ORNL/CON-473

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Industrial Assessment Center Program Impact Evaluation

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LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

ORNL-27 (3-96)

ORNL/CON-473

INDUSTRIAL ASSESSMENT CENTER PROGRAM IMPACT EVALUATION

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December 1999

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
managed by
LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-96OR22464

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ACRONYMS

ACEEE	American Council for an Energy Efficient Economy
AEE	Association of Energy Engineers
AR	assessment recommendation
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BTU	British Thermal Units
BBTU	billion BTU
CBR	Comprehensive Benefit Ratio
CSU	Colorado State University
DOE	U.S. Department of Energy
DOE-NICE(3)	Department of Energy-National Industrial Competitiveness through Energy, Environment, and Economics
DSM	demand side management
EE	energy efficiency
ES	Executive Summary
EREN	Energy Efficiency and Renewable Energy Network
FY	fiscal year
HVAC	heating, ventilation, and air conditioning
IAC	Industrial Assessment Center
IP	Internet Protocol
MMBTU	million BTU
OIPEA	Office of Industrial Productivity and Energy Assessment
OIT	Office of Industrial Technologies
pdf	portable document format
R&D	research and development
ROI	return on investment
RR	realization rate
SIC	standard industry code

ABSTRACT

This report presents the results of an evaluation of the U.S. Department of Energy's Industrial Assessment Center (IAC) Program. The purpose of this program is to conduct energy, waste, and productivity assessments for small to medium-sized industrial firms. Assessments are conducted by 30 university-based industrial assessment centers. The purpose of this project was to evaluate energy and cost savings attributable to the assessments, the trained alumni, and the Websites sponsored by this program. How IAC assessments, alumni, and Web-based information may influence industrial energy efficiency decision making was also studied. It is concluded that appreciable energy and cost savings may be attributed to the IAC Program and that the IAC Program has resulted in more active and improved energy-efficiency decision making by industrial firms.

ACKNOWLEDGMENTS

We wish to thank Linda Berry and Marty Schweitzer for their thorough reviews and constructive comments on the draft of this report. We also wish to thank Andy Gluck and Jim Demetrops for their reviews and comments on various products of this research project. Lastly, we wish to thank Sheila Moore for her secretarial efforts in preparing the report.

EXECUTIVE SUMMARY

ES.1. INTRODUCTION

Oak Ridge National Laboratory (ORNL) is assisting the Industrial Assessment Center (IAC) Program, Office of Industrial Technologies (OIT), U.S. Department of Energy (DOE), in meeting the requirements of the Government Performance and Results Act of 1993 (GPRA). The IAC Program provides small and medium-sized manufacturers with energy, waste, and productivity assessments. These assessments are prepared by teams of engineering students and faculty from 30 colleges and universities across the country. Presently, the IAC Program uses a well-established database (Muller, Barnish, and Kasten 1998) to track savings resulting from recommendations generated during IAC site assessments.

There are, however, additional benefit pathways of the IAC Program that are not quantified in the current database. These include (1) assessment pathway benefits—through replication and implementation of (initially unimplemented or delayed) energy and cost savings recommendations; (2) alumni pathway benefits—through the training of students who will then find jobs in industry where they can use their IAC Program training; and (3) Website pathway benefits—through Web-based dissemination of technical information on energy and cost savings to organizations throughout the United States. This report presents methods used to measure the benefits attributable to the IAC Program from these pathways and estimates of these benefits.

This executive summary first presents the aggregated estimates of source energy savings, energy cost savings, and total cost savings attributable to the IAC Program for the year 1997 (Sect. ES.2). The data that were collected and methodologies employed to develop the estimates are discussed in Sects. ES.3 and ES.4, respectively. How the three IAC Program interventions may have impacted industrial energy-efficiency (EE) decision making is discussed in Sect. ES.5. Recommendations are presented in Sect. ES.6. Details of this study may be found in the report titled "Industrial Assessment Center Program Impact Evaluation," by Martin et al. (1999).

ES.2. AGGREGATE RESULTS

Table ES.1 presents the estimated source energy savings, energy cost savings, and total cost savings (including waste minimization and productivity activities) attributable to the IAC Program from each of the three pathways studied:

- direct assessments conducted for IAC client firms;
- student alumni of the IAC Program who may have jobs with responsibilities that entail reducing energy use and costs; and
- IAC Program Websites that can provide organizations with information about how to save energy and reduce costs.

