Mobilizing Industry: Energy Intensity Reduction Goal Setting for Competitiveness

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ABSTRACT

One of the keys to the food processing industry's ability to remain competitive in the global marketplace is its ability to use energy efficiently. Members of the Northwest Food Processors Association recognized the competitive benefits of pursuing energy efficiency and became the first industry group in the nation to establish an aggressive energy intensity reduction goal.

This paper describes the process to mobilize the regional food processing industry to set an industry-wide energy intensity goal. It also highlights the establishment and characterization of an industry-wide baseline, and progress to date toward achieving the goal. Barriers will also be identified as well as recommendations to overcome those barriers and lessons learned along the way.

Introduction

Founded in 1914, Northwest Food Processors Association (NWFPA) is a trade organization representing over 80 food processors in Idaho, Oregon and Washington with about 180 production plants and about 350 products and service suppliers to the food processing industry. Food processing is the third largest manufacturing sector employer in the Northwest and the second largest user of electricity after the pulp and paper industry.

NWFPA's energy program began in 2003 with a grant from US Department of Energy's (USDOE) Industries of the Future, followed by NWFPA participation in a multi-state State Technologies Advancement Collaborative grant. This funding, along with the partnerships developed with USDOE, the state energy offices, and Northwest Energy Efficiency Alliance (NEEA), allowed NWFPA to establish program infrastructure and provide resources to NWFPA's members. In 2006, NEEA began its six-year Food Processing Initiative which provided expanded training and education, promoted the adoption of energy management into business practices, and supported energy goal setting, roadmap development, and tracking of progress to the goal.

In October 2008, NWFPA, USDOE and NEEA hosted a two-day, facilitated Energy Vision Workshop where food processing executives came together to discuss challenges facing food processors and how energy relates to these challenges, and to consider developing an energy vision and energy intensity goal for the industry. These industry leaders produced both a vision and a goal that were adopted by NWFPA's board of directors in January, 2009:

- **NWFPA Energy Vision**. Enhanced productivity and competitiveness through a sustainable energy efficiency plan.
- **NWFPA Energy Goal**. Reduce member-wide energy intensity by 25% in ten years and by 50% in twenty years.

Energy Intensity Goal Setting

NWFPA uses its energy intensity goal, and the roadmap to achieve the goal, as a means to focus the energy efficiency efforts of the association and its members, and to increase energy efficiency activities in the food processing industry. NWFPA believes that it makes good business sense for industrial manufacturers to focus on energy for a number of reasons:

- Energy is vital to the core business and directly impacts the bottom line.
- Energy prices are increasing or are volatile.
- Energy can be the largest uncontrolled expense at a manufacturing plant.
- Energy often accounts for over 90% of greenhouse gas emissions at a plant.
- Customers want "green" and "sustainable" products.
- Utility incentives and other funding and resources are available for energy efficiency.

An industry-wide goal and roadmap also make sense because they can (1) serve to focus efforts in bringing resources to the industry; (2) enhance the competitiveness of participating companies; (3) attract partners and enhance funding opportunities; (4) garner public recognition for the organization and/or individual companies; and (5) influence regulators, legislators and policymakers.

Nevertheless, the goal and roadmap can only become a reality if industry believes that energy efficiency and goal setting make good business sense. Manufacturers continue to face the same challenges that NWFPA's members discussed at the Vision Workshop in 2008: global competition, rising energy prices, climate change, water shortages, consumer demands for sustainable products, and increased costs of commodities. To move an industry to take action, energy efficiency should be viewed as not just about reducing energy bills but about increasing productivity and bottom-line performance and meeting challenges that the industry faces.

Step One: Executive Ownership

The first and most important step in the energy intensity goal process was to secure ownership of the goal by industry executives. Lacking ownership by industry leaders, there may be little support to take actions to achieve the goal at either the association level or the individual plant level. The surest way to ownership is to have industry executives set the goal. To provide food processing executives with background information for informed decision making, USDOE and NWFPA staff developed a white paper discussing key energy-related challenges and recommending topics for consideration at the Vision Workshop (NWFPA 2008). In addition, the first day of the Vision Workshop included presentations by experts on each of the energy-related challenge topics.

