Web-Based Industrial Energy Management Tool
2009 Version
Software Product ID #1018969

Software Manual, October 2009
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Software Product ID #1018969.
SOFTWARE DESCRIPTION

The Industrial Energy Management Tool (IEMT) is a web-based software resource intended for evaluation of industrial energy-efficiency measures; this user manual covers the 2009 version of IEMT, which was completed in September 2009.

Description

The 2009 version of IEMT covers five industrial market segments: 1) food processing (fruits and vegetables), 2) industrial chemicals, 3) metals fabrication, 4) pharmaceuticals, and 5) plastics and rubber. For each market segment, IEMT contains a list of site-specific questions. Based on user responses to these questions, IEMT provides recommendations for energy-efficiency opportunities that have not yet been implemented. In addition to guidance on energy-efficiency measures, IEMT contains an interactive energy and carbon calculator and an extensive list of energy-efficiency resources (for example, links to manufacturers, trade associations, detailed software tools, and industry reports).

Benefits and Value

The value of IEMT is to help utility marketing and sales representatives identify relevant energy savings opportunities for their industrial customers. Industrial customers understand the connection between energy consumption and economic competitiveness. These customers frequently look to their electric utility for assistance in meeting energy management goals, including advice on emerging technologies that can save energy. There are many resources for evaluating energy-efficiency options, including energy management software tools. However, existing software tools are frequently too complex and cumbersome for busy facility managers to utilize on a regular basis. Feedback from utilities and their industrial customers indicates a need for an easy to use web-based tool that can provide guidance to facility managers on energy-efficiency measures that they might implement, and the magnitude that these measures might have on overall energy consumption. IEMT is intended to fill this gap.

It is anticipated that IEMT will be used by utility personnel to identify energy-efficiency measures that can meet the needs of their industrial customers. Utility personnel can use IEMT to identify appropriate site-specific energy-efficiency measures, and they can also use IEMT to compute expected energy savings and CO₂ emission reductions that will result from these measures. IEMT contains an extensive list of links for energy-efficiency resources, and IEMT can be used as a portal to guide users to a variety of information sources and tools related to improved energy efficiency in industrial applications.
Web-based IEMT is not intended to duplicate existing software products available from the U.S. Department of Energy or other organizations. Rather, IEMT is intended to fill gaps not served by existing web-based tools.

**Platform Requirements**

IEMT has been tested in Firefox (all versions) and Microsoft Internet Explorer (version 6 and above) and therefore should be usable with most web browsers. IEMT is accessible using a web browser on a computer with an active Internet connection with any reasonable connection speed.
ABSTRACT

Electric utilities are aggressively seeking opportunities to help customers reduce energy consumption through implementation of advanced electric technologies and energy management practices. EPRI is committed to helping electric utilities achieve these goals. The Industrial Energy Management Tool (IEMT) is an example of one resource developed by EPRI to help utility personnel and their industrial customers identify and implement energy-efficient technologies.

Several candidate industries were screened, and from this screening process five industrial applications were selected for the 2009 version of IEMT: 1) food processing (fruits and vegetables), 2) industrial chemicals, 3) metals fabrication, 4) pharmaceuticals, and 5) plastics and rubber. These industries were selected, in part, because they are relatively common throughout the United States, and they have relatively high electric energy consumption (potentially good candidates for saving energy). Another reason these industries were selected is that they include a wide cross section of energy-intensive technologies.

For each of the five industrial markets, the following information was developed:

- Survey questions regarding operation of current technology
- Recommendations for energy-efficiency measures (based on answers to survey questions)
- Qualitative ranking of energy-efficiency opportunities (developed for most technologies, but for some technologies there were insufficient data available to prepare a qualitative comparison)

In addition to providing guidance on potential energy-efficiency measures that might be implemented, IEMT includes an energy and CO₂ calculator. This calculator shows energy and CO₂ impacts associated with potential energy-efficiency measures.
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OBJECTIVE AND APPROACH

An alpha version of Industrial Energy Management Tool (IEMT) was completed in March 2008; and a beta version of IEMT was completed in December 2008. The alpha version contained a chapter on food processing (fruits and vegetables), while the beta version added an energy savings and CO\textsubscript{2} emissions reduction calculator and two new chapters: pharmaceuticals, and plastics and rubber. The objective for the 2009 version was to build upon the beta version with two new chapters. Specific goals for the 2009 version included:

- Expand coverage to two new industrial market segments (industrial chemicals and metals fabrication)
- Migrate IEMT web pages from ICF International (Contractor) to EPRI

The purpose of IEMT is to illustrate how energy-efficiency information can be presented, and how energy-efficiency measures can be prioritized. The vision for IEMT is to include numerous industries. However, as a starting point, the 2009 IEMT is built around five industrial segments: 1) food processing (fruits and vegetables), 2) industrial chemicals, 3) metals fabrication, 4) pharmaceuticals, and 5) plastics and rubber.

Industrial customers understand the connection between energy consumption and economic competitiveness. These customers frequently look to their electric utility for assistance in meeting energy management goals, including advice on emerging technologies that can save energy. There are many resources for evaluating energy-efficiency options, including energy management software tools. However, existing software tools are frequently too complex and cumbersome for busy facility managers to use on a regular basis. Feedback from utilities and their industrial customers indicates a need for an easy-to-use web-based tool that can provide guidance to facility managers on energy-efficiency measures that they might implement, and the magnitude that these measures might have on overall energy consumption. IEMT is intended to fill this gap.

Chapter 2 of this user manual provides a summary of the 2009 version development. This chapter covers resources that were used to prepare the content for IEMT, and provides an overview of how the web site is organized. Chapter 3 describes how to use IEMT. This chapter describes features and functionality of the web site, and includes several examples illustrating IEMT use. Chapter 4 describes future expansion and upgrade options for IEMT, and Chapter 5 summarizes resource material.

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Objective and Approach
2 DEVELOPMENT OF THE 2009 VERSION

The beta version of IEMT included an energy savings and CO₂ emissions reduction calculator and covered 1) food processing (fruits and vegetables), 2) pharmaceuticals, and 3) plastics and rubber. The beta IEMT contained contents for 13 process-specific energy-efficiency technology areas and 15 cross-cutting energy-efficiency technology areas. For each of these 28 technology areas, the following information was developed:

- Survey questions regarding the operation of current technology
- Recommendations for energy-efficiency measures (based on answers to survey questions)
- Qualitative ranking of energy-efficiency opportunities within each group

EPRI reviewed the beta version, and comments from this review cycle were used to guide the development of the 2009 version. The decision was to add two industry segments. The first challenge was therefore to identify which two industrial segments to add. To guide the process, ICF first narrowed the selection to the manufacturing sector (NAICS 31-33). Within the manufacturing sector, ICF then reviewed electric energy intensity data and recent reports on energy-efficiency opportunities and advanced technologies. Qualitative criteria that were established to further guide the selection process included the following:

- Relatively high electric energy intensity.
- Numerous remaining opportunities for implementing advanced energy-efficient electric technologies.
- Relatively wide spread applications across the United States.

