# TRACKING ENERGY USE AT INDUSTRIAL COMPANIES

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## 1. INTRODUCTION

Increased competition in product markets has forced U.S. industrial companies to explore ways to reduce costs, including energy expenditures. Increasingly, large and small industrial companies are undertaking energy measurement programs to identify potential energy and cost savings opportunities and to monitor progress. Plant managers can experience first-hand the improvement in their own facility's competitive position by understanding and then implementing successful energy management strategies. Corporate energy managers have the ability to disseminate successful plant energy management strategies through all areas of operation, bolstering a company's competitiveness and insulating it from future price increases.[1]

The development of an effective energy tracking mechanism can help identify energy savings opportunities. Knowing how energy is purchased and used is critical information in deciding how capital is allocated for energy-saving investments. Energy tracking can support environmental reporting efforts for air emissions such as $CO_2$ and $SO_2$. Such efforts can complement voluntary partnerships for reducing greenhouse gas (GHG) emissions such as *Climate Wise*. In addition, energy tracking data can support the voluntary GHG emissions reporting program established under Section 1605(b) of the Energy Policy Act of 1992.

Figure 1. Climate Wise Overview

*Climate Wise* is a partnership initiative between the U.S. Environmental Protection Agency, the U.S. Department of Energy, and industry, designed to stimulate voluntary reductions of GHG emissions by recognizing companies that commit to significantly reduce their emissions. The initiative is a foundation action in the President's Climate Change Action Plan (CCAP). *Climate Wise* hopes to spur innovation by encouraging broad goals, providing technical assistance, and allowing organizations to identify the most cost-effective ways to achieve savings. In addition, *Climate Wise* partners receive public recognition for their efforts.

## 2. TRACKING ENERGY USE

Industrial companies track energy use for reasons such as logging production costs and monitoring process efficiency. Detailed energy data are retained for facility and corporate records, and corporate-level information may be forwarded to industry trade organizations.

### 2.1 Data Collection

For a successful energy tracking system, companies should collect energy consumption and energy cost data for each fuel type. In some cases purchased steam will also be logged. Energy use data are usually available from utility meters and fuel bills or automated energy management systems. Energy-intensive process equipment, such as boilers and kilns, will often be metered individually. When submetered data are available, energy consumption and costs can be broken down by application or *end-use* – for example, the share of energy consumed for motors — useful for identifying potential energy savings opportunities and evaluating past improvements. Metering equipment is generally less expensive to implement at the time of equipment installation. Companies such as Johnson & Johnson keep track of *process* and *non-process* energy use. Process refers to energy used for

manufacturing such as motors, steam, and compressed air. Non-process refers to energy consumption for lighting, heating, ventilating and air conditioning. Energy data can be reported to a corporate energy office on paper or electronic forms with varying degrees of automation.

Figure 2. Johnson & Johnson[2]

Johnson & Johnson (J&J) has had an active energy efficiency program since 1972. As part of their *Climate Wise* pledge, J&J's corporation-wide goal is to reduce indexed energy use by 25% from 1991-2000. (Indexed energy use accounts for changes in output and weather.) Since 1991, J&J has achieved a 15.2% cumulative reduction in indexed energy use. Annual savings in 1995 relative to 1994 attributed to *Climate Wise* efforts were approximately 21,000 metric tons of $CO_2$. Each facility at J&J is a profit-center, so plant managers have the perspective to consider long-term energy costs and the authority to make capital expenditures. The Corporate Engineering Services office provides technical assistance and conducts energy surveys to help facilities identify savings opportunities. J&J offers awards to the facility and company with the best efficiency improvements.

Facilities at J&J track *process* and *non-process* energy use. Each facility selects a processing index (measure of production) to normalize process energy use. Facility energy use and cost data are entered, summed, and submitted electronically to Corporate headquarters for analysis and aggregation with data from other facilities. J&J has developed an interactive database of project information for 1605(b) greenhouse gas reporting and to aid internal communication.