A key outcome of the Vision Workshop discussions was a collective recognition by the food processing executives that the most effective way to manage energy costs and reduce greenhouse gas emissions, while at the same time increasing productivity and economic growth of food processors, was to implement greater energy efficiencies. These leaders understood that energy is a product input just as labor, capital, and materials are product inputs, which was a significant departure from earlier views of energy efficiency as merely a way to reduce energy bills. They also tied reducing energy use per unit of production to the larger challenges of global competitiveness, climate change and sustainability. Essentially, they made for themselves the business case for energy efficiency.

Step Two: Industry-wide Ownership

The second step in the energy intensity goal process was to achieve support within the industry for the goal. To achieve this objective, NWFPA held a one-day Energy Roadmap Workshop to inform the membership about the goal and why the executives decided to set the goal. NWFPA also wanted to engage members in the process by seeking their help in identifying energy efficiency measures and strategies that could be included in the NWFPA Energy Roadmap. Attendees included food processing company employees, utilities, state energy offices, USDOE, NEEA, Bonneville Power Administration, Energy Trust of Oregon and energy consultants and service providers. Over 500 ideas to promote energy efficiency and reduce energy intensity were recorded.

NWFPA recognized that the actions that each individual company takes to reduce its own energy intensity are what contribute to the industry-wide reduction in energy intensity. Therefore, the NWFPA Energy Roadmap (Barrow 2010) defined the basic steps required to develop and implement a strategic energy management plan. NWFPA's objective was to move food processing companies from an ad hoc, reactive approach to energy to a managed, measured and planned approach. The Roadmap includes a self-assessment so that companies can characterize their current approach and understand what is required for improvement.

Step Three: Partner Support

Energy efficiency is a "team sport." NWFPA views USDOE, NEEA, Bonneville Power Administration, Energy Trust of Oregon, the state energy offices, utilities and service providers as partners on its team to achieve the energy goal. These organizations provide advice, support and resources to the energy efforts of NWFPA and its members. Engagement with such partners is critical to progress toward an energy intensity reduction goal. It is also helpful to engage partners in steps one and two of the goal-setting process.

Key Points about an Industry-Wide Energy Intensity Goal

Initially, some industry members had reservations about setting an energy intensity reduction goal and the ability of the industry to achieve the goal. Other industries are likely to have similar reservations. The food processing executives at the Vision Workshop recognized that certain attributes of the goal needed to be clarified to gain industry-wide support for adoption. First, the goal is to be voluntary and not mandatory. The choice to participate is up to individual companies. Second, the goal is industry-wide and not plant-specific. The expectation is that some companies may achieve more than a 25% reduction in energy intensity and others may achieve far less. Nevertheless, all participating companies contribute to achieving the goal. Third, the goal is not a requirement but a target. The 25% in ten years goal was based on the best "guesstimate" of industry executives of what might be achievable. There was no reliable data available on the potential for energy intensity reduction in the food processing industry. Moreover, they decided to add the 50% in twenty years goal as a call to action for the industry and its partners, recognizing that this additional goal can only be achieved through innovation, new technologies and new resources.

Energy Intensity Baseline and Tracking Progress to the Goal

Methodology

Energy intensity was chosen as the metric for the goal because energy intensity is a measurement of the quantity of energy required per unit output or activity. The intent of the goal is to increase energy productivity and industry vitality by using less energy to produce a product, or, alternatively, to produce more product with similar energy inputs. Both reduce energy intensity. This measure can be expressed mathematically, as shown in Equation 1 (EERE).

$$I_{e,i} = \frac{E_{t,i}}{A_{t,i}} \qquad (1)$$

Where:

$I_{e,i}$ Energy intensity for a given plant "i"

$E_{t,i}$ Total delivered energy used at a given plant "i"

$A_{t,i}$ Total activity, or total output from plant "i"

Energy was expressed in British Thermal Units (BTU) of delivered energy because the units are easily understood in the industry by most plant and corporate personnel. All forms of consumed energy were converted into BTUs.

Activity can be measured as any useful output from a plant. Due to the large variation in types of product, a mass value was used. For ease of understanding, the mass unit chosen was pounds. The resulting units of energy intensity are thus BTUs per pound of finished product expressed as "BTU/Lb."

Energy and production data from each plant were collected in one-year time periods coinciding with the calendar year, January 1 to December 31. Evaluation of one-year periods mitigated the seasonal variations in energy consumption due to outside ambient temperature and production volumes, which are timed with harvests and/or affected by seasonal consumer demand. Data collection normally spanned three years at each sampled plant in order to track trends or identify any significant changes in operations that may have been noteworthy. However, to make energy use data and production data coincide in time, a company often needed to contact its utility provider(s) to obtain consumption data within the specified temporal window.