Several industries met these criteria, and a short list of candidates was prepared. These candidates were reviewed with EPRI, and based on these discussions, the industrial chemicals and metals fabrication industries were selected for inclusion in IEMT.

For perspective, Table 2-1 shows three-digit NAICS codes that contain the five industrial markets in the 2009 version of IEMT. Fruits and vegetables are listed in three separate NAICS categories under 311 (Food Manufacturing), industrial chemicals are listed as Basic Chemical Manufacturing under 325 (Chemical Manufacturing), metals fabrication is listed at the three-digit level (NAICS 332), pharmaceuticals are listed in one NAICS category under 325 (Chemical Manufacturing), and plastics and rubber is listed at the three-digit level (NAICS 326).
Development of the 2009 Version

Table 2-1
NAICS Codes for the Five Industrial Markets in the 2009 Version of IEMT

<table>
<thead>
<tr>
<th>NAICS No.</th>
<th>Manufacturing</th>
</tr>
</thead>
<tbody>
<tr>
<td>311</td>
<td>Food Manufacturing</td>
</tr>
<tr>
<td>3114</td>
<td>Fruit and Vegetable Preserving and Specialty Food Manufacturing</td>
</tr>
<tr>
<td>31142</td>
<td>Fruit and Vegetable Canning, Pickling, and Drying</td>
</tr>
<tr>
<td>311421</td>
<td>Fruit and Vegetable Canning</td>
</tr>
<tr>
<td>325</td>
<td>Chemical Manufacturing</td>
</tr>
<tr>
<td>3251</td>
<td>Basic Chemical Manufacturing</td>
</tr>
<tr>
<td>3254</td>
<td>Pharmaceutical and Medicine Manufacturing</td>
</tr>
<tr>
<td>326</td>
<td>Plastics and Rubber Products Manufacturing</td>
</tr>
<tr>
<td>332</td>
<td>Fabricated Metal Product Manufacturing</td>
</tr>
</tbody>
</table>

For each of the five industrial markets in IEMT, ICF researched energy-efficient technologies and energy management practices. The technologies were divided into two general groups – process specific and cross cutting. Compared to the beta version of the IEMT, the 2009 version expanded the number of technology areas covered from 28 to 35. The expanded coverage included 6 process-specific areas and 1 cross-cutting technology area. The 19 process specific technologies are listed in Table 2-2, and the 16 cross-cutting technologies are listed in Table 2-3.

Each technology area is structured with a series of questions that the user answers on the web pages. The questions have fixed responses (i.e., yes/no radio buttons). Based on user responses to the questions, the tool immediately displays a customized list of recommendations for energy-efficiency measures. In the event the user desires to conduct a more in-depth analysis, IEMT provides suggestions for more comprehensive tools that might be appropriate.

In parallel with conducting research to develop content for IEMT, ICF created a framework for the web-based application. ICF followed internal corporate policies and EPRI guidelines for developing this software framework.
### Table 2-2
Process-Specific Technology Areas Selected for Each Industry

<table>
<thead>
<tr>
<th>Fruits and Vegetables</th>
<th>Industrial Chemicals</th>
<th>Metals Fabrication</th>
<th>Pharmaceuticals</th>
<th>Plastics and Rubber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blanching</td>
<td>Electro-Chemical Processes</td>
<td>Process Heating (Metals Fabrication)</td>
<td>Cleanrooms</td>
<td>Controls</td>
</tr>
<tr>
<td>Concentration</td>
<td>Process Heating (Industrial Chemicals)</td>
<td>Machining</td>
<td>Fume Hoods</td>
<td>Process Cooling</td>
</tr>
<tr>
<td>Drying and Dehydrating</td>
<td>Process Integration (for Heating and Cooling)</td>
<td>Welding</td>
<td></td>
<td>Productivity</td>
</tr>
<tr>
<td>Filtration</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freezing/Cooling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load Reduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frying</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasteurization and Sterilization</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peeling, Slicing, and Dicing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Development of the 2009 Version

#### Table 2-3
Cross-cutting Technology Areas Selected for Each Industry

<table>
<thead>
<tr>
<th>Technology Area</th>
<th>Fruits and Vegetables</th>
<th>Industrial Chemicals</th>
<th>Metals Fabrication</th>
<th>Pharmaceuticals</th>
<th>Plastics and Rubber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Envelope</td>
<td>●</td>
<td>●</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Combined Heat And Power (CHP)</td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Compressed Air Systems</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Electric Power</td>
<td></td>
<td>●</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Energy Management Systems</td>
<td>●</td>
<td>●</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Fans and Blowers</td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>HVAC Systems</td>
<td>●</td>
<td>●</td>
<td></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Insulation</td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Motor Systems</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Pumps</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Refrigeration -- Compressors</td>
<td>●</td>
<td>●</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Refrigeration -- Condensers and Evaporators</td>
<td></td>
<td>●</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Refrigeration – Cooling Water System</td>
<td>●</td>
<td>●</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Refrigeration System Management</td>
<td>●</td>
<td>●</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Waste Heat Recovery for Absorption Chillers</td>
<td></td>
<td>●</td>
<td></td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>
3
USING THE 2009 IEMT

This chapter describes how to install and use IEMT. This chapter is intended to help users understand the features and functionality of IEMT, and to understand what type of energy-efficiency results can be obtained from the using IEMT. Several examples for IEMT energy and carbon calculator are included.

3.1 Installation

Platform Requirements

IEMT has been tested in Firefox (all versions) and Microsoft Internet Explorer (version 6 and above) and therefore should be usable with most web browsers. IEMT is accessible using a web browser on a computer with an active Internet connection with any reasonable connection speed.

Installation of EPRI Software at Client Site

EPRI develops software using a number of third party software products and tools that run on various operating systems and server platforms. Reports from the software industry suggest there are known security issues with some products and systems. EPRI recommends that, if you are using EPRI software, you review its use with your Information Technology (IT) department and their overall strategy to ensure that all recommended security updates and patches are installed as needed in your corporation. If you have any concerns please call the EPRI Customer Assistance Center (CAC) at 1-800-313-3774 (or email askepri@epri.com).

If you experience difficulties accessing the application

If you experience difficulties accessing the application after standard installation on Windows 2000, Windows XP, or Windows Vista, please consult your IT department personnel to have proper access permissions setup for your use. If the problem can not be resolved, please call the EPRI Customer Assistance Center (CAC) at 1-800-313-3774 (or email askepri@epri.com).

