Wisconsin's Industrial Cluster Initiative Lessons: Three Years Later

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ABSTRACT

Acknowledging the diversity within the manufacturing industry, Wisconsin's public benefits program, Focus on Energy, developed targeted approaches to five major industries. Paper, Food Processing, Metal Casting, Plastics, and Water/Wastewater are responsible for over 60% of the state's industrial energy use, are. After three years, some of these approaches have already been very successful; others are yet in the process of proving themselves. The success of these initiatives is found in much improved ties between the program and industry leaders; the introduction and acceptance of peer-reviewed best practice guidebooks; strong and aggressive promotion of emerging technologies; and a significant increase in program reach. This paper discusses the keys to the success, but also addresses the potholes encountered along the way.

Introduction

Overall, the industrial sector in Wisconsin consumes 35% (over 24 million MWh) of electricity and 36% (1.4 billion therms) of natural gas. **Table 1** shows electricity and natural gas consumption for Wisconsin's four most energy intensive industries – **Forest Products, Metal Casting, Food Processing,** and **Plastics**, plus **Water Supply and Wastewater Treatment**. These industries account for over 60 percent of electricity and over 80 percent of natural gas consumption of all manufacturing energy in the state. The *Major Markets Study* (Xenergy, 2001), completed for the Focus on Energy program, found a potential savings of 18.9 trillion Btu's for these industries. Since most energy for these sectors is consumed by processes these are logical, but difficult, targets for program efforts (Nicol & Schepp). Volatility in energy

Table 1. Wisconsin Manufacturing Energy Consumption and Savings Potential

	Consumption (10^{12} Btu)		Savings Potential (10^{12} Btu)	
	Electricity	Natural Gas	Electricity	Natural Gas
Forest Products	18.8	31.5	2.2	4.8
Metal Casting	6.4	59.1	0.2	4.1
Food Processing	7.9	32.4	0.8	4.6
Chemicals/Plastics	3.4	17.8	0.4	1.8
Other Mfg	26.3	38.4	na	na
Water Supply	*0.4*	na	*0.1*	na
Wastewater Treatment	*4.5*	na	*1.1*	na
TOTAL	67.7	179.2	4.8	15.3

Source: Xenergy, 2001. (Water & Wastewater are program estimates)

markets has forced industrial customers to take a closer look at energy use. Since manufacturing processes use most of the energy, Focus on Energy initiated efforts to identify and promote energy efficiency opportunities in manufacturing processes for its major energy-intensive industries. For each industry, Focus convened a team of industry experts to find opportunities to reduce energy costs for these top industries. Each team began by concentrating on developing and promoting new, informative technical resources and by connecting with key large customers and players, such as industry associations and industry business allies to create a credible platform for dissemination of Best Practice information.

In the Beginning…

According to the United States Department of Energy (USDOE), Industrial Technologies Program (ITP, USDOE, 2005):

> "BestPractices brings together the best available and emerging technologies and practices to help companies improve energy efficiency, environmental performance, and productivity. …focuses on systems, where significant efficiency and savings can be achieved…helps U.S. manufacturers maintain global competitiveness through strategic energy management, including energy-efficient technologies…helps manufacturers cut costs and emissions —and helps our nation achieve economic and environmental goals."

Since 2001, Wisconsin's Focus on Energy Industrial Program has initiated service relationships with over 2000 industrial customers. The program provides both prescriptive and custom incentives to customers who implement energy efficiency projects that, without Focus support, would not get done or would have to wait. Focus's field energy advisors provide technical support through assistance with grant applications, proposal review, and general best practice information. In addition to implementation grants, the program provides incentives for project feasibility studies, training for managers and operators, and an array of technical information, including case studies and technical best practice sheets. Mostly, these efforts focus on best practices for standard technologies, patterned after information from the USDOE Industrial Technologies Program. These include lighting, motors, pumps, compressed air systems, ventilation, and process heating and cooling.

Industrial Cluster Evolution

For its part, Focus on Energy's cluster initiative focuses on ***Process*** Best Practices and defines them as those measures and activities which provide the best opportunities for energy efficiency in processes that are necessary for production. While many energy users understand the standard Best Practices, such as compressed air and lighting, Best Practices that affect manufacturing processes had received little attention or program promotion until the cluster initiative.