Data collection initially started with 47 food processing plants and has increased to 120 plants across the northwest at the time of publication. The baseline year was set at 2009 (the year the goal was adopted) and tracks from 2009 to present. Data were initially requested for the years 2006 through 2009, with yearly updates for tracking progress to the goal in 2010, 2011 and 2012. Due to variability in record keeping, not every participating plant has been able to provide complete data across the requested years. Although utility companies are a source of energy consumption data, retention beyond the most current 3-year period is sporadic.

Sub-Cluster Characterization

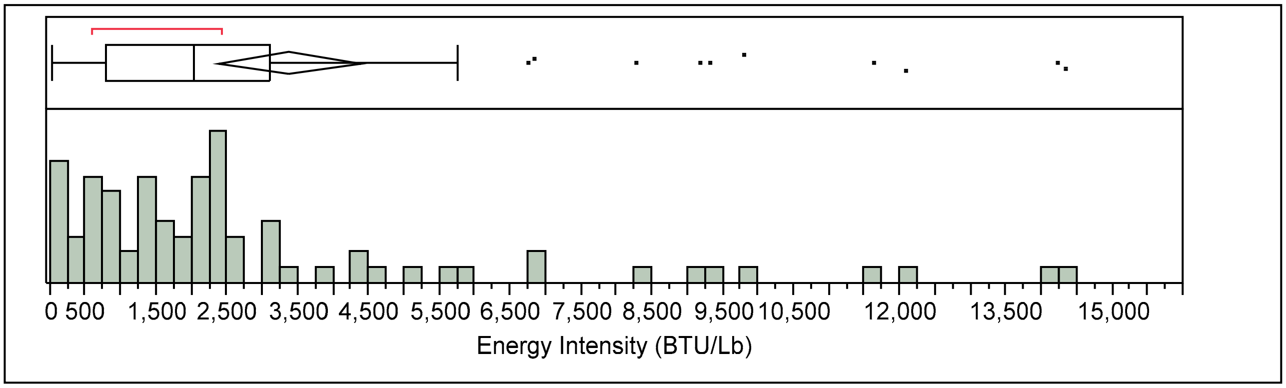
The food processing industry is very diverse and produces numerous products utilizing a wide variety of processes with differing energy inputs. This diversity complicates characterization of the industry-wide energy intensity baseline and measurement of progress to the goal. Energy intensity values for each plant were sub-characterized by the plants' primary North American Industrial Classification System (NAICS) identifier. Baseline participants were classified by the sub-clusters shown in Table 1.

Table 1. Major Food Processing Sub-Clusters

Sub-Cluster	NAICS	Description	Sub-Cluster	NAICS	Description
Grain & Oilseed	311211	Flour Milling	Animal Slaughtering & Processing	311611	Animal (not Poultry)
	311212	Rice Milling		311612	Meat Processed from Carcasses
	311213	Malt Manufacturing		311613	Rendering and Byproduct Processing
	311221	Wet Corn Milling		311615	Poultry Processing
	311222	Soybean Processing	Baking	311230	Breakfast Cereal Manufacturing
	311223	Other oilseed processing		311812	Commercial Bakeries
Sugar	311311	Sugarcane Mills		311813	Frozen Cakes, Pies, & Pastries
	311312	Cane Sugar Refining		311821	Cookie & Cracker
	311313	Beet Sugar Manufacturing		311822	Mixes & Dough from Purchased Flour
Frozen Foods	311411a	Frozen Fruit, Juice, & Vegetables. (excluding Potatoes)		311823	Dry Pasta Manufacturing
	311411b	Frozen Potato Products		311830	Tortilla Manufacturing
	311412	Frozen Specialty	Prepared Refrigerated Foods	311941	Mayonnaise, Dressing, & Other
	311520	Ice Cream & Desserts		311991	Perishable Prepared
Canning	311421	Fruit & Vegetable	Prepared Non-Refrigerated Foods	311320	Choc./Confectionery Mfg. from Cacao
	311422	Specialty Canning		311330	Confectionery Mfg. from Purch. Choc.
Dehydrators	311423	Dried & Dehydrated		311340	Non-chocolate Confectionery Mfg.
	311514	Dry, Condensed, & Evap. Dairy		311911	Roasted Nuts and Peanut Butter
Dairy, Milk, Cream, Cheese	311511	Fluid Milk Manufacturing		311919	Other Snack Food Manufacturing
	311512	Creamery Butter		311920	Coffee & Tea Manufacturing
	311513	Cheese		311930	Flavoring Syrup & Concentrate
Seafood	311711	Seafood Canning		311942	Spice and Extract Manufacturing
	311712	Fresh & Frozen Seafood		311999	All Other Misc. Food Manufacturing

