.S. in Chemistry from Nijmegen-Radboud University (1993) and his Ph.D. in Chemical Engineering from Twente University in the Netherlands. He was a postdoctoral research fellow at Harvard University (1997-2000) where his research focused on microfluidics. In 2000 Dr. Kenis started his independent research position as an assistant professor in the department of chemical engineering at the university of Illinois at Urbana-Champaign. His research program focuses on developing microchemical systems for applications in energy and biology. Presently his efforts focus on electrolysis of CO₂ to value-added chemicals, continuous flow microreactors for semiconductor nanoparticle synthesis, microfluidic lung-on-chip platforms, and solid form screening for pharmaceutical formulation. Prior efforts included microfuel cells, microreactors for radiolabeling of biomolecules, and microfluidic platforms for protein crystallization and cell biology studies. His research has been recognized through a 3M young faculty award, a NSF CAREER award, a Xerox Award, as well as best paper awards from the Separations Division of AIChE and the Society for Experimental Biology & Medicine.

Howard Klee

Member

DR. HOWARD KLEE currently manages an independent consulting practice based in Geneva, Switzerland focused on sustainable business practices, programs, and management. Dr. Klee previously worked with Chevron and Amoco-BP before joining the World Business Council for Sustainable Development (WBCSD) in 2000. He has served in a number of executive and business functions, including strategic planning, program management, business development, environmental affairs, and manufacturing. Dr. Klee received his undergraduate degree in Chemistry from Williams College (1967), and his doctorate in Chemical Engineering from MIT (1972). He also completed an executive management program at Northwestern University's Kellogg Business School (1997). He has previously served on President Clinton's Council on Sustainable Development, and as a Director for the Foundation for Research on Economics and the Environment. He has held adjunct teaching positions at the University of California (Davis), the University of Michigan, and the University of Geneva where he has developed and taught courses in engineering design, technical communications, business and the environment. From 2000 until 2011, Dr. Klee developed and served as Program Director for "The Cement Sustainability Initiative" (CSI) at WBCSD. This program is part of a long-range change management initiative for the cement industry as it reduces its environmental footprint and product impacts, while improving the benefits realized from its activities. Twenty-four geographically diverse companies, eight industry trade organizations, and several partners participate in this global program. The effort is now widely recognized as a leading example of results that can be achieved through voluntary business action to address key sustainability issues. For many years he also directed the WBCSD's Tire Industry Project, and helped manage WBCSD's activities in China. Since 2013 Klee has done independent consulting and/or advisory work for the World Business Council, Cement Business Advisory, the Institute of Industrial Productivity and private sector clients. Today he is widely recognized for his expertise on sustainability issues in the cement sector. He currently divides his time between Switzerland and California. Dr. Klee also has an active career as an artist, with his paintings held in private collections in Switzerland, France and the United States.

Gaurav N. Sant

Member

DR. GAURAV N. SANT is an associate professor and a Henry Samueli Fellow at the University of California, Los Angeles. Dr. Sant's research interests include interfacial solid-liquid, solid-vapor, and solid-liquid-vapor reactions including dissolution, precipitation, and electrochemical corrosion with applications to (i) cement, concrete, porous media, (ii) hard biological tissues, (iii) metals and alloys, (iv) natural and synthetic minerals, and (v) glasses. In his research, special focus is placed on understanding the origin of formation, degradation and aging dynamics of such materials in aqueous environments of relevance to engineered, biological and geological systems. Dr. Sant received his Ph.D. in Civil Engineering from Purdue University in 2009.

Cathy L. Tway

Member

DR. CATHY L. TWAY is the R&D Director for the Inorganic Materials & Heterogeneous Catalysis Capability of Core Research & Development at the Dow Chemical Company. Her organization utilizes traditional and specialized techniques in high throughput experimentation, modeling and informatics, and characterization to accelerate inorganic materials and heterogeneous catalysis discovery, development, and commercialization. Cathy joined Dow in 2007 as a Research Leader in the Inorganic Chemistry and Catalysis organization, where she developed and led the Core R&D efforts for catalyst discovery and also introduced several new inorganic materials research programs. Prior to joining Dow, Cathy held positions at Celanese, Solutia and AkzoNobel, holding both individual contributor and R&D leadership roles. Her industrial experience covers the entire catalyst project life cycle including front end identification and creation of new technologies, process scale-up, commercialization and plant support. Over her career, Cathy has commercialized two inorganic materials and four catalyst technologies, with two of these processes still in use today. Cathy earned her B.S. degree in Chemistry from Wichita State University and her Ph.D. in Physical Inorganic Chemistry from the University of Nebraska - Lincoln.