In early 2004, with the hope of building bridges to key, energy-intensive industries, the Focus on Energy Industrial Program management team solicited assistance from industry leaders, associations, and state government to identify experts to support the development and dissemination of Best Practices in process manufacturing for these industries. Each cluster effort

began with recruitment of industry experts, including former corporate level managers, and industry-specific engineers who understood the industry and its energy management issues. These experts formed an advisory and implementation team. They conveyed the best industry information to the industrial program manager and initiated field efforts to implement process best practice projects. They also linked the program to industry leaders and associations to establish credibility and a foothold for the promotion of leading edge technologies.

While Focus on Energy partners with more than 2,000 of the 12,000 Wisconsin industrial customers through their plant managers and engineers, the cluster approach leverages the strong political and technical connections that team members have to high level executives. For each Cluster team, the program enlisted a Cluster Leader, with 20 or more years of experience in the industry and familiar with the manufacturing processes, and a Cluster Engineer, who understands energy issues in those industries,. Each team developed a series of Process Energy Best Practice descriptions for its respective target industry. Best Practices were derived from literature review, industry roundtables, industry representative interviews, and facility surveys (Nicol, 2005).

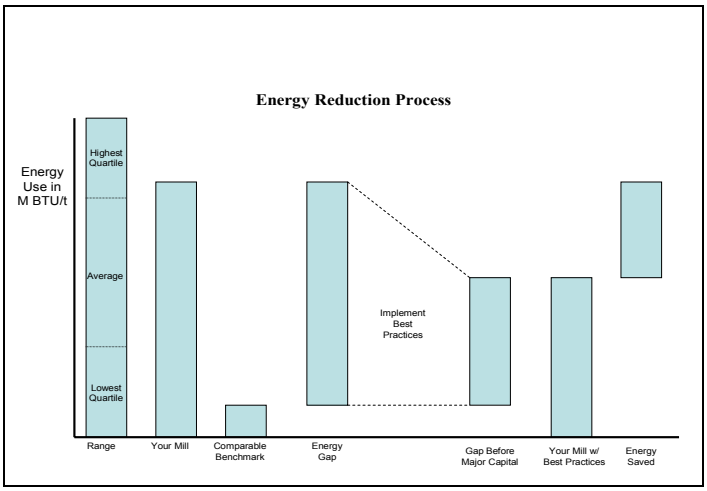
Initially, teams screened and condensed the information for those process best practices from the literature review. After establishing a list of best practices with descriptions, each team developed and published an ***Industry Energy Best Practice Guidebook***. Each *Guidebook* discusses the industry's energy use, benchmarking indices and processes; provides a series of one-page process best practices; and describes how to incorporate technical best practices into a comprehensive energy management process. Before publishing, each *Guidebook* was peer reviewed, both by cluster team members and by industry practitioners, including technically-astute potential users and their suppliers. Over the past two years, these Best Practices have been disseminated and promoted to customers and their allies through Best Practice sheets, case studies, specialized trainings, newsletters, oral presentations, joint conferences, web pages, and through the *Guidebooks*, themselves. The *Pulp & Paper Industry Energy Best Practice Guidebook* was first off the press in May, 2005. The four remaining *Guidebooks* were published in 2006, beginning with Plastics in June and ending with Water and Wastewater in December.

Energy Best Practice Guidebook Elements

1. Energy Benchmarking

Benchmarking determines who is the very best, who sets the standard, and what the standard is. Process energy impacts generally are not subject to standardized measures that fit all industry. They usually depend on the unique circumstances within a facility. Several energy intensive industries have developed benchmarking tools to gauge the energy performance of comparable facilities within their industry. For Pulp and Paper, for example, it is how much energy does a mill use per salable ton of paper produced, and how does that compare to the best performance of others making a similar product (Francis, Towers, Brown, 2002). Benchmarking is a critical tool to minimize energy use. Without comparing performance to an industry standard, a plant manager may not see cost threats and savings opportunities. Benchmarking allows a manager to compare his plant or mill with top performers, estimate the gap between their plants and his, set targets, and model results for best practice implementation. **Figure 1** (Akhtar, et al., 2005) illustrates a basic procedure for benchmarking industrial facilities.

