INDUSTRIAL ASSESSMENT CENTERS

IAC Update

Message from DOE Management

Welcome to another edition of the *Industrial Assessment Centers (IAC) Update* from the Advanced Manufacturing Office (AMO) at the U.S. Department of Energy (DOE).The purpose of the Update is to share the recent successes and highlights from the IACs and our manufacturing partners.

The IACs continue to be a resource to America's small and medium-sized manufacturing enterprises (SMEs), helping them save millions of dollars in energy and water use expenses. In addition, the IACs have provided recommendations to our SME partners that lead to increased competitiveness and productivity through process improvements. In addition to supporting the manufacturing community, the IACs also train engineering students to become tomorrow's energy saving professionals.

On behalf of DOE, I want to thank all of the IACs for their service and all of the participating SMEs for understanding the value of energy efficiency to maintaining a robust manufacturing industry in the United States. For more information about the IAC program, please contact *john.smegal@ee.doe.gov* or at 202-287-6225.

"Your team did an outstanding / professional assessment at PHD in which we have implemented a number of the recommendations and achieved significant savings."

- Source: David French, Vice President of Operations, PHD Inc.,

About the IAC Program

Beginning in 1976, the IACs have provided SMEs with site-specific recommendations for improving energy efficiency, reducing waste and water, and increasing productivity through immediate changes in manufacturing processes and equipment. Since 2006, IAC assessments have identified more than $595M in energy savings and nearly 4.0 million metric tons in carbon dioxide (CO_2) emissions reductions. A typical IAC plant will receive more than $47,000 in annual benefits from each assessment.

Currently located at 24 of the nation's top engineering schools, the IACs combine a traditional engineering curriculum with a unique blend of hands-on experience gained through conducting assessments. Upon graduation, approximately 63 percent of IAC students obtain employment for which energy efficiency or energy management is a significant responsibility.

To sign up for an IAC assessment, please visit *http://iac.university* or contact your nearest center directly.

University of Dayton and University of Kentucky IAC students evaluate the operation of a large reverb aluminum melt furnace located at a smelting facility in Kentucky.

In This Edition

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IAC Program: 4th Quarter Results

During the fourth quarter of FY 2014, the IACs conducted 101 assessments, bring the total for the fiscal year to 460, thereby meeting the annual goal of 350 assessments (see Table 1, below). As a result, IACs made 844 recommendations for increasing energy efficiency, reducing water use and waste, and improving productivity, which identified nearly $18M in potential cost savings. Annual water and waste related savings opportunities increased nearly seven-fold relative to FY 13.

Table 1. Fiscal Year 2014 Quarter 4 Results

Total Assessments	101
Total Recommendations	844
Total Recommended Annual Savings	
Energy Savings	16.2 M Therms
Electricity Savings	120,949,043 kWh
(approx) Generation Reduction	13.81 MegaWatts
Natural Gas Savings	2.5M Therms
CO_2 Reduction	0.11 Tons
TOTAL Cost Savings	$17.92 Million
- Energy Related Savings	$10.58 Million
- Productivity Savings	$1.48 Million
- Waste & Water Savings	$5.85 Million

Plants assessed were located in 28 states (see Figure 1, below). The assessed plants represent a broad range of industries, with plastics and rubber, fabricated metals, machinery, food, and transportation equipment manufacturing being the most common (see Table 2).

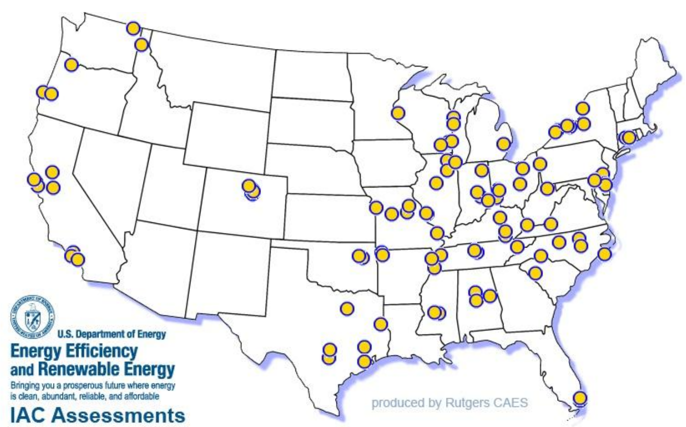

Figure 1. IAC Assessments Nationwide, FY14 Q4

During the quarter, a total of 231 engineering students participated in the IAC program across the 24 centers; nearly 23 percent of the students were new to the program. IACs issued 26 certificates to students meeting all of the certification requirements—raising the annual total to 113 and narrowly missing the aggressive annual goal of 120. These requirements include mastering a number of core skills and participating in at least six assessments.

