

# **Making Pump Systems Matter**

*Vestal Tutterow, Alliance to Save Energy*

*Robert Asdal, Hydraulic Institute*

*Aimee T. McKane, Lawrence Berkeley National Laboratory*

## **ABSTRACT**

The Hydraulic Institute (HI), a trade association of U.S. pump manufacturers, recently established a national pump systems educational initiative called *Pump Systems Matter*<sup>TM</sup>. A primary objective of the initiative is to change the decision-making process for the purchase of pump systems. Today, owners and operators typically buy the pump system with the lowest initial costs, resulting in higher lifetime ownership costs. *Pump Systems Matter*<sup>TM</sup> (PSM) will promote educated decision-making based on life cycle costs, thereby accounting for energy, maintenance, and other significant costs of operating a pump system. This will be accomplished through current, new and re-branded educational materials and tools aimed at facilities owners, managers, operators, contractors, engineering consultants, manufacturers and others, and supportive outreach activities. Some of the unique characteristics of pumps and how they operate in a systems environment will also be briefly discussed for the benefit of explaining how a pump market transformation initiative must focus on the pumping system and not the pump.

*Pump Systems Matter*<sup>TM</sup> is unique in that it is the first market transformation effort announced and led by equipment manufacturers, and not a utility, government entity, or non-governmental organization (NGO). This paper will describe the motivating factors that convinced a large number of pump manufacturers to create this effort to transform their own markets. The paper discusses HI efforts to reach out to NGOs, utilities, users and other potential stakeholders. The paper will also explore other ways in which this initiative is unique, and ways in which it is similar to other market transformation initiatives.

## **Background**

The Hydraulic Institute (HI) recently announced a national pump systems educational initiative called *Pump Systems Matter*<sup>TM</sup> (HI 2004b). This initiative seeks to change owner and operator decision-making on pump systems from a focus on first cost to a focus on life cycle costs while helping pump users capture significant energy-savings and performance improvements. This will be accomplished through a variety of measures, including new educational materials and tools aimed at facilities personnel and others, and other outreach activities as defined by the initiative's Steering Committee, including NGOs, utilities and other stakeholders. The Institute has a long-established history as a standards-writing organization, and in recent years has become a principal source of education on pumps and pump systems.

*Pump Systems Matter*<sup>TM</sup> (PSM) is unique in that it is the first industry-driven and industry-organized national market transformation initiative. Currently in its organizational phase, the Hydraulic Institute is seeking other stakeholders to build PSM into a significant new market transformation program offering unique resources of value to all participants.

## Opportunities for Pumping Systems Optimization

Pumps are widely used in industry to transfer fluids for processing applications, to supply water and process wastewater, to provide fluid circulation in cooling systems and to provide the motive force in hydraulic systems. In fact, virtually all manufacturing plants, commercial buildings, and municipalities rely on pumping systems for their daily operation. After motors, pumps are the second most widely used machine in the world.

In the United States industrial sector, electric motor systems consume over 679 billion kWh of electricity per year, with pumping systems accounting for about 25 percent of that total (DOE 1998). In the commercial sector, pumps are primarily used in heating, ventilation, and air conditioning (HVAC) systems to provide water for heat transfer. Municipalities use pumps for water and wastewater transfer and treatment and for land drainage. Because they serve such diverse needs, pump sizes range from fractions of a horsepower to several thousand horsepower (DOE 1998).

The purchase and operation of pumping systems is a significant expense for most facilities. However, it is common practice for pumping system design and procurement to be based primarily upon the initial purchase cost of the equipment. Often such decisions, particularly with new systems, are under the control of the engineering contractor – who has few incentives in the world of fixed price contracts to embrace energy efficient pump system design and reduce energy.

The initial cost of a pump is typically a small part of the total cost to operate the pumping system over its life, which can average fifteen to twenty years, depending upon its application and operating environment. Energy, maintenance, and other operating costs will far outweigh the initial costs. Therefore, it makes economic sense to consider these lifetime costs when designing and procuring pumping systems (Hydraulic Institute & Europump 2001; Tutterow 2003).

