On July 31st 2019, UC Davis hosted a symposium on *Industrial Energy Efficiency*, which convened ~60 people some from as far as Denmark, including participants from UC Davis, UC Merced, University of Houston and University of Dayton, as well as representatives from regulatory agencies, utilities, the environmental community, and relevant industry sectors.

The event convened public and private sector researchers and leaders representing different industrial sectors (Oil & Gas, Biofuel Refining and Food & Beverage Processing industries) to come together and jointly identify meaningful RD&D opportunities for technology and process improvement that can ultimately save energy, reduce greenhouse gas emissions, and improve economic competitiveness for California industries.

Overall, people felt the Symposium was well-run, a good networking event, and worth their time, and they are interested in follow-on discussions. Below are some of the key takeaways:

Big-Picture Insights

1. Oil and gas companies primarily operate large-scale continuous processes. In some cases (especially for larger complex facilities such as refinieries), they can only realistically make facility improvements during small windows of time that occur every 4-6 years during planned downtimes of their plants. The food and beverage industry primarily operates in batch processes and runs on a seasonal cycle; their windows of time for equipment and operation retrofits and improvement can occur on an annual basis.
2. Oil & Gas facilities tend to be much larger in scale but they do have similar equipment and processes as Food and Beverage firms in terms of dealing with water, heat, and electricity. The food and beverage sector may be in an ideal position to act as a test bed for the Oil and Gas sector by regularly evaluating efficiency and demand side management technologies that can then be adopted by both sectors, on a small scale initially within Food and Beverage, and then at a larger scale once there is more confidence in the deployment for Oil and Gas.
3. Many facility managers within the Food & Beverage industry would greatly benefit from small scale funded projects that help them validate potential technologies that can increase their efficiency. Serving as the prime contractor on large grants from funding agencies can prove to be overwhelming for these operators. Often times, these facilities only need modest assistance to pay for the novel equipment and its installation ($10-30,000) to install pilots that demonstrate effectiveness.
    a. UC Davis and other universities and national laboratories have experience managing large contracts that can be used to identify and implement pilot-scale 3rd party validation for various priority industries that need efficiency upgrades and are willing to host these tests.
    b. A follow-up discussion on this topic with the California Energy Commission on development or management of a small grants program may be beneficial.
    c. CA Energy Commission pilots appear to be focused on smaller plants and processing facilities, but including oil & gas operators in these discussions and

framing of pilots could be be benificial when it comes ot scaling up the technology

4. There is a lot of value in having discussions about these topics across industries, and much to be learned from the successes and failures that various companies have experienced. The Symposium offered a relatively unique opportunity for this to happen.
    a. There was recognition and interest in expanding the discussion outside of California and to include international perspectives.
    b. Providing a forum where end users can connect with vendors is important as well as peers.
5. Co-location of operations may create opportunities for synergy with regard to access to resources (waste management, water consumption, energy capacity, etc.) and energy exchange (district heating, etc.).

Insights from the Water Panel

1. Food safety concerns and plant productivity will always outweigh energy efficiency improvements.
2. There seem to be a lot of opportunities to recover water in industrial processes. Water reuse regulations/requirements are currently hard to understand and treatment targets are not well-defined in many cases.
3. Larger adoption of sensors and flow meters could help companies understand where they have leaks or excess consumption in their systems. Conversely, being able to identify areas where there is use of less water than expected also holds a lot of value so success can be replicated in other processes. Being able to track water usage at points throughout a system is a good first step to achieving better efficiency.
4. Steam is used for a lot of processes in industry. Capturing steam, condensing it and reusing it after sanitization is low hanging fruit.
5. Having tools that allow companies to calculate the trade off between increasing water-use efficiency vs increasing electricity use would be important for decision-making when considering capital investments.
6. Agriculture and food processing industries may be able to share best practices aorund water conservation with oil and gas sector to help the latter reduce their water footprint

Insights from Thermal Efficiency Panel

1. A large majority of industrial heating equipment is used to generate steam and/or process heat, and basically all of this is fueled by natural gas. It would currently be prohibitively expensive to switch to electric heating. It would take massive investments in capital equipment and would require electricity prices to be an order of magnitude lower than what they currently are for industry to be able to afford to electrify steam generation.
2. One potential solution that has yet to be achieved is co-locating food and beverage plants next to chemical and oil/gas plants for the food industry to use oil and gas waste heat. This has not happened due to a number of reasons, but it highlights the need to be able to reuse waste heat as an efficiency measure.

   a. District heating systems would help solve this problem. The Danes have been able to achieve this.
6. Solar Thermal heating and storage has potential to lower heating carbon footprint
7. Some applications require thermal collectors to be made to adhere to non-flat surfaces in order to optimize use of space.
8. Low-hanging fruit may be simply found in insulating pipes, tanks/vessels, and boilers.

Insights from the Electrical and Storage Panel

1. Generating electricity with solar energy takes a lot of space. Similarly to solar thermal, flexible PV panels that can be applied to the sides of buildings and outdoor equipment might make it more possible to increase PV plant capacity to generate electricity at manufacturing plants.
2. Electricity storage is an attractive idea, but is currently too expensive for most applications.
3. The Oil & Gas Industry has created microgrids to ensure operations in remote locations. They may be able to transfer this knowledge to others.
4. Smart pumps with ECM motors and control algorithms combined with sensors would be a cost-effective way to limit electricity consumption (and additionally save water).
5. Working with Utilities to find more custom solutions for TOU pricing with the food and beverage industry could help companies alleviate some of the unavoidable costs that come with seasonal production.
6. The Food & Beverage Industry has high demands but only on seasonal basis and therefore could benefit from mobile solutions to allow for capacity that is delivered at select times during the year (after a harvest).

Process Efficiency Panel

1. There is an interest in leveraging wireless, non-intrusive, in-situ, self-calibrating, self-powered, low-cost sensors.
2. Awareness and interest in carbon capture technologies varies by industry. The wine industry is actively engaged in capturing biogenic carbon emissions from fermentation.
3. There are numerous hurdles that prevent food, beverage, and petroleum industries from testing new efficiency technologies, including lack of policy incentives, lack of third-party validation of technologies, difficulty of pilot testing, and lack of performance data or general awareness for new technologies
4. Given the maturity of boiler technology, new systems may offer only incremental improvements to facility energy efficiency.
5. In the upstream Oil & Gas Industry, sizing equipment for the life-cycle of the asset is challenging since production rates often decrease or change over time.
6. Opportunity for use of more energy data analytics to monitor performance, identify optimization opportunities, and devleop smart control strategies and automation systems