Table ES.1 is meant to be a side-by-side illustration of the potential impacts of the three pathways, and is based on specific, conservative interpretations of the data from the three studies. Because of

the limitations set forth by the data that were available for the study, flexibility in interpretation is feasible. Alternative interpretations, however, must consider all of the evidence, as documented in the full report.

Table ES.1. Estimated IAC Program annual savings for FY 1997 — assessment, alumni, and Website pathways

Program Component	Source Energy Savings (BBtu)	Energy Cost Savings	Total Cost Savings
Assessments	1,901	$9,327,630	$42,632,149
Alumni	3,368	$56,000,000	$66,650,000
Websites[a]	6,054	$26,870,800	$29,104,150
Total	11,323	$92,198,430	$138,386,299

[a] Domestic savings only

ES.3. DATA

The results presented were developed using data collected from follow-up questionnaires with firms (clients) that have received IAC assessments, with IAC student alumni, and with IAC Website users. Each questionnaire was designed primarily to collect data on energy and cost savings attributable to the IAC Program (Martin et al. 1999). However, several questions were added to each questionnaire to explore changes in EE decision making. Each follow-up effort is briefly described below.

ES.3.1 Client Follow-up

Since the inception of the IAC Program in the early 1980s, thousands of small and medium-sized industrial firms have received assessments. For this project, the sampling frame included all firms assessed between October 1, 1991, and September 30, 1997, that implemented or planned to implement at least one recommended EE measure, as recorded in the IAC database. From this frame of 2,954 firms, 102 were randomly selected and 42 agreed to be included in the follow-up. Of the 102 firms included in this sample, 37 could not be contacted because either the original contacts had left, or the plant or center was no longer in existence. Only 23 firms actually refused to participate. Therefore, of the 65 firms contacted, 42 participated, yielding a participation rate of 65%.

ES.3.2 IAC Alumni Follow-up

A database of 656 IAC alumni (out of an estimated 1,420 alumni through FY 1998) was obtained from Rutgers University. From these 656, IAC directors identified 77 alumni believed to be particularly successful in working in industry to save energy. In the spring of 1999, all 656 IAC alumni received a questionnaire in the mail. Two reminder cards were also sent. These three rounds of effort yielded 132 completed questionnaires. Approximately 150 questionnaire packages were returned as a result of bad addresses. Thus, the overall response rate was just over 26%.

ES.3.3 IAC Website Users Questionnaire

An on-line questionnaire of IAC Website users was conducted during a 96-day period in the spring of 1999. Visitors to IAC Websites maintained by DOE, Rutgers University, and Colorado State University were alerted to the questionnaire through an active Java applet on the home pages of these Websites. Visitors were induced to complete the questionnaire with a reward of an ASHRAE Pocket Guide. Twenty-nine responses were received during this time period. Because accurate usage summaries of these sites were not available, a response rate could not be determined.

ES.4. METHODOLOGY

Separate methodologies were used to estimate energy and cost savings impacts attributable to the IAC assessments, alumni, and Websites. These are described briefly below.

ES.4.1 Assessment Methodology

The approach taken to estimate savings was to adjust implemented energy and cost savings reported in the IAC database of client assessments. This was achieved using comprehensive benefit ratios, or CBR's. It is assumed that for measures implemented by IAC clients, the energy and cost savings estimates provided by the assessments are close to actual performance. CBR's are estimated to account for firms implementing more or less of the measures recommended in the assessments, and replication of recommended measures in other parts of the plant or at other plants that interact with the original IAC clients.

The client follow-up questionnaire collected data about the status of all assessment recommendations and replications. The CBR applied to source energy savings to calculate the result presented in Table ES.1 is 1.084. The CBR's for the energy cost savings and total cost savings are 1.004 and 1.15, respectively.

ES.4.2 Alumni Methodology

The alumni respondents to the follow-up questionnaire reported on their activities in saving energy and costs in the years 1995–1998. Energy and cost savings reported by the 132 respondents were generalized to the entire population of 1,420 alumni. This was done by assuming that the 26% response rate would have been the same had all alumni received follow-up questionnaires and that this larger number of alumni (369) would have reported similar mean alumnus energy (equivalent to approximately four audits per year) and cost savings equal to those of the sample of 132. This assumption increases energy and cost savings estimates reported by the follow-up questionnaires between a factor of 2.5 and 2.7, depending on the year of the estimates. This conservative approach assumes that the remaining 74% of IAC alumni do not contribute to program impact.

