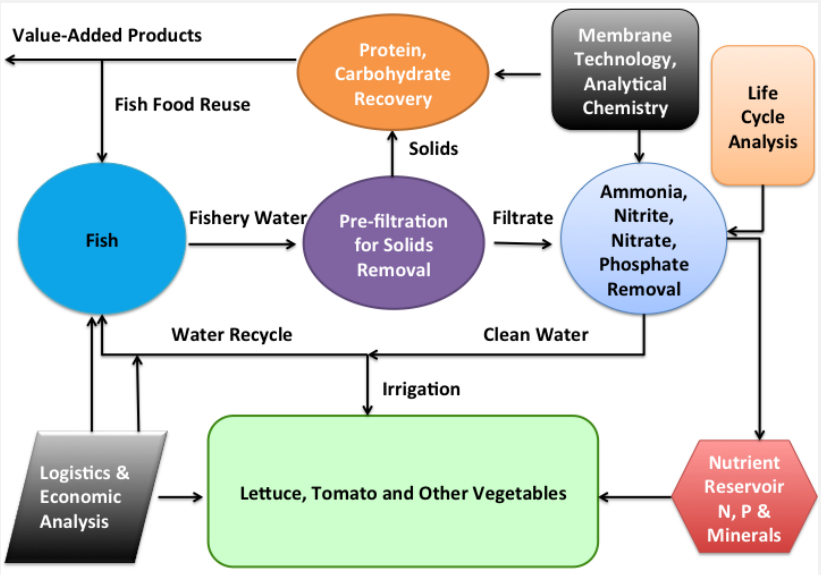
2017 NorCal AIChE Symposium on Food – Water – Energy Nexus

Friday, April 28, 2017

Venue-

Hyatt House Emeryville
5800 Shellmound Street
Emeryville, CA – 94608

Abstracts and Biographies:

8:00 – 8:30 am	Registration and Breakfast
8:30- 8:40 am	Opening Remarks (Symposium Chair)
	Morning Session (Co-Chairs: Akash Narani and Nathan Hanna)
8:40-9:20 am	Speaker 1 - **Ranil Wickramasinghe** (Professor/University of Arkansas-Fayetteville) Title - <u>Addressing the Food Energy Water Nexus through Aquaponics</u> Abstract – Population increase over the next 50 years will result in two opposing demands: added pressure placed on land for urbanization and doubling of global food demand. Production of food in confined systems, such as recirculating aquaculture systems (RAS), hydroponics, intensive greenhouse production, or aquaponics, presents an attractive solution to increased food production demands.  ***Biosystems Design of Aquaponic Production**. This futuristic system integrates membrane water purification and recycling process as well as a nutrient reservoir unit. The waste from the fish farm is removed and recycled as fertilizer for the plants whereas undigested proteins are recovered and reused; and excreted carbohydrates are purified as value added products* Growing interest in sustainable agriculture lead to the integration of RAS and hydroponic systems leading to aquaponics systems. In 2010 it was estimated that 800-1200 home aquaponics and 1,000 school aquaponics systems existed in the US. Today aquaponics systems exist in a variety of scales: personal/hobby use; community and economic development; educational demonstration; demonstration units for increasing food