Table 2. Fiscal Year 2014 Q4 Assessments by NAICS Industrial Category

Industrial Category	Assessments
Food Manufacturing	14
Machinery Manufacturing	13
Transportation Equipment Manufacturing	11
Fabricated Metal Product Manufacturing	10
Wood Product Manufacturing	10
Chemical Manufacturing	7
Plastics and Rubber Products Manufacturing	6
Electrical Equipment Manufacturing	5
Primary Metal Manufacturing	5
Nonmetallic Mineral Product Manufacturing	4
Printing and Related Support Activities	2
Computer and Electronic Product Manufacturing	2
All Other Manufacturing	12

For more detailed IAC metrics and reports, please visit the IAC Forum website located at www.iacforum.org.

IAC Program Highlights

Third Annual IAC Applied Research Awards

The Advanced Manufacturing Office sponsors an annual applied research awards competition to honor exceptional students participating in the IAC program. The program provides students at 24 university-based IACs with hands-on training and real world experience in energy engineering and management.

Each winning IAC received up to $25,000 in additional IAC program funds. The research awards are designed to create incentives for undergraduate and graduate students to pursue assessment-inspired research projects in the areas of manufacturing and industrial energy efficiency. The awards are intended to enhance traditional student-led research efforts and to formally recognize those research proposals that stand out as being exceptional and particularly innovative. This year's four winning student projects include:

- **Substitution of Natural Gas for Electric Industrial Drying: A Cost Saving Strategy** – Danielle Kyser and Karl Stimmel, University of Michigan

  This research investigates (1) the potential for cost savings replacing the electric heaters with natural gas burners, (2) the potential for improvement in the production speed, and (3) how contamination levels of the dry air stream will be affected by the burning of natural gas.

- **Advanced Control Strategies for Variable-Flow Pump Systems** – Alexandra Brogan and Vijay Gopalakrishnan, University of Dayton

  Field studies and research show that few variable-flow systems are optimally controlled and the fraction of actual-to-maximum savings can be as low as 40 percent in poorly-controlled pumping systems. In fact, it is not uncommon to find instances where VSDs actually increase energy use. This research proposes to develop methods to identify and implement opportunities for better control of variable-flow pumping applications. These results will improve pumping system control and result in significant energy savings at minimal additional cost.

- **Pump Impeller Surface Treatment to Reduce Operating Cost** – Dennis Twitty, Sean Rosin and Michael Armstrong, Boise State University

  This research will investigate a new means of reducing pump energy use by modifying the surface properties of a pump impeller creating a surface slip boundary condition reducing friction losses, thereby reducing pump energy use at all speeds of operation.

- **A Novel Method for Non-Intrusive Measurement of Compressed Air Leakage Flow Rates in Industrial Energy Assessments –** Trevor Terrill, Texas A&M University

  The proposed project will develop a novel approach to determine the airflow rate in a compressed air line. The system non-intrusively measures the air flow rate of compressed air due to leaks by analyzing the temperature response of a compressed air line as energy pulses are applied. Dynamic signals are applied to analyze the signals in both the time and frequency domains.

Further information about the IAC program may be found on AMO's webpage.

IAC Support for Water Infrastructure

Delivering sufficient quantities of water of acceptable quality for various human uses requires significant amounts of energy.
This is true for both residential and industrial water use, and the relationship between water and energy applies to the entire spectrum of water infrastructure – from treatment and delivery to ultimate consumption.