### 2.2 Indexed Energy Use and Energy Metrics

Energy and cost savings opportunities may be overlooked if energy use data are not collected and examined by management. It is often helpful to normalize energy use based on production output or facility size. Energy indices allow for comparisons of energy use across years or facilities while correcting for changes in production or company size. Choice of appropriate metrics may vary from company to company and from facility to facility. A cement plant might measure energy intensity in terms of energy consumption per ton of cement produced, while a carpet mill might examine Btu per square foot of carpet. When different facilities have different processing indices, their energy efficiency improvements can be compared on a percent basis, or by devising a common processing index.

Metric choice may also vary by fuel input. For example, a facility that heats metal in a gas-fired furnace and stamps it into shape with an electric press may consider Btu/lb of product for information on furnace and process efficiency, and kWh/lb product to examine press efficiency.

Not all energy use is associated with identifiable outputs. For example, corporate headquarters buildings generally employ individuals to deliver internal services. Facility or corporate characteristics that do not directly correlate to production, but that can significantly influence energy consumption can be reflected in metrics such as Btu per square foot of floor space or Btu per employee. As there may not be a single, ideal metric for any particular facility, it is often useful to analyze a variety of metrics. Figure 3 lists some sample energy metrics.

Figure 3. Sample Energy Metrics (Energy Use Index/Output Index)

| **Energy Use Indices** | **Output Indices** | |
|---|---|---|
| • Total Btu | ***Energy-intensive facilities*** | ***Non-energy intensive facilities*** |
| • Btu by fuel type | • Pounds of output | • Facility square footage |
| • Total energy expenditures | • Number of units of output | • Number of employees |
| • Energy expenditures by fuel type | • Total production costs | • Hours of operation |
| | • Units of intermediate outputs such as steam | |

Some companies analyze energy tracking data to identify deviations from the norm at the facility level. This may mean simply keeping an eye out for anomalies in fuel consumption. Drastic changes in energy use that cannot be explained by changes in production or operating hours might indicate equipment malfunction. Energy tracking data are also used to assess progress toward meeting energy efficiency goals. The raw data may need to be modified (via processing indices and degree days) to account for changes in production and weather.

One of the more innovative uses of energy tracking data is for comparisons among multiple facilities that produce the same product or employ the same process. In such cases, tracking data can be used to identify key energy-efficiency opportunities at numerous sites. If the opportunity involves a new technology or process, companies may invest in pilot projects at one or two facilities.

Figure 4. The 3M Company[3]

Since 1973 3M has monitored energy use at its facilities and has reduced energy use per-unit-output by 60%. The Corporate Energy Policy announced in 1991 has as its objectives to "improve energy consumption efficiency, reduce cost, decrease capital investment, reduce environmental emissions and conserve natural resources." 3M's short-term energy objective is to achieve an annual 3% reduction in energy use per-unit-output through the year 2000. 3M has joined the *Climate Wise* Program as part of its efforts to increase energy efficiency and reduce greenhouse gas emissions.

At 3M, each facility selects and implements energy efficiency projects. The company has been pleased with this voluntary approach. Cumulative savings from 1973 to 1995 have amounted to $1.5 billion and 380 trillion Btu. 3M is currently saving 2.7 million tons of $CO_2$ per year. In the long term, 3M is committed to continuous improvement in the efficient use of energy.

Facilities report their monthly energy use and production indices to The Energy Management Department which prepares quarterly reports on each facility's energy use and Btu per pound of salable product. These data and energy cost information from the Purchasing Department are maintained in a database. The Energy Management Department distributes technical guidelines and manuals. 3M sees many energy savings opportunities in common-sense approaches that focus on making the best use of existing resources. Sometimes the solution is as simple as reducing a temperature setting or turning off machinery when it is not in use.

There is strong potential for feedback and interaction among these various applications of energy tracking data. With appropriate supplemental data and analysis, energy tracking data can help identify savings opportunities and evaluate the effectiveness of energy efficiency programs.