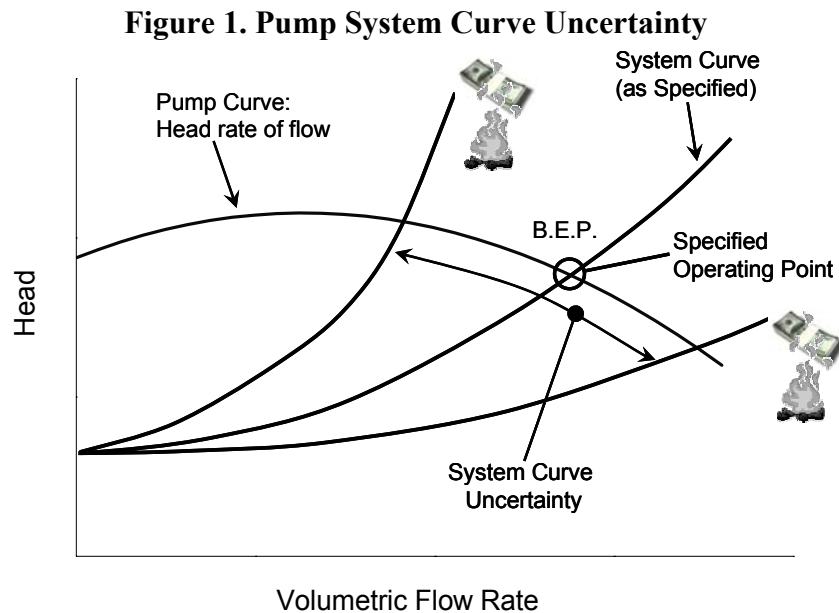
Pump system energy efficiency improvement opportunities fall into two distinct categories: existing and new systems. A successful pump systems market transformation initiative will need to encompass both new and existing systems, even though the markets for servicing new and existing pumping systems are very different (HI 2004a). The number of retrofit opportunities far exceeds the number of new systems each year. Therefore, the bulk of potential savings lies within these existing systems. Opportunities in existing systems often involve changes to the control system or the pump, or both. Significant changes to the piping system and other equipment in existing systems are typically not economically viable. The average energy savings potential through economically viable pump system optimization projects is approximately 20%, although certain installations might realize significantly greater savings, ranging from 25% - 50%. If all facilities in the U.S. implemented such measures, the savings would equal over 28,000 GWh/year, based on a midrange estimate (DOE 1998). This *energy* savings potential represents significant *cost* savings potential for industrial facilities and their owner/operators. Significantly, energy efficiency improvements to industrial systems usually provide improved reliability, productivity, and reduced environmental costs.

Opportunities in new system design must not be ignored, though. For a given *new* system, the potential savings in energy and life cycle costs are far greater than in a given *existing* system of similar size and application. One reason for this is the opportunity to optimize the piping system design. Other aspects of the pump system can also be better tailored to the

system requirements in the design of new systems. But since new system designs are typically under the control of engineering contractors, promoting a systems optimization approach is often difficult, as the contractors typically do not directly benefit (HI 2004a). PSM will address this situation.

## The Need for a “Systems Approach”

The efficiency of a given pump is one small factor affecting the efficiency of a pumping system. A systems approach analyzes both the supply and demand sides of a pumping system and how the performance characteristics of the pump and the system interact. The focus of the analysis thus shifts from individual components to total system performance, the equivalent of looking at the forest, not just the trees. The potential energy and cost savings through a systems approach to optimization typically far outweighs the sum of the savings through component optimization. In fact, approximately 75% of the total life cycle cost of a typical pumping system is accounted for in energy and maintenance costs. (This will vary significantly by application.) To maximize pump system efficiency, the pump must be operated at its “Best Efficiency Point” (B.E.P). According to HI standards, “the B.E.P. is the rate of flow and head at which the pump efficiency is at maximum” (HI 1997, HI 2000).



A systems approach to new pumping system design is equally important, and often overlooked. A recent survey of seven pump manufacturers revealed a significant lack of understanding on the part of pump specifiers and purchasers regarding the proper application of pumps (Walters 2005). These pump manufacturers were asked “What percentage of the pumps your company sells are incorrectly specified by the contractor or owner/operator?” Of the five manufacturers that responded with a percentage, three indicated a value of 60% or greater, and one indicated that 30-40% were incorrectly specified. A follow-up question asked “Of the pumps that are incorrectly specified, what percentages are a result of inaccurate operating point

specifications (i.e., rate of flow, required pressure, and net positive suction head)?” The answers varied between “most” to 90%. Even though this was a small survey, the responses indicate a severe lack of understanding of the proper application of pumps and properly matching their characteristics to the system. Misapplication of pumps has a direct affect on pumping system operating costs. A pump forced to operate away from its Best Efficiency Point (B.E.P.) increases energy and maintenance costs, and shortens the life expectancy of that pump. Figure 1 shows this graphically.