IACs have conducted more than 40 assessments at municipal and industrial water supply and wastewater treatment facilities. And while they are not "traditional" IAC assessments in that they do not fall within SIC codes 20 – 39, much of the equipment at these facilities (motors, pumps, compressors, fans) is also present at industrial facilities. Therefore, IACs are qualified to assist water infrastructure facilities to save energy and reduce water use and wastewater generation.

During FY 15, the IACs will work with the EPA Regions to assess an additional 1 - 2 industrial or municipal water supply and wastewater treatment facilities per Center. Several EPA Regions have already expressed interest and are pursuing direct engagement with the IACs to help them identify candidate facilities.

IAC Internships

The relationship between the IAC program and industry has always been strong. Hiring personnel and managers have long recognized the exceptional knowledge and ability demonstrated by IAC students and sought our graduates to fill key positions. This relationship has now expanded to include a formal internship program – now in its second year. Moreover, relative to FY 13, the number of participating companies has increased from five to nine. These companies include: **Armstrong, Eaton, Hudson Technologies, ICF International, Opterra Energy Services, Plug Smart, Schneider Electric, Siemens Building Technologies**, and **ERS**.

The internship program promises challenging and meaningful opportunities for students. Though the application deadline for this year has already passed, the application period will open again in the fall of 2015 for the 2016 internships.

More information about the IAC internship program is available on the IAC Forum website: *http://www.iacforum.org*.

> "The energy assessment report and the recommendations have helped us better understand our systems. It also enabled us to work on projects that have a direct impact on our energy consumption, helping us to lower our energy bills. I am pleased to report that we recently accepted a state grant to improve our chiller/piping system."
> — University of Delaware IAC Client

IAC Alumni Spotlights

Dayton IAC Alumni Oppose SB58

Gregory Raffio, PE, LEED AP BD+C & John Seryak, PE, Alumni, University of Dayton IAC

Ohio's renewable energy portfolio standards (SB221) were passed in 2008. As a result of these standards, investor-owned utilities in Ohio established annual energy efficiency benchmarks and created energy efficiency programs specifically targeted towards their manufacturing customers.

The Ohio Manufacturer's Association (OMA) commissioned a study of the costs and benefits of these standards and concluded that by the year 2020, Ohio's ratepayers would likely receive several billion dollars more in benefits than the projected program costs. These benefits include both direct savings of avoided energy purchases, as well as the benefits of price suppression from lowered electricity demand.

In 2013, Ohio Senate Bill 58 (SB 58) was introduced with the express intent of reviewing the energy efficiency and renewable energy resource standards established by SB 221. However, according to the OMA, SB58 would wipe out $2.5 billion in projected savings from energy efficiency from 2014 through 2020 and drive up electricity costs for manufacturers. In addition, the bill created incentives for the least energy efficient choices that consumers could make, eliminated consumer protections, and drove utility profits to unprecedented levels at the same time.

Many energy engineers were concerned that the bill eschewed ASHRAE 90.1-based building codes and federal appliance standards, and more importantly, counted electricity savings in Btu, instead of kWh. All IAC alumni and students know electrical energy is universally billed by kWh, so why the modification in SB 58? Counting electrical energy in Btu allowed for using the energy conversion rate instead of the heat-rate of the grid, thereby weakening the energy-efficiency standards by two-thirds. This seemingly innocuous provision was severely damaging to energy efficiency interests in Ohio.

In 2014, SB 58 was unable to gain sufficient support to pass the Ohio Senate Public Utilities Committee and the proposed legislation was not brought to the floor for a full chamber vote. The lesson learned from all of this – at least for now – is that energy policy is complex and should be enacted for the benefit of the ratepayers. When these policies have positive effects such as price mitigation, promoting business competitiveness, cleaning the environment, transitioning away from fossil fuels, and creating jobs, they have been successful. This is what Ohio's current standards have achieved.

Technology Spotlights

How to Improve a Regenerative Thermal Oxidizer

The University of Kentucky IAC (KIAC) recently visited a facility with a Regenerative Thermal Oxidizer (RTO). The RTO was being used to burn toxic fumes from a manufacturing process to compounds that were less harmful to the environment, which requires very high temperatures. The RTO encountered by the KIAC team operated at temperatures of approximately 1800°F.