	production in urban areas. However large-scale economically viable systems remain elusive. The figure illustrates a possible concept for integrated aquaponics food production system with nutrient rebalancing and water recycle / reuse by developing tailored advanced membrane technology. The concept of aquaponics will be introduced in this presentation. The challenges that need to be overcome in order to develop commercially viable aquaponics systems will be discussed. The potential role of novel membranes and membrane based separation processes will be highlighted. Biography – Prof Wickramasinghe obtained his Bachelor's and Master's degrees from the University of Melbourne, Australia in Chemical Engineering. He obtained his PhD from the University of Minnesota, also in Chemical Engineering. He worked for 5 years in the biotechnology/biomedical industry in the Boston area before joining the faculty of the Department of Chemical Engineering at Colorado State University. He joined the Department of Chemical Engineering at the University of Arkansas in 2011 where he holds the Ross E Martin Chair in Emerging Technologies. Prof Wickramasinghe has published over 120 peer reviewed journal articles, several book chapters and patents and is co-editor of a book on responsive membrane and materials. He is active in the American Institute of Chemical Engineers and was the Meeting Program Chair of the 2013 Annual Meeting in San Francisco. He has also served on the Board of Directors of the North American Membrane Society. He is the current director of the Membrane Science, Engineering and Technology (MAST) Center at the University of Arkansas, a NSF Industry/University Cooperative Research Center. Prof Wickramasinghe' s research interests are in membrane science and technology. His research focuses on synthetic membrane-based separation processes for purification of pharmaceuticals and biopharmaceuticals, treatment and reuse of water and for the production of biofuels. Typical unit operations include: microfiltration, ultrafiltration, virus filtration, nanofiltration, membrane extraction etc. A current research focus is surface modification of membranes in order to impart unique surface properties. His group is actively developing responsive membranes. These membranes change their physical properties in response to changed environmental conditions. A second research focus is the development of catalytic membranes for biomass hydrolysis by grafting catalytic groups to the membrane surface.
9:20-10:00 am	Speaker 2 - **John Wind** (CEO/Partners in Sustainability Integration) Title - <u>Sustainability at the Energy-Water-Food-Climate Nexus</u> Abstract – The key sustainability challenge facing humanity is how to ensure secure supplies of food, water, and energy in a changing climate, while another 2.6 billion people are added to the earth's population by 2050. The imperative to decarbonize our energy and transportation sectors and to reliably supply food and water across the economy, can lead to synergistic or competing impacts. By understanding the interaction between energy, water and food/feed/fiber systems, we can make better decisions about resource allocation under increasingly tight constraints and uncertainties in climate. Cost reduction in renewable energy and energy storage technologies are enabling rapid decarbonization of power and transportation systems. Advanced water treatment technologies and application of water reuse can mitigate water supply risk and decreases energy requirements for water

	management. The convergence of these technologies creates significant opportunities to improve sustainability at the energy-water-food nexus. Some of these high-value opportunities will be presented. The challenges ensuring reliable energy, water and food supplies in a changing and uncertain climate will be discussed in detail, with a special emphasis on case studies in California. Biography – Dr. John Wind is the founder and CEO of Partners in Sustainability Integration, an engineering consulting business focused on helping companies and organizations develop and integrate advanced energy, separations and water technologies. He is a chemical engineer with 16 years of industrial experience, along with five years of academic research. Before founding PSI in 2014, he worked for 10+ years at Chevron Energy Technology Company. In the domain of the energy-water-climate nexus, John has significant experience with process engineering, technology development and capital projects. Focus areas include gas separations, greenhouse gas management, gas flaring reduction, carbon markets, climate change adaptation, and renewable energy evaluations and projects. He has also developed and managed projects and programs on water valuation, produced water reuse and advanced RO/FO/MD membrane materials and process development. At Air Products, John developed gas separation membrane systems and modeled cogeneration plants. At Lyondell Petrochemical he provided services in flare management and process efficiency in petrochemical and polymer production facilities. John holds PhD, MS and BS degrees in chemical engineering from the University of Texas at Austin and Purdue University, respectively. He also did a year of postdoctoral research at the University of Washington on development of advanced polymeric electronic materials (solar cells, transistors).
10-10:20 am	Networking Break
10:20-11:00 am	Speaker 3 - **Abhishek Shrivastava** (Senior R&D Manager/Dow Water and Process Solutions) Title - <u>Desalination Energy Efficiency: Future Opportunities and Innovation Roadmap</u> Abstract – Desalination using membranes has evolved over the last few decades resulting in increased energy and cost efficiency of water purification and treatment. This increased efficiency is due to the advances in membrane chemistry, module design, high efficiency pumps, high efficiency energy recovery devices and innovative system designs. As a result, over the last 40 years, the specific energy consumption for seawater desalination has reduced by almost an order of magnitude. In this presentation, a review of state of the art desalination technologies is presented. A comprehensive breakdown of specific energy consumption for current state of the art seawater and brackish water reverse osmosis desalination systems is discussed. Major contributors to the specific energy requirements for reverse osmosis desalination (e.g. thermodynamic energy barrier for salt-water separation, energy losses in the membrane, module and system design) are calculated for typical industrial and sea water purification applications. The analysis and the conclusions drawn here have implications on future opportunity areas for innovation in reverse osmosis and desalination in general. Biography – Abhishek Shrivastava, Senior R&D Manager, The Dow Chemical Company, has more than 10

