



# The Growing Push for Energy Efficiency in Pumping Systems

Michelle Segrest

Discover how several major players in the pumps industry are contributing to the national effort to improve energy efficiency.

With a national goal to drive a 25 percent reduction in industrial energy intensity by 2017, energy efficiency organizations like the U.S. Department of Energy's Save Energy Now Program and the Hydraulic Institute's Pump Systems Matter are providing companies a broad range of resources to identify and implement cost-effective energy saving measures. While the intentions to improve energy efficiency are pure, the costs and effort required to achieve the goal is daunting. That's why many corporations are working with these organizations to maximize efforts.

"I'm trying to put myself out of business," says DOE's Douglas E. Kaempf who is the program manager for the Industrial Technologies Program, Energy Efficiency & Renewable Resources. "We have a huge database of assessments. When improvements exist, we need to tap into that database and use the information. I want to secure an ANSI standard. I also want an ISO standard that will ensure the United States has a fair share in being the supplier to the most competitive four countries—U.S., Brazil, China and Great Britain."

In an effort to promote energy efficiency standards, Kaempf outlined these DOE initiatives and then several executives presented proven energy saving strategies at the Hydraulic Institute Annual Meeting in Marco Island, Fla., in February. Here are just a few of the actions currently implemented by each of these corporations.

## International Paper (Corporate Technology)

Ken Manley, maintenance and reliability staff engineer for International Paper (IP), emphasizes the role of maintenance

in energy efficiency and says that at IP, the focus is on reliability. "Reliable pumps are energy efficient pumps," Manley says.

In 1996, a Finnish Technical Research Center report titled *Expert Systems for Diagnosis and Performance of Centrifugal Pumps* revealed that the average pumping efficiency across the 20 plants and 1,690 pumps studied was less than 40 percent, with 10 percent of the pumps operating below 10 percent efficiency. Also, the average motor efficiency was 81 percent, with pump seal leakage causing the highest downtime and cost.

International Paper, working with the Energy Performance Services group of ITT Industrial Process, has performed in-depth pump system assessments at several of their integrated mills. The results of those studies have provided cross validation of the Finnish Technical Research Center findings and shown a nexus between excess energy and lower reliability, i.e., the excess energy "pumped" into mid-sized systems turns into vibration, heat and noise.

IP's findings clearly demonstrated that the major factors affecting pump system efficiency were over-sizing and throttled valves. The corporate reliability group further discovered that there were a total of 101 pump reliability incidents, which resulted in downtime, from February 2007 through February 2008. While a high bar had been set on what constituted a reliability incident, the combined financial impact of these events was in the range of \$5 million.

While establishing the tremendous cost involved in maintenance and reliability issues, IP has undertaken several actions to correct the problems:

- IP addressed a key issue in the pump selection and sizing process by creating a more disciplined approach to

precision maintenance by requiring that new pump system installations must operate between 70 to 100 percent of the Best Efficiency Point flow (BEP). To meet these stringent allowable operating range requirements, IP's pump specification now requires variable speed operation as the default design approach for multiple operating point applications when the total static head is 50 percent or less of the total dynamic head (TDH) required for the system.

- IP determined that Life Cycle Cost (LCC) provides the optimum pump selection and is part of the IP Project Delivery Process (PDP).
  - Greatest LCC for pumps is energy. Energy consumption depends on proper sizing and operation.
  - IP Mills and the Regional Engineering Organizations need to provide good process data (minimum, BEP and Maximum Flow and Head data) to optimize pump selection and sizing.
  - Pump controls need to accommodate system curve.

### Kodak Park

Kodak Rochester Energy Manager Raul Santiago, P.E., implemented and led a program in 2005 with two key initiatives:

1. Reduce plant heat yearly output from 16 trillion BTUs to less than 12 trillion BTUs by April 1, 2007
2. Reduce Kodak Park East steam peaks from 700-klb/hr to < 400-klb/hr

The expected benefits from these two initiatives included positioning the utilities for permanent shutdown of one of two power plants and a \$27 million-plus/yr savings in fuel and plant operating expenses by year end 2007.