There is a wide variation in energy intensity within the food processing industry. The histogram in Figure 1 illustrates the data distribution. NWPFA research compared sample distributions of energy intensities against a larger sample set of historical data from Industrial Assessment Center data and found a positively skewed lognormal distribution of intensity values (NWFPA 2009).

Figure 1. Variation of Energy Intensity across the Food Processing Industry



Source: NWFPA Energy Intensity Baseline

Typical values of energy intensity by sub-cluster are shown in Table 2.

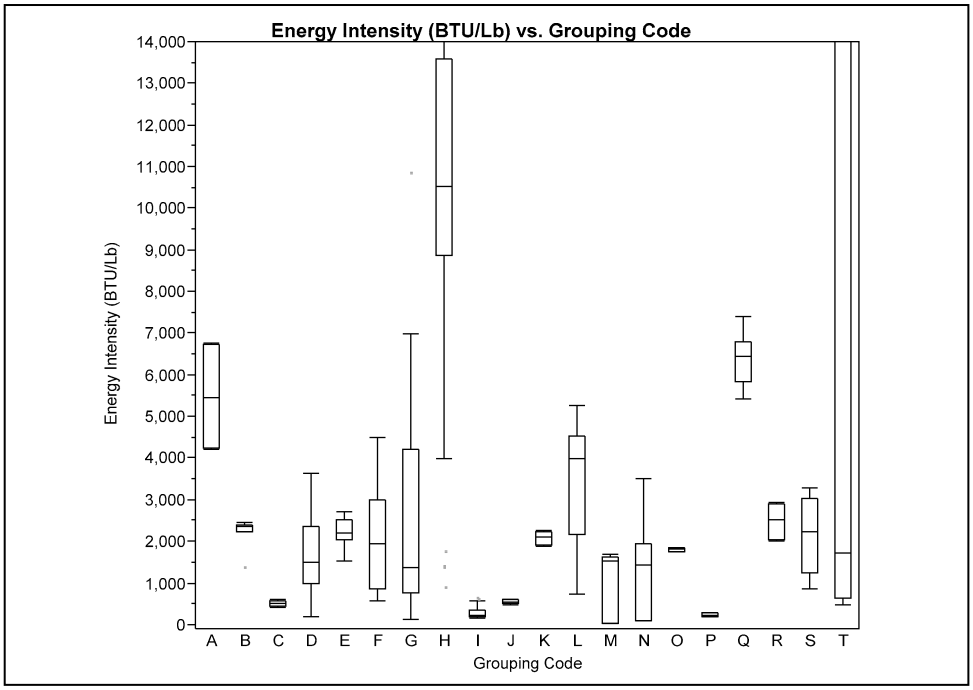
Table 2. Energy Intensity by Process Method

Processing Method	Energy Intensity (BTU / Lb)
Dairy, Milk, Cream, Cheese	375
Grain & Oilseed	473
Frozen Foods	1,073
Baking	1,125
Prepared Refrigerated Foods	1,153
Seafood	1,182
Canning	1,913
Animal Slaughtering and Processing	2,570
Prepared Non-Refrigerated Foods	3,257
Dehydrators	4,656

Source: NWFPA 2009, IAC data

The variation of energy intensity by food processing sub-clusters within NAICS code 311--- is displayed graphically in Figure 2.

Figure 2. Energy Intensity by Sub-Cluster



Source: NWFPA Energy Intensity Baseline

Characterizing Industry-Wide Energy Intensity: Use of Aggregate, Mean and Median

To understand an energy intensity value based on many plants within an industry, it is important to understand the definitions of the energy intensity values that can be used to characterize a group of plants. There are three ways to evaluate the industry intensity: aggregate, mean, and median.

