IETC 2014 Abstracts

Session 3

Embedding Sustainability into Manufacturing Organizations

Vestal Tutterow, Senior Technical Consultant, Project Performance Company

While definitions of sustainability and sustainable development vary to a certain extent, manufacturing organizations tend to define sustainability as the triple bottom line – pursuing profitability, environmental integrity, and social equity. This paper will discuss the best practices and lessons learned by organizations that have ingrained sustainable practices throughout their organizations, as well as their experiences balancing the triple bottom line. The paper will examine the business cases used by such organizations to justify initiating their sustainability programs. Costs and benefits – financial and other – that facilitate and impede sustainability actions will be examined. Existing models and frameworks will be overviewed. Current codes and standards for reporting will be reviewed, also.

The paper will include a focus on smaller manufacturers, and will discuss how large manufacturers can engage the smaller companies within their global supply chains in both energy management and sustainability.

The Role of Professional Risk in Implementing Industrial Energy Improvements

Christopher Russell, C.E.M.

Principal, Energy Pathfinder Management Consulting, LLC

This paper discusses the professional risks and rewards of being an industrial energy manager. The content is derived from the author's personal experience[1] plus 80 separate interviews of industrial energy practitioners and experts conducted during 2012-14 for the American Council for an Energy Efficient Economy. The intended reader is anyone who is interested in reconciling industrial energy management tasks with their business and career performance.

Energy managers ensure that their facilities receive the benefits of improved energy technologies, practices, and accountabilities. But energy issues are not why industrial leaders get out of bed in the morning. Energy management imposes new priorities on long-standing organizational structures and procedures. To propose energy management is to propose change. Changes impact the way money is budgeted and spent, alters the order of work priorities, and can potentially upset the current balance of professional power and influence held by different department heads within a facility. Change elicits perceptions of risk. Risk begets resistance. Energy management becomes change management, which entails the modification of organizational accountabilities and procedures. Change management demands initiatives that are often beyond the reckoning of mechanically inclined staff that are accustomed to hands-on engineering or maintenance tasks.

The energy manager is ultimately an upstart who challenges the goliaths who lead production and finance activities through long-standing, pre-eminent authority. This imbalance ensures that energy management involves as much diplomacy, negotiation, and communication as it does hands-on technical tasks if it is to be sustained beyond a simple punch-list of projects. To advocate energy management is to be an iconoclast, swimming against the tide of traditional industrial priorities. It is an undertaking that requires temerity on the part of the nascent energy manager, and indeed some investment of individual professional credibility.

Hence the purpose of this paper: to propose a framework for identifying the strategies and resources for navigating the tasks of energy management. The goal is to help energy managers to better articulate their relevance to the greater industrial organization. This paper describes the professional risks of energy management-- considerations of which a technical-minded audience may not be fully aware. Navigating these risks (and opportunities) are the key to professional success. Accordingly, this paper introduces a codification of the energy manager's professional risks: (1) technical risk, (2) accountability risk, (3) measurement risk, (4) investment risk, and (5) management risk.

The Benefits and Barriers of Smart Manufacturing

Daniel Trombley and Ethan Rogers American Council for an Energy-Efficient Economy

IETC13-0046

Decision makers in the industrial sector have only recently started to realize the potential of *smart manufacturing* to transform manufacturing. The potential gains in efficiency at the process and supply-chain level are still largely unknown. For utility sector energy efficiency program administrators and policy makers to properly respond to this emerging opportunity to reduce the sector's future energy intensity, they need to better understand the scope of the opportunity and the economic potential it portends. This paper will define *smart manufacturing*, explain its promise, and examine its economic potential in terms of energy and energy costs savings for the industrial sector. Key questions that will be addressed include:

- What is *smart manufacturing*?
- How will it impact the industrial sector?
- What is the potential for it to save energy and reduce energy intensity in the industrial sector?
- What are near-term and mid-term challenges to broad implementation?

The Benefits and Barriers of Smart Manufacturing

Daniel Trombley, American Council for an Energy-Efficient Economy

IETC13-0047

Decision makers in the industrial sector have only recently started to realize the potential of *smart manufacturing* to transform manufacturing. The potential gains in efficiency at the process and supply-chain level are still largely unknown. For utility sector energy efficiency program administrators and policy makers to properly respond to this emerging opportunity to reduce the sector's future energy intensity, they need to better understand the scope of the opportunity and the economic potential it portends. This paper will define *smart manufacturing*, explain its promise, and examine its economic potential in terms of energy and energy costs savings for the industrial sector. Key questions that will be addressed include:

- What is *smart manufacturing*?
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- What are near-term and mid-term challenges to broad implementation?

Session 4

Development of a New Extended Motor Product Label for Industrial Energy Efficiency Programs

Ethan A. Rogers Robert Boteler

IETC14-0065

Recognizing that opportunities for motor system energy savings are much greater than savings from individual components, manufacturers of electric motors, pumps, fans and compressors have launched an initiative to develop a set of voluntary labels for motor driven equipment (e.g., a fan, pump or compressor, and the motor and associated controls) to reflect the relative efficiency of the equipment as it is installed into a motor system application. Participants in this initiative are collaborating with energy efficiency programs from across North America to assure compatibility of the new extended-product label with energy efficiency program measurement and verification needs to incentivize motor systems efficiency. The development of a driven component or "extended-product label" combined with implementation data can be the basis for prescriptive rebate programs with deemed savings values. The paper and presentation will describe on-going efforts and ultimate goals of the initiative.

Boiler MACT Assessments at BASF

Thomas R. Theising

IETC13-0039

The author will present the methodology developed for conducting MACT required energy assessments in a Do It Yourself (DIY) format. A list of what to look for and how to go about preparation and data collection will be presented. A compilation of findings will be presented from what should be, by next May, approximately two dozen assessments.

