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U.S. DEPARTMENT OF ENERGY

Saving Energy: A QuickStart Guide for Small to Medium Manufacturers

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U.S. DEPARTMENT OF ENERGY

Authors and Acknowledgements

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Primary authors for this report are Eli Levine of the U.S Department of Energy's Advanced Manufacturing Office in Washington D.C. and Kristina Armstrong, Christopher Price, Alexandra Botts, Paulomi Nandy, Thomas Wenning and Sachin Nimbalkar of the Energy and Transportation Science Division, ORNL, Oak Ridge, TN, USA.

The efforts of the following contributors are appreciated for their review and suggestions for this guidance:

- Leslie Jones, ICF
- R. Bruce Lung, DOE, Advanced Manufacturing Office
- Clifton Yin, ICF

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Introduction

More than one-third of the energy consumed in the United States (more than $200B a year) is used to power our manufacturing plants and industrial factories.[1] This number is even greater when we factor in energy used to transport the produced goods. While manufacturing operations are amongst the most energy-intensive in the U.S., there exists great potential for improving their energy performance. That's important, because for the manufacturing sector, not addressing energy use can hurt it's competitiveness in world markets. However, for many small to medium-sized manufacturers, acknowledging this may not in and of itself spur action; it can be intimidating to know how to tackle driving energy savings, especially without a large budget or bandwidth.

This is important because most manufacturing companies in the U.S. are considered to be small. According to the 2017 U.S. Census Bureau, 244,125 out of all 248,039 firms were categorized as small (i.e., having fewer than 500 employees). 75% of these manufacturers had fewer than 20 employees.[2] Small to medium sized manufacturers pay significantly higher prices for their energy and tend to have tighter cash flow, so they do not have the buying power or access to purchasing options of large firms.[3]

This document aims to serve as a "quick-start guide" to energy efficiency for small and medium manufacturers. The US Department of Energy's (DOE) Better Plants Program is partnering with US manufacturers and water/wastewater treatment utilities of all sizes to improve energy efficiency and competitiveness in the industrial sector, while helping industrial companies save money in the process.

Better Plants has partnered with nearly 250 organizations, representing over 3,000 plants, from all across the country. Many of these are small and medium manufacturers. As a voluntary program with no-cost to participate, Better Plants tries to help the industrial community set and achieve ambitious energy reduction goals. By joining Better Plants, partners gain access to a wide range of technical resources designed to help build energy management programs, develop an energy baseline, identify energy efficiency projects, quantify energy savings, and develop a culture of energy awareness.

What will this guide do?

- Explain why energy management is important and achievable for all organizations – not just well-resourced large organizations.
- Connect you to tools and resources available through the Department of Energy (DOE) that will help small to medium manufacturers drive energy savings and sustain progress.
- Provide a list of common energy efficiency opportunities for energy-consuming systems, such as steam, process heating, and motor driven systems.

[1] U.S. EIA (2020) Annual Energy Outlook 2020 https://www.eia.gov/outlooks/aeo/pdf/AEO2020%20Industrial.pdf

[2] Facts About Manufacturing, National Association of Manufacturers https://www.nam.org/facts-about-manufacturing/

[3] Daniel Trombley, One Small Step for Energy Efficiency: Targeting Small and Medium-Sized Manufacturers, American Council for an Energy-Efficient Economy, January 2014 https://www.aceee.org/sites/default/files/publications/researchreports/ie1401.pdf

Why Should Small and Medium-Sized Manufacturers Care About Saving Energy?

Every manufacturing plant, no matter how big or small, rural or urban, uses energy -- which adds to the cost of production. Not trying to control your energy use is like paying your taxes and then opting to throw in additional funds for good measure, or over-buying raw material just to be on the safe side. Manufacturers of all shapes and sizes have the potential for energy-driven productivity gains, and these gains do not only benefit the company in the form of lower energy bills. Driving energy savings is vital to driving manufacturing competitiveness. Energy efficiency leads to productivity.

Simply put, manufacturing plants not optimizing their energy use will forgo additional opportunities beyond energy savings. As The National Association of Manufacturers (NAM) explained,

> The very activities that provide energy efficiency also provide better control over plant assets and inputs. For example, energy efficient practices ensure that thermal resources are applied at the right temperature, for the right duration, and in correct proportion to raw materials. This control reduces a facility's scrap rates as well as energy consumed per unit of production. Control provides reliability. Greater reliability means less downtime. Less downtime means orders are filled faster, which allows the facility to complete more orders over the course of a year—thus making more revenue. Energy efficiency is not just about reducing utility bills. It's also about boosting revenue through greater productivity.[4]

By strategically building energy efficiency decision-making into production, manufacturers will identify new ways to:

- Cut costs, raise productivity, and improve shareholder value;
- Improve managerial performance;
- Meet environmental standards;
- Create energy efficient products and market opportunities;
- Improve their competitive position;
- Attract top talent looking to work for a company aligned with their values; and
- Ensure better community relations and an overall better reputation with consumers.

[4] Efficiency and Innovation in U.S. Manufacturing Energy Use, National Association of Manufacturers, 2014 https://www.energy.gov/sites/prod/files/2014/05/f15/energy-nam.pdf

A Few Things to Know First

How exactly your organization adopts an energy management approach may vary, but this document aims to help small and medium manufacturers not only identify energy saving projects, but to sustain the savings through continual improvement. Before we dive into the details, let's first define some basic terms:

Energy efficiency is the use of a technology that requires less energy to perform the same or similar function.

Examples:

- A more efficient process heating system that achieves a similar product quality but heats products more quickly
- A radiant building heating system to provide localized heat to spaces around workers instead of heating an entire facility to a higher temperature
- The use of light-emitting diode (LED) fixtures that require less energy and may produce better light-quantity and quality than high intensity lighting

Energy conservation is any behavior that results in the use of less energy.

Examples:

- Turning the lights off when a space is unoccupied
- Turning a process-supporting system off when the process is offline
- Turning off welding exhaust systems when not needed
- Turning off chilled water flow to supporting equipment that is off-line

Both energy efficiency and energy conservation are important to saving energy. While different plants can save energy through one-off conservation and efficiency efforts, we recommend developing an **energy management system**. The DOE's approach to energy management is aligned with the ISO 50001:2018 Energy Management Standard. Energy management is an essential strategy for all manufacturers (small, medium, and large) that are trying to minimize production cost, improve resiliency and competitiveness, and reduce their environmental impact. Energy management consists of establishing an energy policy, setting goals, and developing processes and procedures to achieve those objectives. Energy management is also a culture geared toward continual improvement of energy performance and efficiency that is integral to an organization's everyday business practices.

How Do I Save Energy?

To start on your energy-saving journey, it is helpful to answer the following six questions:

1. Who will lead the efforts?
   To be successful, someone in your organization needs to be accountable for energy. It can be an energy czar, manager, guru, champion or a full energy/action team, but having a clearly identified leader to own the company or plant's commitments and drive progress is crucial.
2. What is the main goal? What are you comparing to?
   Better Plants Partners typically pledge to reduce their energy intensity by 25% in 10 years. You will also need to establish a baseline for your facilities in order to know where your energy journey begins.
3. When will this take place?
   Set up a timeline: what can be accomplished in the next quarter, next year, next five years?
4. Where in the company can use attention?
   What plants/equipment have the greatest potential? Which production processes are the most energy intensive? DOE has a lot of tools and resources to help you answer these questions. In addition, benchmarking your equipment can help you understand this better.
5. Why are you saving energy?
   Understand and articulate why your facility or company wants to save energy and create company specific goals. What is your end goal (reducing energy costs, improving environmental impact, employee satisfaction, or customer relations)? Get management on board with your corporate energy goals.
6. How will you reach your goals?
   Identify projects and objectives to reach goals. Track your progress and determine what tools and expertise are out there to help you.

DOE, through programs like Better Plants, has resources and technical expertise waiting to help you on your energy saving journey. This guide will step you through the basic, foundational building blocks to quickly get you on your journey to standing up a functioning energy management program that saves energy. Through this document, you will learn about quickly getting a head start on the following aspects:

- Creating an Energy Team and Culture
- Setting an Energy Goal
- Getting a Handle on your Current Energy Use
- Examining your Major Energy Users
- Identifying Opportunities
- Creating an Action Plan and Implement
- Tracking Performance and Celebrate Success
- Looking Beyond Energy Efficiency

Who's Responsible? Create an Energy Team and a Company Culture that Embraces Saving Energy

Organizations with energy reduction goals achieve them with the support of senior management (to empower staff and give them the necessary resources), energy program staff (to design and implement an energy efficiency program), and all employees (to spot energy waste and do their part to use less energy). The best performers adopt a structured approach to energy management and establish policies and procedures needed to ensure long-term, sustainable results. These companies commit to allocating staff and resources, establishing goals, and adopting a philosophy of continuous improvement.

To start an energy project, people must feel empowered, motivated, and responsible for the results. Successful organizations identify an energy champion and/or an energy team to be at least partially dedicated to driving improved energy performance and implementing projects. As a smaller organization, you may feel constrained in allocating resources for energy efficiency. An innovative spirit can help identify existing staff that already have energy management aspects to their duties. For example – environmental managers, maintenance leads or safety officers also managing energy management responsibilities.

Energy Champion and an Energy Team

Ideally, every organization should identify and designate an energy champion to lead its program. The best energy champions have the relevant knowledge, an interest in energy reduction, and authority to drive progress and projects. Often, successful energy champions are already successfully working in a position related to the plant's energy use or environmental performance.

As you grow your energy program, you should grow your Energy Team. Not only does this prevent one person from bearing the burden for the whole organization (and shield you from being back at square one should they leave), but helps you embed a commitment to driving energy savings across all aspects of your organization. Successful teams are comprised of individuals with a variety of expertise, experience, and roles. The size and roles of each individual will vary based upon the size and unique characteristics of the organization or plant. Typical energy teams draw people from management, procurement, accounting, events coordinators, engineers, production, quality, maintenance, floor personnel, or the sustainability/ environmental team. The team should meet regularly, with all members having clearly defined responsibilities. While making a large energy team can be difficult in smaller facilities, sharing the load means responsibilities can be distributed and varied. Some team members can even be there to bring occasional expertise and a new set of eyes!