Aggregate energy intensity. The aggregate energy intensity value is simply the sum of all the energy consumed by the industry sector divided by the sum of the finished product produced by the sector. This is shown in Equation 2.

$$I_{e,s} = \frac{E_{t,s}}{A_{t,s}} = \frac{\sum E_{t,i}}{\sum A_{t,i}} \quad (2)$$

Where:

$I_{e,s}$	Aggregate energy intensity for the cluster sample "s" (BTU/Lbs)
$E_{t,s}$	Total delivered energy used by the cluster sample "s" (BTU)
$A_{t,s}$	Total activity, or total output from the cluster sample "s" (Lbs)
$I_{e,i}$	Energy intensity for a given plant "i" (BTU/Lbs)
$E_{t,i}$	Total delivered energy used at a given plant "i" (BTU)
$A_{t,i}$	Total activity, or total output from plant "i" (Lbs)

Mean energy intensity. Another approach is to use a mean energy intensity value, which is the mean of the sample of each individual plant's energy intensity and is show in Equation 3.

$$I_{e,s} = \left[\frac{1}{n_s}\right] \sum \left[\frac{E_{t,i}}{A_{t,i}}\right] \quad (3)$$

Where:

$I_{e,s}$ Mean energy intensity for the cluster sample "s" (BTU/Lbs)
n_s Number of plants (facilities) in the cluster sample "s"
$E_{t,i}$ Total delivered energy used at a given plant "i" representing the sub-cluster (BTU)
$A_{t,s}$ Total output from plant "I" representing the sub-cluster (Lbs)

Median energy intensity. Yet another approach is to use the median energy intensity value, which in some non-normal distributed samples may better describe the central tendency of the plants. Simply described, the median value is the center of the ordered set of individual plant energy intensity values. An example of the median value of an ordered sample population set is shown in Figure 4 below.

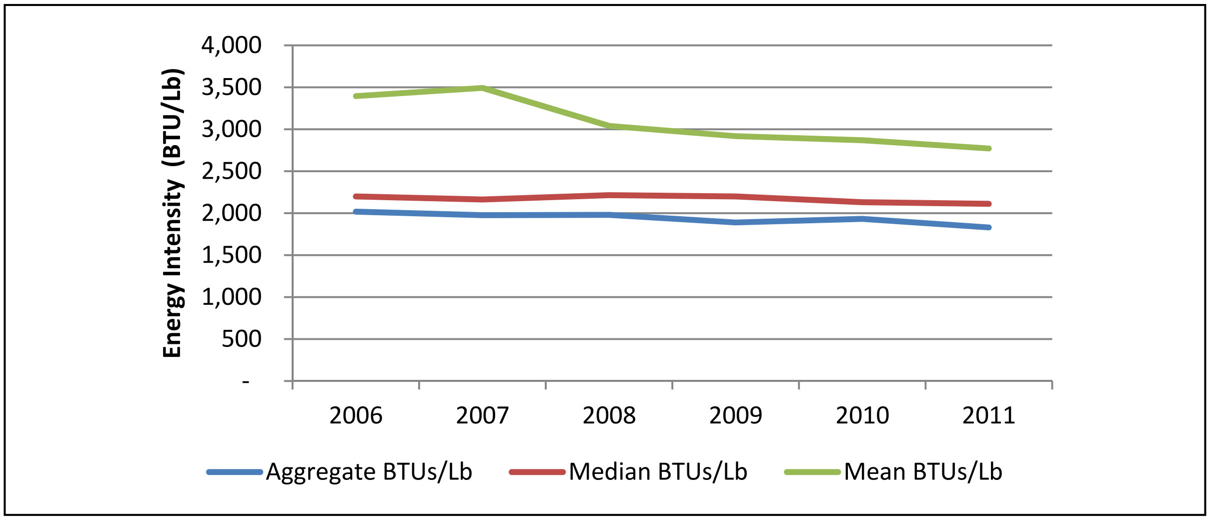
Figure 4. Example of Median Energy Intensity

Because of the ability to better describe the central tendency of the distribution of individual plant energy intensities, the median energy intensity value was chosen to report the northwest food processing cluster energy intensity baseline value (NWFPA 2009).

Progress Towards the 25% Energy Intensity Reduction Goal

Industry-wide, median energy intensity has decreased by 3% since 2009 and 9% from 2006; aggregate energy intensity decreased by 3% since 2009 and is down 9% from 2006; and the mean energy intensity has decreased by 5% since 2009 and by 18% since 2006. Figure 5 shows the industry-wide intensity reductions from 2006 to 2011.

