REDUCING YOUR FACILITY'S CARBON FOOTPRINT

A look at what can be done to further improve efficient energy use, once the low-hanging fruit has been picked

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YOUR PRESENTER:

- Peter Sibilski, P.E., CEM, FAIChE
- Plant Manager, Pharmetic Manufacturing Co., LLC
- B.S., Chemical Engineering - NJIT
- MBA, Technology Management - University of Phoenix
- Member, Industrial Advisory Board, NJIT Otto York Dept. of Chemical and Materials Engineering
- Work experience includes:
  - Diamond Shamrock – specialty chemicals
  - Occidental Chemical – specialty chemicals
  - Henkel Chemical – specialty chemicals
  - Olin Hunt – microelectronics chemicals
  - EI Associates – A/E consulting
  - BOC Gases – industrial gases
  - Schering-Plough - pharmaceuticals
  - ALZO International, Inc. – specialty chemicals

ATTRIBUTIONS

Some information presented on these slides was obtained (with permission) from:

- **Improve Energy Management to Reduce Your Facility's Carbon Footprint** – Edwin van Dijk - Vice President, Marketing – TrendMinder, N.V. - Chemical Engineering, October 2018

- **Successfully Implement the Industrial Internet of Things** – Dan Carlson, Emerson Automation Solutions, Chemical Processing, January 2018

- *…as well as over 35 years of experience in the chemical process industry!*

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Change is Taking Place

- **Discussion about climate change has been taking place for many years and is perhaps more relevant today than ever before**

- **This debate has led to global initiatives to reduce the carbon footprint of chemical process industries (CPI) facilities, which is high on the agenda of nearly every country**

- **Regulations have been established on a global, regional and local scale to reduce greenhouse gas emissions, and these regulations heavily impact CPI process operators**

Change is Taking Place

- **For example, BASF Corp. recently articulated this concept as core to its own operating strategy when it wrote:**

  – *"For us, energy efficiency is the key to combining climate protection, conservation of resources and competitive economic advantages ."*

BASF Corporate Commitments

Our Corporate Commitments cover every part of our value chain and operations to deliver long-term business success.

Suppliers	BASF operations		Customers	And along the way...
We source responsibly	We produce safely for people and the environment	We produce efficiently	We drive sustainable solutions	We value people and treat them with respect

BASF
We create chemistry

Change is Taking Place

- **Reducing an industrial facility's carbon footprint is not only good for the environment, it's good for the bottom line**

  - *Sound energy management often contributes to more efficient operation, reduced fuel usage and improved overall profitability*

  - *Within the CPI, energy use is often one of the largest components of a company's overall expenditures*

  - *Using concerted energy-management strategies to reduce costs is not new, but has become more important due to mandated regulations and leaner profit margins in many sectors*