How did they do it?

Saint-Gobain establishes a corporate energy management plan that places energy champions at all plants.

Click here, or use QR Code to view

Cummins develops energy champion program to train staff and identify Energy Savings.

Click here, or use QR Code to view.

All Employees

At the end of the day, energy is everyone's responsibility. Successful energy programs influence company culture by communicating with and teaching all employees about energy use. There are many activities that can bring energy efficiency to everyone's attention:

- Encourage and enable employees to shut down equipment when not in use (from personal computers to production equipment);
- Open forum for employees to suggest energy efficiency projects or solutions (email box, open discussions, etc.);
- Team huddles where employees meet at the beginning of every shift to review assignments and discuss safety and energy efficiency topics;
- Contests amongst employees (such as different shifts, departments, sites, buildings) to save energy or identify projects. Two exciting examples of this include Legrand's Energy Marathon and ArcelorMittal's Power of One competitions.
- Surveys, questionnaires, or trainings to learn the workforce's knowledge and attitudes toward energy efficiency and raise awareness.
- Posters, newsletters, intranet sites to inform employees about the energy efficiency program and its successes. Check out Celanese Corporation's approach where they developed a set of "Energy Sparks" training tools to promote employee engagement in their plant.

Many companies have identified employee recognition as a major component of their energy efficiency programs. Companies can honor and give awards to individuals or divisions within the company for their leadership and achievement toward their sustainability efforts. Employee's energy efficiency efforts and best practices can be showcased in company newsletters, intranet, social media, or their website to encourage their efforts.

Training is another important tool to enable employees in gaining confidence to identify sustainability measures and act on them. Including an energy focus in new employee orientation training is a simple way to influence company culture and empower employees. Publishing guidebooks, identifying best practices, and highlighting projects that have been implemented in other facilities helps identify opportunities that already have achieved success. Posters with quick tips for energy efficiency encourages employees to take steps towards sustainability.

Above: Energy Management employees at Schneider Electric work together to conduct an energy treasure hunt at one of their facilities.

Companies have also tied consideration of energy efficiency projects to the employee's annual review process and implemented bonus structures for individual employees which are tied to efficiency results. Others have used events and competitions like "Energy Treasure Hunts" (see page 16) to encourage employees to work together to pursue energy efficiency opportunities, and teach employees about common, easy energy saving measures.

Management Engagement

An energy champion's efforts to save energy can only go so far without the robust support of senior management. To really be successful, management needs to perceive energy management as part of the organization's core business and empower the energy team. But how do you get management to agree to energy projects and culture changes?

- Business case: Improvements to energy efficiency improve operational efficiency and reduce costs. Also, more efficient technologies often have higher operational control and flexibility.
- Triple Bottom Line: Most companies do more than make money, they also have social and environmental responsibilities. Energy efficiency goals demonstrate social and environmental awareness. Additionally, energy efficiency should be prioritized before the installation of renewable energy in order to reduce the size of the installation. Energy efficiency is cheaper than renewables (about a third of the cost of energy generation[5]).
- Employees: Improved energy efficiency can also improve the health, safety, and comfort of employees. Today, many employees are more satisfied working for employers who demonstrate high social and environmental responsibility.

To encourage management engagement and streamline decision making, numerous companies have established executive steering committees around energy. The executives may represent a variety of areas including operations, finance, legal, etc. With an executive steering committee, it typically gives the energy manager an opportunity to engage senior management several times a year to ensure widespread support for major activities and projects.

Check out General Electric's (GE) approach, which involved developing an operational leadership program that yielded big savings.

Resources for Engaging Management

Better Plants Presentation

"From the Manufacturing Floor to the Corner Office: How to Communicate with Management and Plant Personnel"

Click here, or use QR Code to view

Better Buildings and Better Plants Presentation

"Speaking Senior Leadership's Language to Advance your Energy Program"

Click here, or use QR Code to view

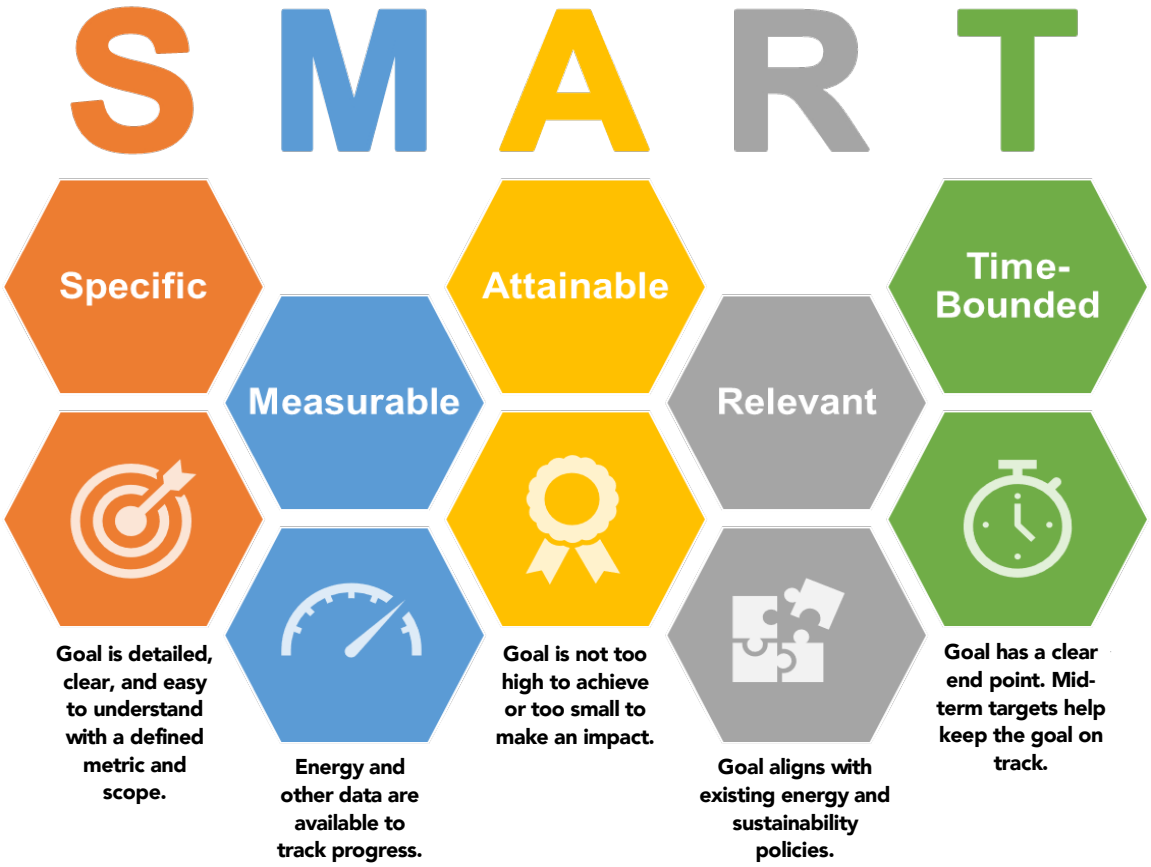
[5] "Renewables are getting cheaper but energy efficiency, on average, still costs utilities less" ACEEE 2018 https://www.aceee.org/blog/2018/12/renewables-are-getting-cheaper-energy

Set A Corporate Energy Goal

Statistically, organizations that set energy goals are nearly three times more likely to save energy[6]. Setting a corporate energy goal requires senior management buy-in. This is important, because senior management buy-in will drive savings by creating internal accountability and moving energy from a 'nice to do' to a 'need to do'. Also, senior management can allocate resources and empower employees to implement energy-saving best practices and projects. Beyond senior management, having an ambitious, public corporate energy goal filters down to every worker in the plant, who will now feel empowered and responsible to do his and her part to reach the goal. Stepping up and pledging to lead on energy reduction will help attract talent that wants to be part of a conscientious organization they can believe in.

Manufacturers all over the world are setting and publicizing their energy efficiency targets.[7] Beyond the accountability highlighted above, public goals also help investors identify companies that are well-managed and provide a useful metric to consider when investing. If a company is in the Better Plants program, the program goal can serve as their public commitment.

When developing an energy goal, remember to make it "SMART":



[6] McKinsey & Co, Unlocking Energy Efficiency in the U.S. Economy, July 2009
https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/epng/pdfs/unlocking%20energy%20efficiency/us_energy_efficiency_exc_summary.ashx

[7] Committed to Savings: Major U.S. Manufacturers Set Public Goals for Energy Efficiency, the Alliance for Industrial Efficiency, June 2018
https://www.smacna.org/docs/default-source/default-document-library/2018-aie-ee-targets_white-paper-final.pdf?sfvrsn=ba7dcda5_4

Corporate energy efficiency strategies are most effective when:

- Efficiency is a fundamental part of a companies' strategic planning and risk assessment processes;
- Internal leadership and organizational support are present and sustained;
- The company has specific, measurable, accountable, and time-bound energy efficiency goals;
- The energy efficiency approaches rely on robust tracking and measurement systems;
- The organization dedicates enough resources to energy efficiency projects;
- The energy efficiency strategy demonstrates results; and
- The company effectively communicates results both internally and externally.

It can be hard to know what is achievable in a given time frame when setting long-term goals. Most Better Plants partners opt for the 25% energy intensity reduction over 10 years. These numbers can be adjusted as you better understand your energy footprint and energy savings opportunities. A key component to setting a goal is establishing corporate and plant **energy baselines**, and to use a process to track energy use over time. Like a starting weight when beginning a diet, the energy baseline is the initial reference point with which future energy performance data can be compared. You can set an energy baseline for your whole company/corporation, facility, building and even down to processes and equipment. Once you understand your current situation, you can begin comparing yourself to other similar facilities (benchmarking) and measure your progress in the future. Most companies choose the current year, or a recent year, as a starting point for their energy baseline.

