Adaptive Management to the Rescue: Helping a Struggling Industrial Program Refocus

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ABSTRACT

Over the past several years, interest has grown in programs aimed at changing behaviors or business practices that affect energy consumption. There are, however, few documented examples of programs that actually achieve energy savings, especially within the Northwest's industrial sector. Existing examples tend to examine localized effects of employee awareness at individual sites. Over the past three years, the Northwest Energy Efficiency Alliance's (NEEA) regional industrial initiative has focused on promoting the systematic use of continuous energy improvement (CEI) in the Northwest's industrial sector, specifically in the pulp and paper and food processing industries. Due to this effort, 32 food processing plants and three pulp/paper mills were in various stages of adopting and practicing CEI at the beginning of 2009.

Still, taking the Initiative to market identified several unforeseen challenges that required significant adjustments to the initial implementation strategy. A key one of these focused on training. Instead of merely earning its mark by generating ample savings, training (or, more accurately, lessons learned from its implementation) became a pivotal element underlying CEI's development and eventual launch as a comprehensive energy management product. This paper illustrates how, in light of significant unforeseen challenges, availability of concurrent evaluation data, and dedication to adaptive management contributed to the successful launch and ongoing calibration of a previously untested behavioral market transformation program targeting the industrial sector. Data presented in this paper draw on three years of primary data collection from a number of sources, including program data, participant surveys, and site visits.

Introduction

NEEA is a non-profit organization that facilitates transforming markets toward greater energy efficiency using a wide variety of programs and initiatives targeting the residential, commercial, agriculture, and industrial sectors as well as technologies across sectors. The region's electric utilities, public benefits administrators, state governments, public interest groups, and efficiency industry representatives support NEEA through financial means and stakeholder feedback. This unique partnership has helped make the Northwest region a national leader in energy efficiency and market transformation.

In 2004, NEEA began developing a behavioral-based market transformation initiative for the industrial sector to focus on changing facility and management staff's perceptions of energy and its management and to make active energy management an integral part of day-to-day operations. To meet this objective, NEEA conducted primary research to characterize the Northwest's industrial market, identify key target markets, and identify barriers to adoption and implementation of energy-efficiency practices in the sector (generally) and target markets (particularly). Research findings suggested three primary reasons for then suboptimal levels of energy-efficiency investment:

1. Absence of corporate energy management policy and practices resulting from an apparent lack of awareness regarding energy use, energy efficiency, and potential returns at both corporate and plant levels.
2. Lack of technical ability to identify and address energy-efficiency opportunities.
3. Low interest levels among those in the supply chain and other trade allies in offering energy-efficient products and services.