## **About the Hydraulic Institute**

The Hydraulic Institute is a North American trade association of nearly 100 pump manufacturing and supplier companies, representing over 80% of the U.S. market. Among other activities, HI develops American National Standards Institute (ANSI)-approved voluntary standards that provide universally accepted language and guidelines for pump nomenclature, definitions, installation, operation, maintenance and test procedures. These standards also define and control the performance, testing, life, and quality of pumps and pump products.

HI is already working in several areas to increase the understanding of pumps and pump systems, including standards, guidelines, e-learning programs<sup>1</sup>, and an energy-savings section on the HI web site<sup>2</sup>. HI and Europump, its counterpart organization in Europe, have created two comprehensive user guides: *Pump Life Cycle Costs: A Guide to LCC Analysis for Pumping Systems*; and *Variable Speed Pumping: A Guide to Successful Applications*.

HI has a long-standing relationship as an “Allied Partner” (and a Charter Partner of the preceding EERE Motor Challenge program) with the U.S. Department of Energy’s Office of Energy Efficiency and Renewable Energy, which has led to a variety of cooperative efforts over the past decade related to pumping systems efficiency and training. Cooperative activities have included training HI members on the EERE Pump System Assessment Tool (PSAT – a software tool developed by EERE), developing a video-based training program, and developing executive summaries to HI/Europump guide books.

## **Creating Pump Systems Matter™**

The Hydraulic Institute and its member companies are concerned about the long-term economic viability of U.S. pump manufacturing and U.S. industry. Many U.S. manufacturers are struggling to compete in the global marketplace, in large part due to an average 22% manufacturing cost disadvantage with competitors on a worldwide basis. Through PSM, HI seeks to expand the U.S. pump market and create new service opportunities while simultaneously enhancing the performance of U.S. industrial, municipal and other sectors through improving pumping system energy efficiency. Additional contributions to competitiveness include increased mean time between equipment failures, lower maintenance, and reduced repair costs (Adams & Taylor 2005).

---

<sup>1</sup> [www.pumplearning.org](http://www.pumplearning.org)

<sup>2</sup> [www.pumps.org](http://www.pumps.org)

Education on pump systems and the advantages of procurement based on life cycle costs are key to helping owner/operators understand why they should undertake improvements of their existing systems. HI and its members also believe that education of pump original equipment manufacturer (OEM) and distributor staff can assist the process of educating owner/operators. As the market transforms, consulting engineers and engineering contractors will benefit from similar education (HI 2004a). Equally important will be educating owner/operators on the benefits of changing the contract award process for new pump systems to one based on pump LCC. The possibility of a program to establish Certified Pump Systems Engineers (CSPE) will be explored. The goal of these educational initiatives is to develop the qualified professional engineering resources needed to sustain a transformed market.

HI members have already begun to retrain their own staff. Many HI member representatives have participated in the EERE-developed PSAT training workshops, and several members have either co-sponsored PSAT workshops or adapted aspects of the PSAT workshops to their own in-house training activities. Training in the assessment of pump systems alone is not enough, however, to transform the market for pump systems. The PSAT software tool and training is geared primarily to technical facilities staff and consultants, and focuses on the assessment of existing systems. A significant expansion of pump educational offerings, knowledge-based resources and tools are envisioned as the core components of *Pump Systems Matter™*.

HI recognizes that to achieve significant transformation of the market for pumping systems, additional resources are needed to create and disseminate new educational resources and tools. HI lacks the resources to accomplish this alone, and recognizes that significant related work has been done in other industries and markets. These efforts engaged the experience, resources and coordination of market transformation and energy-efficiency non-government organizations, utilities and state/federal agencies. HI seeks to partner with like-minded organizations to serve as stakeholders in this educational and outreach effort.