The inlet fumes to the RTO had temperatures of 400 - 600°F, so the temperature differential was around 1200°F. The fumes entered a heating chamber with a fuel burner to raise the temperature of the fumes. As the fumes were heated, chemical reactions occured with the pollutants and oxygen leading to products of CO_2, H_2O, and heat. The resulting byproducts were then exhausted, still at elevated temperatures.

The RTO used two heating chambers, alternating the entry and exit point to use the heat generated by the chemical reactions of the fumes. The air flow is depicted in the image below.

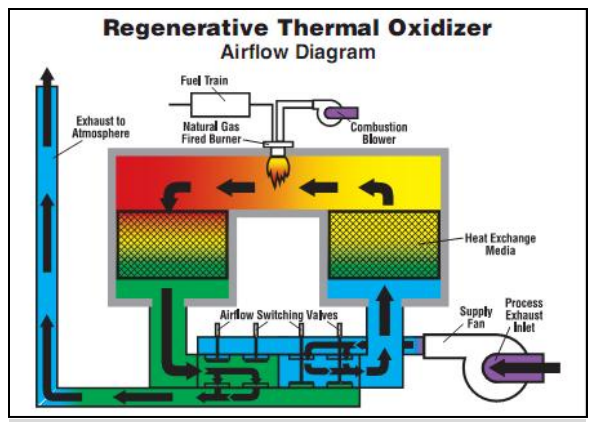

Figure 1: Airflow of an RTO

By taking advantage of the heat released by the fumes, the RTO operated with little to no natural gas input. For example, the facility visited by the KIAC was able to turn off their natural gas burner 70% of the time.

Even though the RTO is very efficient in use of input energy, the nature of its operation is wasteful. The RTO used hot fumes, heated them further to break them down, and then exhausted these hot gases. The exhaust was essentially wasted heat. Estimated heat losses approached 3.5 MMBtu/hr. The IAC team considered a number of options, including using a heat exchanger to preheat boiler feed water; using an adsorption chiller to offset the air conditioning load of the plant; installing a backup steam boiler to assist the steam system of the facility; or installing a small scale steam power plant.

Due to the large amount of heat available, a single solution was likely to exploit only a portion of the wasted heat. Therefore, the IAC team conducted an analysis to capture more of the heat by combining different technologies. The final recommendation included combining a heat exchanger and adsorption chiller.

To analyze the energy available from the waste stream of the RTO and the energy needed for the adsorption chiller and heat exchanger, a high level systematic analysis was performed. The figure below illustrates the energy analysis.

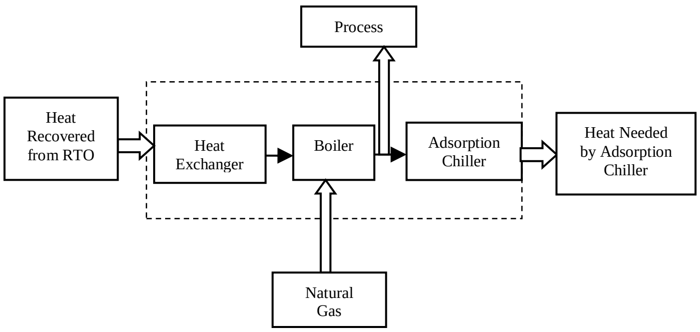

Figure 2: High level energy use analysis

While on site, facility personnel mentioned their interest in using an adsorption chiller to utilize this wasted thermal energy. The idea was to offset the large cooling load of this facility (890 ton with an average of 1.147 kW/ton operating efficiency). By having silica gel as an adsorption media, a low humidity condition is created that causes the water refrigerant to evaporate at a low temperature. Consequently, there is no need for moving parts (fans), resulting in 1 percent of the energy use of typical mechanical chillers.

During the IAC team's review of previous assessments, they noted that a heat exchanger to pre-heat water going to the boiler would be an excellent use for this additional heat, and it would have low implementation costs.

The final recommendation by the IAC was for the facility to install both a heat exchanger on the exhaust of the RTO to pre-heat boiler water and also a 150 ton (cooling capacity) adsorption chiller to work in conjunction with the heat exchanger and boiler system by using the condensate return as a heat source for operation.