	years of experience in research, development and commercialization of water purification technologies. Currently he is responsible for research, development, and technology growth of water technologies in primary, secondary and tertiary water treatment spaces. Shrivastava has held multiple roles in different geographies spanning different water treatment technologies. He had led R&D, new product and application development, cost savings and commercialization projects for FILMTECTM reverse osmosis membranes and modules for desalination applications. Shrivastava led multiple technology platforms aimed at accelerating product and process development through fundamental research on transport phenomena and thermodynamic analysis of membrane and non-membranes systems aimed at optimizing energetics and cost and defining future innovation roadmap for desalination. Shrivastava holds a Ph.D. in Chemical Engineering from the University of Minnesota and a B.Tech in Chemical Engineering from IIT Kharagpur.
11:00-11:40 am	Speaker 4 - **Evan Hatakeyama** (Lead Research Engineer in Separation/Chevron Energy Technology Company) Title - <u>Reducing freshwater usage in Oil & Gas applications</u> Abstract – Demand for food, water, and energy will increase as global populations grow. Due to their interconnection, stress in water supplies can cause disruption to energy and food. This presentation will provide a background on the interconnection of food, water, and energy. A case study related to mitigating the potential effects of a water shortfall will be examined. The presentation will also provide examples of reducing freshwater consumption in the oil & gas industry. Biography - Evan Hatakeyama joined Chevron in 2013 as a research engineer. He has been involved in upstream and downstream separations research with a focus on water treatment technologies. Before joining Chevron, he worked at Intel as a technology development and process engineer for their waste treatment systems. Evan holds a B.S. and Ph.D. in chemical engineering from the University of California, San Diego and University of Colorado Boulder, respectively.
11:40am-12:40 pm	Lunch (NorCal Chapter Introduction and Student Awards)
Afternoon Session (Co-Chairs: Ashok Gopinath and Firehiwot Tachea)	
12:40-1:20 pm	Speaker 5 - **Baoxia Mi** (Assistant professor/ University of California Berkeley) Title - <u>Novel 2D nanomaterials for sustainable water supply</u> Abstract – Recent advances in two-dimensional (2D) nanomaterials offer unprecedented opportunities to fabricate a new class of filtration membranes that can potentially revolutionize the membrane-based process to address food-water-energy nexus. In this talk, I will discuss the unique properties and separation performance of membranes made by layer stacking 2D graphene, graphene oxide, and MoS_2 nanosheets. Focus will be given to our recent progress on characterizing the interlayer spacing and swelling of 2D stacked membranes in water by newly developed experimental approaches and on understanding water transport in the nanochannels by molecular simulation. At the end, I will point out potential directions to

	overcome the outstanding challenges in manipulating the nanostructure of 2D stacked membranes to maximize their separation capability. Biography – Baoxia Mi is an assistant professor in the Civil and Environmental Engineering Department at the University of California, Berkeley. She received BS and MS from Tianjin University in China, Ph.D. from the University of Illinois at Urbana-Champaign, and a postdoctoral training at Yale University, all in environmental engineering. Prior to joining UC Berkeley, she held faculty positions at the University of Maryland College Park and The George Washington University in DC. Currently, she directs the research and educational activities of the Membrane Innovation Lab, studying physicochemical and biological processes with emphases on advanced membrane processes and nanotechnology to address some of the most challenging issues in sustainable water supply and civil infrastructure, renewable energy production, and public health protection. Dr. Mi's recent achievements include an NSF CAREER Award, Journal of Membrane Science Most Cited Author Award, and invited speaker at the US NAE Frontiers of Engineering Symposium.
1:20-2:00 pm	Speaker 6 - **Young-Hye Na** (Research Staff Member/IBM Almaden Research Center) Title - <u>Clean Fresh Water: Materials Innovation</u> Abstract – Water is a constrained resource today and will likely become more of a concern in the future as the world population grows. This global water crisis has led to great interest in improved water purification technologies and innovative materials for water treatment. Starting in 2008, IBM Almaden research center initiated a membrane research program with the goal of developing novel, high performance materials for a variety of water purification applications. The initial entry into this new field was accelerated through our many years of experience in polymer synthesis, water-immersion photoresists, and nanotechnology. To start, we developed a series of materials for reverse osmosis (RO) separation layers, which includes i-phobe (ionizable hydrophobe) functionalities. The first generation of i-phobe membranes showed unique pH-dependent RO behavior and improved chlorine resistance. The second-generation materials exhibited a superior combination of water permeance and salt rejection, with efficient removal of toxic pollutants such as arsenic and boron. We have also developed highly water-permeable antifouling materials that can be applied on various commercially available membranes (UF, NF, RO) with a straightforward coating process. The structures and compositions of the antifouling materials have been controlled to obtain efficient organic-repelling property and antimicrobial function. Besides membrane materials, we have recently expanded our research to design highly selective adsorbents (functionalized organic- or inorganic-particles) to remove challenging impurities (ex. glyphosate, acrylamide) in water and/or other liquid media as well. In the presentation, IBM's novel functional materials designed for a variety of water treatment applications will be introduced, and the rational for performance enhancement will be thoroughly discussed. Biography – Dr. Young-Hye Na is a research staff member at IBM Almaden Research Center. She received her PhD degree in Chemistry from Pohang University of Science and Technology (POSTECH, South Korea), and performed postdoctoral research in the Department of Chemical and