## **Starting the Process**

Inspired by anecdotes of industrial energy efficiency success stories from a variety of sources, HI staff and several champions from within HI member companies formed a Market Transformation Committee and set out to educate themselves on energy efficiency initiatives, including market transformation. This process included attendance at national and regional market transformation conferences and meetings, and discussions with organizations involved in market transformation, such as the American Council for an Energy-Efficient Economy (ACEEE) and the Alliance to Save Energy (ASE).

The HI Market Transformation Committee sought out staff from Lawrence Berkeley National Laboratory (LBNL) and ACEEE for their expertise and experiences in industrial energy market transformation. These organizations were both key stakeholders in the formation of the Compressed Air Challenge (CAC), which successfully initiated a similar shift from a component-based to system services-based approach to U.S. industrial compressed air markets. As with the CAC, true market transformation will require PSM to address the needs of both pump system users and suppliers to achieve permanent change.

Building consensus within the Hydraulic Institute presented unique challenges. The concept of market transformation was at first alien to many members. During several regularly

scheduled meetings, HI staff organized plenary sessions on energy-efficiency and market transformation efforts related to motors, compressors and other industries. Over time, an increasing number of members began to see the prospects for market transformation. Key activities leading to the formation of *Pump Systems Matter*<sup>TM</sup> included:

- A half-day market transformation seminar involving several high-level speakers at HI's 2003 Annual Meeting;
- Participation in national conferences by HI staff and members;
- Liaison with Europump and coordination with European Union initiatives;
- A briefing by HI to members of CEE's Motors Committee; and
- A briefing on the *NEMA Premium*<sup>®</sup> program to HI members by a NEMA representative<sup>3</sup>.

HI then commissioned ACEEE to provide the Market Transformation Committee and Board with research, findings, and program guidance. ACEEE's study evaluated the opportunities for market transformation, along with the successes and shortcomings of other industrial market transformation efforts. Based on the study's findings, the HI Board voted to pursue a market transformation initiative, which is now branded as *Pump Systems Matter*<sup>TM</sup>. In preparation for seeking partners for this initiative, HI staff and committee leaders have secured leadership and financial support from 33 HI member organizations as of March 2005, including all of the leading pump manufacturers in the United States (HI 2005).

### ***Pump Systems Matter*<sup>TM</sup> Vision and Mission**

The Hydraulic Institute recently invited several representatives from key organizations to help articulate the messages that PSM will deliver. The group defined this stated **vision**:

*Pump Systems Matter*<sup>TM</sup> will assist North American pump users in gaining a more competitive business advantage through strategic, broad-based energy management and pump system performance optimization.

Specifically, the creators of PSM envision that through the combined efforts of the pump industry and the many other stakeholders, the following long-term benefits will occur:

- All stakeholders will speak with a common voice, reaching end-users using new educational resources, tools, and outreach efforts to encourage systems energy savings and change the procurement process for pumps and pumping systems to one based on total life cycle costs rather than initial costs;
- Training programs and tools, including a national certification program and incentives, will be provided by sponsors, and eventually a recognition program for Certified Pump Systems Engineers;

---

<sup>3</sup> HI has endorsed the *NEMA Premium*<sup>®</sup> program, and several motor manufacturers are Associate members of the Hydraulic Institute

- Significant and lasting energy savings in process-oriented facilities, including water and wastewater, commercial buildings and manufacturing plants, contributing to increased bottom-line savings and profitability for these organizations using a pump systems approach;
- National partnerships between the PSM sponsors will have resulted in a market which procures pumping systems based on total life cycle cost rather than initial cost; and
- By 2015, users will understand the value of, and demand, pump systems optimization services; and suppliers will be prepared to offer these services.

The vision will be achieved through undertaking the following **mission**:

*To provide end-users, engineering consultants and pump suppliers with tools and collaborative opportunities to integrate pump systems performance optimization and efficient energy management practices into normal business operations.*

Accomplishing this mission will require a wide variety of activities. These activities will seek to achieve the following goals, as initially identified by HI's Charter Partners:

- Changing the mindset of owner/operators and contractors from a purchase decision based on lowest initial purchase cost to one based on total life cycle costs, creating significant bottom-line savings for end-users based on lower energy costs, maintenance costs and improved operations;
- Creating demand among owner/operators and contractors for value-added services from the pump industry and expanding the capacity within the pump industry to meet this need; and
- Developing and disseminating supporting materials to realize these goals.

