Final Technical Report

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Executive Summary

The Industrial Assessment Center (IAC) program at West Virginia University (WVU), which is funded by the Industrial Technologies Program (ITP) in the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE), has provided a unique opportunity to enhance efficient energy utilization in small to medium-sized manufacturers. It has also provided training to engineering students in the identification and analysis of efficient energy use in each aspect of the manufacturing process and associated supporting elements. The outcomes of the IAC Program at WVU have assisted the manufacturers and the students in having a heightened sensitivity to industrial energy conservation, waste reduction, and productivity improvement, as well as a better understanding of the technical aspects of manufacturing processes and the supporting elements through which efficient energy utilization can be enhanced.

The IAC at WVU has conducted 101 energy assessments from 2002 until 2006. The focus of the industrial assessments has been on energy savings. It has been the IAC's interest to strongly focus on energy savings and on waste minimization and productivity improvements that strictly have an impact on energy. The IAC at WVU was selected as the Center of the year in 2005 from amongst 26 centers and has obtained a ranking within the top 5 in the previous few years. From 2002 to 2006, the total recommended energy savings produced by the IAC at WVU is 1,214,414 MMBtu, of which the electricity accounts for 93,826,067 kWh (equivalent to 320,226 MMBtu) and natural gas for 871,743 MMBtu. The balance is accounted for in savings in other fuels, mainly coal and wood. This results in an average recommended energy savings of 928,971 kWh from electricity and 8,631 MMBtu from natural gas per facility. The total CO_2 emissions saved from 2002 to 2006 is 154,462 tons, with an average of 1,529.3 tons per facility. The average recommended energy cost savings per facility is $135,036. The overall implementation rate of the assessment recommendations is 60.6% for the 101 industrial assessments conducted since 2002. The implemented recommendations resulted in total energy savings of 62,328,006 kWh from electricity, 295,241 MMBtu from natural gas, and 43,593 MMBtu from other fuels, totaling 551,557 MMBtu. The average implemented energy savings per industrial facility is 5,461 MMBtu and the average implemented energy cost savings is $ 59,879. The average implemented energy and productivity cost savings exceeds the program average of $ 60,000 per assessment. The IAC at WVU has produced a variety of energy efficiency recommendations in areas of industrial energy consumption such as Boilers and Steam systems (19), Air Compressors (15), HVAC (4), Chillers (12), Furnaces and Ovens (17), Motors (8), Lighting (20), Insulation (3), CHP and Cogeneration (4), and Process Equipment (7). The project has benefited the public by enabling the reduction of CO2 emissions by 89,726 tons due to the implemented energy saving recommendations at 101 small and medium sized manufacturing facilities. Since CO_2 is a green house gas, its reduction will improve the quality of the environment significantly. The reduction in operating costs for the manufacturing facilities in terms of energy cost savings will increase the manufacturing facilities' profits and improve their competitive edge, thus causing possible expansion in the manufacturing activities, leading to increase in good paying jobs.

Task Summary

Task 1: Conduct Industrial Assessments, to include a variety of plant types and sizes and well as coverage of the geographic area defined in the Annual Work plan Industrial Assessments:

Over the life of the award, from 2002 to 2006, the IAC has performed 101 assessment days for 101 small and medium sized manufacturing facilities. The Tables 1 through 4 show the details.

Table 1: Number of assessments for varying SIC in various years
FY indicates Industrial Assessment Center fiscal year
For example, year 2003 means the assessment year October 2002 – September 2003

		SIC																
FY	**STATE**	**20**	**22**	**24**	**26**	**27**	**28**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**38**	**39**	**51**	**Total**
2003	DE	1																1
	KY			3														3
	MD	1						1										2
	OH	2	1				2	3			1	1				1		11
	PA	1						1			1							3
	VA											1						1
	WV	1		3							1		1					6
2003 Total		**6**	**1**	**6**			**2**	**5**			**3**	**2**	**1**			**1**		**27**
2004	OH				1			5			3	4						13
	PA	1								1								2
	VA	2		1	1	1		1				1		1				8
	WV			1			1				1							3
2004 Total		**3**		**2**	**2**	**1**	**1**	**6**		**1**	**4**	**5**		**1**				**26**
2005	MD	1																1
	OH			1	1			3	1		3	2			1			12
	PA			1							1		2	1				5
	VA					1		1									1	3
	WV						1					1						2
2005 Total		**1**		**2**	**1**	**1**	**1**	**4**	**1**		**4**	**3**	**2**	**1**	**1**		**1**	**23**
2006	MD					2								1				3
	OH					1	1	3		1	1	2						9
	PA				1		1				1			1				4
	VA	1					1											2
	WV			1				1						1	1			4
2006 Total		**1**		**1**	**1**	**3**	**3**	**4**		**1**	**2**	**2**		**3**	**1**			**22**
2007	OH											1						1
	PA	1																1
	WV							1										1
2007 Total		**1**						**1**				**1**						**3**
Total		**12**	**1**	**11**	**4**	**5**	**7**	**20**	**1**	**2**	**13**	**13**	**3**	**5**	**2**	**1**	**1**	**101**