Case Studies and Lessons Learned So Far

Vestal Tutterow, Senior Technical ConsultantProject Performance Company

ISO 50001 – Energy Management Systems was published as a voluntary international standard in June of 2011. Companies are slowly beginning to consider use of the standard, and a few are implementing the standard and receiving third party certification. This paper will consider 3-5 facilities within the U.S. manufacturing sector that have completed the certification process. Based on published summaries and interviews with personnel in organizations involved in both the certification process and the decision to implement the standard, the author will examine the motivations for pursuing ISO 50001, lessons learned, and a comparison of costs and benefits. Discussion will consider how adoption of the standard fits with corporate energy management policies and goals, as well as broader sustainability or corporate social responsibility initiatives. The paper will also compare adoption of the standard in other countries relative to the U.S. The paper will attempt to inform companies that are learning about ISO 50001 and assist in their decision-making process.

Session 7

"Metrics (and Methodologies) for Evaluating Energy and Water Impacts of Alternative Process Cooling Systems in a Typical Chemical Plant"

Tom Carter, P.E., Johnson Controls

This presentation will briefly discuss the advantages and disadvantages of energy saving evaporative heat rejection systems when applied to chemical plant processes and then explore the methods and methodologies for financially evaluating water saving alternatives. Two methods will be evaluated: First, a simple case when the cost of one source of water is simply replaced with an alternative source of water and the water supply is unconstrained; Second, a more complex methodology that takes into account the impacts of potential changes in water supply temperature throughout the year and its availability on the overall annual energy input, product output, and profitability of the plant. Weather variability throughout the year and its impact on the cooling tower evaporation rates will be demonstrated. The required minimal energy, water, material, labor, and capital inputs to a simplistic plant system model and a simplistic plant business model will be discussed along with the impact of various heat rejection system control strategies. Examples of outputs from both the system and business models will be shown along with typical plots of key metrics of both the plant net profit and the heat rejection system internal rate of return (IRR) as a function of percent annual water constraint will be shown.

"Thermosyphon Cooler Hybrid System Providing Water Resiliency in a Typical Chemical Plant"

Tom Carter, P.E., Johnson Controls

This presentation describes the operation of the Thermosyphon Cooler and shows how it can be installed in an open cooling tower heat rejection loop to create a Thermosyphon Cooler Hybrid System (TCHS). It will be demonstrated how the energy efficiency and capacity advantages of evaporative heat rejection systems to be achieved with far less water consumption by utilizing the TCHS. The energy, water, raw material, labor, and capital inputs for the simplified performance and business unit models are defined for a typical chemical plant process and then the outputs from these models are reviewed showing the impact that a TCHS has on the annual energy consumption, water consumption, and plant production output compared to a cooling tower only system. The annual plant profitability and heat rejection system internal rate of return (IRR) as a function of percent water constraint are compared to that of cooling tower only heat rejection system for a plant located in the Houston, TX region.

THE ENERGY-WATER NEXUS: IMPLICATIONS FOR ENERGY EFFICIENCY

Muller, M. R. et. al

IETC14-0069

One of the primary tenants of the current interest in the energy/water nexus is that, going forward, water is likely to become increasingly scarce and increase in costs for water will outpace that of energy. Two of the areas of focus are power plants which have enormous water needs, and certain industrial processes which are heavy water users. It is also of interest to consider the impact of increasing water value in terms of energy efficiency. In certain areas around the country, low quality or scarce water combined with inexpensive energy have created a test bed for considering energy efficiency in a different light – namely one which is water conscious.

This paper considers case studies where the decisions that are normally made for energy improvement are altered when water costs are considered. The first case is for a winery in northern California – in this case making tough choices between evaporative cooling and its water consumption and the lower efficiency use of dry cooling towers. Case two from Idaho, shows how an energy audit focusing on energy issues can turn into a water use assessment. The final case study looks at mold cooling in plastic extrusion. In the case shown lowering throughput and letting natural air cooling take place instead of water cooling and the associated consumption is the overall right decision if the cost factors align in a certain way.

Session 8

Accelerating Energy Management Globally

Graziella Siciliano, U.S Department of Energy Tracy Evans, Energetics Incorporated Pamela de los Reyes, Energetics Incorporated

IETC13-0045

Countries participating in the Energy Management Working Group (EMWG) are leveraging their resources and taking collective action to strengthen national and international efforts to make it easier for the industrial and commercial building sectors to adopt energy management systems (EnMS) around the globe. EnMS can potentially conserve 10%–40% of facility energy use, and there are many things that the industry can do to improve EnMS today. The EMWG harnesses the collective expertise of their 11 member countries to provide assistance on policies and programs, help advocate for energy management, and develop tools and resources.

Though national policies and programs to drive EnMS implementation vary, the members of EMWG are working together on several projects with great success, including efforts in workforce development, measurement and verification, and an EnMS practitioner's toolbox. The EMWG organizes its activities using an "energy efficiency continuum" developed in Australia. The stages along this continuum reflect industrial energy efficiency process as an evolutionary process. This process can be characterized as a progressive improvement in the way industrial energy efficiency is perceived, managed, implemented, and monitored. The EMWG also has adopted a country-led approach to advance progress on activities. Each activity has the support of one or two country sponsors that provide strategic leadership and resources.

In order to increase awareness of EnMS, EMWG countries are collaborating on several specific tasks including developing and promoting case studies at a national level; contributing to the Energy Performance Database, which will support the analysis of different EnMS programs and determine their impact; and promoting EnMS activities and resources to companies, non-governmental organizations, and related initiatives. In terms of promoting the application of EnMS, member countries are working to understand the motivations and disincentives for corporations for investing in and implementing EnMS. In order to encourage the implementation of EnMS, the EMWG countries are sharing information about exemplary measures and tools they have used and, where possible, sharing the structure of the measure or tool so that it may be adopted by others as part of the EnMS Practitioner's Toolbox. Member countries are also working on an ISO 50001 Auditor Certification Scheme to develop a detailed job task analysis and associated certification scheme for ISO 50001 auditors. This addresses the lack of skilled and trained personnel for review of organizations' energy management systems, and builds capacity for energy management within the member countries through a qualified workforce.