3.2 IEMT Content for Five Industrial Market Segments

Figure 3-1 shows the home page. This screen provides a quick introduction to the web-based resource, and lets the user know what applications can be examined and what results can be expected. The 2009 version of IEMT has two major parts: 1) chapters covering the industries (discussed in this section) and 2) energy and carbon calculator (discussed in the next section). The left sidebar menu has links to the industry sector chapters, calculator, other information, and, for convenience, direct links to the cross-cutting technology areas. The “Other Information”
Using the 2009 IEMT

section includes a list of resources (Links), EPRI contact information, a site map (included in Appendix A), and a link to 2009 Version User Manual (this document).

Figure 3-1
Home Page of Industrial Energy Management Tool

Figure 3-2 shows the main page of the food processing (fruits and vegetables) section. All chapter main pages are similar to this one. Each has general introductory information at the top of the page. Below that are the links to the process-specific technology areas (which apply only to fruits and vegetables in this case), and the cross-cutting technology areas. Cross-cutting technology areas may apply to many industrial sectors. At the bottom of the page (not shown) are general comments and links for additional technical information. All links that appear on these pages are repeated in the Links section (accessible from left sidebar menu).
Figure 3-3 shows the questions that are asked for drying and dehydrating, an example of a technology area. These questions are representative of how the questions are structured for all technologies. Typically, there are 5-10 questions addressing specific energy savings opportunities. To help identify the magnitude of potential savings, bar charts are available to assist the user in targeting energy-efficient technologies that will have the largest impact at his specific site. Most technology area pages begin with a bar chart. However, for some technology areas there were insufficient data to develop meaningful bar charts. The data shown in the bar charts are approximate, and often result from energy savings calculations performed for a particular facility. They are intended as qualitative guidance to allow the users to prioritize their search for energy savings opportunities.
Figure 3-3
IEMT Drying and Dehydrating page (in Fruits and Vegetables)

Below the bar chart (Figure 3-3) are the questions that lead to the identification of energy-savings opportunities. If a particular question is answered in a way that indicates that the opportunity has already been pursued, then no recommendation will appear. Otherwise, the selection of the radio button will cause an energy-savings recommendation to appear immediately. Other general suggestions are often included at the bottom of these pages. If the customer has pursued every energy-savings opportunity related to a particular technology, then a congratulatory message will appear, as shown in Figure 3-4.
Figure 3-4
IEMT Drying and Dehydrating page (in Fruits and Vegetables) with “Congratulations” Message

Figure 3-5 shows a portion of the energy-savings recommendations that can be generated under drying and dehydrating within the Fruits and Vegetables chapter. As indicated, the recommendations are typically qualitative in nature.

Figure 3-6 shows the main page of the industrial chemicals section, with process-specific technology areas and cross-cutting technology areas. This chapter has few process-specific technology areas, but many cross-cutting technologies areas. Many of these cross-cutting areas also appeared in the Food Processing chapter. As before, at the bottom of the page (not shown) are general comments and links to additional technical information.

Figure 3-7 shows the main page of the metals fabrication section, with process-specific technology areas and cross-cutting technology areas. This chapter has fewer cross-cutting technology areas than the previous chapters.

Figure 3-8 shows the main page of the pharmaceuticals section, with process-specific technology areas and cross-cutting technology areas. This chapter is similar to the Industrial Chemicals chapter.

Figure 3-9 shows the main page of the plastics and rubber section, with process-specific technology areas and cross-cutting technology areas. This chapter is similar to the Metals Fabrication chapter.
Using the 2009 IEMT

Figure 3-5
IEMT Drying and Dehydrating page (in Fruits and Vegetables) with Energy-Savings Suggestions Shown

Figure 3-6
IEMT Industrial Chemicals Page
Using the 2009 IEMT

Figure 3-7
IEMT Metals Fabrication Page

Figure 3-8
IEMT Pharmaceuticals Page
Figure 3-10 shows the energy and carbon calculator page, which compares the energy consumption and CO₂ emissions for an existing piece of industrial equipment to the new equipment under consideration. The existing industrial equipment can be powered with electricity or natural gas, while the new system is limited to electricity as the primary energy source.
To illustrate the functionality of this calculator, Table 3-1 considers an example where the process controls for a 3,000-kW electric dehydrating machine are upgraded to provide a 20% energy savings. The selection for the primary energy source is “All electric.” The average cost of electricity used in this example is 6 cents per kWh. The annual operations hours are estimated to be 8,000 hours per year, with a 100% load factor.

Note: The yellow buttons in the calculator contain more information to guide users with data entry. For example, the load factor button indicates that the load factor is the ratio of equivalent full load hours (EFLH) to operating hours. The load factor should be used to account for time spent at part-load operation. To put it another way, load factor is the actual energy use expressed as a percentage of the energy use if the equipment were to be operated at full load during all operating hours.
Table 3-1
Energy and Carbon Calculator Example – All-Electric Equipment with Percent Energy Savings Known

<table>
<thead>
<tr>
<th>Input Values</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price of electricity</td>
<td>6</td>
<td>cents / kWh</td>
</tr>
<tr>
<td>Annual operating hours</td>
<td>8,000</td>
<td>hours / year</td>
</tr>
<tr>
<td>Equipment load factor</td>
<td>100</td>
<td>% of operating hours</td>
</tr>
<tr>
<td>CO₂ emission factor for grid electricity</td>
<td>700</td>
<td>lbs of CO₂ / MWh</td>
</tr>
<tr>
<td>Existing equipment – rated electric load</td>
<td>3,000</td>
<td>kW</td>
</tr>
<tr>
<td>New equipment – expected energy savings</td>
<td>20</td>
<td>% of existing energy use</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculated Results (all on an annual basis)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use of existing equipment</td>
<td>24,000,000</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy use of new equipment</td>
<td>19,200,000</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy savings</td>
<td>4,800,000</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy cost of existing equipment</td>
<td>$1,440,000</td>
<td>$ / year</td>
</tr>
<tr>
<td>Energy cost of new equipment</td>
<td>$1,152,000</td>
<td>$ / year</td>
</tr>
<tr>
<td>Energy cost savings</td>
<td>$288,000</td>
<td>$ / year</td>
</tr>
<tr>
<td>CO₂ emissions for existing equipment</td>
<td>8,400</td>
<td>tons / year of CO₂</td>
</tr>
<tr>
<td>CO₂ emissions for new equipment</td>
<td>6,720</td>
<td>tons / year of CO₂</td>
</tr>
<tr>
<td>Reduction in CO₂ emissions</td>
<td>1,680</td>
<td>tons / year of CO₂</td>
</tr>
</tbody>
</table>

Next the user must enter the CO₂ emission factor for the utility serving the plant. The default value shown is 1,314 lbs of CO₂ per MWh, which is the 2005 U.S. national average. The user can get the CO₂ emission factor for their particular utility by following the EPA link in the “more info” button (http://www.epa.gov/cleanenergy/energy-and-you/how-clean.html). A value of 700 lbs of CO₂ per MWh is used for this example.

