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Texas Industrial Energy Efficiency Program
Newsletter Volume 2, Number 2, February 2021

Greetings, from the Texas Industrial Energy Efficiency Program!

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Upcoming TIEEP Events

Thursday, March 4, 2021, 4:20-5:50 pm:
TIEEP Virtual Spring Energy Forum, *Decarbonizing the Process Industries*, Cohosted by STS-AIChE.

Thursday, April 15, 2021 2:00-3:30 pm:
TIEEN Webinar, *Turn Energy Efficiency into Cash Savings,* Cohosted by Lone Star Chapter, AEE.

Thursday, May 6, 2021, 4:20-5:50 pm:
TIEEP Virtual Water Forum, *Reducing Water Use in Manufacturing Plants*, Cohosted by STS-AIChE.

The world is in transition, in many different areas – social, political, economic; and of course, everything today is also impacted by the pandemic. At TIEEP, in the midst of all these changes and challenges, our Advisory Council has been faithful in keeping us focused. That focus is on energy, and especially energy use in industry – how that use is changing, and how we can be more efficient.

Our upcoming events, all virtual, are listed on the right. They reflect that focus, and they are described in more detail in "A Busy Spring," below. "From the Casebook," at the end of this newsletter, discusses one of our biggest challenges – decarbonization – which is also the topic of our Energy Forum on March 4. Read on – and please join us at all of events. You'll be glad you did!

A Busy Spring!

TIEEP has virtual events in each of the next three months. We have two well-established programs, our Spring Energy Forum and our Water Forum, on March 4 and May 6, respectively, cohosted by the South Texas Section of the American Institute of Chemical Engineers (STS-AIChE). Our brand new event – the TIEEN Webinar – is on April 15; and we are pleased to announce that it is cohosted by a new partner, the Lone Star Chapter of the Association of Energy Engineers.

Spring Energy Forum, Thursday, March 4, 2021, 4:20-5:50 pm
Theme: *Decarbonizing the Process Industries*.

Decarbonization has become an ESG (environmental, social and governance) priority for the process industries, and energy efficiency is an important component in any decarbonization strategy. However, many other technologies have a part to play, including electrification and biofuels. The Spring Energy Forum will explore these technologies, and their impact in the process sector, with the help of industry leaders and subject matter experts.

James Turner, Executive Process Director, Fluor. *Decarbonizing Industrial Facilities by Electrification.*

Jack Farley, President and CEO, Apex Compressed Air Energy Storage, LLC. *Green Power Supply in Texas.*

John Plant, Plant Manager, REG Houston. *Decarbonization Through Biofuel Use & Production.*

The Energy Forum will be followed by the **STS-AIChE March Virtual Dinner Meeting** at 6:00 pm, with guest speaker Faisal Khan, the new Director of the Mary Kay O'Connor Process Safety Center at TAMU. Energy Forum participants are invited to stay for the AIChE meeting presentation. **PDH certificates** will be available for both the Energy Forum and the STS-AIChE monthly meeting.

AIChE's Meeting Sponsor: TLV®

Turn Energy Efficiency into Cash Savings, Thursday, April 15, 2021, 2:00-3:30 pm
A Webinar from the Texas Industrial Energy Efficiency Network (TIEEN)

TIEEN is a network of publicly supported industrial energy-efficiency organizations in Texas. In this webinar, four of the TIEEN organizations come together to show you how you can leverage their capabilities and resources to improve your bottom line. TMAC, TAMU-IAC, the Southcentral CHP-TAP, and The Texas PACE Authority will present a wide range of technical support and attractive financing opportunities that are available to Texas manufacturers to improve efficiency, resilience, competitiveness, and profitability.

PDH certificates are available for participation in this event.

This webinar is cohosted by the Texas Industrial Energy Efficiency Program and the Lone Star Chapter of the Association of Energy Engineers, and supported by the Texas State Energy Conservation Office through TIEEP.

Confirmed speakers and topics:

Kurt Middelkoop, Senior Sustainability Engineer, TMAC. *Leading Lean to Energy Savings*

Gavin Dillingham, Director, US DOE Combined Heat and Power TAP – Southcentral Region, HARC. *The Benefits of CHP and WHP in Industrial Facilities*

Jim Eggebrecht, Assistant Director, TAMU Industrial Assessment Center. *How to Reduce Your Operating Energy Costs in a Hurry!*

Dub Taylor, Chief Operating Officer, Texas PACE Authority. *PACE – A New Financing Option for Industrial Energy, Water and Environmental Projects.*

Water Forum, Thursday, May 6, 2021, 4:20-5:50 pm
<u>Theme:</u> *Reducing Water Use in Manufacturing Plants*.

Despite the hurricanes and high rainfall along the Gulf Coast, we do experience times or drought and water shortages in Texas; and globally, access to clean water is a major sustainability concern. Water is also inextricably linked to energy: We need energy to pump and to manage water, and we use large amounts of water in our energy systems – for example, steam and cooling water. In this water forum, we explore tools and technologies for reducing water use in manufacturing plants. This includes presentations from two vendors on innovative processes and equipment, and one presentation on a DOE software package to aid understanding, managing, and improving water balances. Not only can these resources save water; they can also lead to energy savings, space savings, quality improvements, and reductions in capital and operating costs for new plants and revamps.