Perform, Achieve &Trade (PAT) : An Innovative Mechanism for Enhancing Energy Efficiency of Industrial Sector in India

Soumya P Garnaik, Senior Manager

On 31st March 2012, India quietly announced a historic regulation for industrial sector in a bid to ensure energy security of the country. The regulation, with an aim to enhance energy efficiency in energy intensive industrial sectors, is empowered by Energy Conservation Act, 2001 of India and National Mission on Enhanced Energy Efficiency (NMEEE) under National Action Plan on Climate Change (NAPCC). The Energy Conservation Act, 2001 which is the first legislative initiative by Govt. of India to give fresh impetus in energy efficiency movement of the country, has the provision of declaring 'Designated Consumers (DC)' in 'Energy Intensive Industries'. The above regulation, under a scheme called Perform, Achieve & Trade (PAT), notified specific energy consumption (SEC) reduction targets for 478 DCs in eight industrial sectors like Cement, Pulp & Paper, Aluminium, Textile, Chlor-Alkali, Iron &Steel, Fertilizer and Thermal Power Plant. Different targets have been assigned to different DCs and to be achieved in a three years time period from the date of notification. The over-performers will be entitled to get energy saving certificates (e-certs) at the end of the compliance period. Similarly, the under-achievers will have to comply the shortfall by purchasing the e-certs in a tradable system or paying the penalty. This market based mechanism is first of its kind in the world.

The PAT scheme envisages an absolute energy saving of 6.68 million tonnes of oil equivalent (mtoe) by March 2015. This would also expect an investment to the tune of 12000 million USD during this period and accelerates technology transfer options in these eight sectors. The PAT scheme in India was launched with much preparedness in legal, institutional, administrative and financial provisions. The major attributes of the scheme like establishing the baseline and targets, monitoring, reporting & verification (MRV) system, compliance check and trading system have been looked into before the scheme was rolled in, but challenges are being faced by every stakeholders at various steps. Few of the challenges are complex and must be addressed or simplified before the next cycle of PAT starts in April 2015. Similarly, the scheme has now arrived in the second year of the first cycle and therefore, many lessons have been learnt or successes have been realized.

This paper highlights the progress of the PAT scheme, its present positioning, challenges faced and the effort of the Government of India to overcome such challenges. Such take ways would be helpful for other countries like Thailand who is proposing to initiate an Energy Performance Certificate (EPC) scheme in the near future. The author attempts to put forward his own experience of designing and administering the PAT scheme in India in this paper.

China's Energy Management Systems Program for Industrial Enterprises

Yongmiao Yu, Robert Taylor, Julia Renaud, Bruce Hedman – Institute for Industrial Productivity

China's senior leadership is firmly committed to improving the efficiency of resource use in the country, and especially the efficiency of energy use. Strong focus consistently has been placed on industry, the country's largest energy consuming sector. China has developed a comprehensive system of policies and programs aimed at achieving improvements in industrial energy efficiency over the long term. While many aspects bear similarities to programs in other countries, China's system, taken as a whole, is unique. China has attempted to initiate a comprehensive approach to industrial energy efficiency that includes many interrelated initiatives.

China developed many aspects of its aggressive industrial energy efficiency system as part of the 11th Five Year Plan (FYP) (2006-2010). China is currently working to fill out the system and improve capacities for implementation during the 12th FYP (2011-2015). The system is expected to continue to improve and yield benefits through the 13th FYP (2016-2020) and beyond. The system includes participation by three institutional groups:

- national, provincial and local governments;
- industrial enterprises; and
- third-party service organizations and companies that provide technical, managerial and financial services.

The basic responsibilities of the government and of enterprises are set out in the China's Energy Conservation Law, as amended in 2007. The Law also provides legal foundation for a wide range of detailed policies and regulations issued in subsequent years.

A key part of China's strategy to increase industrial energy efficiency is a major effort to promote enterprise energy management systems (EnMS) similar to ISO 50001 among the top energy consuming industrial enterprises in the country. This presentation will provide an overview of China's industrial energy efficiency situation and programs over the last 8 years along with a detailed profile of China's EnMS initiative. The presentation will specifically highlight the Institute for Industrial Productivity's (IIP) participation in a pilot program with the Dezhou Energy Conservation and Supervision Center (DECSC) to promote the uptake of EnMS among 53 of Dezhou's largest industrial enterprises. IIP's role is to provide expertise and best practices and tools to support the pilot program and to help build capacity in the region. The pilot program consists of EnMS implementation support at 2 to 3 leading enterprises to demonstrate the approach and benefits of an enterprise EnMS system, and a structured roll-out to the remaining large enterprises in Dezhou. Key elements to the pilot program are the use of Senior Management Exchange Workshops to secure the engagement and buy-in of enterprise managers to EnMS, and the use of international and domestic experts to support a practical exchange on EnMS implementation problems and to provide on-site "trouble-shooting" of specific, practical problems that these enterprises are facing.

Lessons Learned: Guidance based on Early Experiences of Implementing ISO 50001 & SEP

Paul F Monaghan, Enerit Ltd.