ES.4.3 Website Methodology

The data collected from the Website questionnaire were reviewed, first, to determine whether the respondents were U.S. residents and, second, for validity. It was clear from the domain names that several respondents were from foreign countries. The savings reported by these foreign respondents were not included in the results reported in Table ES.1. In addition, three domestic respondents reported very high energy and cost savings. Each respondent was contacted; only one set of savings results could be validated for inclusion in Table ES.1. The energy and cost savings estimates provided by respondents during the 96-day period are not adjusted in any further way. This is a conservative assumption which represents uncertainties about the number of people who may use IAC Website information each year to save energy and costs.

ES.5. IAC IMPACTS UPON INDUSTRIAL ENERGY-EFFICIENCY DECISION MAKING

This project also developed a model to describe an industrial firm's energy-efficiency decision making over time. The model posits seven stages, which range from "no energy-savings decision making" to "EE program implementation" to "steady-state EE decision making" (see Fig. ES.1). It is hypothesized that government EE programs, such as the IAC Program, can accelerate the speed with which industrial firms move through the model's seven stages. In addition to the data collected and described in Sects. ES.2 and ES.3, data were collected about firms' stages in the model before and after receiving one of three IAC benefits: a direct energy assessment, the employment of a student alumnus of the IAC Program, or use of EE information from an IAC Website.

Table ES.2 presents results about shifts in life cycle stages in EE decision making for the client firms, alumni employers, and IAC Website-using organizations. Overall, all three groups can be seen to be moving further along the EE decision-making life cycle after the IAC Program intervention. For example, only 5% of the clients were categorized in the last three stages of the life cycle—routinization, inculturation, or steady state—before the assessment whereas 62% were so categorized after the assessment. As seen above, the changes identified in the alumni employer organizations were less stark but also substantial, with 30% of the alumni employers falling into the last three stages of the life cycle before hiring an alumnus versus 56% after hiring an alumnus. The Website-using organizations also exhibited positive movement along the life cycle but at a much smaller magnitude. The changes for clients and alumni employers were highly statistically significant; the results for the Website-using organizations were much less statistically significant.