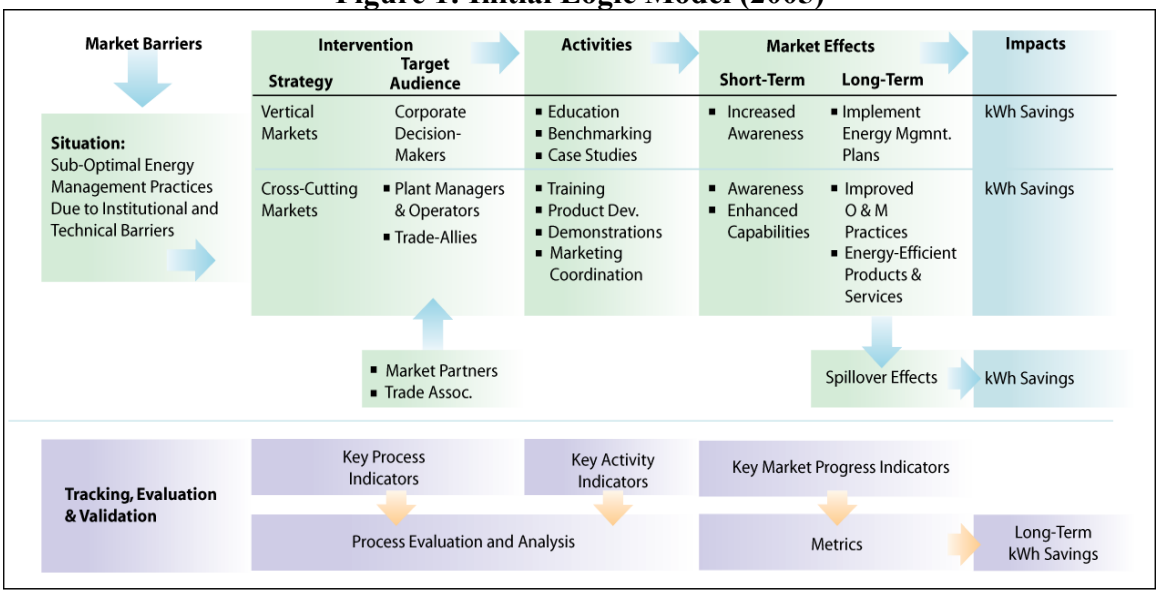
Initial Implementation Plan

NEEA directed program planners to use these identified barriers as a foundation for developing the Initiative's overall market intervention strategies and tactical elements. Specifically, the implementation strategy focused on working directly with industrial firms and their trade allies to help mitigate the market barriers. Specifically, NEEA designed the Initiative to create an ongoing process of education, training, and persuasion resulting in long-term impacts on key industries and leaders, differentiating the program from the immediate yield, measurable results typically found in technology-focused programs. NEEA expected this approach would foster natural, market-based demand for system-oriented efficiency improvements. In light of limited resources and the unproven nature of this approach, NEEA elected to test the Initiative pilot in the two vertical markets with the highest energy-intensity in the region (pulp and paper and food processing).

The initial implementation plan called for developing energy-efficient products and services that focused on the four most (electrical) energy intensive systems in the target markets: motors, compressed air, refrigeration, and pumps. Key intervention strategies for the systems (or cross-cutting markets) included training and education, channel management services,[1] and product and service development. As shown in the Initiative's logic model (Figure 1), the vertical interventions were expected to generate energy savings through increasing corporate awareness and integrating CEI into day-to-day operations. NEEA expected the cross-cutting intervention, especially training, to generate energy savings through increased awareness and capabilities among plant staff, which in turn was expected to result in improved operation and maintenance (O&M) practices and increased use of energy-efficient products and services. Based on the nature of the intervention strategies, NEEA expected to see energy savings resulting from the cross-cutting interventions (specifically training) prior to implementing CEI in the vertical markets.

[1]Channel management was envisioned to have three functions: 1) providing the necessary technical knowledge and specialized expertise to support systems training activities in the vertical markets; 2) working directly with industrial supply channels and trade allies to increase awareness and understanding of the systems optimization business case; and 3) encouraging trade allies to provide these services as part of their normal client offerings.

Figure 1: Initial Logic Model (2005)



In addition to generating savings, NEEA focused on training to be the quintessential "foot in the door." In essence, NEEA hypothesized that offering high-quality, low-cost technical training on a wide range of topics would provide a sufficiently strong value proposition for industrial facilities to engage with the Initiative. NEEA anticipated that if facility staff were offered technical training focused on improving energy efficiency of systems (e.g., pumps, motors, fans) instead of traditional, component-focused training, it would provide participants with the necessary awareness and technical skills to take the desired actions. NEEA also anticipated offering training with a clear value proposition would assist NEEA in establishing the Initiative as key player in the regional energy management market.

The Initiative's strategic plan projected savings of approximately 130 aMW[2] during its 10-year planning horizon (2005 to 2015). Targeted savings represented roughly 9% of total electricity consumption in the two target markets and less than 24% of the sector's region-wide energy savings potential. NEEA initially assumed nearly 45 aMW (35%) of these savings would be achieved during the first five years of the Initiative's operation, from 2005 to 2009. Vertical market interventions in the pulp and paper and food processing industries accounted for approximately 60% of these savings. The remaining 40% were expected to originate from cross-cutting interventions (e.g., training, channel management).

To document the Initiative, NEEA hired The Cadmus Group, Inc. (formerly Quantec, LLC), to conduct concurrent process and, later, impact evaluations of the Initiative.

[2] aMW = Average Megawatt. An aMW is equal to 1 MW of consumption for 8760 hours or 8,760,000 per year. The aMW is a common unit of measure in the Northwest since the Power Act of 1980 established conservation and energy efficiency as an equivalent source of energy to hydro, thermal and nuclear power.