This paper will draw on real experience of implementing ISO 50001 and Superior Energy Performance (SEP) in USA and Europe in a variety of sectors: pharmaceutical, automotive, medical device, metals and plastics, universities & ICT. The paper will aim to give high-level practical guidance on implementation of these types of energy management system (EnMS)
US DoE has reported substantial extra savings with an EnMS approach compared to "business as usual" energy efficiency programs and ISO 50001 is very rapidly growing in Germany. However, there are a number of challenges to: getting started; and making continuous improvement with EnMS.
Firstly, the expression "Energy Management System" means different things to different people. In this paper, we explain what the difference is between EnMS, as meant by ISO 50001/SEP and the general class of Energy Management Information Systems (EMIS), which include monitoring systems and corporate energy/carbon reporting systems.
The next problem is "getting started" with EnMS. In this paper, we first explain identify that there are two key reasons for people to adopt EnMS: These two organizations may start in a different way:

- If the goal is "I want to save more energy in a cost-effective way" it is best to start with an energy review and find ways to visualize how energy is used within the organization.
- If the goal is "I want to get an ISO 50001/SEP certified", start with a gap assessment to establish how well their "way of working" fits with ISO 50001/SEP.

When some sites in the organization have successfully implemented an EnMS, how do you: ensure that those sites continuously improve; and how do you bring the less advanced sites up to the level of the leading sites?
We believe it is useful to view everything in terms of Energy Management Maturity Models and use this as guidance along the path from start-up through to embedded continuous energy management improvement. Factors that we have found useful in successful rollouts are visualization tools e.g.:

- Sankey diagrams - to show energy flows for focusing & persuasion of upper management
- Spider diagrams – to show scoring of "way of working" in different EnMS aspects of individual sites and to compare these for different sites
- Dashboards - for status tracking of: maturity, plans, actions, audits, corrective actions etc.

In this paper, we will show examples of these visualizations in real situations.

Session 9

Low Hanging Fruit Grows Back

Thomas R. Theising

IETC13-0041

The author will present energy maintenance best practices to avoid low hanging fruit from growing back. Often times a roller coaster effect takes place after an energy assessment. Much gets implemented during the immediate times after the assessment and then over time the same inefficiencies re-appear. A new assessment is performed and the cycle starts again. Examples will be given of some of the re-occurring fruit such as motors, traps, leaks, lights, etc.

Energy cost optimization in a Cement Industry

Ven V. Venkatesan, VGA Engg. Consultants Inc.,

This paper highlights the efforts taken by the author in conducting an Energy Audit in a modern state of the art Cement plant in a Far East Asian country.

In the Cement industry, the pyro-processing of limestone into clinker is the most important step and consumes the largest share of the purchased energy. Engineers and managers at the cement plants are constantly trying to optimize the energy use in the pyro-processing of clinker in the modern cement industry. Hence the author developed also an Energy Model for the pyro-processing of clinker production in the dry-process rotary cement kiln system to evaluate the energy cost optimization opportunities, based on actual field input data and site observations. This Model can also be applied to all other modern dry-process cement kiln systems.

In addition to pyro-processing Cement plants also operates large electric motors driving huge grinding mills and big fans, consuming substantial electricity. The Energy Audit, conducted at the site during Jul 2009 – May 2010, identified 10 energy cost optimization opportunities that would result in a total cost savings of $4 million annually. Savings opportunities covered the Raw Mill, the Rotary Kiln system including the Clinker cooler and the Cement Mill aiming to reduce the specific energy consumption in each section and to improve the overall plant efficiency. The initial estimates indicate that 9 of the 10 projects recommended by the study have simple payback periods of less than 24 months.

This Energy Audit is a good example & motivation for all the engineers and managers who are responsible for maintaining the efficiency and reliability of modern dry process cement plants.

Thermal Energy Storage is not just for electric cost savings anymore

John S. Andrepont

IETC14-0070

Large cool Thermal Energy Storage (TES), typically ice TES or chilled water (CHW) TES, has traditionally been thought of, and used for, managing time-of-day electricity use to reduce the cost associated with electric energy and demand charges for air-conditioning or process refrigeration. However, this is but one of the many benefits which are often and increasingly obtained from the use of TES. These other benefits can include one or more of the following, depending on the particular situation of a given facility:

- Operating cost savings with Real-Time Pricing (RTP) or spot market pricing
- Capital Cost Savings during new construction, retrofit expansion, or chiller plant rehabilitation
- Utility Cash Incentives
- Flattened cooling and electric load profiles, for improved Combined Heat & Power (CHP) economics
- Turbine Inlet Cooling (TIC) of gas turbines, for enhanced hot-weather power output
- Redundancy and emergency reserve cooling for Mission Critical Facilities or crucial cooling loads
- Dual-service as a Fire Protection water storage reservoir, reducing risk and/or insurance premiums
- Mitigation of "bottlenecks" in DE piping networks via colder supply temps and/or satellite TES location
- Enhanced use and economics of seasonal "free cooling"
- Enhanced use and economics of Deep Water Source Cooling
- Potential for reduced on-site energy use (annual kWh per ton-hour)
- Reduced "source" power plant fuel use (Btu/kWh) and associated pollutant emissions
- Integration of intermittent renewable power technologies (e.g. Wind and Solar)

Each of these additional benefits will be illustrated with at least one specific real-world TES installation, including example applications of auto assembly, pharmaceutical manufacturing, insurance data processing, computing facilities, corporate research, on-site CHP, etc.

Most systems, whether found in nature or in the man-made environment, have and benefit from some type of storage. Thermal storage in cooling systems (which is also effectively a "virtual" storage of electricity) can and often does provide many benefits both for the owner/user of the cooling system and for the operator and customers of the electricity grid. The potential benefits are myriad. The technology is mature, commercially proven, and often yields extremely attractive economic returns. Owners/operators of large cooling systems (as well as owners/operators of gas turbines) should consider the use of TES, and not just for its ability to reduce electric costs. Often, one or more of the many other potential benefits of TES can justify its use and provide lasting value for the owner.

