RESEARCH, DISCOVERY & INNOVATION

Institute for Energy Solutions

Institute for Energy Solutions Energy Talks
February 20, 2020

On February 20, the University of Arizona's Institute for Energy Solutions held its second Energy Talks event of the year, at Tucson's Sky Bar. At this event, Dr. Vicky Karanikola, Assistant Professor of Chemical and Environmental Engineering, presented a talk titled "Membrane processes at the water-energy nexus: Does energy efficiency imply optimal cost?", and Jose Luis Ruiz Duarte, a PhD student in Systems and Industrial Engineering, discussed how renewable energy can be used as part of greener food production systems.

Karanikola's talk, which focused on water purification, began with a discussion of conservation.

Water, which is scarce in Arizona and throughout most of the world, must be conserved. However, with a growing world population and an ongoing climate crisis, simply conserving water is often not enough, and something must be done to increase the available supply of fresh water. The process of desalination, which removes salts and other contaminants from water, can produce usable fresh water, alleviating shortages. Desalination is typically accomplished through reverse osmosis filtration - a "mechanically driven" process in which water is pressurized, causing it to move through a membrane towards an area of lower pressure. While effective and widely used, this reverse osmosis process can allow up to 15% of contaminants through, necessitating multiple cycles of desalination and potentially resulting in water that is still unsafe or unhealthy to use.

Enter membrane distillation. Unlike reverse osmosis and most other processes involving the movement of water through membranes, membrane distillation is a thermal membrane process, in which water is heated up so that it passes through the membrane as a vapor. This makes it more difficult for contaminants to pass through the membrane, increasing the quality of the filtered water. The downside to this otherwise attractive concept of membrane distillation is the large amount of energy needed to heat water to a vapor - approximately 50 times the energy required for reverse osmosis. These energy requirements, while not prohibitive, do make it difficult to operate desalination sites in the off-the-grid locations where they are most needed. Karanikola and her colleagues have been working to address this problem through a test site on the Navajo Nation.

At this test site, UArizona researchers, working with members of the local community, have installed membrane distillation equipment, powered by solar energy and built to be easily modified. Through analysis of various combinations of components, the system's operating cost could be decreased to below the estimated cost of hauling water, making solar-based membrane distillation a reasonable alternative for people living away from developed utility networks.

The evening's second talk, titled "Using renewable energy for greener food production systems", was presented by Jose Luis Ruiz Duarte, a PhD Candidate in Systems & Industrial Engineering.

Just as reliable access to clean water is becoming a more difficult problem to solve as Earth's population increases, so is reliable access to food. Ruiz Duarte discussed this, and argued that

vertical farming offers a solution. Vertical farming, in which food is grown in dense stacked rows inside an enclosed space, is faster, requires less land, and can be operated year-round, allowing for more food to be produced than in conventional farming. The major downside to vertical farming is that it is more energy-intensive due to the need for artificial lighting, watering, heating, and ventilation. This downside could be mitigated by installing a solar power generation system on-site to provide power for each vertical farming operation. Ruiz Duarte and his collaborators have investigated the viability of such an on-site renewable energy generation system by constructing a mathematical model that takes into account cloud cover, battery degradation, and other factors. This research supports further development of efficient food production systems.

Whether it be in greener food production or in lower-cost water desalination, research being done at the University of Arizona is addressing persistent challenges and helping to improve life here on Earth.

Vicky Karanikola, originally from Greece, obtained a degree in mechanical engineering before working as a heating and air conditioning consultant on construction jobs. Following her interests in buildings and in water, she moved to the United States and studied water filtration as part of a Master's degree in Civil Engineering. Most of Karanikola's work since then has focused on water. She is now an Assistant Professor of Chemical and Environmental Engineering at the University of Arizona, and is involved with Engineers Without Borders.

Jose Luis Ruiz Duarte is a PhD student of the Systems and Industrial Engineering department at the University of Arizona. He received both his bachelor degree of Industrial and Systems Engineer and his master degree of Industrial Engineer at the University of Sonora, Mexico. Before starting his PhD program at the U of A, he worked as a lecturer at the University of Sonora for nine semesters, and worked in the research coordination of the Research Center for Food and Development (CIAD, Mexico). His dissertation topics include micro grids, renewable energy, and optimization, applied in a variety of systems.

For more information about energy-related research at the University of Arizona, visit energy.arizona.edu.