This recommendation resulted in a net energy savings of 10,735 MMBtu/yr. Taking into account the natural gas savings from using the heat exchanger to offset boiler energy use and the electricity savings from using the adsorption chiller to reduce the chilled water needs of the plant air conditioning, the total cost savings from the waste heat recovery was almost $140,000/yr. The facility received quotes for the separate systems, which were used for estimating the implementation costs of $342,000, resulting in a simple payback of 2.5 years.

Increasing Chilled Beam Technology

Chilled beams are commonly used in Europe as a result of increased energy awareness through stricter energy standards and the higher cost of energy. However, implementation of chilled beam technology in the US has yet to flourish due to the higher upfront costs over the conventional variable air volume (VAV) system. Unfortunately, because the benefits of chilled beam technology, properly applied, can significantly enhance energy efficiency in new and existing systems while reducing a building's HVAC energy consumption and increasing overall performance.

There are two types of chilled beams that dominate the industry and they are active and passive chilled beams. Both active and passive chilled beams share the similarity of being mounted in or suspended from the ceiling, and operate by running hot or cold water through heating and cooling coils that loop through rows of copper or other thermally conductive material fins that act as an air to water heat exchanger located inside the beam. However, this is where the similarities stop because the two chilled beams are built and operate differently.

Passive chilled beams take advantage of creating natural or free convection. As a result of air stratification and warm air being less dense than cold air, which creates a buoyancy or rising effect of air, the warm air rises into the chilled beam which is then cooled, becoming more dense where it falls to the floor and is slowly heated back up by the room air or other thermal loads. This process repeats itself creating an infinite cooling and heating loop or circle.

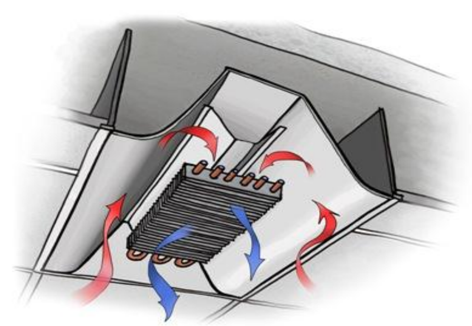

Figure 1: Passive Chilled Beam Design

Active chilled beams also take advantage of natural or free convection, but combine that cooling or heating effect with ductwork that connects and runs through the chilled beam while supplying fresh and cool or warm ventilation air into the room. The increased room airflow as a result of the ventilation air helps force more air up to the chilled beam which makes it better able to handle a room's cooling or heating loads in addition to satisfying fresh air ventilation requirements. Furthermore, because the air handling (AHU) unit only treats fresh ventilation air and not the entire building's cooling load, it can be downsized along with the accompanying ductwork and fan network because the load has been significant reduced.

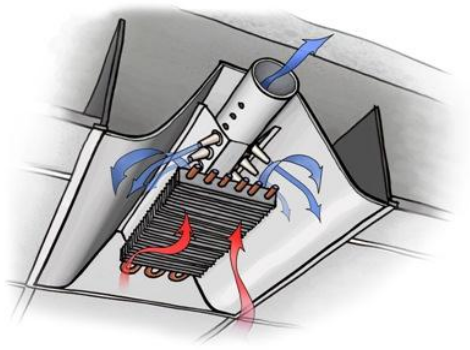

Figure 2: Active Chilled Beam Design

Chilled beams are more efficient than conventional VAV building systems because of the heat storing capacities of air and water. One cubic foot of air at standard temperature and pressure has a heat capacity of 37 J/K, while water has a heat capacity of 20,050 J/K.

Not only is water more efficient at carrying heat, the temperature at which the water runs through the cooling coils in a chilled beam is higher than the temperatures that go into the coils of air handling units. This means the chiller does not have to work as hard to cool the same amount of water, resulting in energy savings.

Beyond energy and reduced construction costs, there are more benefits that accompany chilled beam implementation. They are very quiet and deliver air at lower velocities than VAV systems. They can also be installed in areas where there is not much room in the ceiling as a result of each unit requiring very little duct space and small diameter cold and hot water pipes. This makes them a great option for building retrofit projects. Also, if planned in new building design, ceiling to floor height can be reduced because the size of the supporting mechanical equipment is smaller. The best applications for chilled beams include class rooms, open office buildings, meeting areas, laboratories, libraries, and hospitals.