Figure 5. Sector-wide Energy Intensity Progress

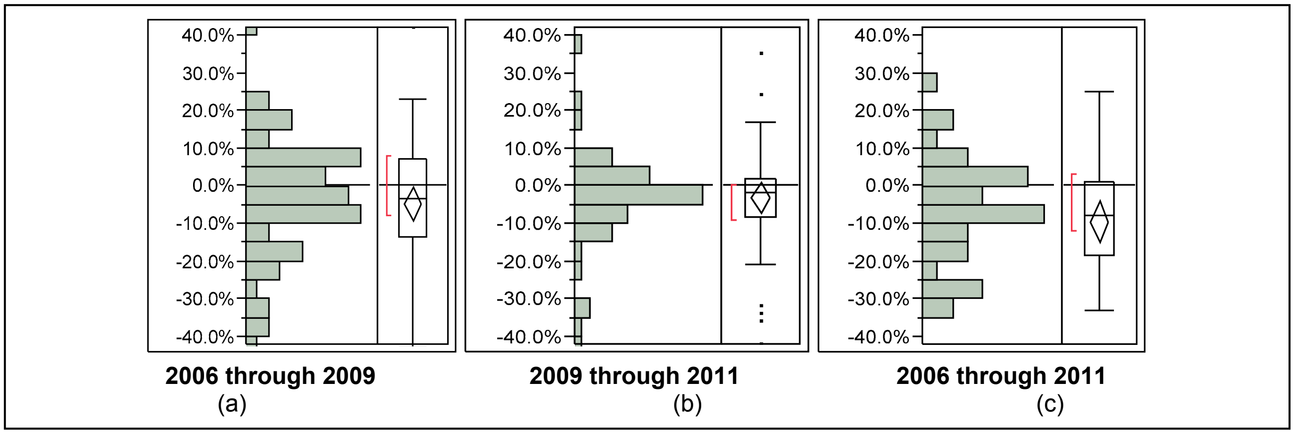


Source: NWFPA Energy Intensity Baseline

The industry-wide energy intensity metric shows progress in reducing energy intensity to achieve the goal. However, the wide variation in intensity values across sub-sectors, combined with inconsistent industry participation, impacts industry-wide reporting. Plants with any missing data within the study period were omitted. Therefore, the reported results include only 44 plants with complete data sets across the study period and not all 120 participating plants. Unfortunately, some very impressive individual plant achievements were omitted from the reported results because their data sets were incomplete.

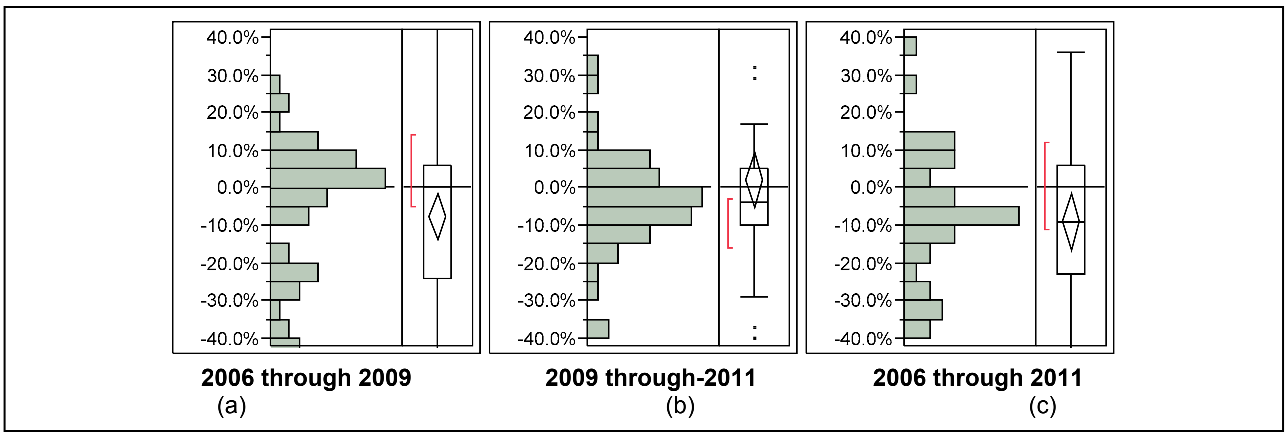
Comparing year-to-year energy intensity percentage change at individual plants prior to adoption of the NWFPA goal (2006 – 2009 data) to post-goal adoption (2009 – 2011 data) indicates increased year-to-year savings. Improved year-to-year energy intensity percentage reductions were observed after the goal was set. The histograms in Figure 6 show the distribution of the percentage change in energy intensity at individual plants for the periods 2006 – 2009 (pre-goal), 2009 – 2011 (post-goal), and from 2006 to 2011 (entire study period). When pre-goal results (6a) are compared to post-goal results (6b), a greater number of plants show a percentage reduction in energy intensity after the goal was set. The histograms in Figures 7 and 8 show electrical and natural gas percentage changes, respectively, with electrical intensity exhibiting reductions post-goal. Gas intensity percentage reductions also decreased post-goal, despite the drop in natural gas prices.