Figure 1: Potential Energy Saving through Benchmarking and Gap Analysis



Industry-specific benchmarks can be developed by studying the energy use and relevant production parameters in a reliable sample of facilities. A benchmark may reflect the industry mean, the top decile, or even the projected energy use based on the implementation of all available and appropriate best practices. In a wastewater treatment industry example, **Figure 2**, both top quartile and Best Practice benchmarks are shown for Wisconsin. These values are the result of an the analysis of a large number of facility surveys and energy bills (Cantwell, et al.). The Best Practice Benchmark represents the energy use (kWh/million gallons) achievable if recommended best practices are implemented.

Figure 2.
Best Practice Benchmarks and Top Performance Quartiles for Wisconsin Wastewater Facilities

Facility Type	Flow Range (MGD)	Average Energy Use (kWh/MG)	Top Performance Quartile (kWh/MG)	Best Practice Benchmark (kWh/MG)	Average Potential Savings [1]
Activated Sludge	0 - 1	5,440	< 3,280	3,060	44%
	1 - 5	2,503	< 1,510	1,650	34%
	> 5	2,288	< 1,350	1,760	23%
Aerated Lagoon	< 1	7,288	< 4,000 [2]	3,540	51%
Oxidation Ditch	< 1.2	6,895	< 4,000 [3]	4,320	37%

2. Process Best Practices

Each best practice is characterized by the following criteria: primary area of application; impact on productivity; economic benefit; energy savings; applications and limitations; practical considerations; other benefits; stage of market acceptance; and helpful resources. **Figure 3** below provides a small sampling of the process best practices identified by each cluster team.

As of this writing, more than 150 process Best Practices had been identified and included in the five *Guidebooks*.

Figure 3. Examples of Process Best Practices in Cluster Industries

Pulp & Paper	Metal Casting
Lime Kiln Oxygen Enrichment Use a Dryer Management System Secondary Fiber High Efficiency Pulper Rotors	Recover Exhaust Heat Optimize Induction Furnace Tap Temperature Convert Shell Sand to Cold Box Core-making
Plastics	**Dairy Processing**
Pulse Cooling Replace Hydraulic Machines with All Electric In-line Thermoforming	Raise Suction Pressure on Refrigeration Spray Dryer Heat Recovery Reverse Osmosis Concentration
Water Supply	**Wastewater Treatment**
Automate to Monitor and Control Replace Pump Throttling with VFDs Computer-Aided Design and Operation	Operational Flexibility Fine-Bubble Aeration Dissolved Oxygen Control: Aerobic

3. Tying Process Best Practices to Energy Management

Using the Practical Energy Management™ approach, Process Best Practices are gradually incorporated into energy planning and management. This approach involves several logical steps. First, the facility establishes its **baseline energy use** by compiling monthly utility bills to develop an overall energy profile. See **Figure 4** for an example of how this can be done. Next, energy use is put into the context of overall organizational operations by comparing it to more widely tracked measures (**Key Performance Indicators – KPI**) such as pounds of resin processed, shipped tons, millions of gallons per day processed, or labor costs. An **Energy Profile Summary**, showing changes in energy consumption and in KPI can then be developed (**Figure 5**). For a complete profile, major systems should be identified and assessed for their contribution to energy use and load profiles. This can show where major opportunities exist.

Figure 4. Energy Use Tracking
Clearwater Wastewater Treatment Facility

					Electric Rate $0.06
Month	MWh/MG	Consumption (MWh*)	Prod Units MG of Wastewater	Billed Demand (kW)	Total Electric Cost
Jan	6.88	330	48	320	$19,800
Feb	6.42	308	48	320	$18,480
Mar	6.22	336	54	360	$20,160
Apr	6.07	364	60	400	$21,840
May	6.14	387	63	420	$23,220
Jun	6.02	397	66	440	$23,820
Jul	6.06	400	66	440	$24,000
Aug	6.00	414	69	460	$24,840
Sep	5.71	394	69	460	$23,640
Oct	5.52	348	63	420	$20,880
Nov	5.67	340	60	400	$20,400
Dec	5.59	302	54	360	$18,120
AVG	6.02			400	
TOTAL		4,320	720		$259,200
5% GOAL	5.72				-$12,960