The calculator accepts energy savings expressed as one of three ways:

- The expected energy savings (% of existing energy consumption)
- The efficiency of the existing and new measure (% and using the higher heating value (HHV) for natural gas)
- The specific energy consumption (kWh of electricity per unit of production or therms of gas per unit of production)
Since the energy savings in the example are expressed in terms of the percentage of energy savings, “energy savings” should be selected. For an all electric application with the energy savings selected, the final two input parameters are the rated electric load of the dryer (3,000 kW) and the percentage of energy savings (20%). After the user clicks on the calculate button, the results immediately appear. Table 3-1 lists nine results, including the annual energy savings, the annual energy cost savings, and the annual reduction in CO₂ emissions.

Note: The calculator does not save or export results. Therefore, users need to print a hard copy to retain results.

The following five tables (Table 3-2 through Table 3-6) provide additional examples of calculator input parameters and corresponding output results.

**Table 3-2**

**Energy and Carbon Calculator Example – All-Electric Equipment with Efficiencies Known**

<table>
<thead>
<tr>
<th>Input Values</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price of electricity</td>
<td>6</td>
<td>cents / kWh</td>
</tr>
<tr>
<td>Annual operating hours</td>
<td>8,000</td>
<td>hours / year</td>
</tr>
<tr>
<td>Equipment load factor</td>
<td>100</td>
<td>% of operating hours</td>
</tr>
<tr>
<td>CO₂ emission factor for grid electricity</td>
<td>700</td>
<td>lbs of CO₂ / MWh</td>
</tr>
<tr>
<td>Existing equipment – rated electric load</td>
<td>3,000</td>
<td>kW</td>
</tr>
<tr>
<td>Existing equipment -- efficiency</td>
<td>75</td>
<td>%</td>
</tr>
<tr>
<td>New Equipment – rated electric load</td>
<td>2,000</td>
<td>kW</td>
</tr>
<tr>
<td>New equipment – efficiency</td>
<td>95</td>
<td>%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculated Results (all on an annual basis)</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use of existing equipment</td>
<td>24,000,000</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy use of new equipment</td>
<td>12,631,579</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy savings</td>
<td>3,368,421</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy cost of existing equipment</td>
<td>$1,440,000</td>
<td>$ / year</td>
</tr>
<tr>
<td>Energy cost of new equipment</td>
<td>$757,895</td>
<td>$ / year</td>
</tr>
<tr>
<td>Energy cost savings</td>
<td>$202,105</td>
<td>$ / year</td>
</tr>
<tr>
<td>CO₂ emissions for existing equipment</td>
<td>8,400</td>
<td>tons / year of CO₂</td>
</tr>
<tr>
<td>CO₂ emissions for new equipment</td>
<td>4,421</td>
<td>tons / year of CO₂</td>
</tr>
<tr>
<td>Reduction in CO₂ emissions</td>
<td>1,179</td>
<td>tons / year of CO₂</td>
</tr>
</tbody>
</table>
Using the 2009 IEMT

### Table 3-3
Energy and Carbon Calculator Example – All-Electric Equipment with Specific Energy Consumption Known

<table>
<thead>
<tr>
<th>Input Values</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price of electricity</td>
<td>6</td>
<td>cents / kWh</td>
</tr>
<tr>
<td>Annual operating hours</td>
<td>8,000</td>
<td>hours / year</td>
</tr>
<tr>
<td>Equipment load factor</td>
<td>100</td>
<td>% of operating hours</td>
</tr>
<tr>
<td>CO₂ emission factor for grid electricity</td>
<td>700</td>
<td>lbs of CO₂ / MWh</td>
</tr>
<tr>
<td>Existing equipment – rated electric load</td>
<td>3,000</td>
<td>kW</td>
</tr>
<tr>
<td>Existing equipment – specific electric use</td>
<td>30</td>
<td>kWh / unit of production</td>
</tr>
<tr>
<td>New Equipment – rated electric load</td>
<td>2,000</td>
<td>kW</td>
</tr>
<tr>
<td>New equipment – specific electric use</td>
<td>20</td>
<td>kWh / unit of production</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculated Results (all on an annual basis)</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use of existing equipment</td>
<td>24,000,000</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy use of new equipment</td>
<td>10,666,667</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy savings</td>
<td>5,333,333</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy cost of existing equipment</td>
<td>$1,440,000</td>
<td>$ / year</td>
</tr>
<tr>
<td>Energy cost of new equipment</td>
<td>$640,000</td>
<td>$ / year</td>
</tr>
<tr>
<td>Energy cost savings</td>
<td>$320,000</td>
<td>$ / year</td>
</tr>
<tr>
<td>CO₂ emissions for existing equipment</td>
<td>8,400</td>
<td>tons / year of CO₂</td>
</tr>
<tr>
<td>CO₂ emissions for new equipment</td>
<td>3,733</td>
<td>tons / year of CO₂</td>
</tr>
<tr>
<td>Reduction in CO₂ emissions</td>
<td>1,867</td>
<td>tons / year of CO₂</td>
</tr>
<tr>
<td>Input Values</td>
<td>Value</td>
<td>Units</td>
</tr>
<tr>
<td>--------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Price of natural gas</td>
<td>1.00</td>
<td>$/ therm</td>
</tr>
<tr>
<td>Price of electricity</td>
<td>6</td>
<td>cents / kWh</td>
</tr>
<tr>
<td>Annual operating hours</td>
<td>8,000</td>
<td>hours / year</td>
</tr>
<tr>
<td>Equipment load factor</td>
<td>100</td>
<td>% of operating hours</td>
</tr>
<tr>
<td>CO₂ emission factor for grid electricity</td>
<td>700</td>
<td>lbs of CO₂ / MWh</td>
</tr>
<tr>
<td>Existing equipment – rated gas load</td>
<td>10</td>
<td>MMBtu/hr</td>
</tr>
<tr>
<td>Existing equipment – ancillary electric load</td>
<td>1.0</td>
<td>kW</td>
</tr>
<tr>
<td>New equipment – expected energy savings</td>
<td>50</td>
<td>% of existing energy use</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculated Results (all on an annual basis, unless noted otherwise)</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated electric load of new equipment</td>
<td>1,466</td>
<td>kW</td>
</tr>
<tr>
<td>Energy use of existing equipment</td>
<td>23,454,659</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy use of new equipment</td>
<td>11,727,329</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy savings</td>
<td>11,727,329</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy cost of existing equipment</td>
<td>$800,480</td>
<td>$ / year</td>
</tr>
<tr>
<td>Energy cost of new equipment</td>
<td>$703,640</td>
<td>$ / year</td>
</tr>
<tr>
<td>Energy cost savings</td>
<td>$96,840</td>
<td>$ / year</td>
</tr>
<tr>
<td>CO₂ emissions for existing equipment</td>
<td>4,686</td>
<td>tons / year of CO₂</td>
</tr>
<tr>
<td>CO₂ emissions for new equipment</td>
<td>4,105</td>
<td>tons / year of CO₂</td>
</tr>
<tr>
<td>Reduction in CO₂ emissions</td>
<td>581</td>
<td>tons / year of CO₂</td>
</tr>
</tbody>
</table>
### Table 3-5
Energy and Carbon Calculator Example – Natural Gas Fired Equipment with Efficiencies Known