Session 12

Wave Energy Conversion

Jeremiah C. Pastor Yucheng Liu

IETC13-0043

Ocean energy conversion has been of interest for many years. Recent developments such as concern over global warming have renewed interest in the topic. Part II provides an overview of the energy found in ocean waves and how each type of device utilizes the available ocean wave energy. Part III of this study focuses on wave energy converters (WEC) as opposed to ocean current energy converters. The point absorber, terminator, and attenuator WEC devices are addressed with regards to their operation and function. In Part IV, the University of Louisiana at Lafayette WEC concept is introduced and a look is taken at the market potential and how WEC devices can be applied in the Gulf of Mexico. A special look is also taken to suggest what use WECs may have in the Gulf Coast region.

Wave Energy Resource Analysis for use in Wave Energy Conversion

Jeremiah Pastor, Dr. Yucheng Liu

IETC13-0044

In order to predict the response of wave energy converters an accurate representation of the wave climate resource is crucial. This paper gives an overview of wave resource modeling techniques as well as detailing a methodology for estimating the naturally available and technically recoverable resource in a given location. The methodology was developed by the EPRI and uses a modified Gamma spectrum that interperates hindcast sea state parameter data produced by NOAA’s Wavewatch III. This Gamma spectrum is dependent on the calibration of two variables relating to the spectral width parameter and the spectral peakedness parameter. Minor changes were implemented by the author to increase accuracy in formulating wave length. Overall this methodology describes how to asses a given region's wave resource for wave power density and total annual wave energy flux.

Potential of Development and Application of Wave Energy Conversion Technology in the Gulf of Mexico

Kelly L. Guiberteau, Yucheng Liu, Jim Lee, Theodore A. Kozman

IETC13-0056

This paper focuses on the potential of developing wave energy technology in the Gulf of Mexico (GOM). In this paper, the actual conditions (weather, wave climate, activity of the oil industry, etc.) in the GOM was assessed, the attributes of wave energy in the GOM was then explored and verified. Based on the findings, the great potential in the GOM for wave energy technology was confirmed and it is expected that the wave energy captured from the GOM can provide a considerable portion of power required by operating the oil platforms in that area.

Guidelines in Wave Energy Conversion System Design

Kelly Guiberteau, Theodore A. Kozman, Jim Lee and Yucheng Liu

IETC13-0057

This paper presents an investigational study on wave energy converters (WECs). The types of WEC available from the market are studied first. The design considerations for implementing a WEC in the Gulf of Mexico (GOM) are then evaluated. There are several different types of devices that can be used to model the system design. Each device type has different attributes that may be helpful or hurtful for the area and wave activity in the GOM. From the evaluation there is a recommendation of the optimal device design conditions, and three device types are recommended for further pursuit as design candidates. Six different WEC projects that are currently being developed and most are ready for commercial testing are examined. The examination evaluates the usefulness of the WECs for the GOM, and provides some factors of both physical and economic scaling. The result of this study reveals that while none of the devices can be installed "as is" in the GOM because of wave power or geometry

requirements, there are some that have the potential to be modified and scaled down to fit the GOM climate.

Session 13

Compressed air system analysis and retrofit for energy savings - industrial case study

Andrew Chase Harding, Darin W. Nutter

IETC13-0061

Compressed air systems in industrial facilities are energy intensive and costly to operate. In fact, many U.S. Department of Energy publications state that compressed air systems use up to 30% of an industrial facility's total energy consumption. This case study paper describes energy efficiency improvements to a large sanitary paper products manufacturing facility that underwent a significant compressed air system retrofit. Energy savings measures were proposed and implemented that included a compressor replacement, piping system changes to reduce pressure drop and leaks, end use efficiency upgrades, plant pressure control with flow controls and pressure boosters, and other various measures. Measurement and verification of the compressed air system energy usage is presented and discussed in detail. A total savings of 17% of annual system operating costs was achieved by this project. Operating costs, equipment costs, utility incentives, paybacks, and life cycle costing are presented showing significant savings and economic viability of the project.

USING OUTSIDE AIR FOR FLOODED OIL SCREW COMPRESSORS AT AN INDUSTRIAL FACILITY

Hunt, David G Terry, Stephen D

IETC13-0005

A study has been performed to determine if inlet air temperature provides an increase in compressor efficiency, seen through reduced power for some specified mass

flow. A theoretical analysis suggests that power is not a function of volumetric flow. However, energy use will be a function of mass flow, since processes demand a given mass flow, which is a function of inlet density and time loaded. However, our experimental results show that for a given mass flow (scfm), compressor power and energy are not a function of inlet air temperature. We believe this to be due to hot compressor oil mixing with inlet air, which dampens any temperature variation due to the high thermal mass of oil. This provides the compressor a near constant effective inlet temperature regardless of outdoor temperature and therefore a near constant power for a given flow.

A New Approach for Determining Optimal Air Compressor Location in a Manufacturing Facility to Increase Energy Efficiency

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IETC13-0031

An approach is proposed to determine the optimal air compressor location in a manufacturing facility. The optimization strategy is based on an objective function that minimizes the total energy consumption of the air compressor —thereby decreasing the energy cost —in the manufacturing facility. Compressor distance to air demand, air pressure, load factor and volume are all factors considered in the model.

The proposed model determines the facility’s attributes based on user inputs of facility size. The model then divides the facility into zones and creates a zone-to-zone distance matrix within the prescribed facility. Demand and pressure profiles of the facility are created based on the equipment and tools present in each zone. The model also determines the ideal air compressor horsepower required to meet the facility air demand at the required pressure. Air pressure drops are incorporated using a compressed air pipeline pressure drop table, while air leaks are calculated throughout the system using novel and conservative estimation techniques. Facility shape and facility temperature profile used to ensure safe and proper operation of the air compressor are also considered in the objective function.