Once the facility has set its energy reduction goals, the energy KPI is tracked over time to show the effectiveness of company energy management. Of course, attainment of goals begins with selection and prioritization of Best Practice implementation. Prioritization should be based on corporate business needs and have the full support of management. While dealing with the ancillary technologies (compressed air, lighting, etc.) certainly will save energy, the facility will also want to implement the appropriate Process Best Practices to have the greatest effect on energy KPI. Matching appropriate Process Best Practices with major energy use systems is the place to begin. When implementation has begun, it is critical to monitor and quantify project savings and costs and communicate results to upper management. Management understanding and commitment are critical to a lasting and effective corporate energy management program.

Figure 5. Key Performance Indicators

Facility Energy Profile - Summary

(Does not include gas, water or other utilities that should also be tracked.)

Clearwater Wastewater Treatment Facility

Electricity	2005	2004	2003	% Change 2004 to 2005
Consumption (MWh)	4,320	4,500	4,872	-4.00%
Electrical Cost ($)	$259,200	$247,500	$243,600	4.73%
$ per MWh	$60.00	$55.00	$50.00	9.09%
Key Performance Indicators				
Millions of Gallons(MG/Yr)	720	740	761	-2.66%
MWh per MG	6.00	6.08	6.40	-1.37%
Electric $ per MG	$360.00	$334.60	$320.19	7.59%
Business Indicators				
Operating Costs	$2,700,000	$2,750,000	$2,800,000	
Electricity as % Oper. Costs	9.60%	9.00%	8.70%	

Cluster Results

1. General Characteristics of Wisconsin Cluster Initiatives

Wisconsin's clusters are populated with generally large to mid-sized companies. The largest serve national and international markets. Cluster members include both end-user companies and equipment and consulting suppliers. The networking strategies in play within the cluster initiatives include the following.

a. Supportive associations. Each Wisconsin cluster has at least one supportive association. The associations and their leading members have come to consider Focus on Energy as a reliable source for energy efficiency information. By cluster, the associations include:

- Pulp and Paper – Wisconsin Paper Council; Lake States TAPPI. Focus developed a particularly strong relationship with WPC and co-hosted several meetings and conferences with senior management from major world class paper makers represented in Wisconsin.

- Metal Casting – Wisconsin Metal Cast Association; American Foundry Society. Focus provided several one-day events to discuss energy efficiency in metal casting facilities. The relationship has been collaborative and is growing. The current *Guidebook* promotion is geared to evaluate the *Guidebook* and look for ways to improve it.
- Plastics – American Chemistry Council; Society of Plastics Engineers. ACC provided a grant to Focus in order to place 230 Guidebooks in the hands of its Wisconsin members. Focus also initiated a collaborative process with a leading European plastics energy efficiency expert from England. Dr. Robin Kent, of Tangram Ltd., provided significant input into the development of the Plastics *Guidebook.* Much of his consulting and research has been with the Carbon Trust and affiliates.
- Dairy Processing – Wisconsin Cheesemakers Association; Midwest Food Processors Association. These associations provide marketing support for the Dairy Processing *Guidebook*. Through the development of the *Guidebook* Focus has also strengthened its relationship with the International Refrigeration Consortium.
- Water and Wastewater – Wisconsin Rural Water Association; Association of Wastewater Operators; American Water Works Association. Focus has provided many presentations on the Water and Wastewater *Guidebook* at regular association conferences and workshops. The Wisconsin Rural Water Association received an EPA grant to sponsor a Focus training for small operators. In addition, Focus has initiated an Energy Guidelines Committee with the Wisconsin Department of Natural Resources to garner more support and cooperation for operation changing retrofits.

