Closeout Final Technical Report

Award No. DE-FC36-02GO12093

Award Recipient: University of Dayton

Project Title: Industrial Assessment Center

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Executive Summary

This closeout report summarizes activities accomplished by the University of Dayton Industrial Assessment Center (UD-IAC) under Award No. DE-FC36-02GO12093. The report documents how project objectives to perform energy assessments, train students and support U.S. D.O.E. objecti ves were accomplished. In particular the UD-IAC performed 96 industrial energy assessment days for mid-sized manufacturers. During this period, the average identified and implemented savings on each assessment were $261,080 per year and $54,790 per year. The assessments served as direct training in industrial energy efficiency for 16 UD-IAC students. The assessments also served as a mechanism for the UD-IAC to understand manufacturing energy use and improve upon the science of manufacturing energy efficiency. Specific research results were published in 16 conference proceedings and journals, disseminated in 22 additional invited lectures, and shared with the industrial energy community through the UD-IAC web site.

Objectives and Actual Accomplishments

In May 2002, the University of Dayton responded to Solicitation DE-PS36-02GO92002 with a proposal to perform DOE specified activities for four years. In that proposal, the University of Dayton Industrial Assessment Center (UD-IAC) proposed to:

- Perform 25 on-site assessment days per year for industrial clients in Ohio, northern Kentucky and eastern Indiana. (In contract years, 2004-2005 and 2005-2006 the scope of work was amended to perform 23 assessment days per year.)
- Train graduate and undergraduate students in industrial energy-efficiency, pollution-prevention and lean-manufacturing fundamentals and applications.
- Support the Office of Industrial Technologies (OIT) Industries of the Future (IOF) and Best Practices initiatives through dissemination of software, cooperative agreements and participation in workshops and conferences.

Over the course of the next four years, the UD-IAC:

- Fullfilled the work plan and objectives by performing 25, 25, 23 and 23 assessment days over the four years covered by the work plan. The average identified and implemented savings on each assessment was $261,080 per year and $54,790 per year respectively.

- Fulfilled the work plan and objectives by training 10 graduate students and 6 undergraduate students in industrial energy-efficiency, pollution-prevention and lean-manufacturing fundamentals through direct participation in industrial energy assessments, course work and research.

- Fulfilled the work plan and objectives to support the Office of Industrial Technologies (OIT) Industries of the Future (IOF) and Best Practices initiatives through dissemination of software, cooperative agreements and participation in workshops and conferences by:

    - Teaming with the Ohio Department of Development, Office of Energy Efficiency and the Edison Materials and Technology Center to conduct motor system assessments for local industries and train them in the use of Motor Master.

    - Teaming with AMP-Ohio to conduct assessments for of 20 IOF facilities in support of a grant from the US-DOE.

    - Sending lead students to the IAC student meetings

    - Distributing OIT software and literature to clients.

    - Aiding in the development of U.S. D.O.E. I.T.P. tool QuickPEP.

    - Writing and presenting 16 papers on industrial energy efficiency in national conferences.

    - Delivering 22 invited lectures on industrial energy efficiency to regional trade associations, conferences and meetings.

Project Activities

The goals of the UD-IAC are to:

- Improve manufacturing performance and energy efficiency by providing specific advise to mid-sized manufacturers.
- Educate the next generation of energy efficiency engineers
- Advance the science of industrial energy performance.

In support of these goals the primary activity of the UD-IAC from contract year 2002-2003 to 2005-2006 was to perform 96 industrial energy assessments for mid-sized manufacturers. During this period, the average identified and implemented savings on each assessment were $261,080 per year and $54,790 per year.

The assessments served as direct training in industrial energy efficiency for 16 UD-IAC students. In additional support of education the next generation of energy efficiency engineers, Dr. Kissock developed and taught the following classes:

MEE 420/569 Energy Efficient Buildings
MEE 499/590 Energy Efficient Manufacturing
MEE 471/571 Design of Thermal Systems

The assessments also served as a mechanism for the UD-IAC to understand manufacturing energy use and improve upon the science of manufacturing energy efficiency. Specific research results were presented at conferences, published in conference proceedings and journals, and shared with the industrial energy community through the UD-IAC web site.

Products Developed Under Award

Publications

Specific publications on industrial energy efficiency are listed below.

Inside-out Approach For Identifying Industrial Energy and Waste Reduction Opportunities, Kissock, Hallinan and Bader, Journal of Strategic Planning for Energy and Environment, 2001.

Understanding Manufacturing Energy Use Through Statistical Analysis, Kissock and Seryak, Industrial Energy Technology Conference, Houston, TX, 2004.

Lean Energy Analysis: Identifying, Discovering And Tracking Energy Savings Potential, Kissock and Seryak, Advanced Energy and Fuel Cell Technologies Conference, Society of Manufacturing Engineers, Livonia, MI, 2004.

Productivity and Energy: Challenges and Opportunities For U.S. Manufacturers, Kissock, Ohio Energy Management and Restructuring Conference, Columbus, OH, February 17-18, 2005.

Benchmarking Approaches: An Alternate Method to Determine Best Practice by Examining Plant-Wide Energy Signatures, Patil Y., Seryak, J., and Kissock, K., ACEEE Summer Study on Energy in Industry, West Point, NY, July 19-22, 2005.

Lean Energy Analysis: Guiding Energy Reduction Efforts to Theoretical Minimum Energy Use, Seryak, J. and Kissock, K., ACEEE Summer Study on Energy in Industry, West Point, NY, July 19-22, 2005.

Measuring Industrial Energy Savings, Kissock, K. and Eger, B., Society of Automotive Engineers World Congress and Exposition, Detroit, MI, April 3-6, 2006.