Joe Tardio, Product Manager, Aqua-Aerobic Systems, Inc. *Reduced Life-Cycle Costs and Enhanced Sustainability of Wastewater Treatment Utilizing AquaNereda® Aerobic Granular Sludge Technology.*

Kiran Thirumaran, Research Associate, Oak Ridge National Laboratory. *DOE's Plant Water Profiler Tool for Water Assessment of Manufacturing Facilities.*

Josh Summers, Regional Sales Manager, Voltea. *Introduction to Voltea's Membrane Capacitive Deionization (CapDI) Water Treatment Technology, and its Applications*.

The Water Forum will be followed by the **STS-AIChE March Virtual Dinner Meeting** at 6:00 pm. Water Forum participants are invited to stay for the AIChE meeting presentation. **PDH certificates** will be available for both the Water Forum and the STS-AIChE monthly meeting.

AIChE's Meeting Sponsors: TLV® AQUA-AEROBIC SYSTEMS, INC. A Metawater Company

From the Casebook: Decarbonizing the Process Industries

I started my career in the chemical industry in 1979, in the wake of the oil crisis. Rising energy prices appeared inevitable forever, and companies were scrambling to save energy to stay profitable.

Times and priorities change. Comparatively low, though volatile, energy prices have been with us in for some time now, especially in the United States, and it has become much harder to justify energy efficiency projects based on energy cost savings alone. However, another driver has emerged for energy efficiency in the process industries – decarbonization, the reduction of emissions of carbon dioxide and other greenhouse gases.

The push for decarbonization is driven by numerous factors, but notably by the growing focus by investors on ESG (environmental, social and governance) issues, and carbon taxes and carbon trading systems in many parts of the world. Carbon pricing has not yet arrived at the federal level in the United States, but it is currently under active consideration by the Biden administration.

Within the process industries, the main decarbonization approaches that are being evaluated, and in some cases already implemented, include:

<u>Energy Efficiency:</u> Unlike most other approaches, energy efficiency reduces not only greenhouse gas emissions, but also energy consumption. This makes it a very attractive option, as it results in operating cost savings in the consuming facility, and also infrastructure savings for the energy supply system.

Within the process industries, there is a long history of energy efficiency improvements. These have been achieved through a combination of technical innovations and behavioral changes. The types of improvements include:

- Operational improvements, which are generally achieved with little or no capital investment.
- Effective maintenance, which sustains the performance of existing equipment and systems.
- Engineered efficiency improvements, where additions and upgrades are made to existing facilities, or new plant designs improve on existing plants by incorporating commercially proven equipment or systems.
- New (breakthrough) technologies developed through research and development. These range from single items of equipment, such as new types of heat exchangers, to completely new process designs.

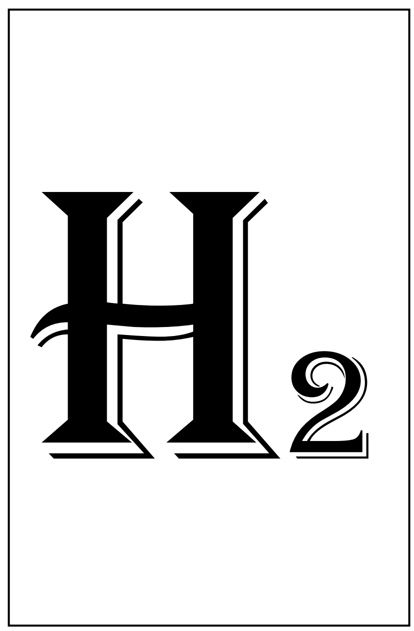
However, there are limits to energy efficiency. Some of these are due to fundamental science: There is a thermodynamic minimum energy requirement for every process. In addition, many processes have practical limitations (for example, in heat recovery) that are prohibitively difficult and expensive to overcome. Energy efficiency therefore has to be supplemented by additional approaches to achieve the deep decarbonization that society now demands.

Electrification. Almost all heating in oil refineries and chemical plants is done by burning fossil fuels in boilers and furnaces. Furthermore, much of the power requirement is met either by steam turbines or gas turbines, often in some type of cogeneration configuration. Together, these are the main combustion-related sources of CO_2 emissions from within these facilities.

Replacing fired boilers and furnaces with electric boilers and furnaces, and turbine drivers with electric motors, can in principle eliminate most of these energy-related CO_2 emissions. New technologies, such as electric reactors, are also emerging. However, the devil is in the details. Both the capital cost and the operating cost are typically higher for electrical equipment. For some applications (e.g., cracking furnaces) there are no commercially demonstrated technologies. Research and development is ongoing in these areas, and progress is being made.