Implementing the Plan--Launching Training 1.0

Concurrently with developing the basic program infrastructure, processes, and tools, the primary focus of the first few moths of implementation activities was developing and launching a comprehensive suite of technical training targeting system operators (i.e., shop floor employees who operated motor, compressed air, refrigeration, or pump systems). Each training event was a maximum of eight hours and centered on a qualified instructor, a PowerPoint presentation, and various hand-outs, such as a best practices guide for refrigeration. In many cases, a local utility would host the training and assist in recruiting participants. Except for a brief satisfaction survey at the conclusion of each training event, Initiative staff did not track or follow-up with participants following completion of training.

As envisioned by the implementation plan, the thrust of the early efforts focused on offering training to any individuals from industrial facilities or the trade allies serving them. NEEA recruited training participants using a variety of methods, including mail and e-mail invitations, phone calls, personal invitations from Initiative technical staff, and collaboration with local utilities.

In light of NEEA's hypothesis that increases in awareness and skills among facility staff would result in changes on the shop floor (both capital and O&M), one of the key evaluation activities during the first three years of implementation was to survey as many participants as possible, approximately three months after training. The survey generally sought to identify any actions resulting from training. In particular, the survey was designed to collect information on any capital projects and/or changes in operation and maintenance practices the participant believed to have resulted in energy savings. In light of the number of training participants, the evaluation plan stipulated Web-based surveys. If a participant identified potential energy savings, the evaluation contractor would conduct brief telephone interviews, and, where energy savings seemed likely, carried out site visits to identify energy conservation measures and ascertain estimates of energy savings.

Implementation of Web-based surveys proved challenging for three primary reasons:

- Training organizers had not collected contact information from most participants, reducing the sample frame to nearly 50% in 2005 and 64% in 2006.
- For participants for whom organizers collected information, most were system operators who did not have individual, job-related, e-mail addresses; so were unlikely to receive the survey.
- Implementation staff did not inform participants of the upcoming evaluation survey.

These issues resulted in average survey response rates ranging from 9% to 16%, depending on the year (Table 1). In light of these difficulties, the collected data have arguably been impacted by sample bias.

Table 1: Summary of Basic System Trainings (2005 to 2008)[3]

Year	Number of Trainings	Number of Attendees	Sample Frame	Number of Completes	Response Rate
2005	25	580	224	20	9%
2006	45	707	420	69	16%
2007	18	361	246	37	15%
2008	30	533	NA*	NA*	NA*

*Evaluation data were only collected for training conducted between 2005 and 2008.

Analysis of survey data identified three previously unanticipated barriers. First, many participants targeted by the survey had limited (or no) authority or opportunity to implement the changes promoted during training. Second, while more than half of survey respondents reported making system optimization changes, the time required to make these changes ranged from six months to over 12 months. Together, survey data suggested a lack of follow-through and a "shelving" of training knowledge and/or materials. When asked to identify the primary reasons for not implementing systems optimization changes following training, 2005 and 2006 training participants most frequently listed long payback periods (28%), no authority (26%), lack of support from management (13%), and lack of resources (10%) (Quantec, LLC 2007). Finally, analysis of the survey data indicated the 1,247 training participants represented a total of 410 unique facilities, 260 of which were outside the two target markets (based on SIC code). This evaluation finding suggested the non-targeted nature of the recruitment efforts resulted in diverting resources into non-targeted industries (Table 2).

Compounding these barriers, survey data further suggested training participants working at 43 facilities had taken some type of systems-optimizing action following the training. Follow-up phone calls with participants resulted in 23 site visits, with the evaluation contractor able to validate savings at 17 of these. Based on information collected during the site visits, validated savings associated with the Initiative's training activities totaled 0.6 aMW and 0.50 aMW of savings expected for implementation within one year from the site visit.