Figure 6. Energy Intensity Percentage Change



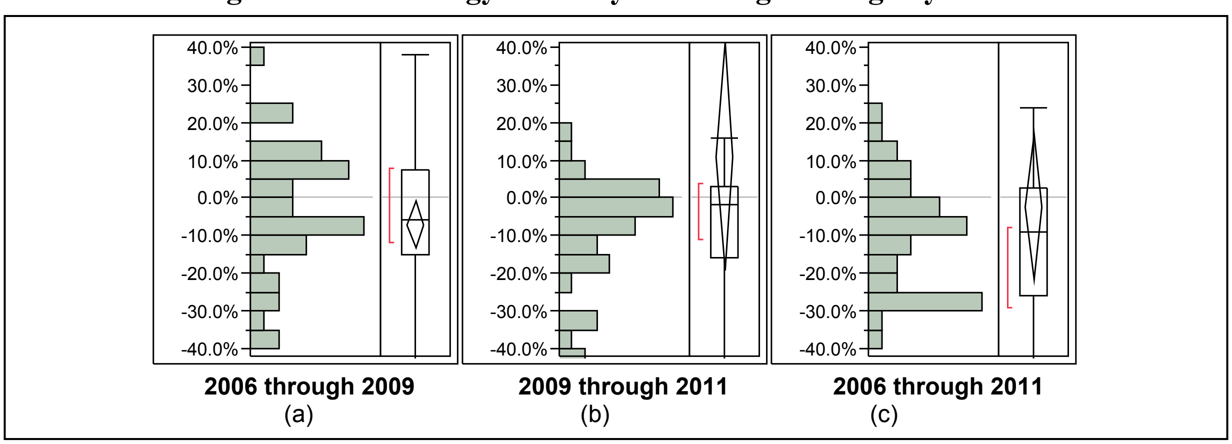
Source: NWFPA Energy Intensity Baseline

Figure 7. Electrical Energy Intensity Percentage Change



Source: NWFPA Energy Intensity Baseline

Figure 8. Gas Energy Intensity Percentage Change by Period



Source: NWFPA Energy Intensity Baseline

Challenges and Lessons from Industry-Wide Energy Intensity Tracking

Data Intervals

At the outset, it was thought that collection of energy and production data in annual intervals was sufficient to characterize the baseline energy intensity of the northwest food processing industry. Because managers and other data-reporting individuals have limited time to accomplish their regular duties, the data collection was simplified to use a calendar-year time increment for energy and production data.

In 2011, data collection was transitioned to monthly intervals to provide greater insight into the plants' energy use - to better determine plant energy profiles, to understand seasonality, and to help identify anomalies and data-reporting errors. For example, using annual energy and production data, a site with a plant expansion exhibited an energy intensity increase in a single year followed by a decrease the following year. With monthly data, the impact of increased energy use and production ramp-up to planned utilization levels was recognized. In addition, errors can be more readily discovered such as the reporting of differing metering groups, and errors of transcription or omissions.

Since monthly utility bill data is typically used to determine the annual plant energy consumption the transition has been well-received, although selected plants prefer reporting annual figures for confidentiality reasons. Going forward, all data is being collected in monthly intervals, but success has been mixed in back-collection of historical monthly data to replace previously-reported annual data for the years 2006 to 2010.

Energy Intensity and External Drivers of Energy Use

Energy intensity is a metric that can be well-understood by industry and works well for many plants. Energy intensity is a good starting point to raise energy efficiency awareness and increase energy fluency at the operating level.

Many factors cause changes in energy intensity that have little bearing on the plant's energy performance. For instance, energy intensity at many plants increased as production levels dropped during the Great Recession. Besides plant utilization, product mix and input product attributes also impact energy intensity. Weather has an influence on energy consumption and energy intensity, although generally with a lesser impact than the aforementioned factors.