Electrification also raises issues outside the plant boundaries. Electrifying all of this equipment would greatly increase the electric demand at each site. This, in turn, would not only require expansion of the onsite electric infrastructure, but also the electric grids and the power generating facilities that serve the industry. Moreover, while electrification can eliminate carbon dioxide emissions within the manufacturing site itself, the net impact on global CO_2 emissions will only be favorable if the electricity comes from low-carbon sources. In other words, electrification of manufacturing only leads to decarbonization if power generation and distribution is both increased and decarbonized. This is not going to be cheap.

<u>Hydrogen.</u> Large quantities of hydrogen are used in oil refinery processes (e.g., hydrotreating) and in chemical production (e.g., ammonia). Refinery fuel gas typically contains a lot of hydrogen, too. However, hydrogen has not generally been considered a major fuel source in its own right. This perception is changing. The reason is simple chemistry:



$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

$2H_2 + O_2 \rightarrow 2H_2O$

In plain English, with hydrocarbons such as the methane shown in the first equation, the main products of combustion are carbon dioxide and water. When we burn hydrogen, there is only one product – water – and there is no carbon dioxide. In principle, this is 100% decarbonization. (Minor side reactions are neglected in this discussion.)

As with electrification, there are several ways this concept can be used to decarbonize processes. The simplest is by blending hydrogen with natural gas, to reduce carbon intensity. This is already done in most refineries, where refinery fuel gas is commonly mixed with natural gas, and the mixed stream is used as fuel in boilers and furnaces. This can be taken further. The mixed gas could also be used in gas turbines; and to achieve deep decarbonization, pure hydrogen could be used as a fuel for all combustion processes.

Once again, though, there are challenges. There are limits on how much hydrogen you can add to natural gas streams, both because of metallurgical limits and because of the design of the boilers, furnaces, and gas turbines that use it. Use of higher concentrations of hydrogen – or pure hydrogen – demands major equipment modifications, or equipment replacements. Furthermore, as in the electrification scenario, we have to consider not just the consumers, but also the sources. Most hydrogen today is produced from fossil fuels. Consequently, it has a large carbon footprint. To achieve a reduction in global carbon emissions, we need to decarbonize the production of hydrogen. The two most common options are:

- Blue hydrogen, for which CCUS (carbon capture, utilization and storage) is used to recover the CO_2 coproduced with fossil fuel-based hydrogen, and store it permanently, either geologically or in a product.
- Green hydrogen, which is produced by the electrolysis of water, using renewable electricity.

These options both require a great deal of new equipment, and they consume a lot of energy.

Biofuels. Biomass is plant or animal material used as fuel. It include grasses, leaves, and wood, as well as algae, and also vegetable and animal oils. These forms of fuel are used in many places, including some industry sectors (e.g., forestry, pulp & paper, and agriculture), where "waste" biomass is available. However, they are not widely used in oil refining or chemicals.

A biofuel is any fuel that is derived from biomass. One big benefit of biofuels is that they can be tailored as “drop-in” substitutes for existing fuels – e.g., biodiesel is a drop-in replacement for petroleum diesel. Of more potential interest at most process plants is biomethane, also known as renewable natural gas, which can be distributed via the existing natural gas grid and burned in existing equipment. Unlike hydrogen, it should not require major modifications on the consuming sites.

Burning biofuels does produce CO_2. However, that CO_2 is reabsorbed by crops that are then used to make more biomass, and hence more biofuels – a virtuous cycle that, in theory at least, results in “net zero” carbon emissions. However, once again, these benefits come with a cost.

Most importantly, biomass sits at the water-energy-food nexus. If the goal is to achieve large-scale decarbonization, the biomass has to be grown in large quantities. This requires correspondingly large land areas, competing with other land-use options, most notably food production. Alternatively, new land could be cleared for biomass crops, disrupting natural habitats and causing deforestation. Moreover, most commercial biomass production depends on irrigation, which reduces the availability of water for other purposes, including drinking, hydropower and, once again, food production.

Three other concerns that are often raised with biomass and biofuels are:

- the energy used in harvesting and transporting biomass, together with the nuisance caused to nearby communities;
- emissions other than CO_2 that arise in the production, harvesting, transportation, processing and combustion of biomass; and
- uncertainties in the effectiveness of the “virtuous cycle” as a mechanism for achieving net zero carbon emissions.

In summary, energy efficiency remains an important strategy in the process industries – not only for energy cost reduction, but also, increasingly, for decarbonization. Additional options are also needed to achieve deep decarbonization. These include electrification, hydrogen, and biofuels. Some of the relevant technologies are already demonstrated at commercial scale; many others are the subject of ongoing research and development. However, whatever decarbonization strategies are chosen, it is important to consider not only the impact within the process plant boundaries, but also the cost and environmental impacts throughout the energy production and distribution infrastructure.

In Closing…

Thank you for taking the time to read along with us. We hope you found the information useful, and that you'll join us in our upcoming events.

If you would like to ensure that you receive all program updates and notices of upcoming events, please subscribe on our webpage.

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