These associations provide support as conduits for information flow to and from the industry in many activities such as newsletters, seminars, demonstration development, and *Guidebook* dissemination.

b. **Information dissemination.** The clusters get informational support through association and program web pages, newsletters, Best Practice promotions, *Guidebook* distribution. For example, TAPPI asked to publish the Guidebook and agreed to be the official dispenser of the *Guidebook* for Pulp and Paper. The American Plastics Council supported distribution of the Plastics Guidebook with a grant for publishing and mailing to 230 of its members. The Energy Best Practice Guidebooks are, indeed, the centerpieces of each cluster initiative. They are the leveraging tool that enables the Focus on Energy Program to begin dialogue with interested customers and the forum for objective, useful energy information.

c. **Common workshops and meetings.** From the beginning the Pulp and Paper cluster has worked with the Wisconsin Paper Council and TAPPI to bring its membership several energy-related workshops and conferences, including a Paper Drying web cast.

d. **Arranging contacts for customers and for equipment/consulting suppliers** Cluster engineers for the various clusters have helped bring in expert consultants and suppliers to conduct feasibility studies and provide state-of-the-art equipment for implementing Best

Practices. Two prime examples of this are for energy efficient repulpers and dryer management systems for the paper industry.

e. **Joint research and development.** Focus on Energy provides both support funding for feasibility studies and measurement and verification for emerging Best Practice technologies.

f. **Cooperation with research and educational institutions.** The cluster initiatives have also promoted University of Wisconsin training opportunities through course scholarships and bonus incentives for projects that follow from the courses in energy efficient refrigeration for food processors and energy efficient wastewater treatment.

g. **Innovation of products and processes.** Through its Best Practice Guidebooks and technology studies, each cluster has helped identify emerging technologies for its industry.

h. **Joint investment with customers.** Focus on Energy provides supportive for feasibility studies, project implementation, and demonstrations. This has been done extensively in the Pulp and Paper, Metal Casting, and Plastics clusters. CleanTech Partners, Inc. (CTP), an organization that supports the commercialization of emerging technologies through engineering, business planning, and financing has helped several emerging cluster technologies. CTP is a Focus on Energy partner organization and participates on several cluster teams.

i. **Dominant company leadership.** Wisconsin's clusters, particularly Pulp and Paper, have key large customers that lead and drive the agenda for the cluster initiatives.

2. Linkages to Focus on Energy Program Services

Special incentives and opportunities beyond the standard Focus Industrial Program are available to cluster industry participants. For one, special Best Practice promotions, especially as prescriptive incentives for specific emerging technologies, are available. Within the customer tracking database, cluster industry customers are now identified so they can be sorted for analysis and special offers. The Focus on Energy web site now has specific pages for each cluster. Cluster leaders and engineers also work closely with program energy advisors, energy utility account executives, and industry business allies. The cluster initiatives have been integrated into the framework of the overall Focus Industrial Program. Specific promotions have included:

- Energy Efficient Repulper Rotor installation incentive - $20 per hp (Pulp & Paper)
- Dryer Management System study grant (amount depends on circumstances (Pulp & Paper)
- Boiler Optimization Study grant – completed through a special arrangement with PAPRICAN - $10,000 per study for the first 10 studies (Pulp & Paper)
- Pump System Study grant – up to $10,000 @$5 per hp (Pulp & Paper)
- Metalcasting Guidebook Demonstration grant - $5,000 for the first four applicants who apply the Guidebook to their facilities (Metal Casting)
- University of Wisconsin Energy Efficient Ammonia Refrigeration course scholarship for $400, plus the remaining $695 if the trainee implements a follow up project (Dairy Processing)

- University of Wisconsin Energy Efficiency Water and Wastewater course scholarship for $400, plus the remaining $595 if the trainee implements a follow up project (Water & Wastewater)

3. Observable Effects Shown in Program Tracking Database

In spite of these early promotions, actual project impacts are difficult to see. Clearly, Pulp and Paper has seen activity beyond standard program participation, largely due to the special promotions. Given the newness of the other Guidebooks, this finding is not surprising. **Figure 6** provides the actual energy savings amount for each cluster over the past three program years. Even though activity does not show up in the Focus program's project tracking database, there is likely considerable unaccounted activity that gets lost due to program requirements, such as the two year payback minimum. Anecdotal evidence from the field suggests that some projects arising from *Guidebook* use are getting done without Focus financial incentives. The rank shows the relative position of the cluster with respect to the other clusters in terms of the magnitude of the parameter. Pulp and Paper, Dairy Processing, Plastics, and Wastewater generally show higher rankings than Metal Casting and Water Treatment, largely due to opportunity. More recent activity, not available for analysis in time for this paper, indicates an increase in overall program activity for FY07 (July, 2006 – June, 2007) that will exceed activity in FY06. The cluster impacts will likely also reflect this increase.