Kodak achieved its initiatives using a few key strategies:

1. Aggressive energy conservation
2. Kodak Park footprint reduction
  - a. Aggressively marketing and selling surplus buildings
  - b. Demolishing old high-maintenance buildings
3. Power Plant Upgrade of Building 321
  - a. De-mineralizing water, cyclone boiler and electrical grid upgrades

b. Integrated purchase power strategy

Kodak Park implemented its initiatives with real-time online monitoring, better management and heightened awareness throughout its facilities via monthly scorecards and newsletters (which included tips on saving energy at home). Kodak encouraged its managers to observe abnormalities and

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immediately correct problems by actually going onto the plant floor to see firsthand what was happening rather than relying on perceptions. "This allows management to question the status quo with an energy conservation mindset," Santiago says. They then determine the root cause of the problem, eliminate it and create standards to prevent recurrence.

Kodak also invested in a full-time, onsite energy conservation consultant to survey, assess and document all pumps and seals at Kodak Park and then troubleshoot for solutions.

As a result of these combined energy conservation efforts, Kodak Park has been able to screen 229 pumps over 75-hp with 122 systems analyzed in the past two years (2006-2007). A pump energy cost savings of \$2.3 million/yr, electrical savings of 50,460-mwh/yr and an additional \$1.1 million in implementation cost savings has been realized.

### Jacobs Engineering

Jacobs Engineering works with companies to improve energy efficiency through projects involving sustainability, repair and modernization. According to Steve Dowe, the company's director of pulp and paper process, "There is more pressure on companies to produce quicker, and it takes more time to get materials. These are all realities. We work with our clients to prioritize and reach goals, while keeping energy efficiency in mind."

In evaluating the energy efficiency practices of a company, Jacobs suggests improved design standards, software selection, project team education, life cycle analysis, value engineering and design philosophy.

According to Jacobs Engineering, the development of efficient pumping system designs should include:

- Making realistic assumptions
- Learning from examples
- Trimming impeller based on final design
- Sizing control valves correctly
- Using turbulence inducers in shell and tube heat exchangers
- Designing systems to minimize pump head (by using 3-D models)
- Using variable speed drives
- Grouping shower services by pressure range
- Sizing in-line devices
- Line sizing

"The drive for energy efficiency must come from the top down," Dowe says. "We should all be looking for opportunities to team with suppliers and utilities to achieve our goals."

### 3M Corporation

3M has maintained an energy management program since 1973 that has produced a steady decline in its inefficient use of energy. By tracking all data since 1973, the company determined it is only using about 35 percent of the energy it used prior to establishing the program.

The corporate energy management team provides global leadership to control energy costs, improve operational

efficiency, reduce environmental impacts, ensure the availability of reliable energy supplies for all operations and develop and implement a strategic energy management plan.

According to Corporate Energy Manager Steve Schultz, 3M's energy reduction goals for 2008 include a 4 percent reduction in energy use per pound of product produced and the implementation of projects representing a 4 percent savings of the 2006 energy expenditures. 3M also hopes to have a 20 percent reduction in energy use/net sales from 2006 to 2010.

3M provides many resources to its plant energy teams, including implementation guides, best practices, online data and news, an energy database, an HVAC recommissioning program, regional meetings, conference calls, specialized optimization teams and both internal and external plant energy opportunity assessments.

More than 2,700 energy projects were identified since 2000 and all have been tracked in an energy cost reduction projects database.

Based on 3M's success, Schultz offers advice on how to increase energy conservation project implementation:

- Develop a corporate initiative
- Screen for opportunities
- Assign experts to study energy conservation in-depth
- Simplify the up-front process and identify the likely candidates to devote more time and effort on the project
- Do not try to make everyone an expert

3M's ongoing push for energy efficiency includes:

- A pump systems screening tool
- Corporate initiative to screen facilities for energy saving opportunities
- DOE Save Energy Now assessments
- Reward program for plants and managers who achieve energy efficiency goals

"It is important to 3M to reduce the environmental impact of our energy use," Schulz says.

### The Dow Chemical Company

Dow is one of the world's largest industrial consumers of power and steam and is among the world's largest industrial energy consumers, according to the company's Energy Conservation Leader Bill Behr. "The energy used at Dow is equivalent to that of San Francisco, Oakland and San Diego combined," Behr explains. The company requires 3,700-MW of electricity to operate, and the feedstock and energy demand is estimated at \$25 billion per year (which is almost 50 percent of its total revenue).

