Dr. Bhavik Bakshi, Professor of Chemical and Biomolecular Engineering at the Ohio State University completed an Ohio Water Resources Center USGS 104(b) and OSU's Office of Energy and Environment jointly funded project titled **"Addressing the Water-Energy Nexus of Fossil Power Generation by Considering Technological, Agro-Ecological, and Economic Options in the Muskingum Watershed**". The objectives of this work was to investigate various alternative scenarios to understand the trade-offs between energy, water, and CO_2 flows in the Muskingum River Watershed (MRW), and suggest better watershed management solutions that could be "win-win" in terms of multiple objectives for watershed sustainability.

Dr. Bakshi's team employed a holistic TES (Techno-Ecological Synergy) assessment approach to examine watershed sustainability. The results showed that the amount of water supply in the MRW is larger than the amount of water demand, which implies that the reduction in water quantity indicator may not be a huge concern. However, TES metrics for other ecosystem goods and services, such as natural gas, CO_2, and air and water pollutants, show negative values, which indicate unsustainable conditions of activities in the MRW. Since most of the air emissions and natural gas consumption are attributed to thermoelectric power generation, various technological alternatives that include different fossil fuels, cooling technologies, CO_2 conversion technologies, and renewable power generation technologies were examined. It was identified that TES sustainability metrics for carbon sequestration and air quality regulation services can be improved by employing NGCC (Natural Gas-Fired Combined Cycle) power plants with recirculating cooling system and CO_2 conversion to formic acid that uses electricity from wind power generation (Figure 1). The synergistic solution that includes both technological and agroecological alternatives could produce "win-win" outcomes in terms of multiple objectives.

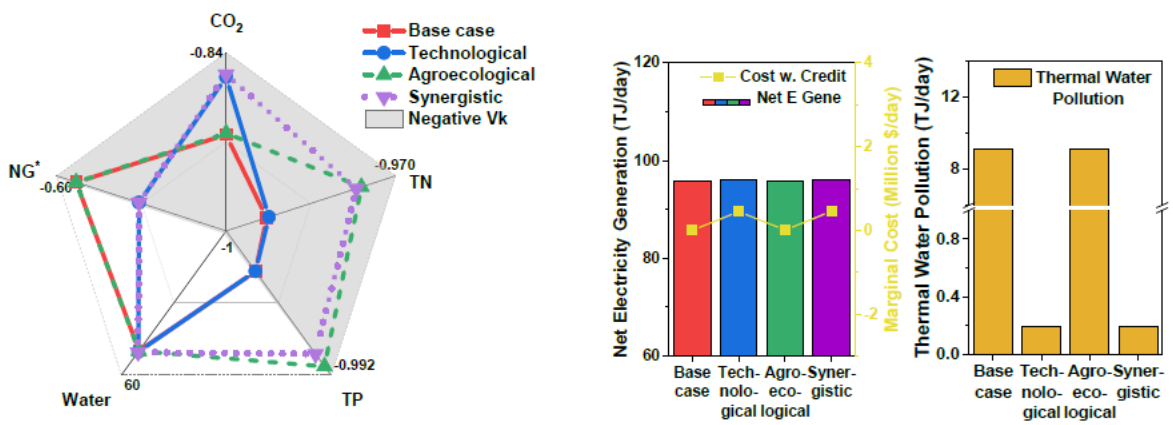

Figure 1 Sustainability indicators for best case scenarios. TES metrics are plotted in radar diagrams. Technological solutions include shale NG-fired combined cycle power plants with recirculating cooling system and 1,000 t/day of CO2 conversion to formic acid with wind power generation. Agroecological solutions include the implementations of no-till practice and the construction of wetlands on available land. The synergistic solution combines both technological and agroecological solutions.

<u>Researcher Profile:</u> Professor Bakshi is an internationally-recognized expert on sustainability engineering. His research focuses on sustainability science and engineering, and process systems engineering. Bakshi is among the first to identify the importance of thermodynamic principles for developing ecological solutions, laying the much-needed fundamental framework for analyzing ecosystems. His contributions to the field of sustainability include bringing useful thermodynamic rigor to various sustainability analyses, pioneering the development of tools for tasks such as process-to-plane framework, introducing the idea of the ecosystem as unit operations, and educating a generation of students in the pioneering field of sustainability.