Better Plants partners can choose the current year as their energy baseline, or set a year up to three years from the year they join the program to count any energy savings that were achieved within these years.

Need help establishing your energy baselines?

Energy Baseline Summary Guide

A summary of the essential steps you'll need to take to set your energy goals and baselines.

Click here, or use QR Code to view

Energy Intensity Baselining and Tracking Guidance

An in-depth guide to establishing energy baselines and tracking usage.

Click here, or use QR Code to view

Getting a Handle on your Current Energy Use

Some managers may feel that producing and shipping more product vastly outweighs any benefits from taking time to analyze energy bills. Often, they will send bills unopened to their accounting clerk and won't think about it again until the next one arrives, leading to years of potential unnecessary spending. Before you can start effectively saving energy, it's important to understand how much energy you're currently using, how much you're paying for it, and what your big energy uses are. Once you know that, you can understand how much less energy might be used if you took action. Many of the best practices outlined in this guide can even apply to other utilities such as water.

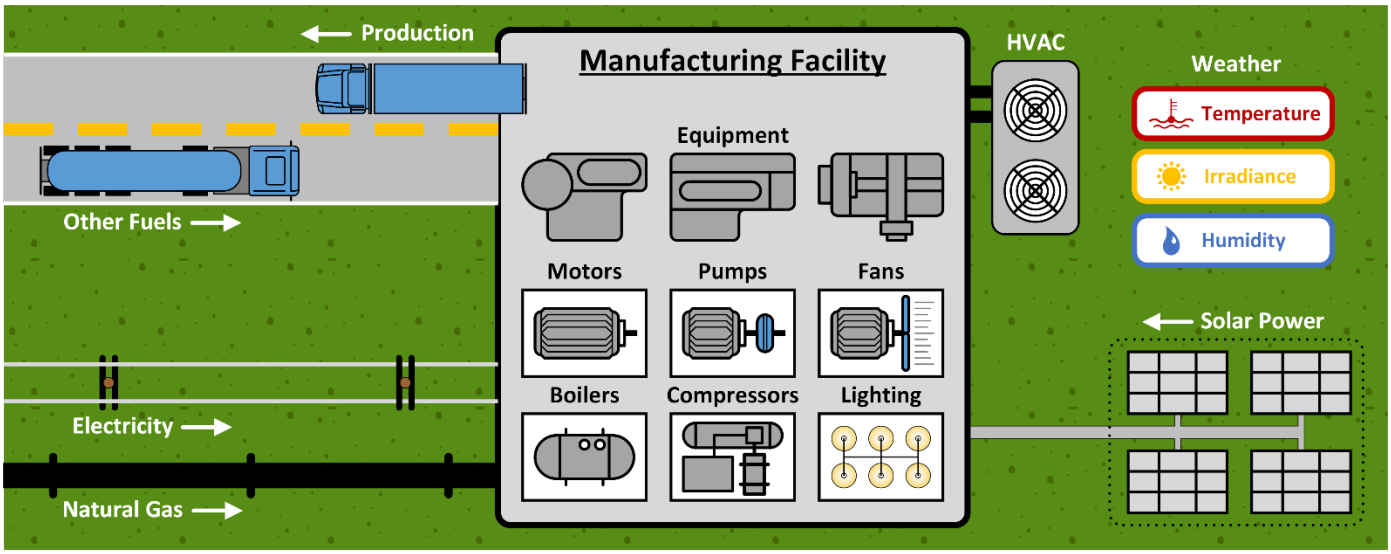
Big questions to figure out:

- What energy sources do you use (e.g. electricity, natural gas, propane, etc) in your facility?
- What type of rate structure do you have for the utilities at your facility?
- At what time of day do you use energy and how does this demand affect your costs?
- Where do you use energy (for heating, cooling, lighting, or to do work)?
- What **relevant variables** significantly affect energy consumption (e.g. production, weather, occupancy, operating hours, raw material mix)?

The amount of electricity or fuel a site consumes is recorded using meters that are typically near the site perimeter. Utilities collect this information to bill their customers. Typically, you can work with your utility to access your energy data and better understand your use. When you begin to track your monthly energy consumption, oftentimes, trends will become apparent. These trends can provide valuable insights to understand how you are using energy and where you may be able to identify opportunities for improvement. Beyond the monthly energy bill, utilities can provide you with a higher resolution load profile for your facility (typically 15 or 30 minute intervals). Analyzing this interval data can be extremely helpful for understanding how much energy is being unknowingly wasted at a facility during non-production times (typically nights, weekends, and breaks). By reviewing your energy bills from multiple years, requesting a load profile from your utility, and looking at how your rates are structured, you can likely identify various cost saving opportunities. It is important, however, to pair this top-down approach with a bottom-up approach to examine your largest energy-consuming equipment (more on this later).

To further dive into how you are using your energy, it is useful to determine the relevant variables that are affecting consumption. Typically, these variables are things tied to your largest energy-using pieces of equipment. Production rates often drives the consumption of most equipment; however, some equipment, such as chillers and HVAC systems, are largely influenced by the weather. A basic way to analyze relevant variables is to look at trend graphs; a slightly more advanced approach would be to use simple regression trendlines to compare the various items. Understanding how these variables affect your energy use can help you better understand your true energy footprint, how your energy use can be controlled, and where you can improve. As your energy program grows over time, you could start looking at the weekly or daily data to control and optimize energy use more aggressively.

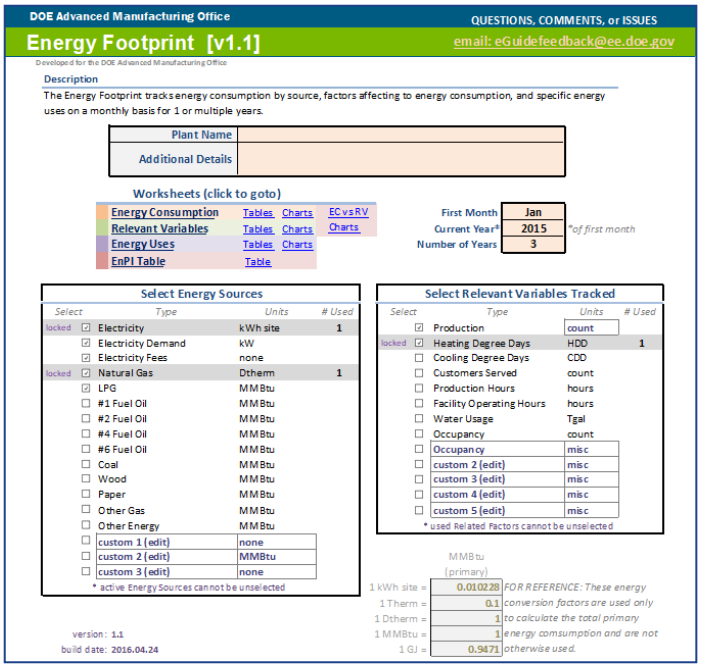
The figure at the top of page 12 depicts the typical energy sources and energy consuming equipment within a typical plant.



Recording your data

Once you understand your energy bills, you should have a place to store and analyze the data. Many companies have developed internal dashboards or have purchased commercially available software platforms. These dashboards allow users to view their energy data from anywhere on network and are easily sharable with facility personnel and upper management. A lower tech, but equally effective alternative is a simple spreadsheet that displays key charts and statistics.

DOE has developed several free software tools that can help you store your energy data. The Energy Footprint Tool is a great resource for companies looking to collect their energy data. It can track up to 20 types of energy consumption (electricity, natural gas, etc.) as well as 20 relevant variables that affect your energy consumption (production levels, operating hours, weather conditions, etc.). You can also enter your significant energy uses and the software will generate several charts analyzing your energy usage.


DOE Advanced Manufacturing Office

QUESTIONS, COMMENTS, or ISSUES

Energy Footprint [v1.1]

email: eGuidefeedback@ee.doe.gov

Developed for the DOE Advanced Manufacturing Office

Description

The Energy Footprint tracks energy consumption by source, factors affecting to energy consumption, and specific energy uses on a monthly basis for 1 or multiple years.

Plant Name	
Additional Details	

Worksheets (click to goto)

Energy Consumption	Tables	Charts	EC vs RV Charts
Relevant Variables	Tables	Charts	
Energy Uses	Tables	Charts	
EnPI Table	Table		

First Month	Jan	
Current Year*	2015	*of first month
Number of Years	3	

Select Energy Sources

Select	Type	Units	# Used
locked ☑	Electricity	kWh site	1
☑	Electricity Demand	kW	
☑	Electricity Fees	none	
locked ☑	Natural Gas	Dtherm	1
☑	LPG	MMBtu	
☐	#1 Fuel Oil	MMBtu	
☐	#2 Fuel Oil	MMBtu	
☐	#4 Fuel Oil	MMBtu	
☐	#6 Fuel Oil	MMBtu	
☐	Coal	MMBtu	
☐	Wood	MMBtu	
☐	Paper	MMBtu	
☐	Other Gas	MMBtu	
☐	Other Energy	MMBtu	
☐	custom 1 (edit)	none	
☐	custom 2 (edit)	MMBtu	
☐	custom 3 (edit)	none	

* active Energy Sources cannot be unselected

Select Relevant Variables Tracked

Select	Type	Units	# Used
☑	Production	count	
locked ☑	Heating Degree Days	HDD	1
☐	Cooling Degree Days	CDD	
☐	Customers Served	count	
☐	Production Hours	hours	
☐	Facility Operating Hours	hours	
☐	Water Usage	Tgal	
☐	Occupancy	count	
☐	Occupancy	misc	
☐	custom 2 (edit)	misc	
☐	custom 3 (edit)	misc	
☐	custom 4 (edit)	misc	
☐	custom 5 (edit)	misc	

* used Related Factors cannot be unselected

	MMBtu (primary)	
1 kWh site =	0.010228	FOR REFERENCE: These energy
1 Therm =	0.1	conversion factors are used only
1 Dtherm =	1	to calculate the total primary
1 MMBtu =	1	energy comsumption and are not
1 GJ =	0.9471	otherwise used.

version: 1.1

build date: 2016.04.24

How did they do it?