4. Guidebook Distribution and Acceptance

A recent evaluation of the Focus on Energy Program looked specifically for the impacts of the Pulp and Paper *Guidebook* in Wisconsin mills (Agnew, et al., 2006). Two-thirds of mills are aware of the *Guidebook*. Sixteen mills (33 percent of installed capacity) identified one or more measures in the *Guidebook* for implementation. Facilities representing 16 percent of installed capacity have installed or are in process of installing improvements, **Figure 7**. According to the evaluation, mills in Wisconsin are utilizing the *Guidebook* for industry-specific practices. Based on installed capacity, seven percent of the industry indicated the *Guidebook* was influential in their energy related decision making.

While the "evaluation" reports (from survey responses) that none of the respondents had implemented any of the core best practices (energy cost reduction goals, energy management budget, energy benchmarking, pump system assessments; reuse hot mill water, VFDs, high efficiency motors) as the result of the *Guidebook*, respondents representing 50 percent of the installed capacity in Wisconsin said they had used the *Guidebook* as a resource. (The overall sample included 67 percent of Wisconsin's installed capacity, in tons).

Endorsement of the *Guidebook* can be seen as a precursor to wider endorsement in the marketplace. Within a year of publication, after TAPPI published their version, a major conference was held that highlighted energy issues in general and the *Guidebook* in particular (*Forum on Energy: Immediate Solutions, Emerging Technologies* – 2006 TAPPI, Appleton, WI, May 15-17, 2006). This conference was initiated by the Focus Paper Cluster team and sponsored by major industry groups including the Wisconsin Paper Council and Lake States TAPPI. All participants of the conference received a copy of the Guidebook.