- **What might a "structured energy management" program look like, you might ask, let's see……………..**
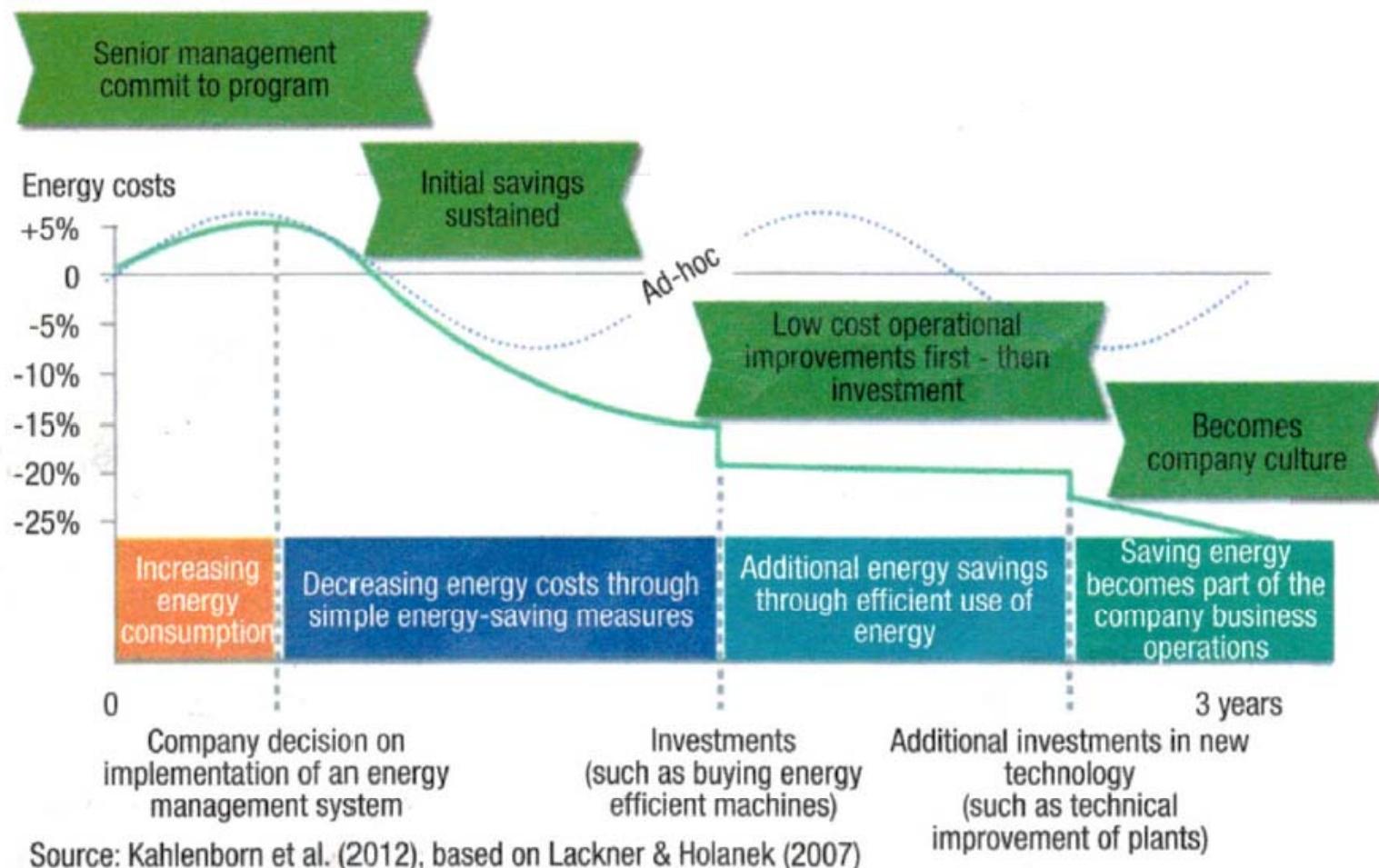
Structured energy management

Senior management commit to program

Initial savings sustained

Low cost operational improvements first - then investment

Becomes company culture

Energy costs

+5%
0
-5%
-10%
-15%
-20%
-25%

Ad-hoc

Increasing energy consumption

Decreasing energy costs through simple energy-saving measures

Additional energy savings through efficient use of energy

Saving energy becomes part of the company business operations

0

Company decision on implementation of an energy management system

Investments (such as buying energy efficient machines)

Additional investments in new technology (such as technical improvement of plants)

3 years

Source: Kahlenborn et al. (2012), based on Lackner & Holanek (2007)

FIGURE 1. At many CPI sites, quick wins in energy savings may have already been carried out. Additional investment in new technology, such as self-service analytics, can continuously help to reduce your organization's carbon footprint

ISO 50001

- As part of their "**Structured Energy Management**" program, many CPI companies are adopting the **ISO 50001** standard

- **ISO 50001** is based on the management system model of continual improvement also used for other well-known standards such as **ISO 9001** and **ISO 14001,** making it easier for organizations to integrate energy management into their overall efforts to improve quality and environmental management

- **ISO 50001:2018 provides a framework of requirements for organizations to**:

    – *Develop a policy for more efficient use of energy*
    – *Fix targets and objectives to meet the policy*
    – *Use data to better understand and make decisions about energy use*
    – *Measure the results*
    – *Review how well the policy works, and*
    – *Continually improve energy management*

ISO 50001

- The standard aims to help organizations continually reduce their energy use, and therefore their energy costs and their greenhouse gas emissions

- Originally released by ISO in June 2011, it is suitable for any organization, whatever its size, sector or geographical location. *(The second edition, **ISO 50001:2018** was released in August of 2018.)*

- The standards **ISO 9001** and **ISO 14001** both require improvement to the effectiveness of the Management System but not to the quality of the product/service (**ISO 9001**) or to environmental performance (**ISO 14001**)

- **ISO 50001**, therefore, has made a major leap forward in 'raising the bar' by requiring an organization to demonstrate that they have improved their energy performance

    – *No quantitative targets are specified – an organization chooses its own then creates an action plan to reach the targets. With this structured approach, an organization is more likely to see some tangible financial benefits.*