Legrand drove organizational change through submetering and energy dashboards.

Click here, or use QR Code to view

Celanese Corporation added dashboards that provided real-time energy monitoring.

Click here, or use QR Code to view

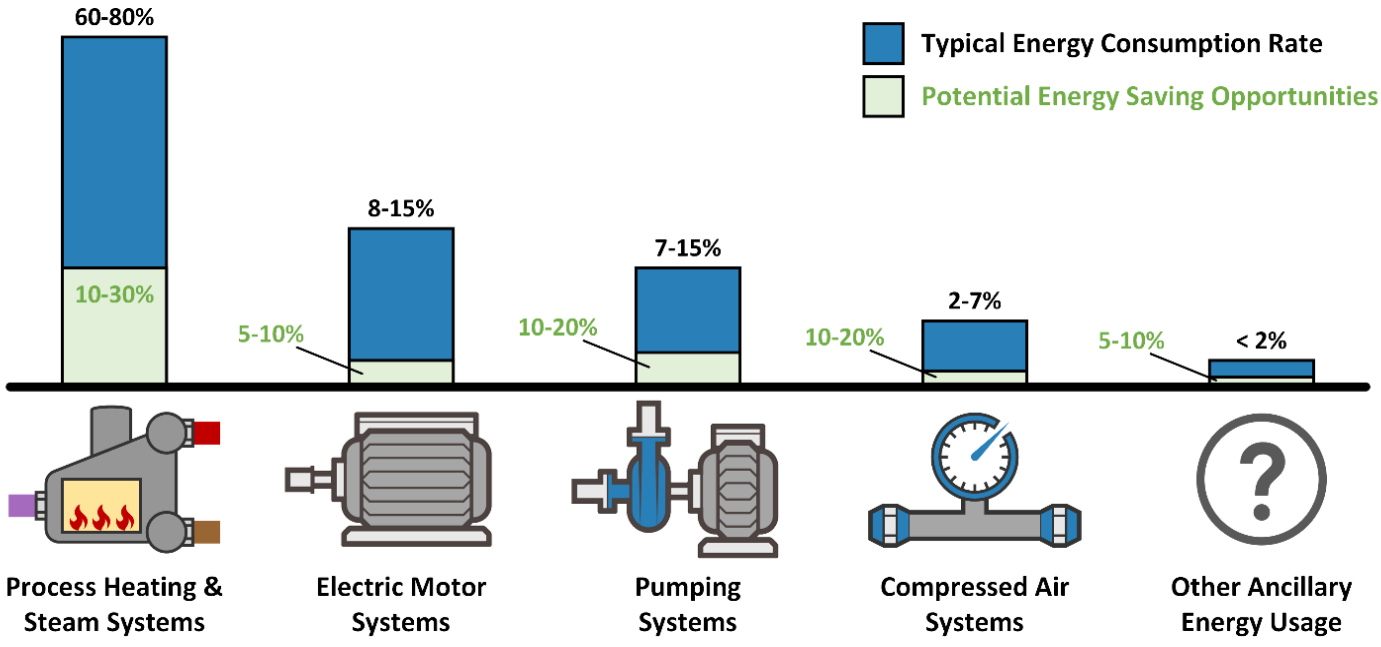
Examining Major Energy Users

While understanding the information on utility bills is important, understanding where that energy is being consumed is also valuable. While each manufacturing facility and production process is unique, every industry has common equipment within its operations. In fact, major energy consumers in most facilities fall into just a few basic systems: lighting, process heating, steam generation, compressed air, pumping, and fans; the latter three being motor-driven. Data from the DOE's Industrial Assessment Centers (IACs) have shown that the most common recommendations for these systems make up a significant portion of possible savings for these systems at relatively low cost.

Creating a list of Significant Energy Users (SEUs) can help focus efforts on projects that will provide the biggest savings. In addition to determining and then monitoring SEU energy performance, it is important to identify the people who influence or affect the operation of SEUs. In most cases, the energy performance of SEUs is affected by people who perform ongoing operational control and maintenance activities.

To develop a list of SEUs, it is good to list groups of equipment by location, type, or process and record information about estimated operating hours, rated power, and loading. You can then estimate the energy used by the SEUs and compare it to the information you have previously gathered from your utility bills. Doing this comparison lets you estimate the fraction of your energy use that is from your SEUs. As your energy program evolves, you can include more and more of your energy users until you can balance the estimate of your SEU energy consumption with the energy you are being charged for by your utilities. An accurate footprint can help you prioritize and direct resources towards high-impact efficiency projects.

The figure below is an example of the different systems and equipment that consume energy within a typical plant, and the differences in potential energy savings between facility systems.



Benchmark Major Energy Users

Benchmarking your energy data helps a manufacturer compare their equipment, process, or facility to others, and learn where energy savings opportunities may exist. **Benchmarking** is the task of both understanding how you currently operate (how much energy your plant or a single SEU uses) or comparing that to similar operations.

Benchmarking can be comparing your equipment internally (comparing similar motors in the same facility), company-wide (comparing air compressors in different facilities), industry-wide (information from surveys, trade groups, etc.), or integrate all three. For many small manufacturers, benchmarking can feel daunting since, unlike your larger industry peers, you don't have a large pool of plants, lines, and/or heavy equipment of your own plants, manufacturing lines, and heavy equipment to compare against. But it is important for even the smallest manufacturers to benchmark their major energy users to best practices.

The 80/20 Rule

In industry, the 80/20 rule typically applies; i.e., 80% of the energy consumption will be accounted for by 20% of the equipment or processes. Typically, only a few energy systems consume most of the energy at a site. Consider focusing your resources on these systems.

Baselining vs. Benchmarking

Baselining: The process of comparing facilities, processes or equipment over time.

Benchmarking: The process of comparing energy performance of facilities, processes, or equipment to similar internal equipment or external facilities over time.

Benchmarking the performance of your SEUs is an excellent starting point for your energy saving journey. If you are in a multi-facility organization, you can use benchmarking to compare facilities in your organization and combine results to identify best practices. Even if you are only a one facility company, benchmarking against similar equipment within your facility allows you to find both places to improve and best practices of your own.

In addition to equipment energy use, benchmarking can also include practices, such as understanding, comparing, and optimizing maintenance measures (such as boiler blowdown or compressed air leaks). You can find best practices from trade magazines, equipment standards organizations, or trade organizations. Better Plants is another great source of best practices – the Better Buildings Solution Center - Technology Focus Areas webpage houses DOE sourcebooks, tip sheets and other publications, presentations, webinars, and other partners' solutions for 11 major energy users, plus renewable energy and water.

DOE Scoping Tools

The DOE has several self-assessment tools to help you determine your current level of energy efficiency. The DOE Plant Energy Profiler (PEPEx) Excel tool can be used as a starting place for tracking your energy. While this tool only tracks one year of data, it includes several self-assessment questionnaires and scorecards that help you estimate the current level of savings opportunities in common systems. Based on your responses, the tool can estimate potential savings in energy and costs and provide a simple list of the most common recommendations for your equipment.

A similar tool is available through Oak Ridge National Laboratory for steam systems. The Steam System Scoping Tool walks you through several worksheets to gather information about your steam system. These include profiling your system, understanding your operating practices, and accounting for your steam end uses. Based on your overall score, you can estimate the overall operating efficiency of your steam system.

As mentioned previously, the Energy Footprint Tool can help you both track your data and quantify your major energy using systems. Finally, DOE's MEASUR tools suite can help you assess your industrial systems and start assessing reduction opportunities (more information on MEASUR follows).

Identifying Opportunities, Creating an Action Plan

When starting the journey to your goal, it may seem difficult and tedious to find projects. But energy savings can be found everywhere, from building energy consumers (lighting or HVAC) to manufacturing energy consumers (compressed air or process heating). As mentioned above, it may help to start finding projects internally by outlining your manufacturing process and identifying energy intensive equipment and processes. For each piece of machinery or process, identify the types of energy resources they consume. A paint booth, for example, will have compressed air to spray the paint, fans for exhaust, and process heating to cure the painted product. This activity will make it easier to identify the individual energy consuming systems and their auxiliary equipment. If you do not have the time and/or resources to map SEUs with systems, you could use DOE's Plant Energy Profiler (PEPEx) tool to map the energy flow in your facility by systems. Solutions could be small low-cost options, or they could include a complete reconfiguration of an energy system that would have lasting effects for years.

As a small or medium sized manufacturer, you may not have a large energy team, budget, or resources to conduct large scale energy audits or major equipment overhauls. Here are some easy and less expensive (possibly free) ways to get started:

Identify Low-to-no cost opportunities: Treasure Hunts and Free Assessments

The best way to gain management's trust is to tackle the low-to-no-cost opportunities first, rather than asking for a big initial corporate investment in expensive energy projects. Low hanging fruit opportunities can be as simple as turning off the energy-using equipment when it's not required, fixing steam or compressed air leaks, and/or identifying other projects (like lighting) with a short or no payback period. A key to addressing the low hanging fruit is to aim to implement systems and standard procedures to ensure the fruit remains consistently picked.

A great place to start is to involve everyone at the company; some of the best ideas can come from the most unsuspecting places. Remember, floor workers will see the process all day and know the process better than most. Engage the staff and hear their suggestions. In turn, this will promote and foster a work culture that will improve company morale and help achieve the energy saving goals. To do this, consider hosting companywide "energy treasure hunts". A treasure hunt is a two or three-day event where quick fixes and no-cost, low-cost energy saving projects are identified in a miniature internal energy audit. These activities can become a routine practice performed at facilities and even incorporated into employee contests.