## 3. CORPORATE ENERGY EFFICIENCY PROGRAMS

Corporate energy efficiency efforts range from the individual efforts of inventive plant managers to formal corporate energy policies signed by the CEO. Corporate energy policies serve to integrate energy awareness into company culture, and may include explicit goals.

### 3.1 Energy Policies and Goals

Corporate-level awareness of energy use and expenditures and top-management commitment to reducing energy use are essential for emphasizing that reducing energy use is a priority. When specific energy savings goals are set, the importance of energy efficiency is reinforced even more. Explicit goals can provide tangible targets and serve as a yardstick against which to measure achievements. Goals may be expressed as an absolute reduction in energy use or as indexed goals that account for energy efficiency improvements in the context of increased production. For example, 3M's short-term energy goal is to achieve a three percent reduction in energy use per-unit-output through the year 2000. On the other hand, Dow Chemical's successful "Energy/Wrap" contest did not establish a specific savings target but focused on sustaining the processes and mechanisms by which energy efficiency projects are developed and implemented.[4]

### 3.2 Organizational Structures

Successful corporate industrial energy management efforts delegate responsibility and authority to facilities or business units for implementing efficiency programs. Innovative corporate energy offices often organize workshops, coordinate inter-departmental *energy teams*, provide technical assistance, and distribute information on increasing energy efficiency. Large, energy-intensive facilities usually have a plant manager or engineer responsible for recording and reporting energy use. At smaller, less energy-intensive facilities, one person may be responsible for tracking and reporting energy use for many buildings.

At some companies, energy teams consist primarily of corporate-level members, while at others, facility-level representation with experience from across the company is emphasized. Team members may include facility managers, energy managers, procurement representatives, environmental and process engineers. Corporate-level participation is important to ensure that plant-level employees are attentive to energy issues and to keep the corporate energy office attuned to progress and problems at facilities. Energy team responsibilities may include developing energy reduction targets and strategies, conducting energy audits, and providing technical assistance.

Innovative companies promote energy savings targets as goals rather than mandates. It is up to the individual facilities or business units to plan and implement their efficiency improvements. Delegating responsibilities to the business unit level or facility level moderates corporate resource commitment and prevents micromanagement. Also, those most familiar with facility operations and energy use can explore opportunities in the context of process requirements. Finally, business units maintain autonomy and flexibility; their "ownership" of the implementation can make for more enthusiastic and effective participation.

Figure 5. DuPont[5]

DuPont, the first *Climate Wise* Partner, pledged a 40 percent reduction in $CO_2$-equivalent emissions. To date, the company has already achieved emissions reduction of 19 percent. In 1992, DuPont developed a *Corporate Energy 2000* strategy to reduce energy consumption by 15% on a Btu per-unit-of-production basis by 2000 for a total savings of $300 million. DuPont's Corporate Energy Leadership Team (CELT), 40 members from a cross-section of Business Units and corporate operations, is responsible for developing the strategic plan to achieve these savings. In April 1997, DuPont's CELT received the Industrial Energy Technology Conference (IETC) Energy Award at the 19th Annual IETC Conference hosted by Texas A&M University.

In 1993, DuPont implemented *Jump Start*, a four-month effort to find and implement low-or-no-cost opportunities that yielded immediate improvements in energy efficiency at their 25 most energy-intensive U.S. facilities. At the conclusion of the 120-day period, energy-related cost savings reached $12.5 million, or twice the initial goal. DuPont is now expanding the program to its other U.S. facilities, and expects ongoing savings of $31 million per year. Typical *Jump Start* measures include compressed air leak repair, improved steam trap programs, condensate collection and return, insulation repair and shutting down equipment when not in use.

DuPont views the "know-how" on energy efficiency as a means to increase value with their customers. Sharing this knowledge with major customers improves their opinion of DuPont as a supplier and also provides a more secure foundation for future business dealings.