Change is Taking Place

- **Using concerted energy-management strategies to reduce costs is not new, but has become more important due to mandated regulations and leaner profit margins in many sectors**

- **Most CPI companies have formalized energy-management programs and use various automation and control technologies to help minimize energy costs**

- **It is clear, however, that many process operators need to take their efforts to the next level, by monitoring and optimizing energy use in real time**

- **This can be accomplished by leveraging data generated via the Industrial Internet of Things (IIoT)…...**

The Industrial Internet of Things

- **What is the Industrial Internet of Things (IIoT)?**

  - *Initially, the Industrial Internet of Things or IIoT, mainly referred to an industrial framework whereby a large number of devices or machines are connected and synchronized through the use of software tools and third platform technologies in a machine-to-machine and Internet of Things* context*
    - » ** a.k.a., Industry 4.0 or Industrial Internet context*

  - *Today it is mainly used in the scope of Internet of Things applications outside of the consumer space and is about applications and uses across several sectors, to distinguish between consumer Internet of Things applications and business/industry applications.*

  - *The Industrial Internet of Things is defined as "machines, computers and people enabling intelligent industrial operations using advanced data analytics for transformational business outcomes".*

The Industrial Internet of Things

- **The Industrial Internet of Things is part of the Internet of Things**

  - *The Internet of Things (or IoT) is data-rich: large amounts of data get collected, aggregated and shared in a meaningful way*

  - *The goal is to increase the automation level at domestic and commercial levels*

  - *Change human tasks where automation leads to a decrease of specific types of work but at the same time requires new skillsets*

  - *The goal of the Industrial Internet of Things is also not to fully replace human work, but to enhance and optimize it*

    - » *e.g., creating new revenue streams and business models with a big role for data analysis*

- **Benefits of the Industrial Internet of Things in manufacturing and beyond**

  - *One of the greatest benefits of Industrial Internet of Things has to be seen in the reduction of human errors and manual labor, the increase in overall efficiency and the reduction of costs, both in terms of time and money*

  - *We also cannot forget the possible underpinnings of IIoT in quality control and maintenance.*

The Industrial Internet of Things vs. the Consumer Internet of Things
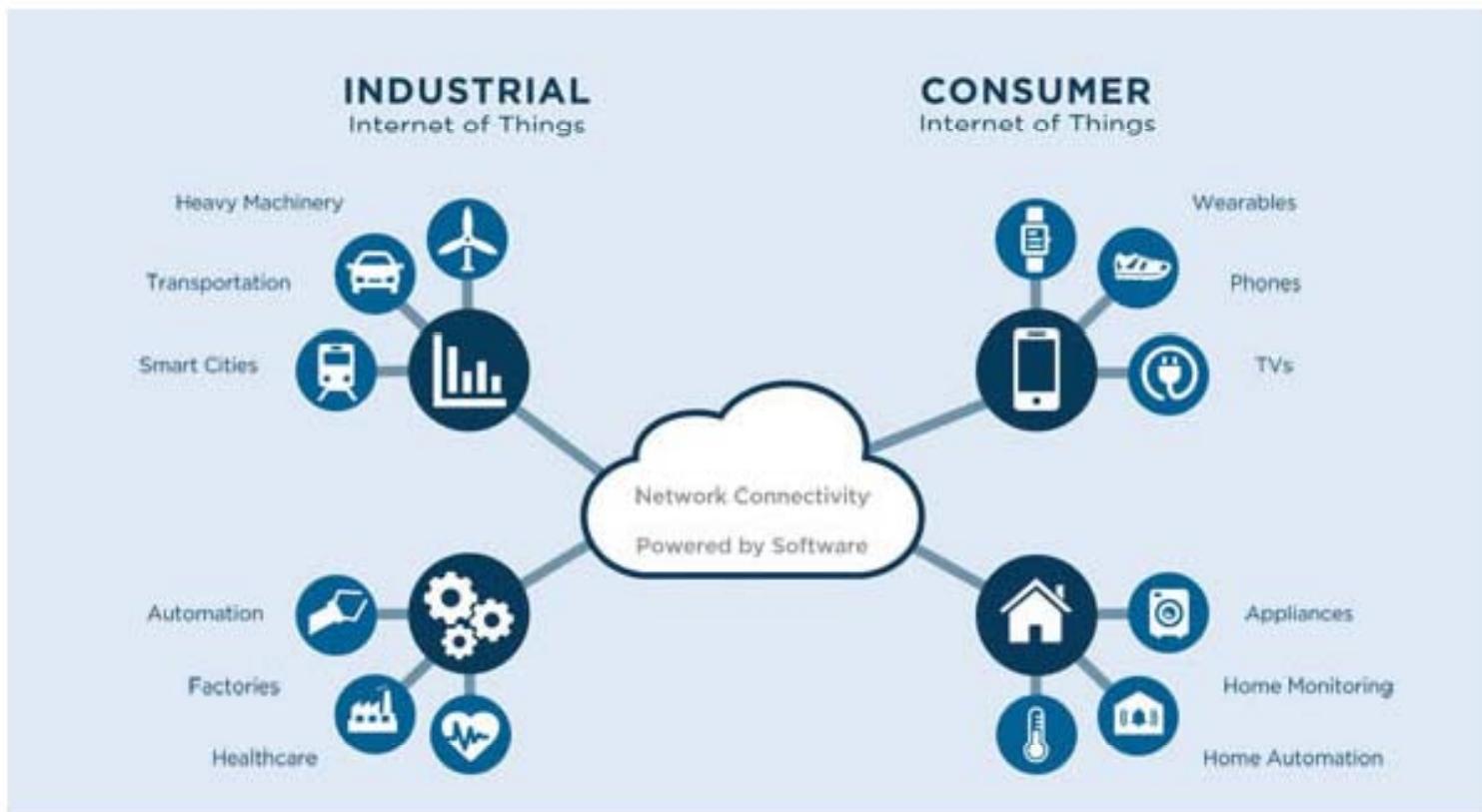
The difference between the Industrial Internet of Things and Consumer Internet of Things as depicted by Vector Software – source – courtesy Vector Software