NWFPA discovered situations where other factors can significantly impact energy intensity if not normalized. For instance, a plant that had implemented several energy efficiency measures during the study period saw only marginal energy intensity change. However, after normalizing for product mix and weather its improved energy performance became apparent.

Normalization of energy consumption using readily available regression tools such as the EnPI 3.0 (EERE) can help plants better understand and track their energy performance. Similar methods using statistical models to disaggregate industrial energy use into production-dependent, weather-dependent, and independent components (Kissock and Seryak 2004) (Abels, et al 2011) (Lammers, et al 2011) could enhance energy intensity tracking by considering external drivers.

Data Confidentiality

Confidentiality was the greatest barrier to initial progress on the baseline establishment and tracking of progress to goal. Food processors consider energy use data and especially production data as highly confidential. Despite NWFPA's close relationships with food processors, assurance of confidentiality at the outset of the project was a major issue. After several months of meetings and conference calls, NWFPA and its members agreed to the following protocol:

- A non-disclosure agreement is signed with each participating company that defines how the data may be used and reported by NWFPA. NWFPA will only release data in the aggregate and individual company data will not be discernible.
- Data is stored on the NWFPA network on a secure drive with access limited to approved staff and contractors. Company names are stripped from data files and replaced by a code. The company names and corresponding identifiers are maintained in a separate secure file.

Timeliness of Data Submissions

Timeliness of data submissions continues to be a major issue for completeness of the NWPFA Energy Intensity database. Plant participation is voluntary and not a prime priority for plant personnel with other pressing responsibilities. NWFPA simplifies the process with a spreadsheet reporting template for electronic data submission to permit a simple cut & paste from internal company reports. The reporting spreadsheet has been improved over time to include energy graphs using plant data to provide valuable visualization and encourage use. Other preferences in energy reporting formats by participating plants are accepted by NWFPA research staff to encourage participation. In addition, NWFPA will collect energy data directly from utility provider(s) with consent from participating companies to reduce participant's efforts. However, production data must still be acquired from the participating plant.

Another challenge is electricity use data is only maintained on a rolling three-year basis by many utilities. Data older than three years is archived on a different system and is unavailable, very difficult to access and/or requires payment of a fee, depending on the utility. This is particularly problematic for capturing historical data on new participants in the energy baseline tracking project.

Conclusion

Mobilizing an industry to adopt an industry-wide energy intensity goal requires education and outreach to the industry in general as well as conversations with senior management at individual companies. Executive ownership and industry-wide ownership are essential to adoption and successful progress toward achieving the goal. The critical prerequisite to adoption, however, is that industry must articulate for itself the business case for energy efficiency. If the industry does not see the connection between energy efficiency and core business objectives and challenges there will be little perceived value in adopting a goal.

Tracking progress of the industry toward the goal requires establishment of an industry energy intensity baseline and a system to collect and analyze data. Confidentiality and data submission challenges can thwart data analysis efforts and impact characterization of industry-wide progress toward the goal. Even so, a direct benefit of the goal and the baseline and tracking effort has been a raised industry awareness of energy use monitoring and tracking which has moved the industry to collect and monitor its energy use. Prior to NWFPA data collection, a number of companies did not track their energy use. Energy bills went to the accounting department for payment and energy use was seldom recorded and reviewed. NWFPA has been working with food processors to improve data collection and monitoring, including the use of energy monitoring and management systems. Further, tools such as USDOE's EnPI can provide assistance as well as education and training specific to industrial site energy use data collection, monitoring and analysis.

Industry must understand what the goal means. Despite clarification by industry executives, several NWFPA members remain concerned that the goal may not be achievable. Some question why the organization should strive to achieve a goal when there is no certainty that it is achievable. They also fear that non-achievement could be viewed as a failure and not reflect well on the industry. Communication with industry on a regular basis on progress to the goal, roadmap activities and accomplishments, and benefits to the industry that result from the goal and roadmap are essential to alleviating concern and bolstering participation. A well thought out communication strategy that includes industry partners as well as industry members will attract support for goal efforts and advance progress toward the goal.

NWFPA analysis indicates progress to achieving the 25% energy intensity reduction goal of between 3% and 5% over the two-year period following goal adoption, or 1.5% to 2.5% per year. NWFPA believes this is good progress, especially considering that some plants have been excluded due to incomplete data sets. Many of these excluded plants had significant reductions in energy intensity. NWFPA is continuing to acquire data to complete sets in the database and add new plants.

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