### 3.3 Discovering and Evaluating Energy Savings Opportunities

Most industrial companies have a general sense of total energy consumption, but the level of detail can vary by company and by facility. In general, energy-intensive companies and manufacturing facilities track energy use closely and monitor key end-uses. Less energy-intensive companies and facilities may log only very basic data. Companies that have developed and maintained databases of energy use and cost by fuel type at the facility or division level have found that they are in good position to profit from energy efficiency improvements. Depending on the level of detail, energy tracking data can be useful aid in pursuing energy savings opportunities. Energy data such as load patterns, load factors, and degree of interruptability, can also provide information useful for negotiating more favorable terms with energy suppliers.

Facilities with high energy use can be identified from historical tracking data. If processing indices are included with energy tracking data, energy intensity (e.g., Btu per lb of product) can be calculated. The energy intensities of facilities with similar production outputs can be compared to indicate necessary efficiency improvements. Indexing can also provide information on performance over time and can call attention to equipment maintenance needs. If energy *end-use* data are collected, a company can identify the primary uses of energy and focus efficiency efforts accordingly.

Potential savings may also be discovered through energy audits initiated either from the corporate or the plant level. In one creative approach, a team audits energy use at many different company facilities in conjunction

with a plant engineer and energy specialist at each facility. In this way, knowledge gained from audits at other facilities can be tapped while benefiting from the expertise of those who actually operate the particular facility. Other approaches include applying rules of thumb based on published materials and company experience. Rules of thumb can include typical energy savings, cost savings, and payback periods associated with actions such as steam trap replacement and boiler optimization.

3M's Energy Management group sees many opportunities to implement common sense energy efficiency measures. 3M emphasizes improving the performance of existing equipment as well as installing new equipment. Asking basic questions can make such opportunities more evident:

- Does the equipment operate the way it *should* operate?
- Can the process variables be optimized?
- Does the equipment operate only when necessary?

Once energy savings opportunities are identified, cost savings must be calculated. Maximum payback time requirements or minimum "hurdle" rates of return may vary from year-to-year, across companies and facilities. Companies with low operating margins may require payback within a very short time frame, perhaps as short as one year. In 1993, DOW's Energy/WRAP contest required that projects had a return on investment (ROI) greater than 50 percent to be implemented (the average ROI was actually 300%).[4] 3M has a target to achieve a minimum internal return on energy efficiency investments of 15 percent, but typical returns are much higher. Choice of hurdle rates also depend on the return from other investments competing for the same capital.

Many companies complement energy tracking efforts with project and environmental tracking. Project Summary Sheets at Lucent Technologies are described in Figure 6. Environmental tracking can include information on effluent and emissions levels.

Figure 6. Lucent Technologies[6]

In November 1996, Lucent Technologies announced its new corporate environmental, health and safety policy that affirms Lucent's commitment to responsible energy use. Lucent's year 2000 energy goal requires its operating units to develop and implement energy management goals and plans. These goals support Lucent's *Climate Wise* pledge to reduce annual emissions by 135,000 metric tons of $CO_2$-equivalent by the year 2000. Expected savings are $15 million per year by 2000.

Each operating unit chooses an appropriate index (e.g., Btu per dollar of output) for year-to-year energy use comparisons to track progress toward efficiency goals. Operating units report annual energy consumption and cost data to the corporate environmental, health and safety organization which analyzes the data, prepares reports on corporate energy use, and provides technical support. Operating units also prepare Project Summary Sheets that include a project description, energy and cost savings by fuel type, O&M cost savings, utility rebate, and additional benefits such as quality or reliability improvements. Lucent encourages physical measurement to verify estimates, and follows up with local energy managers to confirm project savings.

Lucent is developing a corporate-wide database to manage annual energy consumption and cost data, as well as information from Project Summary Sheets. The database will support data analysis and will be accessible to the operating units' energy managers so that all parts of the company can benefit from the information. The database will also keep track of GHG emissions and emissions reductions for 1605(b) reporting.