Benefits of
the Industrial Internet of Things

- **An intelligent communication loop set up between machines enables timely attention to maintenance issues minimizing downtime and lost productivity**

- **The safety level of the operations can be boosted by alleviating the risk factors**

  – *The **Industrial Internet of Things** enhances the benefits of the **Internet of Things**, offering significant benefits to the industries where human error could result in massive risks*

  – *Moreover, the **Industrial Internet of Things** is and can be used to reduce the exposure of the human workforce to scenarios with high industrial hazard potential*

Monitoring Operating Data

- **For many years, process data have been captured in data historians**

    - *Such data are valuable and need to be unlocked and leveraged for continuous improvement in efforts to lower the carbon footprint of the company*

- **In recent years, advanced data-analytics techniques have been used by some large companies, to help optimize their larger onsite energy-related issues**

    - *However, such time-consuming, centrally led, data-modeling projects are typically less well-suited for process-related optimization efforts that are carried out more locally and require subject matter expertise.*

- **More recently, the availability of tools that put advanced analytics capabilities in the hands of subject matter experts (SMEs), such as process and field engineers, has helped to bring these powerful capabilities to the plant and process level**

Change is Taking Place

- **In general, energy savings can be achieved in various ways via the following efforts:**

  - *Changes in daily behavior (such as switching off the lights)*
  - *Installation of more energy-efficient equipment*
  - *Improved equipment maintenance*
  - *Ongoing process optimization*
  - *Efforts to ensure operation of equipment systems within their best operating zones*

- **The last bullet point above offers one of the biggest opportunities for energy savings, but such efforts require a deeper understanding of operational process data and asset-related data** (*such as data collected by the data historian*)

- **One of the best ways to leverage new innovations like those of the IIoT, is to apply advanced industrial analytics to production data generated by sensors**

Monitor and Analyze Key Items

- **The major process and asset-related energy consumers include water, air, gas, electricity and steam (WAGES) systems, and the performance of each of these processes can be directly or indirectly analyzed using sensor data**

  - *Too often, however, utilities and energy are neglected at the plant level, since there are more-pressing needs and analyzing inefficiencies in WAGES systems is laborious*

- **Specifically, looking for inefficiencies across the various WAGES systems is time-consuming because these critical plant utilities are used all across assets, plants and sites**

  - *For example, a plant could have hundreds of unit operations that require nitrogen or steam, so how could this be realistically and efficiently evaluated?*

Monitor and Analyze Key Items

- **Finding the root-cause of something that has created an increase in overall steam usage could require looking at possibly hundreds of tags from the data historian – akin to finding a needle in a hay-stack**

- **Using self-service analytics tools, data can be descriptively analyzed in the field by SME's who are best positioned to evaluate the data, in order to determine what has happened**

  - *Sometimes certain issues happen infrequently, but can have a big impact on overall energy consumption, e.g.; a trip that causes a shut-down*