	Biological Engineering at University of Wisconsin-Madison (Supervisor: Paul F. Nealey). Since she joined IBM in 2007, she has been a leading scientist in the project developing novel functional materials for water treatments. Her research interests focus on antifouling and antimicrobial coatings, interfacially polymerized polyamide separation layers for water desalination (RO, NF, FO), and highly functionalized solid particles for the selective removal of challenging impurities (ex. herbicides, process by-products) in water and other beverages. Recently, she expanded her research focus into the field of energy storage to support IBM's advanced Li-battery program, and has developed ion-conducting composite materials for solid-state electrolytes. Dr. Na is also appointed as an adjunct professor in the University of Alberta, Department of Mechanical Engineering this year, and she maintains active collaborations with academic and industrial partners. Her research accomplishments in these fields (materials, nano chemistry and engineering) include more than 45 papers in peer-reviewed journals, 25 granted and pending patents, and several awards including a best dissertation award from POSTECH, IBM Outstanding Technical Accomplishment Awards, and IBM Invention Achievement Awards.
2:20-2:40 pm	Coffee Break - Networking
2:40-3:20 pm	Speaker 7 - **David Blume** (CEO/Blume Distillation) Title - <u>Optimizing food waste for Bioethanol fuel and High-Return Co-Products</u> Abstract – Appropriate scale alcohol fuel is an inexpensive to produce commodity and a channel for high-value high-return co-product development. The keys to profitability in a well-run small-scale alcohol operation are getting good margins, and producing value-added co-products. These co-products are actually worth much more than the fuel itself and provide revenue stability when alcohol or feedstock prices are volatile. This talk provides detailed and unique insight into the design and development of lucrative new products related to fuel production as well as myriad non-exportable jobs related to development and distribution for small-scale biofuel businesses and presents proven methods for market development and communications. The presentation will be based on interactive discussion and Multimedia PowerPoint support. Starting from a strong case assertion that Millions of non-exportable jobs can be generated through proper application of biofuel production. **Subtopic focuses will be on:** 1. Feedstock options and acquisition (looking at regenerative agricultural process that support best practices appropriate scale biofuel development) 2. Production technology and methods 3. End product value chain **Attendees will gain an understanding of:** • The value of appropriate scale biofuel production • The myriad co-products derived from this fuel production methodology • New market channel and outlet development for biofuel and co-products • Suited to Ag market, finance agencies, biofuel production engineers, biofuel contractors, Government Agencies • How appropriate scale biofuel production provides a means of optimizing local resources and repurposing waste products to deliver sustainable localized resources