Figure 6.
Cluster Performance by Cluster and Program Year

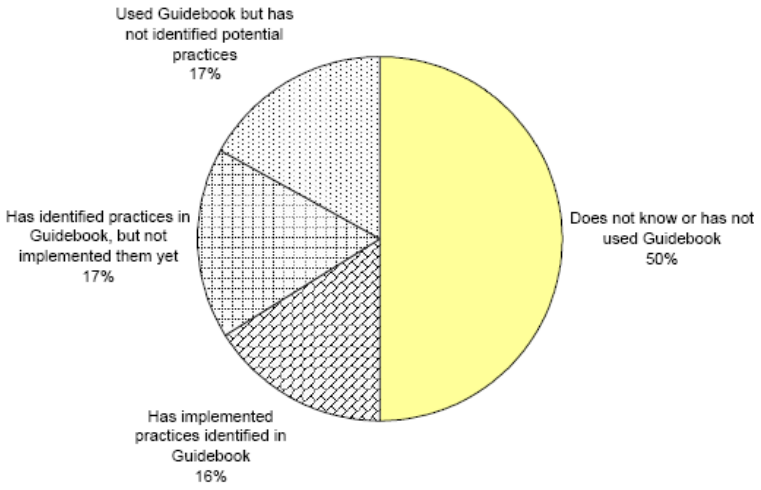
		FY2005	FY2006	FY2007	2/3 year 3 yr total	Percent	Rank	
Dairy	kW	49	1,030	303	1,382	11.8%	4	kW
	kWh	477,073	5,789,466	2,584,477	8,851,016	11.1%	4	kWh
	therms	337,352	661,649	5,059,001	6,058,002	49.7%	1	therms
	grant $	61,546	241,753	269,131	572,430	19.9%	2	grant $
	customers	12	22	13	47	19.7%	4	customers
Metal Casting	kW	37	115	71	223	1.9%	6	kW
	kWh	31,622	558,525	1,618,802	2,208,949	2.8%	6	kWh
	therms	169,280	190,947	16,031	376,258	3.1%	3	therms
	grant $	74,846	42,561	72,402	189,809	6.6%	5	grant $
	customers	5	10	4	19	7.9%	5	customers
Paper	kW	822	2,653	1,119	4,594	39.2%	1	kW
	kWh	6,391,657	20,703,628	5,123,171	32,218,456	40.4%	1	kWh
	therms	1,267,266	3,188,393	901415	5,357,074	44.0%	2	therms
	grant $	349,000	576,738	332,699	1,258,437	43.8%	1	grant $
	customers	19	18	15	52	21.8%	3	customers
Plastics	kW	721	766	366	1,853	15.8%	3	kW
	kWh	6,510,868	6,051,995	2,544,398	15,107,261	18.9%	3	kWh
	therms	29,890	40,785	287,285	357,960	2.9%	4	therms
	grant $	57,333	176,759	105,102	339,194	11.8%	4	grant $
	customers	17	27	13	57	23.8%	1	customers
Water	kW	484	92	0	576	4.9%	5	kW
	kWh	4,219,456	232,767	0	4,452,223	5.6%	5	kWh
	therms	0	6,378	0	6,378	0.1%	6	therms
	grant $	50,240	9,967	0	60,207	2.1%	6	grant $
	customers	3	4	0	7	2.9%	6	customers
Wastewater	kW	2,053	387	641	3,081	26.3%	2	kW
	kWh	10,193,953	1,810,246	4,931,688	16,935,887	21.2%	2	kWh
	therms	28,184	0	0	28,184	0.2%	5	therms
	grant $	279,168	51,843	123,412	454,423	15.8%	3	grant $
	customers	30	12	15	57	23.8%	1	customers
Totals	kW	4,166	5,043	2,500	11,709	100%		
	kWh	27,824,629	35,146,627	16,802,536	79,773,792	100%		
	therms	1,831,972	4,088,152	6,263,732	12,183,856	100%		
	grant $	872,133	1,099,621	902,746	2,874,500	100%		
	customers	86	93	60	239	100%		

Conclusion

All cluster initiatives are reporting some successes. Whether it is establishing a self-sustaining annual energy conference for an association membership or providing the needed technical and financial resources for a single company to come back from bankruptcy, most efforts and responses have been positive. A strong partnership exists between the Focus on Energy program and the industries that have learned to trust Focus to respect and care for their interests. Focus also continues to assess the value of its *Guidebooks*, relying on industry feedback.

Where significant success may yet need to be seen for some clusters, the timing is early and more resources will be needed to take the effort to the next level which will certainly include:

Figure 7: Implemented Best Practices identified in the Guidebook (Percent of Wisconsin's Active Installed Capacity)



- Increased ally development for promotion of emerging Best Practices
- Scoping out and focusing on emerging technologies
- Building upon existing industry relationships
- Testing the guidebooks

The success of these initiatives will be found in: improved connections between the program and industry leaders; the dissemination, acceptance, and adoption of peer-reviewed best practice guidebooks; strong and aggressive promotion of emerging technologies; the proliferation of energy management that incorporates Process Best Practices; and a significant increase in program reach resulting in resource acquisition of energy efficiency. **Figure 8** depicts where in the Succession Cycle each of the Wisconsin Cluster initiatives finds itself at this time. Pulp and Paper obviously has gained the most ground, in part due to its earlier start, but also due to strong industry leadership with significant need in a global marketplace. While the other industries face similar pressures, most are still sorting out priorities and measuring how they fit into their own markets. It may take a little time to get more of their attention.

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Figure 8. Cluster Progress in Succession Cycle

Cluster Succession Cycle	Elements	Pulp & Paper	Metal Casting	Plastics	Dairy Processing	Water & Wastewater
Identify new opportunities	Technologies and Markets					
Connect to industry	Forerunners and leaders					
Cooperative resource development	Needs Feasibility feedback Marketing Dissemination					
Early adoption	Projects Savings EM process					
Market diffusion	Same as above with more market players					
Best Practice maturity	Most of market has adopted					

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