- **Based upon historical data, best operating zones or best performance envelopes, (sometimes called "Golden Fingerprints") with regard to energy consumption can be created**

- **Monitoring equipment performance live can also be used for predictive analytics – to predict the impact on downstream performance of behavior at some time upstream**

Monitor and Analyze Key Items

- **Usually, best-in-class, self-service analytics tools will be easier to use and more efficient than creating data models from scratch**

- **By using an analytics tool, SMEs can quickly get answers to relevant questions such as:**

    - *Is the air or demineralized-water usage in my steam or nitrogen plant abnormal?*

    - *Is there anything that correlates with this abnormal usage right now?*

    - *How can I quickly figure out why my WAGES are abnormal so I can take timely corrective action?*

- **With traditional data-modeling tools, these questions could take weeks to answer, which is why they are often neglected**

Case 1: Energy Consumption Within a Cooling Water Network

- **A large number of reactors were consuming cooling capacity from the utility network for cooling water**

    – *Sufficient cooling capacity is critical for many of the reactors, because thermal runaway reactions could occur when the available capacity is insufficient*

- **To avoid this hazardous situation, advanced analytics capabilities were established to monitor the cooling capacity in real time**

    – *Early warning signals were created to alert for actual problematic situations, thereby minimizing false-positive alarms that could be triggered by measurement noise or spikes in the data*

    – *Once the process operator or engineer receives a warning, there is ample time to re-balance the reactors and de-prioritize other equipment so that the critical ones have access to the maximum cooling capacity*

    – *This helps overall energy consumption and process safety to remain within target boundaries*

Case 2: Energy Consumption Related to a Burner Oven

- **A burner oven was suffering from multiple trips, causing production losses and increased gas consumption**

  - *Through advanced process-data analytics, multiple previously unknown root causes were found to be responsible for the trips*
  - *With this increased understanding of the process, monitors were added to alert the key stakeholders*
  - *The monitors allow the SMEs to take appropriate action when a specific cause of a trip occurs, and thus avoid a trip from happening*
  - *The events are now also automatically annotated with the explanation of the root cause, this way, the organization is actively learning to control the process based on combining actual process behavior with subject matter expertise*

- **With downtime reduction achieved, gas consumption has also decreased significantly, but more importantly, the energy consumption is being improved continuously over time**

Case 3: Predictive Maintenance to Reduce Fouling of Heat-exchangers

- **In a reactor with subsequent heating and cooling phases, the controlled cooling phase is the most time consuming**

    – *Fouling of heat exchangers increases the required cooling time, however; scheduling maintenance too early leads to unwarranted downtime, while scheduling it too late leads to degraded performance, increased energy consumption and potential safety risks*

- **To enable timely maintenance, a cooling time monitor was set up, extending the asset 's availability, and reducing the maintenance cost and safety risks**

- **All of these benefits, including controlled energy consumption, ultimately led to 1% or more overall revenue increase of the production line**

Continuous Improvement

- **Generally, finding and solving root causes for process deviations and anomalies results in a more energy efficient operation**

- **Monitoring the live production performance allows for better control of various production parameters, including energy consumption**

- **When the total energy consumption of a specific year is taken as a baseline, the monitoring of performance against corporate goals becomes possible, for example….**

Continuous Improvement Example

- **Covestro AG, a leading manufacturer of polymeric materials for many CPI applications, initiated three major projects for its polyether plant in Antwerp as a part of its energy-savings goals and IS050001 directives:**

    - *Self-service industrial analytics solutions were implemented for online detection, logging and explanation of unexpected energy consumption (providing both root-cause analysis and hypothesis generation), and for comparing the results with the reference year 2013*

    - *Using specific formulas and calculated tags, various energy-consuming operations are monitored and controlled*

    - *By monitoring the performance against the reference year, the company was able to see that energy consumption has been effectively decreased year over year, meeting its corporate goals*

    - *More importantly, with a growing knowledge and insight into the process, Covestro is continuously improving its overall performance*

In Summary

- **Energy management is not new; many companies have a structured energy-management program in place**

- **However, new self-service analytics tools now allow SMEs to analyze, monitor and predict process and asset performance, which can help them to meet companywide carbon footprint goals**

- **And when the so-called low-hanging fruit for energy savings has been picked and more knowledge is applied to improve operational performance, SMEs get the added benefit of improving overall profitability and increased safety**

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"There is no expedient to which a man will not resort to avoid the real labor of thinking."

Sir Joshua Reynolds

THANK YOU

Psibilski@.ALZOUSA.com

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