Table 2: Business profile of facilities assessed

Dates	FY*	No of Assessments	Avg. Sales/Facility $	Avg. Employees/Facility	Avg. Plant Area Sq. Ft./Facility
9/1/2002 to 11/30/2006	2007	3	48,333,333	169	136,007
	2006	22	44,100,000	175	201,450
	2005	23	27,534,783	138	131,976
	2004	26	24,134,615	138	150,046
	2003	27	26,194,444	134	236,948
Average per Facility			**34,059,435**	**151**	**171,286**

***Financial Year**

Table 3: Energy profile of businesses assessed

Dates	FY	No of Assessments	Avg. kWh Cost/Facility ($)	Avg. Demand Cost/Facility ($)	Avg. Other Costs/Facility ($)	Avg. NG* Cost/Facility ($)
9/1/2002 to 11/30/2006	2007	3	309,645	222,419	7,176	1,033,846
	2006	22	637,286	220,283	13,599	844,692
	2005	23	218,106	92,576	8,395	188,328
	2004	26	209,963	78,692	14,358	174,952
	2003	27	299,913	124,008	34,443	246,015
Per Facility Average			**334,983**	**147,596**	**15,594**	**497,567**

***Natural Gas**

Table 4: Recommended energy savings

Dates	FY	# of Assess-ments	# ARs*	Recommended Energy Savings				Total Recommended Cost Savings ($)
				kWh	kW	Natural Gas MMBtu	Other Fuel MMBtu	
9/1/2002 to 11/30/2006	2007	3	44	4,536,536	6,356	68,387	0	1,068,002
	2006	22	261	27,251,948	51,334	377,027	0	5,819,173
	2005	23	282	16,755,310	24,759	77,042	-75,944	1,521,051
	2004	26	352	18,253,090	32,278	98,614	16,843	1,972,007
	2003	27	311	27,029,183	17,263	250,673	81,546	3,258,439
Grand Total		**101**	**1,250**	**93,826,067**	**131,990**	**871,743**	**22,445**	**13,638,672**

***Assessment Recommendations**

Task 2: Promote and increase the adoption of assessment recommendations and employ innovative methods to assist in accomplishing these goals.

Table 5: Implemented energy savings

Dates	FY	No of Assess-ments	Total Annual Implemented Energy Savings				Total Annual Implemented Cost Savings ($)	# Imp. ARs	Avg. Payback (months)
			kWh	kW	Natural Gas MMBtu	Other MMBtu			
9/1/2002 to 11/30/2006	2007	3	3,593,116	4,905	6,536	0	218,769	23	10
	2006	22	19,201,541	33,717	154,150	0	2,616,467	160	12
	2005	23	8,128,336	13,010	43,308	5,070	804,053	166	17
	2004	26	10,910,582	18,607	28,468	12,731	837,021	211	8
	2003	27	20,494,431	13,488	62,779	25,792	1,571,456	198	15
Grand Total		**101**	**62,328,006**	**83,728**	**295,241**	**43,593**	**6,047,766**	**758**	**-**

Task 3: Promote the IAC Program and enhance recruitment efforts for new clients and expanded geographic coverage.

The Directors of the IAC periodically promote the IAC program by associating with professional organizations such as the Society of Manufacturing Engineers, WV Board of Professional Engineers, WV Industries of the Future (WV IOF) program, WV manufacturers association, WV Manufacturing Extension Partnership (WV MEP), and Institute of Industrial Engineers (IIE). The Directors often visit manufacturing facilities for discussing energy saving opportunities. Workshops are conducted periodically to expose industry participants to various energy efficiency measures. Presentations on the IAC program have been made at various local level meetings conducted by federal and state organizations. Contacts were made with many potential clients to discuss the DOE's Save Energy Now (SEN) program. The Directors and students periodically participate in webcasts and teleconferences with various industry groups to promote the IAC program. The Directors have participated in DOE sponsored technology showcases to promote the IAC program to potential industry clients. The Directors have collaborated with a utility company in Ohio and other outreach organizations to promote the services of the IAC. The IAC website has been periodically maintained to be at an excellent level so as to attract potential industrial clients for an IAC assessment. The Director of the IAC is a member of the WV IOF wood, steel, chemical, and cross cut industry groups.

Task 4: Provide educational opportunities, training, and other related activities for IAC students.