Table 2: Training-Inspired Systems Changes and Site Visits (2005 to 2006)

Training Type	Number of Plants Participating in Training	Plants Indicating Action	Number of Completed Site Visits	Plants with Validated Savings
Pulp and Paper	24	3	1	1
Food Processing	126	15	15	11
Other	260	25	7	5
Total	**410**	**43**	**23**	**17**

Adjusting the Plan: Piloting Industrial Mentored Training

In light of the resources dedicated to systems training and the relatively low incidence of reported changes and validated savings identified through evaluation activities, Initiative management began a comprehensive review of its strategy. To address issues preventing system training participants from taking energy-saving actions, NEEA began to experiment in mid-2006 with a new form of training. This was first termed "cluster training" but was later renamed "industrial mentored training." This training divided into four phases: intake, instruction, review,

[3] NEEA, Industrial Tracking System, May 24 2009

and recognition. The intake phase included recruiting facilities in cooperation with local utilities. The instruction phase included one to two days of instruction and facility tours as well as development of energy savings goals. As part of the in-class instruction, participants would develop a site-specific action plan that identified, in priority of ease of installment and rough cost-effectiveness, projects or changes to be made. The review phase included support of either a qualified trade ally or staff from the local utility in terms of planning activities to achieve the energy savings goals established in the previous phase. The final phase, recognition, included a dinner and presentation event attended by the system operators, their management, local utility staff, and NEEA employees. At the dinner event, the system operators presented their progress towards their respective goals and shared lessons learned. By design, this type of training represented several improvements over the basic technical trainings offered during the early implementation stages:

- Each facility would agree to identify one individual with the authority to implement the techniques learned in training as well as having the responsibility for achieving the energy savings goals, and would designate this individual as the energy champion.
- Each participant would leave with a clear and prioritized action plan for their facility.
- Participants had quick and free access to technical advise from a technical advisor dedicated to them.
- After training, the technical advisors would provide ongoing reminders and coaching on implementing desired changes identified during training.
- Staff involved in energy management would receive increased visibility among peers and in front of management.

For example, an action plan for a food processing company who underwent a mentored training on compressed air may have included the following items:

- Developed compressor system map with coach
- Establish KPI's and monitor for future reference
    - Established plant baseline
    - Monitor kW and machine Amps
        - Able to shut down 75hp machine 90% of time
- Install system PLC control system to replace individual compressor controls
- Institute leak detection and repair program with repair documentation
- Identify inappropriate uses of compressed air.
    - Replaced electrical cabinet coolers
        - Replace compressor generated vacuum with vacuum pump on #1 Boxer
- Install new air receiver
- Lower system pressure to 90 psig

NEEA hoped these changes would sufficiently address barriers facing systems training and would result in participants being increasingly likely to implement changes due to attending the training.

Between 2005 and 2008, NEEA offered 10 industrial mentored training sessions, which included participants from 63 facilities. While evaluation data from participant and utility

sponsors alike indicated high satisfaction levels with the training, analysis of participant data also indicated less than 16% of the participating facilities belonged to the Initiative's two target markets.

Table 3: Summary of Industrial Mentored Training Basic System Trainings (2005 to 2008)[4]

Year	Number of Trainings	Number of Attendees	Unique Plants Represented	Plants in Target Markets
2005	1	12	8	0
2006	2	34	11	0
2007	3	63	21	6
2008*	4	91	23	4
Total	**10**	**200**	**63**	**10**

*Evaluation data were only collected for training conducted between 2005 and 2008.

Analysis of data from 8 food processing plants indicates that 35 of the 52 action items listed in the facilities' plans had been implemented six months after the training with the remainder being in progress. While the data were largely based on self-reporting and reporting by the facilities' technical mentor, the findings clearly indicate that the approach to providing training with focused follow-up generated changes on the shop floor.

However, due to inconsistencies between measure names tracked by the implementation team and the items listed in the action plans, correlation of the action plan items to the measured validated by the evaluation contractor proved to be challenging. For instance, to date validated savings estimates are available for only 6 of the 35 actions and/or measures, totaling 0.09 aMW. (Table 4). The authors expect this number to increase as already validated measures will be able to matched up to specific action plan items.

Table 4: Summary of Savings Validated at Facilities Participating in Industrial Mentor Training (2005 to 2008)[5]

Savings Type	Validated Savings (aMW)
O&M	0.02
Incented Capital Project	0.07
Unincented Capital Project	0.00
Total	**0.09**

In addition to illustrating the need for targeted marketing and recruitment, NEEA's experience with the industrial mentored training showcased the need to have an individual at each facility (the energy champion) with the authority and responsibility to affect positive change. To better understand the role and potential impact of a dedicated energy champion, NEEA collaborated with the Bonneville Power Administration (BPA) in co-sponsoring an energy champion at a Washington paper mill from 2007 to 2008. The energy champion was a qualified engineer with experience in paper manufacturing whose sole job was to identify energy savings opportunities and coordinate projects to achieve those savings. The BPA supported this activity with engineering services and incentives for qualifying projects.