### **Scope of the *Pump Systems Matter*<sup>™</sup> Initiative**

The ultimate scope of activities for the *Pump Systems Matter*<sup>™</sup> initiative will be determined by the *Pump Systems Matter*<sup>™</sup> sponsors. However, several short-term objectives have been identified by HI and the Charter Sponsors. These objectives are to be accomplished within the first year of the effort, and include:

- Hiring a part-time coordinator to organize the effort and evaluate other staffing needs, particularly with educational development and re-branding;
- Holding follow-up meeting with potential stakeholders concerning investment and defining the missing pieces of the framework of the initiative;
- Developing significant visibility within 12 months of start by building on core sponsors' strengths and offerings (such as existing training, tools, case studies, etc.);
- Maximizing key public awareness opportunities (meetings, conferences, trade press, etc);
- Presenting a turnkey offering to potential new sponsors that includes customer-focused services (training, tools, etc.), a program baseline, and evaluation metrics for the purpose of attracting funding; and

- Hosting regional events to showcase work done to date on pump systems optimization for both users and potential stakeholders.

With financial commitments from the 33 HI member companies that have already become charter partners, HI has the foundation necessary to move forward toward these short term objectives and now seeks other stakeholders/partners from beyond the HI umbrella.

Once the sponsors are in place, longer term objectives will be agreed upon and pursued. Based on suggestions from the Charter Sponsors and advisors, potential mid- and long-term (two to three years) activities could include:

- Developing case studies highlighting pump system optimization, energy savings, and life cycle cost analyses;
- Publishing trade journal articles, white papers, and web content;
- Creating simplified life cycle analysis software tools;
- Authoring a textbook on pumping systems optimization;
- Developing a technically-oriented training curriculum for facilities engineering personnel
- Establishing a multi-level certification program for pump system operation, optimization, design and troubleshooting; and
- Developing a training curriculum for procurement personnel focused on transforming buying channels to encourage the use of life cycle cost methodology.

Additionally, mid- and long-term communications and outreach efforts could include:

- Creating a centralized internet resource for information and sponsor links, using the domain name of [www.pumpsystemsmatter.org](http://www.pumpsystemsmatter.org);
- Incorporating PSM speakers, courses, workshops, tutorials, and publicity into national or regional conferences and trade shows;
- Creating regional training sessions and pump systems “summits” focused on systems optimization; and
- Providing training via internet, using HI’s existing [www.pumplearning](http://www.pumplearning) training portal, and possibly in collaboration with PSAT Qualified Instructors.

## Next Steps

Currently, a group of volunteer advisors, including ACEEE, EERE, LBNL, ASE, the Northeast Energy Efficiency Partnerships, the Northwest Energy Efficiency Alliance, and the New York State Energy Research and Development Authority is providing guidance to HI in the formation and implementation of *Pump Systems Matter*<sup>TM</sup>. As of publication of this paper, HI is in the process of seeking NGOs, utilities, end-users, engineering consultants, contractors, governmental agencies, and others interested in supporting the initiative as PSM sponsors and stakeholders. A briefing on a draft prospectus and informational discussion is planned for an informal session at the 2005 ACEEE Summer Study for Industry, and is a key next step in inviting broader participation in this initiative.

Based on these initial discussions, plans are in place to begin coordinating some of the existing activities available from PSM sponsors beginning in the Fall of 2005. Work will also



begin on developing the program baseline and evaluation metrics. The sponsors will have the opportunity to further refine the program goals and objectives to achieve a balanced approach among all participants for achieving pump system market transformation. In response to these goals and objectives, it is anticipated that new educational offerings will be added during the second year.

## **Applicability to Other Markets**

As the first supply-industry led market transformation initiative, *Pump Systems Matter*<sup>™</sup> is forging new ground while also building on the experience and lessons learned from such initiatives as the CAC, *NEMA Premium*<sup>®</sup> and Motor Decisions Matter<sup>™</sup>, as well as more traditional market transformation efforts spearheaded by utilities and energy-efficiency organizations. While challenges will emerge from aligning the needs and goals of the pump industry with those of the other organizations participating in *Pump Systems Matter*<sup>™</sup>, the early investment in this effort by the Hydraulic Institute and the pump industry should go far in ensuring its success. The first wave of training for the CAC was directed largely toward engaging the supplier community and training them on the systems approach. With *Pump Systems Matter*<sup>™</sup>, much of this preliminary effort has already been accomplished within the pump industry, putting the initiative in a very good position to launch a user-focused educational effort.