Since 2002, the IAC has utilized the services of 19 graduate and 7 undergraduate students as shown in Table 6. The IAC students have obtained high quality training on the development of energy efficiency measures, utilization of energy analysis and diagnostics equipment, and safety. The students were periodically sent to various training programs, conferences, and to specific

initiatives targeted towards improving industrial energy efficiency measures. Some examples of such training include, industrial process heating, CHP energy policy summit, IAC student conferences, process control for energy savings, boiler efficiency, energy efficiency webcasts, building energy efficiency conference, ACEEE summer study conference, SPIE conference, and DOE BestPractices tools training in compressed air and process heating systems. The students were encouraged to present and publish papers at conferences such as the ACEEE summer study and to publish papers in energy efficiency journals and books, working closely with the Directors. Some of the students were given an opportunity to interact with sophomores in the BS IE program to discuss and introduce industrial energy efficiency measures. Most of the students who have graduated have found jobs in the energy efficiency sector, having done their thesis or problem reports on the topic of industrial energy efficiency.

Table 6: Students at the Industrial Assessment Center

Year	2003	2004	2005	2006	2007
No. of Graduate students	7	9	6	9	9
No. of Undergraduate students	1	2	1	3	2
No. of IAC Students	**8**	**11**	**7**	**12**	**11**

Task 5: Coordinate and integrate Center activities with other Center and IAC Program activities, DOE's Industrial Technologies programs and other EERE programs.

The Directors have continued to interact with other IAC Directors in terms of enhancing their industrial energy efficiency activities, including visiting other IACs. During each assessment, the Directors take the time to introduce the DOE EERE, ITP programs to the industrial clients, most recently the Save Energy Now (SEN) program and BestPractices Software. The IAC has worked closely with the WV Development Office (now the WV Division of Energy) in its initiatives to promote industrial energy efficiency. The Director of the IAC has been a principal investigator on a number of State and DOE sponsored projects. The Director has been an investigator in a research projects, funded by DOE, titled *Multifunctional Metallic and Refractory Materials for Energy Efficient Handling of Molten Metals* and *Life Improvement of Pot Hardware in Continuous Hot Dipping Process* that aims to save energy in molten metal containment systems. This project has the participation of over 25 steel companies and he continues to interact with them, their vendors, and Oakridge National Laboratory (ORNL) in terms of energy validation research. The Director has participated as member of energy assessment team for the plant wide energy assessments conducted for Bayer Corporation, PPG Inc, Ford Casting Plant, and Weirton Steel. These activities have initiated synergistic partnerships with industry, and have resulted in energy assessments for qualifying facilities. The Directors have developed significant industrial partnerships by working with the WV IOF program and the State Energy Office, WVMEP, WV Manufacturers Association, and the Society of Manufacturing Engineers. These activities have supported and enhanced the activities of the IAC at WVU. The IAC Director at WVU has worked with the DOE's Office of EERE and ITP programs with respect to Industries of the Future, BestPractices, and Crosscutting Technologies; and has interfaced with DOE Laboratory partnerships, specifically with Oakridge National Laboratories High Temperature Materials Laboratory (HTML).

Task 6: Other tasks or special projects, as needed, and as determined by DOE to be advantageous to the program and in furtherance of IAC Program goals.

The Director of the IAC is a DOE Qualified Specialist in the areas of compressed air and process heating. The IAC at WVU has participated in several DOE special initiatives in the past and is currently participating in the Save Energy Now initiative. The IAC has conducted 9 assessments for the "Save Energy Now" initiative that has produced total recommended savings of 346,950 MMBtu per year, recommended cost savings of $4,179,774 per year, implemented energy savings of 146,339 MMBtu per year and implemented cost savings of $1,581,110 per year. Case studies have been developed every year to showcase the implemented energy efficiency measures at an IAC assessment. Workshops have been conducted every year during the IOF WV symposium on topics related to energy efficiency measures for reducing natural gas and electricity. The IAC website has been modified periodically to ensure the furtherance of the IAC goals. The IAC has been responsive to DOE requests for conducting energy assessments in geographical areas outside its service region. For example, in 2003, three assessments were conducted in the state of Kentucky, one in Delaware, and one in Virginia. The IAC has a good working relationship with the WV Division of Energy that funds two energy efficiency projects targeted towards the manufacturing facilities in the State of WV that do not qualify for an IAC assessment. The collaboration with the WV Manufacturing Extension Partnership (WVMEP) began in 2006 and it has evolved into a fruitful relationship between the WVMEP and the IAC. Joint assessments and referred assessments were conducted with the WVMEP. The WVMEP personnel participated in these assessments along with the IAC Directors and IAC students. The WVMEP personnel were trained in the use of energy analysis and diagnostics equipment and in data collection. Workshops were conducted for the WVMEP personnel on various aspects of industrial energy efficiency as well as on the use of DOE BestPractices tools. During this period assessment details were discussed in association with the WVMEP personnel and several site visits were conducted. The WVMEP Director and his personnel now routinely discuss energy efficiency as a part of their services portfolio with their industrial clients.