Need help organizing a treasure hunt?

Energy Treasure Hunt Overview

A summary of the different stages of a treasure hunt, as well as the materials you can use.

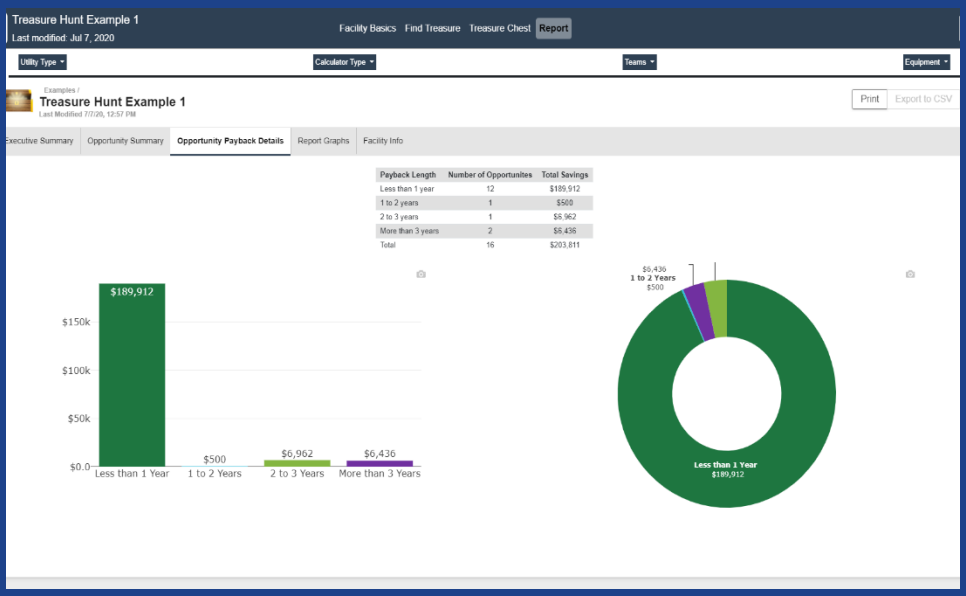
Click here, or use QR Code to view

Energy Treasure Hunt Toolkit

A collection of free documents and materials you can use to organize and track your treasure hunt.

Click here, or use QR Code to view

Better Plants offers a form of hands-on instructional assessment, called In-Plant Trainings, to help partners host and conduct treasure hunts and identify opportunities throughout the plants. Once you've identified the opportunities from an assessment, you can use DOE's MEASUR to catalog and estimate the savings potential.



Need help estimating your savings potential?

MEASUR Treasure Hunt Module

A free software tool suite from DOE to help you catalog and estimate energy savings potential.

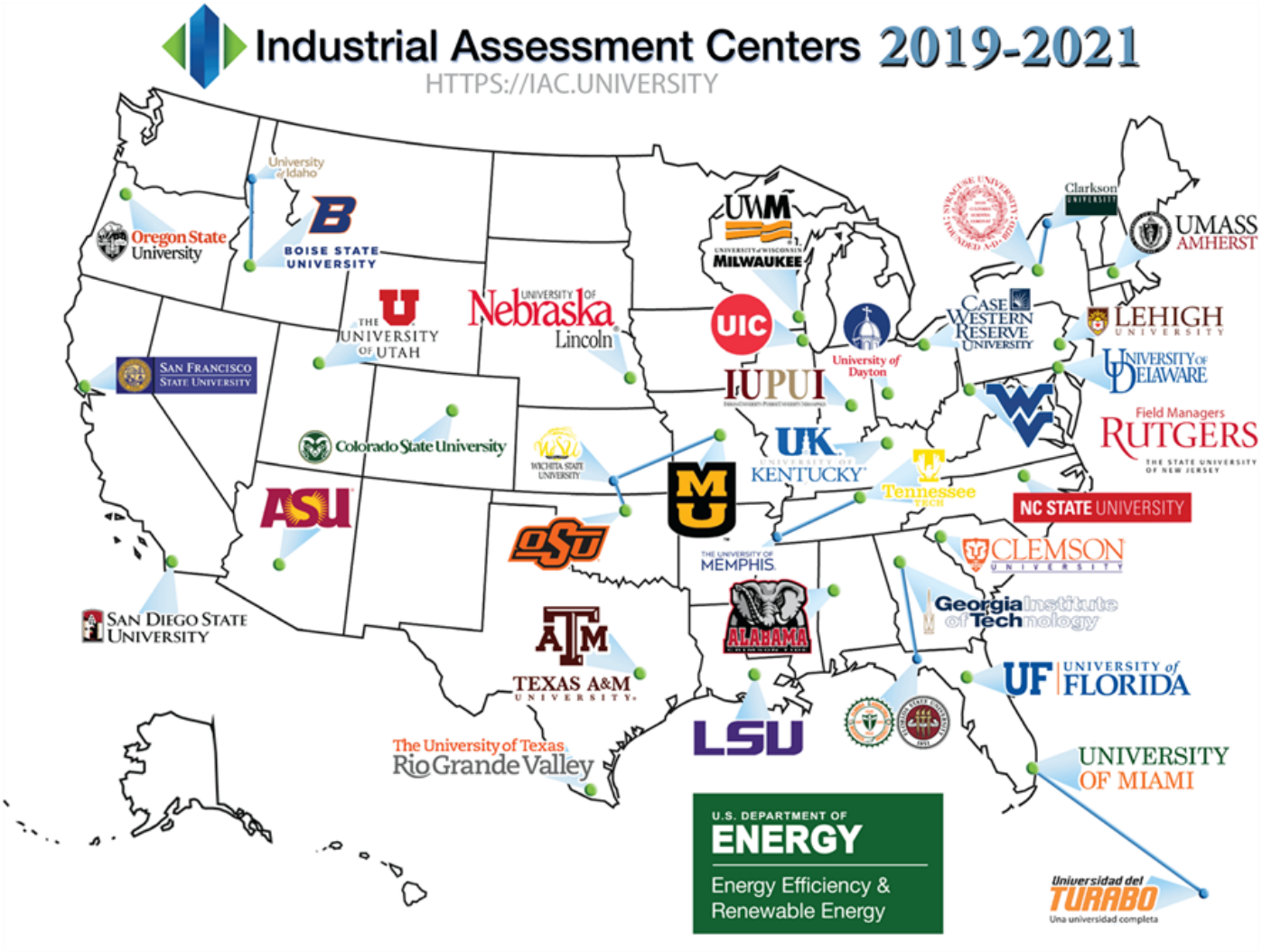
Click here, or use QR Code to view

Another important way to understand a plant's current energy use is by conducting an **energy assessment**. An energy assessment is a methodical review of a plant's energy use and are a great tool for identifying potential energy efficiency strategies and practices, energy and cost savings opportunities, and employee training specific to your facility. They can also quantify energy savings and help determine which opportunities would lead to the most significant energy and cost savings. Energy assessments help to identify issues such as failing or poorly commissioned equipment and uncoordinated operations. While there are consultants you can hire to conduct an energy assessment, Better Plants helps open the door to several free or low-cost assessment opportunities.

Industrial Assessment Centers

The DOE offers free energy assessments through the Industrial Assessment Center (IAC) Program. IAC centers are located at more than 30 universities across the country. Free assessments from an IAC are available to small and medium-sized manufacturing facilities within the U.S. that meet specific criteria outlined on the IAC website. The IAC team will conduct a one-day, on-site assessment, identify energy, waste, and water saving recommendations, and deliver a detailed technical report within 60 days. This report should then be evaluated and used to establish investment grade projects. IAC assessments are known for finding low payback (less than 5 years) recommendations that can effectively save energy; typical assessments result in identify savings representing approximately 8% of a sites footprint.

Do you have a technical question that you need help answering? Contact an IAC for assistance in finding an answer.