In 1994, Dow began its first long-term energy reduction drive and saved \$4.3 billion in an 11-year period. Dow's energy efficiency drive focuses on four vehicles:

1. **Businesses/Tech Centers** – responsible for technology implementation, setting business-specific energy goals and plans and driving the energy efficiency efforts.

2. **Six Sigma** – the methodology used to ensure sustainable results and to measure the success of all projects with savings tracked versus goals.
3. **The Sites** – the site energy focal points that drive the site energy efficiency efforts to develop tools and methods, drive assessments and best practices, develop the culture of energy conservation and ensure active participation with DOE's Save Energy Now Program.
4. **All Employees** – establishing the culture of energy conservation, and developing energy efficiency training in which everyone participates. "If people consider efficiency in small things, then they are more likely to consider it in large things," Behr says. "If they think about turning off the lights when they are not in use, then they may think about turning off the pumps when they are not in use."

Behr says his company believes in site-wide energy efficiency efforts for the following reasons:

- Ensure process plant projects translate into actual savings at the site/company level
- Maximize integration and energy use synergies between plants
- Share and leverage energy savings ideas and projects
- Identify savings opportunities in site-managed activities
- Support energy studies that may be initiated at a site
- Improve planning for changes in utility needs for new plants and shrinking sites

Dow has 60,000 pumps (avg. 15-hp) at 130 sites in 500 plants, which generate power consumption of 300+-MWh. This translates into \$175 million per year in energy costs at \$60/MWh. Therefore, designing pumping systems for energy efficiency is critical. Some of the actions to achieve this include:

- Developing specifications and design aids with selection criteria
- Developing line sizing optimization programs
- Evaluating offers from other suppliers
- Conducting a pump design process that calls for default use of variable frequency drives

Dow also engages in about 25 percent outside energy efficiency consulting to combine with about 75 percent of in-house expertise.

"The industry needs all the help it can get to achieve its energy goals," Behr says. "The stakes and opportunities are big for both pump suppliers and pump users. But there needs to be a big change in the approach to system design. We must do it faster and cheaper, and it will require working together to get there."

*For more information, contact Pump Systems Matter, 9 Sylvan Way, Parsippany, NJ 07054, 973-267-9700, [www.PumpSystemsMatter.org](http://www.PumpSystemsMatter.org).*

*U.S. Department of Energy—Office of Energy Efficiency & Renewable Energy, 1000 Independence Avenue, SW, Washington, DC 20585, 1-877-337-3463.*

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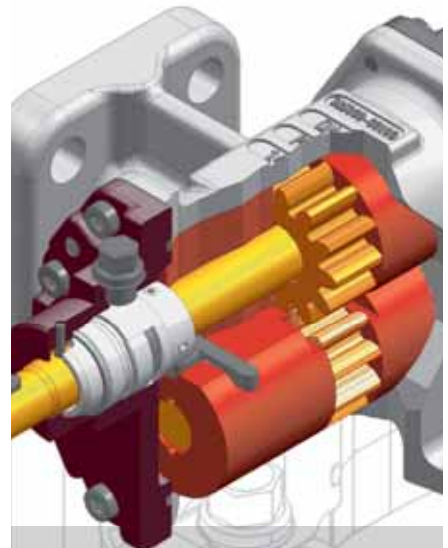
**Editor's Note:** For updated information and expert insight, look for Mike Pemberton's Pump Blog on Energy Efficiency at the new [www.pump-zone.com](http://www.pump-zone.com).

*Michelle Segrest is the editor of Pumps & Systems.*

*Pumps & Systems Editorial Advisory Board members Mike Pemberton and Robert Asdal contributed to this report.*

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# Variable Speed Pumping for a District Cooling System

Rex Noble, P.E., FPL Services, LLC

**This case study outlines the energy and cost savings realized at a District Cooling System when a guaranteed energy savings program was implemented.**

**U**nder an Energy Conservation Performance Program, Miami-Dade County commissioned a study to evaluate potential capital improvement projects fully funded from the projected savings in energy consumption and/or operating and maintenance costs. Through this program, the cost of new equipment is financed through energy and/or other realized operational cost savings. The capital funding otherwise required to replace existing mechanical systems is avoided, and those funds can then become available for other County needs.