<table>
<thead>
<tr>
<th>Input Values</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price of natural gas</td>
<td>1.00</td>
<td>$/ therm</td>
</tr>
<tr>
<td>Price of electricity</td>
<td>6</td>
<td>cents / kWh</td>
</tr>
<tr>
<td>Annual operating hours</td>
<td>8,000</td>
<td>hours / year</td>
</tr>
<tr>
<td>Equipment load factor</td>
<td>100</td>
<td>% of operating hours</td>
</tr>
<tr>
<td>CO₂ emission factor for grid electricity</td>
<td>700</td>
<td>lbs of CO₂ / MWh</td>
</tr>
<tr>
<td>Existing equipment – rated gas load</td>
<td>10</td>
<td>MMBtu/hr</td>
</tr>
<tr>
<td>Existing equipment – gas efficiency</td>
<td>80</td>
<td>% (of higher heating value or HHV)</td>
</tr>
<tr>
<td>Existing equipment – ancillary electric load</td>
<td>1.0</td>
<td>kW</td>
</tr>
<tr>
<td>New equipment – electric load</td>
<td>2,000</td>
<td>kW</td>
</tr>
<tr>
<td>New equipment – electric efficiency</td>
<td>200</td>
<td>%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculated Results (all on an annual basis)</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use of existing equipment</td>
<td>23,454,659</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy use of new equipment</td>
<td>6,400,000</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy savings</td>
<td>9,608,000</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy cost of existing equipment</td>
<td>$800,480</td>
<td>$ / year</td>
</tr>
<tr>
<td>Energy cost of new equipment</td>
<td>$384,000</td>
<td>$ / year</td>
</tr>
<tr>
<td>Energy cost savings</td>
<td>$162,400</td>
<td>$ / year</td>
</tr>
<tr>
<td>CO₂ emissions for existing equipment</td>
<td>4,686</td>
<td>tons / year of CO₂</td>
</tr>
<tr>
<td>CO₂ emissions for new equipment</td>
<td>2,240</td>
<td>tons / year of CO₂</td>
</tr>
<tr>
<td>Reduction in CO₂ emissions</td>
<td>959</td>
<td>tons / year of CO₂</td>
</tr>
</tbody>
</table>
### Table 3-6
Energy and Carbon Calculator Example – Natural Gas Fired Equipment with Specific Energy Consumption Known

<table>
<thead>
<tr>
<th>Input Values</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price of natural gas</td>
<td>1.00</td>
<td>$/ therm</td>
</tr>
<tr>
<td>Price of electricity</td>
<td>6</td>
<td>cents / kWh</td>
</tr>
<tr>
<td>Annual operating hours</td>
<td>8,000</td>
<td>hours / year</td>
</tr>
<tr>
<td>Equipment load factor</td>
<td>100</td>
<td>% of operating hours</td>
</tr>
<tr>
<td>CO₂ emission factor for grid electricity</td>
<td>700</td>
<td>lbs of CO₂ / MWh</td>
</tr>
<tr>
<td>Existing equipment – rated gas load</td>
<td>10</td>
<td>MMBtu/hr</td>
</tr>
<tr>
<td>Existing equipment – specific gas use</td>
<td>1.0</td>
<td>therms / unit of production</td>
</tr>
<tr>
<td>Existing equipment – ancillary electric load</td>
<td>1.0</td>
<td>kW</td>
</tr>
<tr>
<td>New equipment – electric load</td>
<td>2,000</td>
<td>kW</td>
</tr>
<tr>
<td>New equipment – specific electric use</td>
<td>12</td>
<td>kWh / unit of production</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculated Results (all on an annual basis)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use of existing equipment</td>
<td>23,454,659</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy use of new equipment</td>
<td>6,551,040</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy savings</td>
<td>9,456,960</td>
<td>kWh / year</td>
</tr>
<tr>
<td>Energy cost of existing equipment</td>
<td>$800,480</td>
<td>$ / year</td>
</tr>
<tr>
<td>Energy cost of new equipment</td>
<td>$393,062</td>
<td>$ / year</td>
</tr>
<tr>
<td>Energy cost savings</td>
<td>$153,338</td>
<td>$ / year</td>
</tr>
<tr>
<td>CO₂ emissions for existing equipment</td>
<td>4,686</td>
<td>tons / year of CO₂</td>
</tr>
<tr>
<td>CO₂ emissions for new equipment</td>
<td>2,293</td>
<td>tons / year of CO₂</td>
</tr>
<tr>
<td>Reduction in CO₂ emissions</td>
<td>906</td>
<td>tons / year of CO₂</td>
</tr>
</tbody>
</table>
4
FUTURE DEVELOPMENT

The 2009 version of the Industrial Energy Management Tool (IEMT) has been developed such that it can be easily expanded to other industrial market segments. The next release of IEMT could cover several new industrial segments, and a few of the possibilities include:

- Automotive manufacturing
- Glass (or perhaps all Nonmetallic Mineral Product Manufacturing)
- Breweries
- Ethanol and biofuels production (including corn wet milling)
- Cement

It is also possible that the coverage will be expanded to include other types of content within each section. For example, IEMT could include content that emphasizes the carbon benefits of the energy-efficiency alternatives (in addition to the results shown in the carbon calculator). Other possibilities for expanding the content within each section would be to include data on the following topics:

- Market size
- Competing technologies
- Trends

Calculator upgrades are another possibility for IEMT. Upgrades might include:

- Incorporate more complex rate structures that include electric demand (kW) charges. The 2009 version of the IEMT is configured to calculate economics based only on average annual energy charges (i.e., $/kWh).
- Insert graphical output, such as bar charts, to illustrate the difference between energy use or carbon emissions before and after the efficiency measure is implemented.
- Add the ability to save and/or download data files.
REFERENCES AND ADDITIONAL RESOURCES

The bibliography section of this user manual provides references for reports and websites that were consulted for this project. This bibliography lists websites with links to several software tools that have been developed and made available by the U.S. Department of Energy (DOE) and other organizations. These software tools were reviewed, and one common theme is that many of the tools are focused on a single technology (e.g., pumps, air compressors, furnaces, etc.). Some tools do take a more general approach and encompass multiple end-use equipment types found throughout an industrial plant. However, these more detailed tools can be complex to use or require a substantial amount of energy audit data that may not be readily available. Also, it was noted that most of the software resources were delivered as standalone applications (i.e., delivered on CD or as web downloads), not interactive web-based resources.