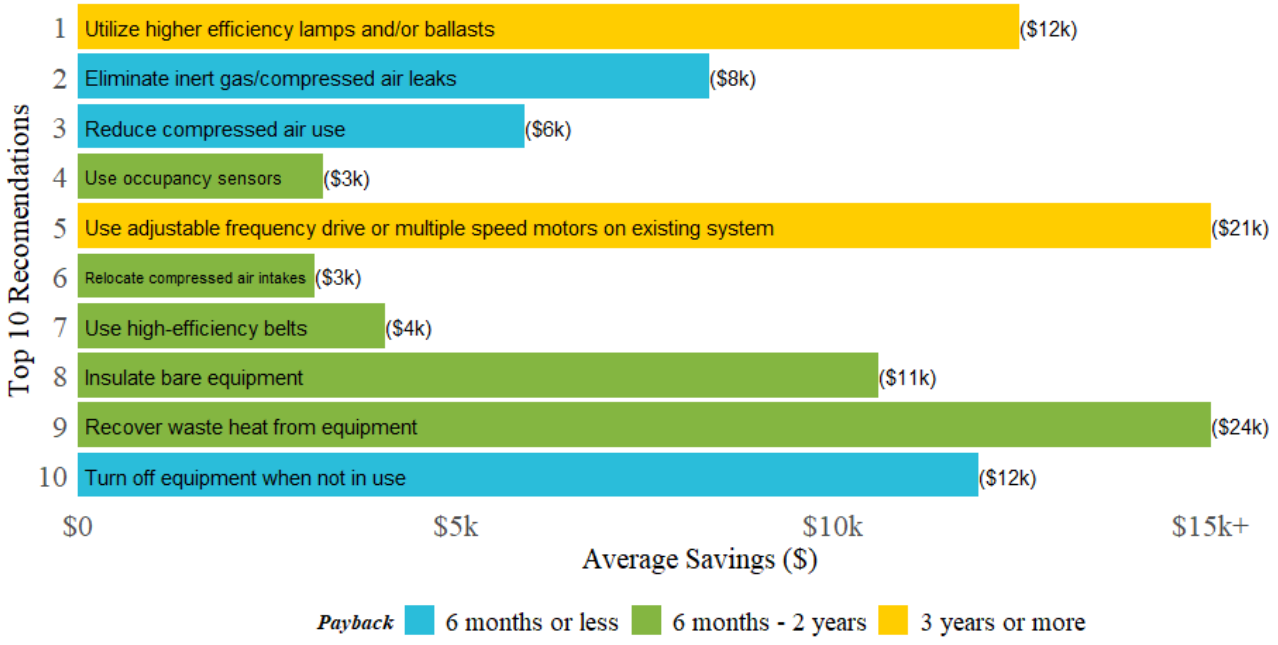
In-Plant Trainings

There are several other external methods to identify potential projects that will lead to energy, water, or waste savings in a facility. A key resource offered to Better Plants partners are In-Plant Trainings (INPLT). INPLTs are on-site, multi-day training sessions hosted by a Better Plants partner at one of their facilities. The sessions are led by Better Plants experts who train participants on how to identify, quantify, implement, and replicate energy-saving projects. Technical expertise gained through the INPLTs help companies overcome common barriers found when embracing energy management practices. INPLTs cover a wide range of topics, mostly focusing on high energy consuming systems such as compressed air systems, process heating, and fans. A full list of trainings currently offered can be found at the Better Plants webpage.

Other Great Ways to Identify Energy Projects

If an INPLT or IAC visit is not possible for you, best practices and energy saving suggestions can be found in DOE energy saving info cards. These two-page tip sheets share best practices for energy systems commonly found in industry and can help manufacturers evaluate their savings opportunities. Currently, info cards are available for pumping, steam, motors, compressed air, process heating and plant wide systems. These references can be a great place to start gathering information.

Another publicly available source for common recommendations is the IAC database. The database allows users to see the most recommended projects, as well as the cost and payback period; you can even filter the lists by sector, location, or recommendation type. For example, the top 10 most suggested assessment recommendations between 2005-2019 are:



Finally, depending on where your facility is located, numerous states and utilities across the country operate their own energy efficiency programs. Many of these state and utility programs will provide free energy screenings and assessments along with project implementation rebates to their customers.

Better Buildings Solutions Center

The Better Buildings Solution Center is the website for Better Buildings and Better Plants. It contains a vast collection of real-world case studies implemented by Better Buildings and Better Plants partners. Showcase Projects illustrate technical projects for specific systems (often new equipment installations). Implementation models outline corporate-level solutions to barriers faced by many companies (employee engagement, standardizing best practices). Solutions-at-a-Glance are short and informative snapshots of successful and innovative ideas or practices. All of these case studies show innovative solutions implemented in industry and can provide guidance and inspiration for overcoming your own barriers in project implementation.

In addition, Better Plants has created Technology Focus Area pages – a one-stop shop full of resources for those seeking actionable solutions for energy efficiency challenges involving specific systems. Each page contains links to helpful resources, such as relevant Better Plants showcase projects and implementation models, DOE tip sheets and publications, software tools, webinars, and contact information for a subject matter expert.

Field Diagnostic Equipment Program

Field measurement and validation are key tasks when finding and analyzing possible energy improvement projects. It's a lot easier to justify to management when you can say with high confidence what the energy savings opportunity is. Accurate, reliable measurements can be critical to the success of a project.

When starting to benchmark or estimate savings for an energy project, you may not know where to begin, whether it be a lack of knowledge or being unaware of what measurements can be useful. This is where Better Plants partners can take advantage of the Field Validation and Diagnostic Equipment Program.

This program provides partners with free access to many of the instruments needed to measure energy consumption (flue gas monitors, IR cameras, sensors and data loggers). Historically, these pieces of equipment were only used by Experts for In-Plant Trainings, but now, partners can directly access equipment free of charge (for up to 30 days). The full list of equipment available through the loan program can be found on the Better Buildings Solution Center.

How did they do it?

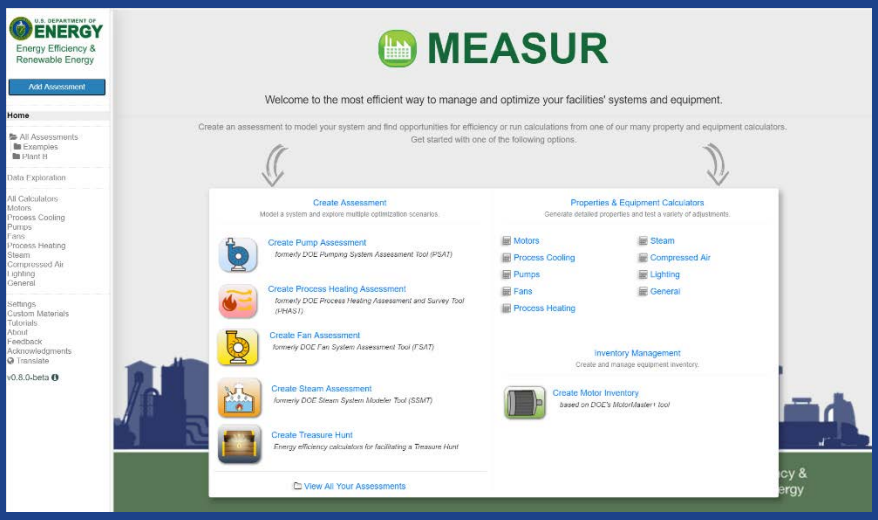
Ozinga Brothers completed a project using the Diagnostic Equipment Program data loggers.

Click here, or use QR Code to view

Quantify Energy Savings Potential

Now that you have identified energy saving recommendations and measurements have been taken, it is time to quantify possible savings. Quantifying savings will help you make a more compelling case to management, and better grasp the opportunity ahead of you.

The DOE has developed a free, open-source tool for industry use called MEASUR. The tool is designed for industrial energy coordinators, plant managers, engineers, and personnel who are interested in improving system efficiency and measuring potential savings opportunities in both dollars and energy savings. The software allows users to evaluate their existing industrial systems and estimate the impact of improvement projects. In addition to having the capability of modeling common energy using systems for deep dive assessments, the tool also features a module for performing simple treasure hunts. Beyond these capabilities, MEASUR features numerous standalone calculators (for quick, on the spot calculations), a data explorer (for generating simple data visualizations), an equipment database (to catalog and track equipment and maintenance), and multiple reporting functionalities.[8]



Looking to explore the tools and calculators in MEASUR?

MEASUR Software Tool Suite

A free software tool suite from DOE to help you catalog and estimate energy savings potential.

Click here, or use QR Code to view

[8] K Armstrong, T Wenning, S Nimbalkar, "Innovative Open-Source Energy Software to Drive and Enable Energy Savings and Process Optimization," 2019 ACEEE Summer Study on Energy Efficiency in Industry, Portland, OR, August 12-15, 2019.

Craft an Action Plan

Now that you have some projects identified, it's time to obtain management approval (if needed) and to implement them. The first step is to create an action plan: a detailed proposal outlining activities and steps needed to execute energy saving projects that will help your organization reach one or several ambitious goals. The action plan will be your roadmap for project implementation. In it, you will need to choose which projects to implement immediately and which to hold off on. Your company may already have specific decision criteria in place – if not, some companies have developed scoring matrices that weight the relevance of various criteria of a project to help them decide. If you are just starting off, try to always prioritize the low- and no-cost opportunities to build momentum and show results. Next, aim for other quick and easy "wins" when doing your initial prioritization.

When developing the action plan, aim to be as detailed as possible and be cognizant of all the potential stakeholders needed to successfully implement a project. A high-quality action plan will assign "owners" for each savings project and will include detailed milestones, budgets, personnel allocation and due dates for tasks to be completed. To track implementation progress, you may want to consider developing a scorecard or thermometer approach to clearly identify where things stand at any given point. Within your action plan, you should also consider how you may want to communicate the success after completion and recognize individuals. Doing so will help set you up to be successful on future projects. Without a well-defined action plan, you are not likely to reach your goals in a systematic or timely manner. An action plan can bring your company together, assigns accountability, outlines the problem and allows for solution generation amongst a team.

You will likely need to present this action plan to your management, or executive steering committee, before moving forward with implementation. Your detailed action plan will help you address any questions or concerns you may receive; however, when presenting to management, be sure to keep things simple. Develop an elevator pitch that focuses on the benefits of the projects and speaks in terms of dollars saved, not energy. To often, good projects get ignored and pushed aside due to poor communication.

DOE's Guiding Principles for Successfully Implementing Industrial Energy Assessment Recommendations Guidebook has numerous tips, checklists, templates and basic tools for crafting your action plan. The guide provides tips for obtaining stakeholder buy-in, pitching the project concepts to management, developing an implementation tracking system and communicating once it is all complete.

Implementing the Action Plan

Finding financing

Financing can be one of the most prominent barriers when implementing projects. The DOE has attempted to help lower that barrier by developing the online Better Buildings Finance Navigator. The Financing Navigator is a web-based tool that helps public and private sector organizations find financing solutions for energy efficiency and renewable energy projects. These financing options range from simple (loans and leases) to more specialized options for overcoming specific challenges, such as Property Assessed Clean Energy (PACE) or off-balance sheet mechanisms such as Efficiency-as-a-Service. It also connects users to the Better Buildings Challenge Financial Ally community: banks and lenders actively searching for investment opportunities in efficiency and renewables. For more information please visit the Navigator website.

Finding Incentives

Incentives are another form of financial assistance that can help ease the cost burden of projects. Incentives typically come in the form of tax credits, rebates and savings programs. There are several organizations that offer incentives including local utilities, municipal, state, or federal establishments.