A Hybrid Method For Estimating Natural Lighting Potential In Buildings, Kissock, ASME International Solar Energy Conference, Portland, OR, 2004.

Power Characteristics of Industrial Air Compressors, Schmidt and Kissock, Industrial Energy Technology Conference, Houston, TX, 2003.

Estimating Energy Savings in Compressed Air Systems, Schmidt and Kissock, Industrial Energy Technology Conference, Houston, TX, 2004.

Improving Performance of Compressed Air Systems Through Calibrated Simulation, Schmidt, C., Kissock, K., and Eger, C., ACEEE Summer Study on Energy in Industry, West Point, NY, July 19-22, 2005.

Energy Efficient Process Heating: Managing Air Flow, Carpenter, K. and Kissock, K., Society of Automotive Engineers World Congress and Exposition, Detroit, MI, April 3-6, 2006.

Energy Efficient Process Heating: Insulation and Thermal Mass, Carpenter, K. and Kissock, K., Society of Automotive Engineers World Congress and Exposition, Detroit, MI, April 3-6, 2006.

Quantifying Energy Savings From Improved Boiler Operation, Carpenter, K. and Kissock, K., Industrial Energy Technology Conference, New Orleans, LA, May 11-12, 2005.

Feasibility Study of Fuel Cell Cogeneration in Industry, Phelps, S. and Kissock, J.K., Industrial Energy Technology Conference, Houston, TX. 1997.

UD-IAC Website

The UD-IAC maintains a website at www.engr.udayton.edu/udiac to share information on energy efficiency developed by the UD-IAC with the broader energy efficiency community. The UD-IAC website serves as a reference to IAC students nationwide.

This website contains the following information, which describes important aspects of the services offered by the UD-IAC.

- Overview
- How to Qualify
- Results
- Confidentiality
- Technical Information
- Publications
- Helpful Links
- Contact Us
- UD IAC Team

The Technical Information section of the web site offers information about the following aspects of manufacturing productivity, energy and waste.

- Overview
    - Assessment Organization
    - Utility Bill Analysis
        - Electric Rate Structures For Ohio/Indiana/Kentucky Utilities
    - Assessment Equipment
    - Safety
        - What Not To Do!
    - Economic Analysis: Methods and Examples
    - Inside-Out Approach For Energy and Material Efficiency
    - Lean Energy Analysis
        - LEAThinking and Savings Opportunities

        - Energy Use Breakdowns and Savings Opportunities
        - Energy Use Signatures and Savings Opportunities
        - Energy Use Scatter and Savings Opportunities
        - Tracking Progress and Savings
- Process Descriptions
    - Metal Casting
    - Forging
    - Electroplating
    - Glass
- Energy Systems
    - Electrical Systems
        - Identify Billing Errors
        - Purchase Transformer
        - Correct Power Factor
        - Consolidate Meters
        - Correct Power Quality
        - Acquire Uninterruptible Power
        - Reduce Peak Demand
        - Purchasing Renewable Electricity
    - Lighting Systems
        - Lamp and Ballast Database
        - Fixture CU Database
        - Daylighting Examples
        - Occupancy, Timer and Photo Control Examples
        - Lighting Efficiency Upgrade Examples
        - Miscellaneous Examples
        - External Lighting Links
    - Motor Drive Systems
        - Turn Off When Not in Use
        - Downsize
        - Belt Drives
        - Energy Efficient Motors
    - Compressed Air Systems
        - Fix Leaks
        - Reduce Air Use With Air Saver Nozzles
        - Shutoff Air Use With Solenoid Valves
        - Replace Vortex Tube Cooling with Chilled Water
        - Reduce Air Use in Bag Houses
        - Replace Compressed Air with Blowers
        - Reduce Operating Pressure
        - Compress Outside Air
        - Stage Compressors
        - Reclaim Heat
        - Compressed Air Dryers
    - Fluid Flow Systems
        - Piping Systems
        - Pump Systems
        - Variable Speed Pumping Recommendations
        - Trim Impeller Recommendations
        - Other Pumping Recommendations
        - Duct Systems
        - Fan Systems
        - Variable Speed Fan Recommendations

        - Other Fan System Recommendations
        - Hydraulic Systems

    - Process Heating
        - Insulation
        - Open Tanks
        - Reclaiming Heat
        - Pinch Analysis
        - Steam Traps
        - Boiler Operation
        - Combustion Efficiency
        - Thermal Mass
        - Process Control

    - Process Cooling
        - Once-Through Cooling
        - Cooling Tower Theory
        - Cooling Tower Examples
        - Chiller Optimization
        - Absorption Chillers
        - Mixing
        - Pinch Analysis

    - Heating, Ventilating and Air Conditioning Systems
        - Reduce Outside Air
        - Economizers
        - Radiant Heat
        - Night Setback
        - CAV to VAV
        - Insulation
        - Equipment Upgrade
        - Pilot Lights
        - Heat Reclaim
        - Thermal Storage

    - Combined Heat and Power

- Pollution Prevention
    - Cardboard
    - Cutting Fluids
    - Hazardous Waste
    - Paint and Filters
    - Pallets
    - Sand and Concrete
    - Water and Sewer
    - Other Waste
    - Thermal Oxidizers

- Lean Manufacturing
    - Automation and Productivity
    - Cellular Manufacturing
    - Inventory
    - Material Handling
    - Preventive Maintenance
    - Quality Control
    - Setup and Changeovers

Computer Modeling

Some algorithms used to model energy systems and quantify savings from energy saving retrofits were compliled into software applications that can be downloaded free of charge from the UD-IAC website. The software applications include:

- HeatSim: for modeling heat loss and combustion processes
- CoolSim: for modeling cooling tower performance
- AirSim: for modeling compressed air systems