To examine the effectiveness of our approach, conduct a simulation based experimental analysis was conducted using a representative facility layout (office space, production area, machine shop, shipping and receiving, and sand blasting) with nameplate data for compressed air demand, air pressure, and load factor. The outcomes of the experimental analysis were validated through an established theoretical approach, with analysis conducted on multiple facility zones. The results suggest that, by utilizing the proposed model to optimize the air compressor location in the facility, significant energy reduction can be achieved.

Air Compressor Power Trend Analysis Based Retro-Commissioning for Compressed Air Systems

Xiang Liu (Primary author - Senior Project Engineer, Nexant Inc.; Return Address: 101 2nd Street, Suite 1000, San Francisco, CA, 94105, USA; fwdbker@gmail.com; 415-369-1027), Sherry Hu, Alan Deng, Mushtaq Ahmad, Safdar Chaudhry

IETC13-0037

Compressed air system retro-commissioning uncovers cost-effective energy efficiency opportunities that optimize the operation of the compressed air systems. Air pressure and air flow at different spots in a compressed air system are critical information to identifying various deficiencies in the retro-commissioning. Retrieving these information usually involves costly and intrusive measurement and trending that may interfere normal compressed air plant operation. Air compressor(s)' power draw contains compounded information on both air pressure and air flow, and can be easily measured and trended. This paper lists common compressed air system deficiencies in the air demand, air distribution and air supply side of a compressed air system. Their impacts on the compressor operation and power use are studied and characterized. The paper then proposes algorithms on segregating and distinguishing different features in the power trend resulting from the deficiencies, identifying design and operational deficiencies according to the unique features in the power trend, analyzing these characteristics to reveal the significance and magnitude of the deficiencies and proposing pertinent solutions. Several case studies are included to demonstrate how the algorithms should be applied to effectively pin point cost effective energy efficiency opportunities for the compressed air systems. Suggestions and recommendations on enabling an air compressor power trend analysis based retro-commissioning for compressed air systems are made.

Air Compressor Power Trend Analysis Based Retro-Commissioning for Compressed Air Systems

Xiang Liu (Primary author - Senior Project Engineer, Nexant Inc.; Return Address: 101 2nd Street, Suite 1000, San Francisco, CA, 94105, USA; fwdbker@gmail.com; 415-369-1027), Sherry Hu, Alan Deng, Mushtaq Ahmad, Safdar Chaudhry

IETC13-0038

Compressed air system retro-commissioning uncovers cost-effective energy efficiency opportunities that optimize the operation of the compressed air systems. Air pressure and air flow at different spots in a compressed air system are critical information to identifying various deficiencies in the retro-commissioning. Retrieving these information usually involves costly and intrusive measurement and trending that may interfere normal compressed air plant operation. Air compressor(s)' power draw contains compounded information on both air pressure and air flow, and can be easily measured and trended. This paper lists common compressed air system deficiencies in the air demand, air distribution and air supply side of a compressed air system. Their impacts on the compressor operation and power use are studied and characterized. The paper then proposes algorithms on segregating and distinguishing different features in the power trend resulting from the deficiencies, identifying design and operational deficiencies according to the unique features in the power trend, analyzing these characteristics to reveal the significance and magnitude of the deficiencies and proposing pertinent solutions. Several case studies are included to demonstrate how the algorithms should be applied to effectively pin point cost effective energy efficiency opportunities for the compressed air systems. The paper concludes with suggestions and recommendations on enabling an air compressor power trend analysis based retro-commissioning for compressed air systems.

Session 14

GM's Energy Management Process & Global Manufacturing System

Alfred J. Hildreth, Seog-Chan Oh, Ph.D, General Motors Company

In the car making industry, energy use is a large, but mandatory, expense and contributes to Greenhouse Gas (GHG) emissions. At General Motors (GM), although our expenditure for energy is not a large percentage of our total cost, we do spend in excess of $1 Billion USD annually. GHG emissions from energy use represent over 7 million metric tons per year of GM's carbon footprint. Hence, a sustainable energy management is needed to meet the challenge for industry. Management of energy and carbon to reduce environmental impact has become important enough to be included in our business plan, similar to safety, people, quality, responsiveness, and cost. Following a model similar to EPA Energy Star's seven step approach, energy as an environmental element has been integrated into GM's business policy and model. Based on top level commitment and public goals to reduce energy and GHG by 20% from 2010 to 2020, GM uses its standardized Global Manufacturing System (GMS) to ensure that energy efficiency and conservation is properly managed through performance assessment, action plans, evaluating progress, and recognizing achievements. The methods used to integrate energy management into our business plan include dedicated resources at all levels in the organization. With people as one of our most important resources, having qualified energy leaders at the corporate, global, regional and site levels is key to our success. To implement initiatives a dedicated budget for systems and projects is required, similar to other areas of the business. Forecasting energy, establishing targets, implementing projects and processes, regular monitoring, and corrective action when required ensures timely adherence to meeting our energy and carbon goals. GM recognizes achievements internally with various processes – Plant energy performance recognition, employee suggestions, employee compensation tied to business results, and others. Also, GM's recognition of our energy performance externally includes many awards and recognitions – winning EPA Energy Star labels for 8 facilities, meeting Energy Star's Challenge for Industry for 63 plants globally over the past year with 22 of the facilities achieved this for the second time in 2013, placing 1 GM warehouse in the top 10 for water and 2 in the +20% group for energy reduction in 2012 Energy Star's "Battle of the Buildings" contest, and winning Energy Star Partner of the year awards 3 times with the most recent for Sustained Excellence, along with many global, regional, and local awards for protecting the environment.