Once this effort is underway and begins meeting its goals, there are many other possible applications for this approach in the industrial fan, steam, and process heating markets, as well as many other industrial and commercial markets that do not lend themselves to the component standards and labeling approach to greater energy efficiency.

## **Summary**

As the first industry-led market transformation effort in the United States, *Pump Systems Matter*<sup>™</sup> (PSM) was created by the Hydraulic Institute and 33 of its members who have signed-on as PSM Charter Sponsors. PSM is now reaching out to other potential stakeholders and partners to build the initiative and associated educational programs and tools. HI has received guidance from leading NGOs, energy-efficiency organizations, and federal agencies, which, working together, have developed a vision, mission and goals.

This paper has explored the key factors that led the Hydraulic Institute and its members to pursue this initiative, and the factors necessary for success – including lessons learned from other industrial initiatives. Significant opportunities exist to transform the market for energy-efficient pumping by focusing on the system, rather than components, and by working with both buyers and sellers. Substantial energy savings will result, as well as significant opportunities to improve the competitiveness of end-users that embrace broad-based energy management and pump system optimization approaches.

A significant lack of understanding currently exists regarding the proper application and operation of pumps. This leads to excessive operating costs – including energy. It is clear to the PSM organizers that new educational resources and tools need to be developed. An expanded body of knowledge will include a wide range of awareness-building and educational materials, including case studies, software tools, training curricula, and a certification program for pump

systems engineers. The education and outreach is intended to result in owner/operators embracing the concepts of life cycle costing, energy management as a standard business practice, and pump system performance optimization. The PSM brand will incorporate relevant existing resources of the stakeholders while creating new tools and resources tailored to achieving goals and objectives of the initiative.

With these groups coming together in 2005 with aligned interests, the following 10-year vision stands the best chance of being realized: “By 2015 pump users would understand the value of, and demand, pump system optimization services and the supply chain would understand the value of offering these services on a competitive basis.” And, once the success of this effort is realized, the *Pump Systems Matter*<sup>™</sup> model could be applied to other industrial and commercial markets such as fans, steam and process heating, among others.

## References

- Adams, William V, and William E. Taylor. 2005. “Why Do Pump Systems Matter?”, *Pump & Systems Magazine*, February 2005.
- [DOE] Department of Energy. 1998. *United States Industrial Motor Systems Market Opportunities Assessment*. Washington, D.C.: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy.
- [HI] Hydraulic Institute. 1997. ANSI/HI 9.6.3 – 1997, Centrifugal & Vertical Pumps for Allowable Operating Region.
- [HI] Hydraulic Institute. 2000. ANSI/HI 1.1 – 1.2, Centrifugal Pumps for Nomenclature & Definitions.
- [HI] Hydraulic Institute. 2004a. *Pump Systems Matter*<sup>™</sup> *National Pump Systems Educational Initiative*. Unpublished HI White Paper. September 1, 2004.
- [HI] Hydraulic Institute. 2004b. *HI Announces Pump Systems Matter*<sup>™</sup> *National Pump Systems Educational Initiative*. Parsippany, NJ: Hydraulic Institute Press Release. September 15, 2004.
- [HI] Hydraulic Institute. 2005. “*Thirty-Three Pump & Supplier Companies to Lead Pump Systems Matter*<sup>™</sup>”. Parsippany, NJ: Hydraulic Institute Press Release. March 15, 2005.
- Hydraulic Institute and Europump. 2001. *Pump Life Cycle Costs: A Guide to LCC Analysis for Pumping Systems*.
- Tutterow, Vestal, Don Casada, and Anthony Radspieler. 2003. “Life Cycle Cost Savings Opportunities in Pumping Systems.” In *2003 AWWA Annual Conference Proceedings*. Denver, CO: American Water Works Association.
- Walters, Trey. 2005. “The Cost of Incorrectly Specified Pumps – and Ideas on How to Reduce It”. Presentation given at Hydraulic Institute Annual Meeting. February 22, 2005.