References that were consulted during the development of the Industrial Energy Management Tool (IEMT) are listed in Section 5.1. Reports are listed alphabetically by the organization that published the information, and conference papers are listed alphabetically by conference sponsor. Websites that were consulted are shown in Section 5.2. Websites that are linked from within the 2009 website are listed in Section 5.3.

5.1 Literature Consulted


References and Additional Resources


5.2 Websites

- **Carbon Trust**, Carbon Trust Good Practice Guides, [http://www.carbontrust.co.uk/publications/](http://www.carbontrust.co.uk/publications/)
- **Department of Energy**, AIRMaster+, [http://www1.eere.energy.gov/industry/bestpractices/software.html#air](http://www1.eere.energy.gov/industry/bestpractices/software.html#air)
- **Department of Energy**, Chilled Water System Analysis Tool (CWSAT), [http://www1.eere.energy.gov/industry/bestpractices/software.html#cwsat](http://www1.eere.energy.gov/industry/bestpractices/software.html#cwsat)
- **Department of Energy**, Combined Heat and Power Application Tool (CHP), [http://www1.eere.energy.gov/industry/bestpractices/software.html#chp](http://www1.eere.energy.gov/industry/bestpractices/software.html#chp)
- **Department of Energy**, Fan System Assessment Tool (FSAT), [http://www1.eere.energy.gov/industry/bestpractices/software.html#fsat](http://www1.eere.energy.gov/industry/bestpractices/software.html#fsat)
- **Department of Energy**, MotorMaster+, [http://www1.eere.energy.gov/industry/bestpractices/software.html#mm](http://www1.eere.energy.gov/industry/bestpractices/software.html#mm)
- **Department of Energy**, NOx and Energy Assessment Tool (NxEAT), [http://www1.eere.energy.gov/industry/bestpractices/software.html#nox](http://www1.eere.energy.gov/industry/bestpractices/software.html#nox)
- **Department of Energy**, Plant Energy Profiler (PEP) for the Chemical Industry, [http://www1.eere.energy.gov/industry/bestpractices/software.html#Plant_Energy_Profiler](http://www1.eere.energy.gov/industry/bestpractices/software.html#Plant_Energy_Profiler)
- **Department of Energy**, Process Heating Assessment and Survey Tool (PHAST), [http://www1.eere.energy.gov/industry/bestpractices/software.html#phast](http://www1.eere.energy.gov/industry/bestpractices/software.html#phast) and [http://www1.eere.energy.gov/industry/bestpractices/phast.html](http://www1.eere.energy.gov/industry/bestpractices/phast.html)
- **Department of Energy**, Pumping System Assessment Tool 2004 (PSAT), [http://www1.eere.energy.gov/industry/bestpractices/software.html#psat](http://www1.eere.energy.gov/industry/bestpractices/software.html#psat)
- **Department of Energy**, Quick PEP Software Tool, [http://www1.eere.energy.gov/industry/bestpractices/quickpep_tool.html](http://www1.eere.energy.gov/industry/bestpractices/quickpep_tool.html)
- **Department of Energy**, Steam System Tool Suite, [http://www1.eere.energy.gov/industry/bestpractices/software.html#ssat](http://www1.eere.energy.gov/industry/bestpractices/software.html#ssat)
- **Electrochemical Society**, Industrial Electrolysis and Electrochemical Engineering, [http://www.electrochem.org/dl/interface/spr/spr06/spr06_p52-54.pdf](http://www.electrochem.org/dl/interface/spr/spr06/spr06_p52-54.pdf)
5.3 Links Included in IEMT, Sorted By Topic

The following links can provide additional information for those interested in industrial plant energy efficiency measures for electric technologies.

Calculators

- Best Practices Software Tools [link to http://www1.eere.energy.gov/industry/bestpractices/software.html] developed by the U.S. DOE Industrial Technologies Program
- CoolCalifornia.org website with Carbon Footprint calculator along with additional tools and resources to help users reduce their carbon footprint [link to http://www.coolcalifornia.org/index.html]
- Find a Qualified Specialist [link to http://apps1.eere.energy.gov/industry/bestpractices/qualified_specialists/] trained in U.S. DOE Best Practices assessment and analysis software tools
- Fan System Assessment Tool (FSAT) [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#fsat]
- Lean and Energy Toolkit [link to http://www.epa.gov/lean/energytoolkit/ch2.htm]
References and Additional Resources

- **NOx and Energy Assessment Tool (NxEAT)** [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#nox] for the petroleum refining and chemical industries
- **Plant Energy Profiler (PEP)** for the Chemical Industry (ChemPEP Tool) [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#Plant_Energy_Profiler]
- **Process Heating Assessment and Survey Tool (PHAST)** [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#phast]
- **Pumping System Assessment Tool (PSAT) 2008** [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#psat] developed by the U.S. DOE Industrial Technologies Program for high-level energy plant energy assessments

**Food Processing -- Fruits and Vegetables**

- **Energy Star** -- Focus on Energy Efficiency in the Food Processing Industry [link to http://www.energystar.gov/index.cfm?c=in_focus.bus_food_proc_focus]
- **Flex Your Power** [link to http://www.fypower.org/bpg/index.html?b=food_and_bev] best practice guide for food and beverage growers and processors
- **Food Engineering** [link to http://www.foodengineeringmag.com/]
- **Food Production Daily** [link to http://www.foodproductiondaily.com/]
- **Energy Efficiency Improvement and Cost Saving Opportunities for the Fruit and Vegetable Processing Industry** [link to http://repositories.cdlib.org/lbnl/LBNL-59289-Revision/]