	• How to create productive and lucrative closed loop production systems for cradle to market to cradle development solutions for food and energy needs This talk address global issues and provides insights that can be applied in any bioregion and is appropriate for rural or urban application Biography - David Blume is the founder CEO and CTO of Blume Distillation LLC and is the Executive Director of the International Institute for Ecological Agriculture (IIEA). Blume is a globally renowned expert on regenerative agriculture and Bio-waste-to-biofuel production. Blume is the author of the critically acclaimed book *Alcohol Can Be a Gas!* Over the last 30 years, Blume has worked on energy projects with Nasa, Mother Earth News, Universities, Governmental Energy and Ag Agencies, Farmers, Municipalities and Business Entrepreneurs around the world Featured in the Documentary film *PUMP*, Blume is a principle advocate for the role regenerative Ag practice and food waste optimization can play in stopping deforestation and GHG concerns. Blume is focused on the conversion of underused food waste resources as well as purpose grown energy crops to produce clean, low-cost and local energy solutions sustainably. Blume has presented at the USDA/ARS Energy and Climate Partnership of the Americas conference, ACORES" s Renewable Energy for Latin America and the Caribbean, Waste Conversion Technology Conference, Energy Utility and Environment Conference, USDA Sugar Waste to Profits Conference and countless renewable energy expositions. He is a recipient of the American Corn Growers Association "Truth in Agricultural Journalism" award, for his role in educating famers about the benefits of poly-cropping and producing energy as well as food products. He is regularly featured in Coast to Coast AM radio with George Noory, Clear Channel, Premier and GCN radio networks and on NPR with Ms. Caroline Casey.
3:20-4:00 pm	Speaker 8 - **Mike Fero** (CEO/TeslaGen) Title - Automatic Protocol Generation for Synthetic Biology Applications in Industry Abstract – Until recently modifying microbes to improve production of chemicals and enzymes via fermentation has been a slow and somewhat artisanal process. With advances in recombinant methods dating from 2006, systems can now be put in place that vastly accelerate product development of everything from fragrances to future fuels. In this talk we will review the progress made and show how systems can be implemented that will completely automate microbial modification research and development. Biography – Dr. Fero is a California based scientist and entrepreneur who is best known for his work on the fundamental physics of the Electroweak interaction at MIT and Stanford, human genome microarrays at Stanford, and synthetic biology at TeselaGen. After leaving physics to spend several years spent developing software companies, Dr.

	Fero's expanding interest in fundamental biology culminated in collaboration with Pat Brown and David Botstein to build and manufacture the world's first human genome microarrays at Stanford. Dr. Fero then turned to systems biology and with Lucy Shapiro and Harley McAdams at Stanford where he developed an automated high content diffraction limited microscopic screen of triply fluorescently tagged bacteria to better understand the bacterial cell cycle. In the aftermath of the Deepwater Horizon accident Dr. Fero and two Stanford colleagues started TeselaGen as a way to accelerate synthetic biology and the bio-based economy. Seeing a gap in the ability for biologists to be able to create what they imagine, TeselaGen focused on making the mind to molecule process easier and faster with automated design/build software. Since then, TeselaGen has had a laser-like focus on building professional state of the art intelligent software systems for industrial scale synthetic biology.
4:00-4:30 pm	Speaker 9 – **Chuck Coronella** (Associate Professor/Univ. of Nevada, Reno) Title – <u>Nutrient Recovery from Waste Streams</u> Abstract – Society produces enormous waste streams, many with large moisture contents. For example, approximately 30 million tons per year (dry basis) of wastewater sludge is produced in the US each year, and approximately 1 billion tons (dry basis) of animal manures are produced in the US each year. Such waste streams can be used through land application as fertilizers; however modern practices of concentrated production, smaller or distant crop lands, and tighter regulations all indicate the need for new practices. Environmental impacts and societal acceptance of traditional practices, i.e., land application, are of great concern to waste producers, and new solutions are needed. At the University of Nevada, Reno, we have been developing a hydrothermal process for capturing both nutrient value and fuel value from such waste streams. This talk will discuss progress made so far, and point to several unanswered questions. Biography – Chuck Coronella is an associate professor of chemical engineering at the University of Nevada, Reno, where he has been teaching and doing research since 1993. His research has been in alternative fuels, in waste valorization, and in fluidized bed applications. Author of nearly 50 peer-reviewed publications and 5 patents, he is best known for developing the "rapid hydrothermal carbonization" process. He was awarded a "distinguished chair" in alternative energy by the Fulbright foundation, and spent a year in residence at Chalmers University of Technology in Sweden studying chemical looping combustion.
4:30 pm	Closing Remarks