One of the most comprehensive sources used for finding incentives is the Database of State Incentives for Renewables and Efficiency (DSIRE). The database allows users to enter their zip code and view possible incentives in their area. The *Directory of Energy Efficiency Programs Leveraging Energy Star®* is a similar resource. Finally, companies are also encouraged to directly contact their utility providers and their state energy office. A directory of state energy offices can be found on the DOE website.

It is extremely important that if a company is interested in taking advantage of an incentive that the proper organizations are contacted at the very start of a project, well before a project is implemented; in many cases, incentives are based on before and after comparisons and must be validated by an outside source. For utility or state energy efficiency programs, it is often advised to involve those relevant entities during the initial assessment and scoping activities.

How did they do it?

Bentley Mills used Efficiency as a Service (EaaS) to reduce risk and liability with energy upgrades.

Click here, or use QR Code to view

OWASA expedited project financing through state and local partnerships.

Click here, or use QR Code to view

Incorporating Measurement and Verification

When applying for funding, it is important to consider the costs associated with validating energy savings from your efficiency projects. When planning a project, including upgraded control panels with logging capabilities can be instrumental in helping you catch any issues during initial commissioning and determine if your project meets the original expectations. Other options include installing new submetering capabilities or external data loggers to track energy usage. Including measurement options in project planning may help project justification and can help ensure project savings were achieved. In addition, the additional metering may help with future retuning and optimization of the equipment.

How did they do it?

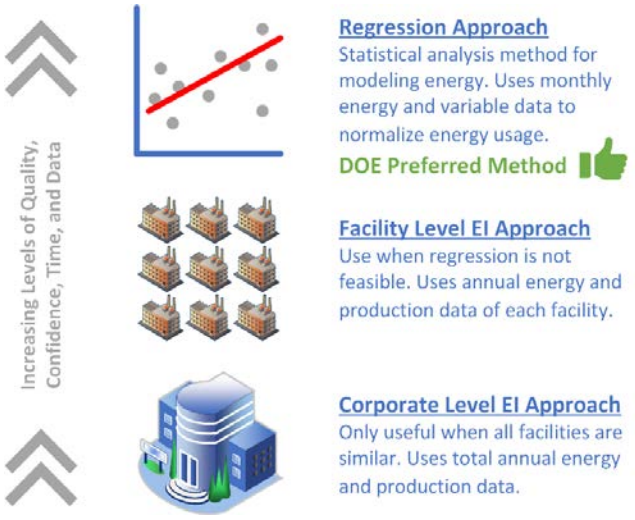
Des Moines Water Works coupled real time energy data use with enhanced staff training.

Click here, or use QR Code to view

Tracking Performance and Celebrating Progress

Once you have set a goal and started implementing projects and practices throughout your energy efficiency journey, you need a way to check your progress. **Energy Performance Indicators (EnPIs) also known as Key Performance Indicators or KPIs,** are quantitative metrics used to monitor improvements in your energy efficiency. The simplest EnPIs are total energy or energy expenditures. While easy to calculate, these absolute EnPIs are only suitable if your facility/facilities have consistent loads or production from year to year. A better EnPI is Energy Intensity (EI) or energy consumed per unit of production (energy per parts produced, hours worked, etc.). Unlike absolute metrics, EI will normalize for changes in production from year-to-year. There are three main ways to calculate EI:

- Facility-level Regression-based Approach:
  This approach is highly recommended by the Better Plants program. EI improvement for each facility is found using statistical regression with variables including production, weather, raw material quality, etc. Corporate-level EI improvement is found using a weighted average. Regression provides the best normalization of the three methods but requires most time and data.
- Facility-level EI-based Approach:
  Energy and production data for each facility are used to calculate individual EI improvement. Results are combined using a weighted average as with regression. While this method can highlight your best performing facilities, it does not account for other factors like weather.



Above: A diagram of three different types of approaches you can use to track your energy performance

- Corporate-level EI-based Approach:
  This is the most common way companies calculate EI. Energy and production from all facilities are combined and divided to estimate EI. While simple to calculate, this method does not identify good and bad performing facilities or account for other factors such as weather. This method also requires each facility to measure production in the same way which can be difficult for companies with many different products.

After selecting your EnPIs, you will need to collect data and actively monitor your progress. Most companies will be able to track their progress monthly utilizing the data from their energy bills. If you have submetering capabilities, it is possible to track your energy progress on a weekly, or even daily/hourly, basis. Measuring and regularly evaluating your efficiency improvements will allow you to answer key questions like:

- Are your current objectives and energy targets are being met?
- Are your EnPIs are moving in the right direction?
- Are you getting the most out of your largest energy consumers (SEUs)?

The Better Plants Energy Intensity Baselining and Tracking Guidance provides in-depth information on data collection, normalization techniques, and detailed examples.[9] In addition, the DOE has developed the free Energy Performance Indicator Tool to help facilities analyze their energy data. This tool can run facility-level regression, calculate changes in energy intensity, and automatically combine facility-level results into a corporate-level metric.

Employee Awareness, Communication and Recognition

Communicating and celebrating your energy savings will bring positive attention to your work and can spur further momentum. You should plan the best way to share your successes with employees (internal communications) and your community (external communications).

External Communication

External communication can provide benefits for both the organization and the individuals involved. It can enhance an organization's image and show how the organization is meeting its responsibility to the community. For individuals, it can provide wider recognition. In addition, external promotion can make the energy program more integral to the company. External communication could include case studies, trade press articles, social media content, informal discussions among peers, organization open days, focus groups, community dialogue, involvement in community events, websites and e-mail, press releases, advertisements and periodic newsletters, and annual or other periodic reports. Better Plants offers a wide range of communications tools and materials that your company can leverage to expand communications about your energy efficiency accomplishments.

Internal Communication

Having communication channels in place among internal departments can make energy management initiatives more interesting and easier to understand. Internal communication should cover events like internal assessments, management reviews, , emails, team meetings, energy recognition activities, inquiries to energy professionals, and new energy efficiency best practices. Some means of promoting energy efficiency are posters, stickers, newsletters, notice-boards, exhibitions, website, and training sessions. Internal communications can provide a great mechanism to build an energy focused company culture. It also provides a means for soliciting new ideas for projects or practices as well as engaging and recruiting new members to your energy team.

[9] *Energy Intensity Baselining and Tracking Guidance 2020*, ORNL/SPR-2020/1566, Oak Ridge National Laboratory, Oak Ridge, TN, June 2020.

Beyond Energy Efficiency

After you have gotten started on your journey to improving your facility's energy efficiency, you may want to explore alternate energy sources to further reduce your energy and carbon footprints. There are several options for energy sources (combined heat and power, solar, wind) which can be obtained on and off site. On-site renewable generation can be a good way to reduce your carbon footprint, increase energy reliability, and promote your energy endeavors. Reducing water & waste generation also helps with resilience and reducing your carbon footprint.

Renewable Energy

Clean energy is picking up pace all over U.S., with more than 17.5% of the generation now coming from renewable sources (hydropower, wind, biomass, solar, and geothermal). Renewables not only help reduce greenhouse gas emissions but also are becoming cheaper than traditional resources. Renewable energy prices are generally predictable, with no price surges like the natural gas market.

The use of renewable energy is a common strategy for achieving zero carbon emission goals. Setting goals for renewable target helps engage the community (generating excitement and support for a plan), identify key issues and priorities, and signals their local industries to invest in renewable energy.

The U.S. DOE and the National Renewable Energy Laboratory offers a wide array of energy data and tools for renewable energy technologies. Two of these tools include REOpt Lite and the PV Watt tool which can help you estimate renewable project potential for your facilities given location. One great example to check out from a Better Plants partner is Schneider Electric's construction of a solar field to help with continuous energy improvement.

Water

Water is essential to manufacturers – whether for generating steam for complex steam processes or for simple domestic needs. Water is a resource that has come under increasing risk in recent years, making it more imperative to reduce water waste. Recognizing this, more manufacturers are expanding their sustainability efforts to include water efficiency and conservation. There are many challenges to implementing water efficiency measures at a manufacturing facility, such as poor payback on water efficiency projects and insufficient data on water use within the facility. However, understanding the true costs of water and assessing water efficiency opportunities can lead to substantial water and energy savings. Starting with basic good housekeeping practices and progressing to more advanced conservation strategies can help facilities establish a robust water management program.

The Better Plants Program has a water efficiency initiative where partners pledge to reduce their water consumption and in return receive technical assistance and recognition. The Program has developed several guides on developing a water management strategy and water reduction tips, a water focused In-Plant Training, as well as a Plant Water Profiler Tool for Industry based on the water/energy nexus to help you conduct a water balance and discover the actual cost of water waste.

How did they do it?

Nissan North America recycled plant water using advanced filtration systems.

Click here, or use QR Code to view

United Technologies Corporation developed a guidance document for global water conservation.

Click here, or use QR Code to view.

Waste

The Better Plants Program launched a Waste Reduction Pilot program in 2019 aimed to help facilities learn how to set, track, and meet waste reduction goals. Pilot program partners have formalized their commitment to waste reduction with goals that in some cases are similar to the Better Plants' energy goals.

Waste reduction can be tracked by a variety of metrics that fit the waste generation of the facility: waste to landfill diversion, absolute reduction, waste generation per employee (product or revenue), or even embodied energy flows in processes or products.

See how Bristol-Myers Squibb applied principles of green chemistry to significantly reduce their material waste.