Energy Management - When Good is Not Enough

Sharon L. Nolen, P.E., CEM

IETC13-0003

Eastman Chemical Company has a long history of promoting and implementing energy efficiency. In 2010, the company made a public commitment to the DOE Better Buildings, Better Plants program and recognized changes were in order to take the program to a new level. Since that time, Eastman's energy program has seen significant advancements and has been honored as a 2012 and 2013 ENERGY STAR Partner of the Year, the first chemical company to ever win more than once.

It is commonly known that energy costs are significant to the chemical industry. Because of cost pressures, energy has long been a target for process and efficiency improvements. In addition to cost pressures, Eastman has a goal to create value through environmental stewardship, social responsibility and economic growth. Energy efficiency addresses both cost concerns and sustainability goals.

This paper will discuss the actions taken by the company that proved significant in transforming the already good energy program to one that has received national attention and recognition. Two of the most significant actions occurred very early in the journey. The level of reporting was advanced so that the corporate energy management team began reporting to an executive steering team made up of three of the top eight Eastman executives. In tandem with the change in reporting, a capital budget was provided for use by the corporate energy program to fund the best energy efficiency projects that were not currently funded due to competing needs in the local area. This funding would not have been possible without the opportunity to communicate needs directly to senior management and led to increased interest in and involvement with the energy team.

As the program reached a new maturity level, other significant milestones included:

- additional communications designed to promote awareness and drive employee engagement
- an energy survey process intended to identify energy savings projects
- improved measures with more accuracy and more frequent review
- more detail provided to manufacturing managers

In addition to these new efforts, steps were taken to institutionalize current programs which were positively impacting energy intensity. Finally, the paper will conclude with a description of additional items that have been identified to continue the energy program's effectiveness and value

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Organized Approach to an Energy Walk Through

Thomas R. Theising

IETC13-0040

The author will present the method of preparing a walk through audience to quantify opportunities during the walk through eliminating a lot of the guess work. A checklist on how to educate “the walkers”, how to record opportunities, how to capture ideas on paper, and the brainstorming process of collecting ideas will be presented.

Top down approach to Transformation (Conference Paper)
Sirisha Chada, TPC Group

TPC Group is a $2B petrochemical company, with energy costs being the second largest contributor to the Cost of Goods Sold (COGS). There is an increased focus in both optimization of the energy and utilities consumed and concentration on controlling and reducing the costs affiliated.
During 2012, the TPC Group energy program went through “rapid transformation” with a focused, cross-functional improvement team supported by the top leadership in the company. This successful and concerted effort is part of the overall corporate and sustainability strategy (Triple bottom line: People/Plant/Profit).
Looking back at the journey over the past year provides valuable insight into the triumphs and tribulations of a successful energy program delivering multi-million dollar savings.

Session 15

Realizing Real Time Energy Analysis for Industrial Energy Audits

Franco J. Morelli, Bryan P. Rasmussen, Ph.D., P.E.

IETC13-0050

In an effort to conclude if industrial energy audit report implementation rate is affected by report timeliness, an analysis using data from the Industrial Assessment Center (IAC) shows no conclusive evidence relating report implementation with timeliness. In an attempt to increase report implementation by increasing report timeliness, a suite of tools has been designed to decrease analysis and reporting of retrofit and optimization assessments. A pre-analysis tool automates reporting and analysis of utility usage. The demand visualization tool helps to quantify reduction savings by attenuating minimum electrical consumption. The tool also presents information relevant to demand shifting. The weather effect disaggregation tool is an attempt to disaggregate weather-based loads from 15-minute demand curve data. To decrease demand, a photovoltaic (PV) optimization tool has been developed to optimize PV cost with demand reduction. Finally, an automated report generation tool is an attempt to decrease the time required of assessment analysis and reporting.

Impact of Control System Technologies on Industrial Energy Savings

Priyam Parikh, Bryan P. Rasmussen

IETC14-0064

With growing industrialization and the mounting energy crisis, finding newer ways to reduce the energy consumption of industrial processes is essential. The objective of this paper is to highlight the role of control systems in bringing this reduction. The paper presents five control system related strategies to achieve this- Improve Algorithm, Setpoint Adjustment, Fault Detection, Actuator Retrofit and System Coordination. Each strategy is explained using the energy saving recommendations in the US Department of Energy's Industrial Assessment Center database. Time trends are presented for these recommendations, with the average energy saved for each type of recommendation. Some newer technologies that are less recommended are also included.

Integration of Multiple Sensors with Embedded Data Acquisition for Automation of Lighting Analysis and Retrofit Report in an Energy Assessment

Trevor J. Terrill, Christopher Bay, Bryan P. Rasmussen

IETC13-0048

Buildings are responsible for approximately 40% of all US energy use and carbon emissions. Lighting technologies continue to evolve, leading to potential energy savings through retrofits of lighting systems. Building lighting systems are typically the first item evaluated by commercial and industrial energy auditors. This paper presents continuing work on a project to develop unmanned aerial and ground vehicles capable of conducting autonomous energy audits of commercial buildings. As the aerial vehicle navigates throughout a room, the prototype system captures images and collects frequency data of lighting. These data are used to quantify and classify lighting in a room. Additionally, images acquired from the optical camera are merged to form a composite image of the area. This composite image serves to eliminate duplicate counting of lamps from overlapping images. This paper also presents work on creating a lighting simulation program to predict lighting levels based on lighting arrangement and type in an area.

Session 16

U.S. Manufacturing Energy Use and Loss, The Big Picture

Sabine Brueske, Ridah Sabouni

IETC14-0074

A first step in realizing industrial energy efficiency opportunities is to understand how industry is using, and losing, energy. The U.S. Manufacturing Energy and Carbon Footprints provide a reliable macro-scale reference for manufacturing energy use benchmarking. The footprint analysis incorporates published energy use and loss data with layers of peer review to develop a macroscopic view—the "big picture"—of energy use in U.S. manufacturing.