**Industrial Chemicals**

- **ATLAS Project** on energy research and technological developments [link to http://ec.europa.eu/energy/atlas/html/industry.html]
- **Carbon Trust Good Practice Guides** [link to http://www.carbontrust.co.uk/publications/]
- **Electrochemical Process Technology in the Textile Industry** [link to http://www.industryhk.org/english/fp/fp_hki/files/HKI_03_09_textile_e.pdf]
- **Energy Efficiency Improvement and Cost Saving Opportunities for the Petrochemical Industry** [link to http://repositories.cdlib.org/lbnl/LBNL-964E/]
- **Energy Use and Energy Intensity of the U.S. Chemical Industry** [link to http://repositories.cdlib.org/lbnl/LBNL-44314/]
- **Industrial Electrolysis And Electrochemical Engineering** [link to http://www.electrochem.org/dl/interface/spr/spr06/spr06_p52-54.pdf]

• Journal of the Electrochemical Society [link to http://scitation.aip.org/JES/]

• Process Heating Assessment and Survey Tool (PHAST) [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#phast]

• Process Heating Best Practices [link to http://www1.eere.energy.gov/industry/bestpractices/process_heat.html]

• Source Book for Process Heating [link to http://www1.eere.energy.gov/industry/bestpractices/techpubs_process_heating.html]

• U.S. Department of Energy’s Save Energy Now program [link to http://www1.eere.energy.gov/industry/saveenergynow/assessments.html]

### Metals Fabrication

• ComedCare Metal Fabrication Tips [link to http://www.comed.com/businesssavings/tips/byindustry/industrial.htm]


• Fabricated Metal Product Manufacturing [link to http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/fabmetsn.pdf]


• Lincoln Electric [link to http://www.lincolnelectric.com/knowledge/articles/content/inverter.asp]

• Miller Welds [link to http://www.millerwelds.com/education/articles/articles31.html]

• Process Heating Best Practices [link to http://www1.eere.energy.gov/industry/bestpractices/process_heat.html]

• Source Book for Process Heating [link to http://www1.eere.energy.gov/industry/bestpractices/techpubs_process_heating.html]
References and Additional Resources

**Pharmaceuticals**
- **Energy Efficiency Improvement and Cost Saving Opportunities for the Pharmaceutical Industry** [link to http://repositories.cdlib.org/lbnl/LBNL-57260-Revision/]

**Plastics and Rubber**
- DOE Industrial Technologies Program Best Practices for Plastics Manufacturing [link to http://www1.eere.energy.gov/industry/bestpractices/iac_tools_and_publications.html]
- Improving Energy Efficiency at Plastics Manufacturing Plants [link to http://www.nrel.gov/docs/fy05osti/37791.pdf]
- IDES [link to http://www.ides.com/default.asp] for plastic materials information

**Building Envelope**
- Efficient Windows Collaborative [link to http://www.efficientwindows.org/]

**Combined Heat and Power (CHP)**
- DOE CHP Technologies [link to http://www.eere.energy.gov/de/chp/chp_technologies/]
- DOE CHP Applications [link to http://www.eere.energy.gov/de/chp/chp_applications/]
- DOE Combined Heat and Power Application Tool (CHP) [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#chp]
- EPA CHP Partnership [link to http://www.epa.gov/CHP/basic/efficiency.html]
- Midwest CHP Application Center Evaluation Tools [link to http://www.chpcentermw.org/10-00_tools.html]
Compressed Air Systems

- AIRMaster+ [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#air]
- Compressed Air Challenge [link to http://www.compressedairchallenge.org/]

Electric Power

- Carbon Trust Good Practice Guides [link to http://www.carbontrust.co.uk/publications/] -- find CTG007 -- Power Factor Correction Technology Guide
- EC&M Magazine [link to http://ecmweb.com/]
- Phase Converter Info [link to http://www.phaseconverterinfo.com/]
- Power Factor Correction: A Guide For The Plant Engineer [link to http://centralvalleykvar.com/hammerPOWERFACTORCV.pdf]

Energy Management Systems

- Building and Plants [link to http://www.energystar.gov/index.cfm?c=business.bus_index]
- Energy Star for Industry [link to http://www.energystar.gov/industry]
- Industrial Assessment Centers (IAC) [link to http://www1.eere.energy.gov/industry/bestpractices/iacs.html]
- Industrial Assessment Centers (IAC) Database [link to http://iac.rutgers.edu/database/index.php]
- ISO 14001 program [link to http://www.iso.org/iso/iso_catalogue/management_standards/iso_9000_iso_14000.htm]

Electrochemical Processes

References and Additional Resources

- Industrial Electrolysis And Electrochemical Engineering [link to http://www.electrochem.org/dl/interface/spr/spr06/spr06_p52-54.pdf]
- Journal of the Electrochemical Society [link to http://scitation.aip.org/JES/]

Fans and Blowers

- Carbon Trust Good Practice Guides [link to http://www.carbontrust.co.uk/publications/] and see GPG 383: Energy Savings in Fans and Fan Systems
- Fan System Assessment Tool (FSAT) [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#fsat]

HVAC Systems

- Chilled Water System Analysis Tool (CWSAT) [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#cwsat]
- Fan System Assessment Tool (FSAT) [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#fsat]
- Federal income tax incentives [link to http://www.energystar.gov/index.cfm?c=products.pr_tax_credits&s8] for upgrading HVAC system efficiency

Insulation

- 3E Plus® industrial insulation tool [link to http://www.pipeinsulation.org/index.html]
- Efficient Windows Collaborative [link to http://www.efficientwindows.org/]
Lighting Systems

- Daylighting Collaborative [link to http://www.daylighting.org/], led by the Energy Center of Wisconsin
- Federal income tax incentives [link to http://www.energystar.gov/index.cfm?c=products.pr_tax_credits#s8] for upgrading lighting efficiency

Machining


Motor Systems

- Motor Decisions Matter [link to http://www.motorsmatter.org/]
- MotorMaster+ [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#mm]
- MotorMaster+ International [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#imssa]
- Motors, Pumps, and Fans [link to http://www1.eere.energy.gov/industry/bestpractices/motors.html]
- National Electrical Manufacturers Association (NEMA) [link to http://www.nema.org/]

Process Cooling

- Chilled Water System Analysis Tool (CWSAT) [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#cwsat]
- Fan System Assessment Tool (FSAT) [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#fsat]
- International Institute of Refrigeration [link to http://www.iifiir.org/en/]
- Optimizing Load Sharing [link to http://www.ecw.org/prod/334-1.pdf]

Process Heating (Industrial Chemicals)

- DOE Industrial Technologies Program Source Book for Process Heating [link to http://www1.eere.energy.gov/industry/bestpractices/techpubs_process_heating.html]
References and Additional Resources

- **Process Heating Assessment and Survey Tool (PHAST)** [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#phast]

**Process/Industrial Heating**

- Energy Efficiency Improvement and Cost Saving Opportunities for the Petrochemical Industry [link to http://repositories.cdlib.org/lbnl/LBNL-964E/]
- Process Heating Assessment and Survey Tool (PHAST) [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#phast]
- Source Book for Process Heating [link to http://www1.eere.energy.gov/industry/bestpractices/techpubs_process_heating.html].