[4] NEEA, Industrial Tracking System. May 24 2009.
[5] NEEA. Industrial Tracking System, May 24 2009

The energy champion succeeded in both achieving energy savings (as detailed in Table 5) as well as changing the culture and business behavior of mill management. The mill's ownership and management realized a qualified engineer dedicated to managing energy, the second largest annual operating expense, yielded positive results. In addition, the local utility (a public utility district [PUD]) found this intervention improved the overall working relationship between the mill and the PUD.

Table 5. Energy Saving from a Pulp and Paper Mill Energy Champion (2007–2008)

	Energy Savings (aMW)	System Type
Changes in operation and maintenance practices	0.12	Compressed air and lighting
Incented capital projects	0.16	Pump replacement and lighting retrofit
Unincented capital projects	0.58	Pump VSD replacement
Total	0.86	

In 2008, when the project ended, the mill's owners and management found such value in the energy champion's actions that they decided to fund the position without subsidy from NEEA or BPA.

Despite the success of industrial-mentored training and the energy champion demonstration project, the cost and administrative burden associated with providing the necessary post-training follow-up to all facilities provided a natural limitation to widespread implementation. To collaborate with local utilities, NEEA tailored its implementation activities to fit the utilities' specific objectives, which, in many cases, included facilities outside the two target markets (see Table 3). To refocus all available resources on the two target markets as well as to integrate key lessons learned from mentored trainings, NEEA began to integrate training into a larger energy management "product": CEI.

Application of Lessons Learned: Fine Tuning Continuous Energy Improvement

In late 2007, NEEA began to apply the lessons learned from its training and energy champion interventions. Specifically, NEEA used insights gained during the first two years of implementation as well as evaluation findings documented in four market progress evaluation reports to refine its initial ideas surrounding offering business practice services and its expected role in market transformation (The Cadmus Group, Inc. 2009; Quantec, LLC 2008). The first two implementation years had shown a strong focus on facility level staff without effectively addressing corporate needs failed to result in expected participation and resulting actions. NEEA set out to develop a product that addresses employee needs (i.e., training regarding general awareness and specific technical skills) as well as business practices (organizational structure, goal setting, and performance measurement). These efforts developed CEI (Figure 2).

Figure 2
Continuous Energy Improvement
A Strategic Process for Industry

NEEA's working hypothesis for CEI intervention was all its elements (organizational structure, people, manufacturing systems, and measurement) were necessary for sustained improvement in energy intensity (energy use per unit of output), but no single element was sufficient by itself. Adopting CEI at a facility requires executive commitment and support within facility organizational structures to establish and achieve energy productivity goals. Adoption also required employees adopt behaviors, established through training and management reinforcement, that minimize energy waste and focus on continuous improvements. Additionally, CEI provided a framework to fit manufacturing systems already in place at facilities. For facilities with LEAN[6] manufacturing, CEI treated energy as a manageable waste stream. For facilities with existing safety or quality improvement programs, energy became a new and easily integrated metric. Of course, for facilities without such systems, CEI could serve as an initial framework from which to manage energy as a controllable cost.

The fourth element of CEI, measurement, proved to be a catalyst for the evolution of both implementation and evaluation. NEEA's implementation contractors spent considerable time assisting food processors in establishing baselines and key performance indicators for energy. In mid-2008, NEEA's implementation contractors began to work with facility managers to analyze energy productivity (pounds produced per unit of energy) on an annual basis. For some food processing facilities, CEI implementation was the first time managers had energy-use and production data presented in the same spreadsheet. This changed the managers' perception of energy from one of cost to one of value—a value they could optimize for the benefit of their bottom line.