Our analysis indicates that **36% of U.S. manufacturing primary energy is applied to useful end uses, with the remainder lost in the pathway from supply of source energy to facility end use.** The manufacturing energy use and loss analysis discussed here helps us understand where these losses occur, in each sector, from supply to end use. As with all resource management decisions, having a business-as-usual point of reference for resource allocation is a necessary first step in determining opportunities for change. The results serve as a guide for industry, government, and researchers alike in framing the opportunity for reduced energy consumption in manufacturing. Various visual approaches exist for documenting the analysis results with varying levels of detail.

Productivity Improvements and Non-Energy Benefits from Energy Efficiency Investments: A Cobb-Douglas Approach to Evaluating GDP Impacts

John 'Skip' Laitner, Economic and Human Dimensions Research Associates, Robert Bruce Lung, Energy Efficiency Consultant, Aimee McKane, Lawrence Berkeley National Laboratory

This paper examines the impacts of energy efficiency measures and productivity improvements on GDP. Energy efficiency measures often yield significant energy savings that are accurately measured. In many cases, energy efficiency measures also generate important non-energy

benefits that are not systematically represented in most models or M&V protocols. Productivity improvements lead to better or greater production, which is also well quantified. However, productivity improvements often result in energy savings, which are rarely captured either. Because non-energy benefits are not always captured the impact of energy efficiency on GDP growth is often understated. Because energy savings from productivity improvements are not often measured, the impact on GDP growth from such improvements is incomplete.
This paper details the types and scale of non-energy benefits resulting from implementation of energy efficiency measures and energy savings that stem from improvements to production equipment. The data is then analyzed using a Cobb Douglas model to show the impact on GDP from such measures. The model shows that when non-energy benefits from energy efficiency measures and energy savings from productivity improvements are captured, positive impacts on GDP growth result. The inclusion of non-energy benefits in such a model provides a more accurate assessment of the impact of energy efficiency on GDP. By integrating such benefits systematically in economic models, energy efficiency and investments in production equipment can become more compelling.

Manufacturing Energy Bandwidth Studies - Chemical, Petroleum REfining, Pulp and Paper, and Iron and Steel Sectors

Sabine Brueske, Joe Cresko, Alberta Carpenter

IETC14-0076

Energy efficiency underlies American manufacturing competitiveness. To guide research decision-making and ensure that federal funds are spent effectively, the U.S. Department of Energy’s (DOE’s) Advanced Manufacturing Office (AMO) needs to know which manufacturing sectors and processes are the most energy intensive and least efficient. DOE AMO commissioned bandwidth studies to analyze the most energy consuming processes and products in four of the most energy-intensive manufacturing sectors in the United States. The Chemical, Petroleum Refining, Pulp and Paper, and Iron and Steel Energy Bandwidth Studies serve as generalized guides for energy technology advancement opportunities.

These studies identify energy intensity and consumption for key manufacturing processes and the sector as a whole. Potential energy savings opportunities are identified by quantifying four measures of energy consumption for each process area: current average (year 2010), state of the art, practical minimum, and thermodynamic minimum. These measures enable prediction of *current* savings opportunities and *future* savings opportunities, with supporting detail on opportunity areas. The resulting reports provide useful guides for determining which manufacturing sectors and processes are the most energy-intensive and offer the greatest energy savings opportunity.

Session 17

Cognitive Energy Value Chain: Leveraging Big Data to Optimize Energy

Dr. Graham Bird & Tyler Reitmeier, Yokogawa Corporation of American/Soteica Visual MESA LLC

Utilizing business analytics for more effective energy decision-making

Most industrial operating companies manage operational decision-making with the assistance of a patchwork of unconnected systems. As a result, time to process information in order to make informed decisions can be on the order of hours to days. To reduce the time required to obtain useful information for decision-making, oversimplification of complex opportunities limits the typical organization's ability to optimize across the enterprise.

Recent developments, such as server virtualization, mobile and smart devices, and wireless technologies, are proliferating and providing unprecedented opportunities to leverage "Big Data" in operational decision-making. Advances in cognitive systems, involving analytics applied to the increasing data available, are changing the way we think and interact.

"Big Data" harnessed through a unified system can optimize operational decisions across the energy value chain from well-head to product supply. The application of such a system also allows the organization the benefit of near real-time data to best modify current and schedule future operations.

Cognitive Energy Optimization (CEO) is a system designed to achieve this vision. CEO provides continuous optimization of the energy value chain by ensuring ongoing monitoring and control of asset and enterprise from both the operational and commercial perspectives.

Big Data and Efficient Energy Markets

Mark DeSantis, PhD CEO of kWantera and Adjunct Professor, Carnegie Mellon University

IETC13-0052

The US deregulated markets offer a new opportunity for optimal energy prices for buyers and sellers of energy. The main challenge is the capability to continuously find the opportune time to bid, price to bid (whether to buy or sell) and quantity to bid in the wholesale markets. Countless factors, weather, congestion, market conditions, demand to name a few, impact the pricing of energy. The effort to get the best price is made more complicated by additional factors including the dynamic nature of real-time spot markets and the need to continuously monitor and process vast amounts of disparate information.

Pricing the spot sale of energy in particular is very acute for renewable energy providers, given the variability of their ultimate source. In fact, renewables have the dual challenge accommodating the variability of weather directly in to their bid prices while having the simultaneous need to bid in to the market to purchase energy (for later resale) at a moments notice should they not be able to meet their commitment due to sudden weather changes (i.e., cloud cover or lack of wind).

Fortunately, 'Big Data' technologies such as machine learning and ensemble analytics, which are well developed in the fields of social media and predictive data analytics, are now available to buyers and sellers of energy alike. These tools will not only optimize the purchase and sale price of energy but create much more efficient markets across the deregulated markets of the US and abroad.