**Process Heating (Metals Fabrication)**

- ComedCare Metal Fabrication Tips [link to http://www.comed.com/businesssavings/tips/byindustry/industrial.htm]
- Source Book for Process Heating [link to http://www1.eere.energy.gov/industry/bestpractices/techpubs_process_heating.html].]
**Process Integration**

- **ATLAS Project** on energy research and technological developments [link to http://ec.europa.eu/energy/atlas/html/industry.html]
- **Carbon Trust Good Practice Guides** [link to http://www.carbontrust.co.uk/publications/] and see Good Practice Guide 225: Industrial cooling water systems and Good Practice Guide 141: Waste heat recovery in the process industries.
- **Energy Efficiency Improvement and Cost Saving Opportunities for the Petrochemical Industry** [link to http://repositories.cdlib.org/lbnl/LBNL-964E/]
- **Energy Use and Energy Intensity of the U.S. Chemical Industry** [link to http://repositories.cdlib.org/lbnl/LBNL-44314/]
- **U.S. Department of Energy’s Save Energy Now program** [link to http://www1.eere.energy.gov/industry/saveenergynow/assessments.html]

**Pumps**

- **Pumping System Assessment Tool** (PSAT) 2008 [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#psat]

**Refrigeration**

- **Chilled Water System Analysis Tool** (CWSAT) [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#cwsat]
- **Fan System Assessment Tool** (FSAT) [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#fsat]
- **International Institute of Refrigeration** [link to http://www.iifiir.org/en/]
- **Optimizing Load Sharing** [link to http://www.ecw.org/prod/334-1.pdf]

**Steam Systems**

- **Steam System Tool Suite** [link to http://www1.eere.energy.gov/industry/bestpractices/software.html#ssat]

**Waste Heat Recovery for Absorption Chillers**

- **Thermally-Activated Technologies** [link to http://www.eere.energy.gov/de/thermallyActivated/techBasics.html]

**Welding**

- **Efficient Process Heating in the Aluminum Industry** [link to http://www1.eere.energy.gov/industry/aluminum/pdfs/process_heating.pdf]
References and Additional Resources

- **Lincoln Electric** [link to http://www.lincolnelectric.com/knowledge/articles/content/inverter.asp]
- **Miller Welds** [link to http://www.millerwelds.com/education/articles/articles31.html].

**Whole Buildings**

- **Building Upgrade Manual** [link to http://www.energystar.gov/ia/business/BUM.pdf]
- **Cal-Arch online Commercial Building Energy Benchmarking Tool** [link to http://poet.lbl.gov/cal-arch/index.html]
- **Efficient Windows Collaborative** [link to http://www.efficientwindows.org/]
- **Lawrence Berkeley National Laboratory’s Energy Benchmarking For Homes, Commercial Buildings And Industrial Applications** [link to http://energybenchmarking.lbl.gov/]
- **Links to Other Software Tools at Cal-Arch** [link to http://poet.lbl.gov/cal-arch/links.html]

**Other Information**

- **Best Practices Software Tools** [link to http://www1.eere.energy.gov/industry/bestpractices/software.html] developed by the U.S. DOE Industrial Technologies Program
- **Carbon Trust Good Practice Guides** [link to http://www.carbontrust.co.uk/publications/]
- **Find a Contractor** [link to http://www.nationalcontractors.com/submit_job.html]
- **Find a Qualified Specialist** [link to http://apps1.eere.energy.gov/industry/bestpractices/qualified_specialists/] trained in U.S. DOE Best Practices assessment and analysis software tools
- **Labs21®** [link to http://www.labs21century.gov/index.htm]
A

SITE MAP OF INDUSTRIAL ENERGY MANAGEMENT TOOL

The following is the site map of the 2009 version of the Industrial Energy management Tool (IEMT):

• Industrial Energy Management Tool
• Energy and Carbon Savings Calculator
• Industry Segments
  • Food Processing -- Fruits and Vegetables
    • Process-Specific Technologies
      • Blanching
      • Concentration
      • Drying and Dehydrating
      • Filtration
      • Freezing/Cooling Load Reduction
      • Frying
      • Pasteurization and Sterilization
      • Peeling, Slicing, and Dicing
    • Cross-Cutting Technologies
      • Building Envelope
      • Compressed Air Systems
      • Energy Management Systems
      • HVAC systems
      • Lighting
      • Motor Systems
      • Pumps
      • Refrigeration
        • Compressors
SITE MAP OF INDUSTRIAL ENERGY MANAGEMENT TOOL

- Condensers and Evaporators
- Cooling Water System
- System Management
- Waste Heat Recovery for Absorption Chillers

- Industrial Chemicals
  - Process-Specific Technologies
    - Electrochemical Processes
    - Process Heating (Industrial Chemicals)
    - Process Integration
  - Cross-Cutting Technologies
    - Building Envelope
    - Combined Heat and Power (CHP)
    - Compressed Air Systems
    - Electric Power
    - Energy Management Systems
    - Fans and Blowers
    - HVAC Systems
    - Insulation
    - Lighting
    - Motor Systems
    - Pumps
    - Refrigeration
      - Compressors
      - Condensers and Evaporators
      - Cooling Water System
      - System Management

- Metals Fabrication
  - Process-Specific Technologies
    - Process Heating (Metals Fabrication)
    - Machining
    - Welding
- Cross-Cutting Technologies
  - Compressed Air Systems
  - Fans and Blowers
  - Insulation
  - Lighting
  - Motor Systems
  - Pumps
  - Waste Heat Recovery for Absorption Chillers
- Pharmaceuticals
  - Process-Specific Technologies
    - Cleanrooms
    - Fume Hoods
- Cross-Cutting and Utility Technologies
  - Building Envelope
  - Combined Heat and Power (CHP)
  - Compressed Air Systems
  - Energy Management Systems
  - HVAC systems
  - Lighting
  - Motor Systems
  - Pumps
  - Refrigeration
    - Compressors
    - Condensers and Evaporators
    - Cooling Water System
    - System Management
  - Waste Heat Recovery for Absorption Chillers
- Plastics and Rubber
  - Process-Specific Technologies
    - Controls
    - Process Cooling (Plastics and Rubber)
SITE MAP OF INDUSTRIAL ENERGY MANAGEMENT TOOL

- Productivity
- Cross-Cutting and Utility Technologies
  - Compressed Air Systems
  - Electric Power
  - HVAC systems
  - Insulation
  - Lighting
  - Motor Systems
- Other Information
  - Links
  - Contacts
  - Site Map
  - Documentation