Conclusion

Hopefully this guide has shown you that starting your energy journey is very doable. With a few simple steps, you will be well on your way to having a basic, but functioning energy efficiency program. These are the foundational pieces of any energy management program. Once you establish the basics, you just iterate on them until your company is at the "world class" level. To recap, the basic steps are:

1. Create an Energy Team and Culture
2. Set an Energy Goal
3. Get a Handle on your Current Energy Use
4. Examine your Major Energy Users
5. Identify Opportunities
6. Create an Action Plan and Implement
7. Track Performance and Celebrate Success
8. Look Beyond Energy Efficiency

Small to medium-sized manufacturers make up over 90% of all firms in the United States and account for up to 50% of industrial energy consumption. While these manufacturers may not have the same resources and expertise that their large manufacturing peers do, they still have meaningful opportunities to save energy. The U.S. Department of Energy and the Better Plants program wants to work with these manufacturers, and to help them leverage all of the no-cost, publicly available resources they exist for them through program like Better Plants, the IAC, 50001 Ready and the CHP TAPs.

Appendices

Appendix A — Glossary

Action Plan	A plan or document detailing how a facility plans to meet its energy goal(s), including energy efficiency opportunities that will be implemented.
Benchmarking	The task of both understanding how a facility currently operates (how much energy your plant or single SEU uses) and comparing to similar operations.
Energy Assessment	Energy assessments are a methodical review of a plant's energy usage and a great tool for identifying potential energy efficiency opportunities and training employees on efficiency. Assessments can be carried out internally, by a third party, or with help from the Better Plants program.
Energy Baseline	The energy baseline is a snapshot of energy consumption before implementing efficiency opportunities. The baseline is used to track energy usage for annual reporting and to validate savings.
Energy Champion	An individual in charge of a facility's energy use reduction program. Could also be known as an energy czar, manager, or guru.
Energy Conservation Opportunity	Any behavior resulting in the use of less energy.
Energy Efficiency	A measure of the amount of output per energy input. Being energy efficient means using less energy to perform the same task or eliminating energy waste.
Energy Efficiency Culture	An institutional culture that emphasizes energy efficiency and conservation from upper management through to the factory floor.
Energy Efficiency Opportunity	The use of a technology that requires less energy to perform the same or similar function.
Energy Efficiency Opportunity	A project or change that has a positive effect on a facility's energy efficiency.
Energy Intensity (EI)	EI is the energy consumed per unit of production (energy per parts produced, hours worked, etc.). Lower EI indicates a more efficiency use of energy at a facility.
Energy Management System	An organized and integrated approach to managing energy use that helps to reduce the financial burden from energy consumption.

	Effective energy management systems should be organized to outlast the current energy personnel.
Energy Performance Indicators (EnPIs)	EnPIs (also known as Key Performance Indicators or KPIs) are quantitative metrics used to monitor improvements in your energy efficiency. While simple EnPIs could be total energy, EI is a better measure for facilities with variable production.
Energy Sources	Any energy stream utilized within the facility, regardless of location of generation (electricity, wind power, natural gas, etc.).
Energy Treasure Hunts	A two- or three-day event where quick fixes and no-cost, low-cost energy saving projects are identified. These activities are essentially a miniature internal energy audit and can become a routine practice at facilities and even incorporated into employee contests.
Industrial Assessment Centers (IACs)	IACs offer no-cost assessments for small to medium-sized manufacturing facilities within the U.S. that meet specific criteria outlined on the IAC website. IAC teams conduct one-day, on-site assessments, identify energy, waste, and water saving recommendations, and deliver a detailed technical report within 60 days.
In-Plant Trainings (InPLTs)	InPLTs are on-site, multi-day training sessions hosted by a Better Plants partner at one of their facilities. The sessions are led by Better Plants experts who train participants on how to identify, quantify, implement, and replicate energy-saving projects.
Measurement and Verification (M&V)	The process for quantifying savings realized after completing energy efficiency projects.
Relevant Variables	Any external variable that affects energy usage at a facility. Relevant variables are used in regression analysis to model energy consumption of manufacturing plants. Example independent variables in a regression include production, heating degree days, cooling degree days, etc.
Significant Energy Users (SEUs)	SEUS are any equipment, system, or process that consumes a large fraction of a facility's energy demand. In some standardized energy management systems, this is further limited by being only equipment or systems that have savings potential.
Triple Bottom Line	An accounting framework that incorporates the social, environmental, and financial goals of a company.

Appendix B — Resources

Category	Resource	Links
Tools	DOE Energy Footprint Tool	https://www.energy.gov/eere/amo/downloads/energy-footprint-tool
	DOE Plant Energy Profiler Tool	https://www.energy.gov/eere/amo/downloads/plant-energy-profiler-excel
	Energy Performance Indicator (EnPI) Tool - Excel	https://www.energy.gov/eere/amo/articles/energy-performance-indicator-tool
	Energy Performance Indicator (EnPI) Lite - Online	https://enpilite.lbl.gov/
	MEASUR	https://www.energy.gov/eere/amo/measur
	ENERGY STAR Portfolio Manager	https://portfoliomanager.energystar.gov/pm/login.html
	50001 Ready Navigator	https://navigator.lbl.gov/
	Better Buildings Financing Navigator	https://betterbuildingssolutioncenter.energy.gov/financing-navigator
Guidance Documents	Better Plants Energy Intensity Baselining and Tracking Guidance	https://www.energy.gov/eere/amo/downloads/energy-intensity-baselining-and-tracking-guidance
	ENERGY STAR: Teaming Up to Save Energy	https://www.energystar.gov/buildings/tools-and-resources/teaming-save-energy
	Employee Energy Awareness planning guide	https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/power-smart/business/programs/employee-energy-awareness-planning-guide.pdf
	Guiding Principles for Successfully Implementing Industrial Energy Assessment Recommendations	https://www.energy.gov/sites/prod/files/2014/02/f7/implementation_guidebook.pdf
Assessments & Trainings	Industrial Assessment Center (IAC) Assessments	https://iac.university/
	DOE Better Plants In-Plant Trainings	https://betterbuildingssolutioncenter.energy.gov/better-plants/activity/plant-trainings
	DOE Energy Treasure Hunt Exchange Toolkit	https://betterbuildingssolutioncenter.energy.gov/energy-treasure-hunt-exchange-toolkit
Other	DOE System Tip Sheets	https://www.energy.gov/eere/amo/tip-sheets-system
	DOE Field Diagnostic Equipment Loan Program	https://betterbuildingssolutioncenter.energy.gov/better-plants/technology-solution/field-validation-and-diagnostic-equipment-program
	Better Buildings Solution Center	https://betterbuildingssolutioncenter.energy.gov/browse-solution-types

Appendix C — System-Specific Conservation Measures

Compressed Air:

1. Eliminate inappropriate uses of compressed air
2. Stabilize system pressure
3. Explore lowering pressure requirements of end uses
4. Minimize compressed air leaks
5. Provide compressed air of appropriate pressure and quality for manufacturing processes
6. Minimize unnecessary pressure loss through maintenance of filters and dryers

Fans:

1. Shut down fans when not needed by manufacturing processes
2. Use variable speed control on fan motors instead of modulating dampers or inlet guide vanes for airflow control
3. Ensure uniform airflow before fan inlet and after fan outlet to avoid swirls and vortices in the ducts
4. Replace standard V-belts with cogged belts
5. Operate close to Best Efficiency Point

Lighting:

1. Conduct a lighting audit – every 5 years
2. Consider redesign rather than "remove and replace" option
3. Consider lighting controls for improved efficiency
4. Check with local utilities for rebates and incentives

Motors:

1. Assess motor and drive system operating conditions
2. Establish a motor management program (repair/replace, purchasing, inventory & tracking motor life)
3. Provide proper maintenance as specified by the manufacturer
4. Select the right motor for different applications
5. Use variable speed control for motors with variable demands

Process Cooling and HVAC:

1. Design hydronic loops to operate chillers near design temperature differential
2. Use variable speed control on compressors with an appropriate condenser water reset
3. Design and Control Cooling Tower System for Low Condenser Temperatures
4. Reset chilled water supply temperature setpoints based on process load
5. Reset entering condenser water temperature setpoints based on ambient wet bulb temperature

Process Heating:

1. Check Burner Air-to-Fuel Ratios
2. Use Oxygen-Enriched Air for Combustion
3. Check Heat Transfer Surfaces
4. Reduce Air Infiltration in Furnaces
5. Furnace Pressure Controllers
6. Reduce Radiation Losses from Heating Equipment
7. Install Waste Heat Recovery Systems for Fuel-Fired Furnaces
8. Pre-heat Combustion Air
9. Pre-heat Loads Using Flue Gases from a Fuel-Fired Heating System
10. Using Waste Heat for External Processes

Pumps:

1. Shut down pumps when not needed by manufacturing processes
2. Operate the minimum number of pumps that systems require
3. Use variable speed control instead of throttle valves for flow control
4. Trim or change pump impellers on oversized pumps
5. Reduce pipe and valve pressure loss
6. Re-optimize pumping system when system requirements change
7. Restore internal clearances
8. Replace worn throat bushings, wear rings, impellers, pump bowls
9. When purchasing new pumps ensure that they are of proper sized/selection
10. When fully worn, replace standard efficiency motors serving pumps with NEMA premium

Refrigeration:

1. Minimize condensing pressure setpoint
2. Revise compressor/condenser control scheme to develop combinations that allow for most efficient sequencing
3. Implement variable speed control on the evaporator fan and compressor motor
4. Reduce system lift by raising suction or lowering discharge pressure
5. Apply floating head pressure control and oversize evaporative condenser

Steam:

1. Inspect and repair steam traps
2. Insulate steam distribution and condensate return lines and cover heated, open vessels
3. Install a condensing economizer
4. Use feedwater economizers for waste heat recovery
5. Minimize boiler blowdown
6. Recover heat from boiler blowdown
7. Replace pressure-reducing valves with backpressure turbogenerators
8. Use low-grade waste steam to power absorption chillers
9. Upgrade boilers with energy-efficient burners
10. Improve boiler's combustion efficiency

Water:

1. Conduct a water balance
2. Identify and fix leaks
3. Consider water efficiency in the design and procurement of new systems
4. Review equipment specifications and adjust water use accordingly
5. Eliminate once-through-uses where possible, such as for cooling or cleaning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