The proposed efficiency improvements to the County's existing chilled water loop were roughly placed in two groupings:

1. Measures which reduce the energy consumption at the building level associated with chilled water distribution (pumping energy)
2. Measures that address energy consumed at the Central Plant, associated with the production of the primary cooling medium (chilled water)

Schemes considered to reduce building water-side energy consumption included adding variable frequency drives to existing building pumps, and replacing three-way valves with two-way valves, where applicable. Finally, measures were explored to reduce Central Plant energy and conversion of the chilled water distribution system to a variable volume primary distribution system.

FPL Services, LLC has an energy performance contract with the County to assist in reducing energy costs. As part of the overall energy saving strategy, FPL Services examined the application of variable speed pumping for the Downtown



Miami District Cooling Plant. The Central Cooling Plant provides chilled water to approximately nine office buildings that encompass more than 1.8 million square feet of conditioned space in downtown Miami. The plant has a pumping capacity of 11,200-gpm, which provides 4,700 tons of chilled water to the buildings. Because of Miami's subtropical climate, the cooling plant operates year round.

Pumping, a large consumer of electrical consumption, provided great potential for energy savings. Reducing energy costs with this application would finance the construction of these energy conservation improvements and allow for infrastructure improvements. An extension of the chilled water piping to serve a new County office building was funded through the energy savings.

To evaluate the energy conservation potential through

variable speed pumping, an engineering evaluation was performed on the entire pumping and piping system. There were three steps performed during the engineering evaluation. The first step was to develop building load profiles for each of the building on the district loop. Each building had a baseline model developed. This model was calibrated to the actual building consumption. Once the baselines were within 5 percent of the actual energy bills, the energy conservation measure of variable speed pumping was analyzed. Each building was modeled with variable speed pumping and compared to the baseline for energy savings.

Once the energy analysis was completed, the second step was to determine a baseline flow analysis for all of the buildings supplied by the central chilled water plant. The data developed by the load analysis model in the first step was used to develop the baseline flows and pressures. In the flow analysis, the entire piping loop and all buildings were modeled. Once the baseline

Bldg.	Baseline energy use	Post-Installation energy use	Calculated Annual Energy Savings (kWh/Yr)	Calculated Annual Electrical Savings (\$/Yr)
SPC	11,225,339	10,625,164	600,175	\$42,913
Cult Cntr	4,792,217	4,391,923	400,294	\$28,621
Flagler	3,120,589	2,979,480	141,109	\$10,089
MD Crthse	3,154,263	2,850,636	303,627	\$21,709
Central Support	2,670,537	2,288,863	381,674	\$27,290
<b>Total</b>	<b>24,962,945</b>	<b>23,136,066</b>	<b>1,826,879</b>	<b>\$130,622</b>

Table 1. Projected Energy Savings for Variable Pumping Energy Conservation

was developed, a retrofit baseline was modeled applying variable speed pumping to the various buildings. These models were developed to ensure the District Cooling Plant could provide chilled water to the buildings based on the proposed operating scenarios.

After the load analysis models, flow analysis models and diagrams were completed, engineering drawings and scopes of work were developed for implementation. The design was developed by applying variable speed drives to existing pumps on the primary, secondary and tertiary systems. There were a total of 15 variable speed drives installed, ranging from 15-hp to 150-hp. A control sequence was developed to vary the flow of the pumps based on building load. The variable speed drives are controlled by differential pressures sensors in the building. As the pressure increased, the pumps would slow down. Conversely, as the pressure dropped, the pumps would speed up. By allowing the pumps to match the chilled water requirements of the building, energy savings could be achieved.

The projected energy savings for the variable pumping energy conservation measure are in Table 1.

The electrical savings achieved by the application of variable speed pumping was approximately \$130,622. The electrical savings compensated for construction costs for 15 years. Through the project savings, the County was able to connect an additional building to the District Chilled Water Loop.

After construction, the long-term measurement and verification process begins. Each year, for 15 years, FPL Services, LLC will be verifying the savings achieved through the variable speed pumping application. A report of the savings will be issued each year. FPL Services is in the first year of the 15-year guarantee.

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Variable Speed Drive Operation