Recruiter Spotlights

Listed below are corporate profiles of several companies that routinely post positions on the IAC web site and actively recruit IAC students and alumni. For more information on these and other opportunities, see the career section of the IAC Student and Alumni web site: *http://www.iacforum.org/iac/app?service=page/RecruitersCorner.*

Cascade Energy Engineering is a consulting firm specializing in industrial energy efficiency projects. Cascade has offices in Portland, Oregon; the Salt Lake City, Utah area; and Walla Walla, Washington.
Contact Dan Brown, 503-287-8488

NORESCO is one of the nation's most experienced energy service companies, building self-funding energy-efficient infrastructure improvements and renewable energy installations for a wide range of educational, government, commercial, correctional, and industrial customers.
Contact Anthony Sclafani, 508-614-1049

Nenni and Associates is a leading resource in retained and permanent placement recruiting and consulting in the HVAC, energy services, and renewable industry.
Contact David Kelley , 815-899-9421

The Cadmus Group is an environmental consulting firm headquartered in Watertown, Massachusetts.
Contact Lauren Mattison, 617-673-7107

Enovity, Inc. is a sustainability consulting firm that provides customized energy and operational solutions for high performance buildings.
Contact Pamela Boyes, 415-974-0390

CHA is an Engineering News-Record (ENR) Top-100 Engineering Firm and was recognized in 2008 among Zweig White's 100 Hottest Firms in North America.
Contact Jennifer Schembari/Ann Devost, (518) 453-4500

Geo-Marine, Inc. (GMI) has more than 30 years of experience in delivering innovative, cost-effective engineering and environmental services to our clients.
Contact Steve Silva, 817-226-8385

ERS, Inc. is a progressive energy engineering consulting firm based in Haverhill, Massachusetts, with additional offices in New York, Maine, and Texas.
Contact Recruiting, 978-521-2550

Energy Solutions is one of the leading consulting firms in the field, specializing in energy efficiency program design, implementation, and marketing, as well as solar feasibility studies and financing, and water conservation programs.
Contact Kate Merrill, 510-482-4420 x223

Siemens Building Technologies As a leading provider of energy and environmental solutions, building controls, and fire safety and security systems solutions, we make buildings more comfortable, safe, secure, and less costly to operate.
Contact Kristin Junia, 847-215-1000

Elara Engineering ELARA Energy Services, Inc. is a 9 year old Mechanical, Electrical, Plumbing, Fire Protection and Information Technology (MEPFPIT) consulting engineering firm located in Hillside, Illinois.
Contact Caitlin Levitsky, 708-236-0300

Ameresco, Inc. is an independent energy solutions company delivering long-term customer value through innovative systems, strategies, and technologies.
Contact Trish Puopolo, 508-661-2200

Nexant, Inc. is a provider of intelligent grid software and clean energy solutions—pioneering, developing, and advancing electric power grid and alternative energy technologies and services.
Contact Tami Cusi, tcusi@nexant.com

McKinstry Established in 1960, is full service design, build, operate and maintain (DBOM) firm.
Contact Heidi Cunningham, 206-762-3311

Honeywell Building Solutions (HBS) is a strategic business unit in Automation and Control Solutions (ACS).
Contact Ryan Smith, 763.954.5969

Schneider Electric offers integrated solutions across multiple market segments, including leadership positions in energy and infrastructure, industrial processes, building automation, and data centers/networks, as well as a broad presence in residential applications.
Contact Michelle Rouley, 847-925-3694

Ecova delivers proven results for clients looking to reduce their energy use, manage their carbon emissions and make their operations more environmentally sustainable.
Contact Kia Packard, 503-525-2700

Johnson Controls is a global diversified technology and industrial leader serving customers in over 150 countries. Our 130,000 employees create quality products, services and solutions to optimize energy and operational efficiencies for our diverse client base.

EnerNOC is transforming the way the world uses energy. We help commercial, institutional, and industrial organizations use energy more intelligently, pay less for it, and generate cash flow that benefits the bottom line.
Contact Derek Popek, 617-692-2538