### 3.4 Encouraging Energy Efficiency Improvements

The most common approach to rewarding energy efficiency achievements is that profit centers retain energy cost savings. Financial bonuses as incentives for increasing energy efficiency are uncommon — recognition awards are more typical. Energy management awards may be issued corporation wide, or within business units. Companies can identify greater savings opportunities when the authority for making capital investments is coupled with the responsibility for paying energy costs. Lucent Technologies promotes healthy competition among operating units by distributing graphical depictions of each operating unit's progress on energy efficiency goals to encourage managers to strengthen their resolve to increase energy efficiency.

## 4. VOLUNTARY REPORTING OF GHG EMISSIONS AND REDUCTIONS

Energy tracking systems can facilitate reporting under the Voluntary Reporting of Greenhouse Gases Program (Form EIA-1605). GHG emissions can be calculated easily from energy tracking data by applying appropriate $CO_2$ emission factors for each fuel type. Emissions reduction calculations are based on estimates of what emissions would have been without the project in question.

Figure 7. Why Report Under the Voluntary Reporting of Greenhouse Gases Program?

- To demonstrate environmental stewardship and receive recognition for voluntary actions.
- To establish a public record of emissions and reductions.
- To support voluntary approaches to achieving environmental policy goals.
- To inform the public debate about activities to reduce GHG emissions.
- To demonstrate progress towards meeting commitments to reduce emissions of greenhouse gases under voluntary programs (such as *Climate Wise*).

For more information contact the Voluntary Reporting Hotline at 1-800-803-5182.[7]

## 5. CONCLUSIONS

Tracking energy consumption and expenditures can enhance corporate competitiveness while furthering environmental goals. The most successful corporate energy efficiency programs make use of energy tracking systems for identifying and evaluating energy savings projects. The best results are seen when authority and responsibility are assigned at the facility level where energy consumption actually occurs. Corporate-level commitment is key to sustaining energy efficiency programs. One clear way for management to demonstrate its resolve is to help facilities establish energy tracking systems and to examine the data on a regular basis. A corporate energy office can serve as an clearing-house for technical information and as the "institutional memory" on energy efficiency projects. Maintaining an on-line energy efficiency project database is an effective way to manage data collection, reporting, and communication.

Companies such as DuPont, J&J, Lucent Technologies, and 3M have been able to make the connection between their energy tracking efforts and their pledges to reduce GHG emissions as participants in the *Climate Wise* program. There appear to be many opportunities for U.S. companies to take advantage of the synergies between tracking energy use, pursuing energy efficiency, lowering energy costs, and reducing emissions.

## REFERENCES


1. More detailed information on many of the topics discussed in this summary monograph can be found in, S. Winkelman, J. Drzemiecki, J. Haydel, "Industrial Energy Efficiency Programs and Energy Tracking Systems: Best Practices and Innovative Approaches," *Pollution Prevention Review*, Winter 1996/1997.
2. Personal communication, Anthony Galdi, Johnson & Johnson, June 3, 1997.
3. 3M Company, "Mind Over Energy: 3M's Winning Approach to Managing Energy," St. Paul MN, 1992; and personal communication, Steven Schultz, 3M, May 9, 1997.
4. Nelson, Kenneth E. "DOW's Energy/WRAP Contest, a 12-Year Energy and Waste Reduction Success Story," Dow Chemical Company, March 1993.
5. Clevenger, L. and J. Hassell, "Case Study: From Jump Start to High Gear — How DuPont Is Cutting Costs by Boosting Energy Efficiency", *Pollution Prevention Review*, Summer, 1994; and personal communication, John Stewart, DuPont, June 3, 1997.
6. Personal communication, Jim Walton, Lucent Technologies, June 5, 1997.
7. U.S. Department of Energy, Energy Information Administration, *Form EIA-1605 Voluntary Reporting of Greenhouse Gases, Instructions*, 1996.


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