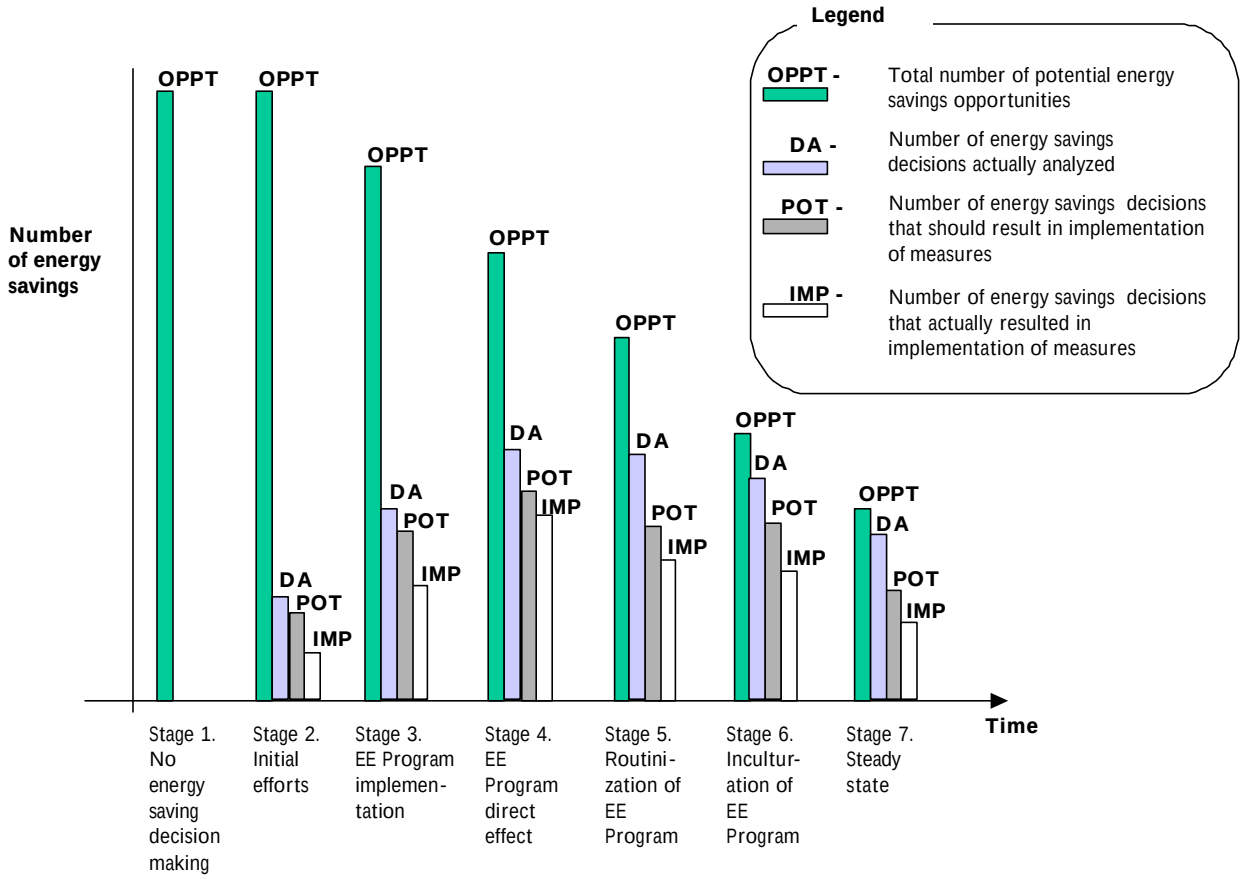

Fig. ES.1. Life cycle model of participant firms' energy-efficiency (EE) decision making.

Table ES.2. Stages in the energy-efficiency (EE) decision-making life cycle before and after IAC Program interventions[a]

Study	IAC Intervention	No EE Decision Making = 1	Initial Efforts = 2	EE Program Implementation = 3	EE Program Direct Effect = 4	Routinization of EE Program = 5	Inculturation of EE Program = 6	Steady State = 7	Number	Mean	Standard Deviation	T-Test Significance
Client	**Before**	2	43	38	12	0	5	0	40	3.5	2.0	0.001
	After	0	3	18	18	5	49	8	39	4.6	1.8	
Alumni	**Before**	15	23	29	2	2	12	16	82	3.5	2.1	0.001
	After	1	16	19	8	8	29	19	89	4.7	1.9	
Web	**Before**	8	12	16	16	8	16	29	25	4.5	2.0	0.15
	After	5	5	18	9	0	41	23	22	5.1	1.8	

[a]Numbers are percentages except for T-test significance

ES.6. CONCLUSIONS AND RECOMMENDATIONS

The results indicate that the IAC Program can be credited with saving an appreciable amount of energy and costs. Direct energy and cost savings associated with assessments are higher than previously thought. Less directly, employers hiring IAC student alumni and organizations using IAC Websites are also receiving significant energy and cost savings. Additionally, there are strong indications that the three IAC Program elements are capable of affecting long-term and permanent changes in industrial energy-efficiency decision making. Details of this study may be found in the report titled "Industrial Assessment Center Program Impact Evaluation," by Martin et al. (1999).

The following recommendations pertain both to improving future evaluations of IAC Program energy and cost savings and to improving the program itself:

- increase number of clients responding to the long-term (greater than 2 years) follow-up questionnaire to better address savings persistence and to reduce the standard errors of the energy and cost saving estimates;
- continuous collection of client and alumni data, with annual analyses of impacts;
- continually maintain the Website users questionnaire, as this is a very cost efficient way to collect data;
- implement usage monitoring software for IAC Websites;
- conduct exit interviews with alumni on a routine basis and develop and maintain an alumni follow-up questionnaire on the Web;
- implement procedures that promote continuous interactions with clients and alumni over time;
- estimate energy and cost savings associated with moving from one stage to the next in the EE decision-making model illustrated in Fig. ES.1.;
- work to better understand which IAC and OIT products are most appropriate for firms at different stages of the model illustrated in Fig. ES.1 and develop new program elements (e.g., executive training courses) as appropriate; and
- conduct research to better understand how firms currently make EE decisions and identify IAC and OIT elements that can help overcome deficiencies in this type of decision making—e.g., specifically evaluate why recommended measures with paybacks of 2 years have implementation rates of less than 50%.