Results to Date

As documented in the Initiative's logic models, the Initiative's goal is to engage 13% of the large[7] food processor market and 10 pulp and paper mills in CEI by the end of 2009. Based

[6] LEAN manufacturing facilities operate under a comprehensive system of processes intended to maximize value and minimize waste in the manufacturing process.
[7] More than 250 employees in the region.

on 2008 evaluation data, nearly 20% of the target market[8] now implements CEI, suggesting the region's food processing market appears to be adopting the CEI message. Based on progress to date, it appears the Initiative will not only reach but exceed its penetration goals by the end of 2009. In contrast, CEI appears to have limited traction with the region's 27 pulp and paper mills. A 2008 market characterization, completed by the evaluation contractor, identified several reasons including lack of capital, raising input costs, downsizing and staff turnover, shifts in ownership type (private ownership to investment firm ownership) and an increase in nonregional ownership. As of October 2008, the Initiative was engaged with four mills (14% of the market). Based on data available to date, the evaluation contractor considers it unlikely the Initiative will meet its stated goals of engaging 10 mills by the end of 2009.

Based on available data, the evaluation contractor has validated a total of 4.04 aMW[9] in electric (Table 6) and 1,057,414 therms in gas savings (Table 7) associated with Initiative activities from 2005 through 2008 (The Cadmus Group, Inc 2008 and 2009). The tables capture savings by type: changes in operation and maintenance (O&M) practices and upgrades/replacement of capital equipment. The latter category is further broken down by whether the facility received utility incentives (Incented Capital) or not (Unincented Capital). Table 4 and 5 include all savings resulting from training activities.

Table 6: Electric Savings (aMW) by Market (2005–2008)*

	Validated Electric Savings (aMW)			
	O&M	Incented Capital	Unincented Capital	Electric Total
Food Processing				
2006	0.15	0.49	0	0.64
2007	0.21	0.01	0.27	0.50
2008	0.44	1.06	0.02	1.52
Total	**0.81**	**1.57**	**0.29**	**2.66**
Pulp & Paper				
2006	0.01	0	0	0.01
2007	0.04	0.11	0.01	0.17
2008	0.55	0.09	0.57	1.21
Total	**0.60**	**0.20**	**0.58**	**1.39**
Grand Total	**1.41**	**1.77**	**0.87**	**4.04**

* All numbers are rounded to the nearest hundredth, which accounts for any seeming discrepancies.

As noted, Table 7 presents the same overview for gas savings, with 2008 marking the first year the evaluation contractor was able to validate these savings for the Initiative.

[8] Based on employment.

Table 7: Gas Savings (therms) by Market (2008)

	Validated Gas Savings (therms)			
	O&M	Incented Capital	Unincented Capital	Gas Total
Food Processing	68,750	0	988,664	1,057,414
Pulp & Paper	0	0	0	0
Total	**68,750**	**0**	**988,664**	**1,057,414**

Conclusions

This paper describes how effective use of adaptive management and timely evaluation data allowed NEEA to adjust the implementation strategy of its Industrial Initiative. Specifically, it highlights how NEEA's experiences with implementing different training types ultimately resulted in refocusing its entire implementation strategy and, specifically, fine-tuning its key offering: CEI. Integration of lessons learned from implementing different training strategies resulted in a product that, based on evaluation data, indicates strong signs of market adoption. While it can be argued the implementation of a non-traditional program such as this, especially in the industrial sector, would likely require some calibration and updates to align with market realities and unforeseen issues, NEEA's experiences over the past three years have generated several valuable lessons:

- Effective use of adaptive management to address program design and/or implementation issues is dependent on consistent and timely data collection. Involving evaluation during early implementation stages appears to provide an optimal feedback loop.
- Providing program managers with timely and well-summarized evaluation data proves key to effective use of adaptive management during program implementation.
- Conducting detailed and market-specific research prior to designing and launching a program is vital to success. Key research objectives should include: identification of market-specific value propositions, availability of data and contact information, and viable methods of data collection. Conducting a detailed evaluability assessment during the program planning phase can help avoid surprises.
- Accessing industrial facility staff, especially non-managerial staff, proves challenging. Web-based surveys appear ill-designed for data collection from industrial facility staff.
- Mentored training, while expensive and challenging to conduct, appears to be an effective way of ensure high measure implementation rates.
- Lack of consistency in measure naming conventions can create significant problems for program management and evaluation staff. These problems can be addressed by 1) establishing consistent naming conventions for measures, 2) placing responsibility/authority for naming measures with a limited number of technical/engineering staff, 3) use of unique measure IDs.

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