How Building Assessment Centers Can Leverage the Success of the Industrial Assessment Centers to Train the Next Generation of Efficiency Experts

Daniel Trombley and Jennifer Amann, American Council for an Energy-Efficient Economy
Kelly Kissock, University of Dayton

ABSTRACT

Awareness of energy efficiency in the buildings sector is growing at a rapid pace, and efficiency programs are expanding equally fast. Many states are seeking to triple their current programs in the next few years. While this increased attention is necessary to meeting energy efficiency targets set by states and utilities, there is concern that there are not enough knowledgeable practitioners to do the work. Many training programs focus on certifying installers, but there is also a need for higher-level engineers and architects to perform detailed assessments of large commercial and institutional buildings. To address this concern, the pending American Clean Energy and Security Act of 2009 includes a provision to establish Building Assessment Centers (BAC) modeled after the Department of Energy's highly successful Industrial Assessment Center (IAC) program, a longstanding and successful program that trains industrial efficiency engineers.

This paper will explore how the BAC program can replicate the successes of the IAC program, building on the expertise of IAC directors and building efficiency practitioners to describe effective program strategies. BACs, located at universities throughout the country, could serve as centers of regional coordination to meet public-private market needs. The paper will examine how the BACs can work collaboratively with universities, state governments, regional efficiency organizations, and utilities, as well as partner with the IACs and DOE's Combined Heat and Power Clean Energy Application Centers. If established properly, the BAC program could serve a vital role in training building efficiency experts while helping to meet state and utility energy efficiency targets.

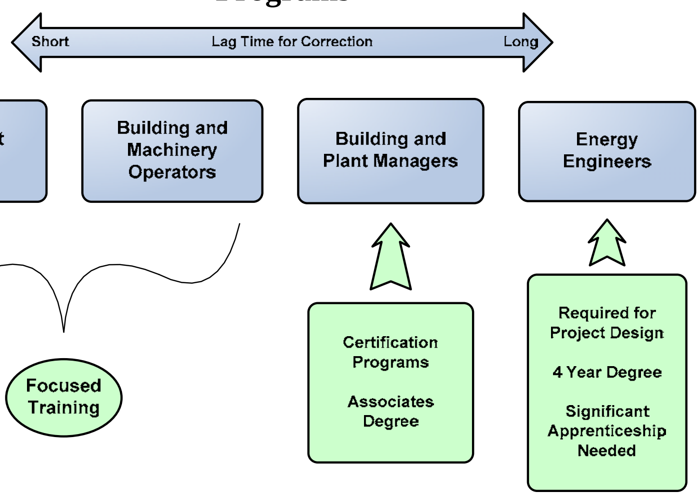
Introduction – The Need for a Trained Workforce

Meeting established energy savings targets and the growing demand for building energy performance improvements will require a dramatic increase in the number of buildings and total floor area serviced each year with building energy analysis, retrofits, and retrocommissioning. Several recent studies estimate the opportunity for job creation and the challenge of adequate training and retraining of engineers, technicians, analysts, and operators to fill these positions. In New York City alone, officials estimate 5,000 new jobs in building retrofits and retrocommissioning to meet the PlaNYC program goals (City of New York 2007). A study conducted for the District of Columbia estimates that D.C.'s Green Building Act will create demand for 9,200 workers between 2009 and 2018 with skills in operation and maintenance of energy-efficient facilities for buildings constructed or retrofitted under the Act (Louis Berger Group 2008). A recent study by Lawrence Berkeley National Lab estimates that by 2020, as many as 1.3 million people may be involved in energy efficiency projects (Goldman, et al. 2010).

However, simply hiring more workers will not be sufficient to meet energy savings targets. Improved education, training, and retraining with an emphasis on energy efficiency is needed for professionals and workers in the trades. Building service professionals report that recent engineering graduates rarely have experience in the field and that engineers, technicians, and operating staff lack understanding of system interactions, whole building performance concepts, and building controls (Nexant 2008, Quantum Consulting 2006), highlighting the need for internships and/or field-oriented project work and better continuing education opportunities.

Figure 1 below shows the wide range of energy efficiency workforce needs, from installers to operation and maintenance experts to building managers to energy engineers—and these jobs are just within the buildings themselves. Building energy efficiency relies in a broader sense on the larger energy efficiency community, which requires energy efficiency experts for energy modeling, audit services, research and development, education, and policy.

Figure 1. Relationship Between Workforce Expertise Level and Lag Time for Educational Programs



Source: Muller 2008

Figure 1 also suggests the timeframe needed to train the different parts of the workforce[1]. While installers can be trained in weeks or months, energy engineers can take four or more years to train. Few programs exist that meet the long-term needs of the energy efficiency workforce and no current programs target the whole range of workforce. The program that comes closest to meeting these needs on a national level in the industrial sector is the U.S. Department of Energy's *Industrial Assessment Center* program, which will be discussed in detail in the next section. In the buildings sector, there are a number of programs that address different parts of this continuum, but a coordinated program to address the entire range of workforce needs, such as the proposed *Building Assessment Center* program, will effectively meet these needs and produce energy experts who understand a wide array of buildings efficiency issues.

[1] This graphic was originally designed for the industrial energy efficiency workforce, but it applies to building energy efficiency as well.)

History and Results of the IAC Program

For over 30 years, the Industrial Assessment Center (IAC) program has provided small- and medium-sized manufacturing firms[2] with the technical assistance necessary to make important energy efficiency improvements in their facilities. There are currently 26 centers located at engineering universities across the country, each performing about 15 assessments per year. Staffed by faculty energy efficiency experts, the centers train undergraduate and graduate engineers to identify potential energy, waste, and productivity savings in manufacturing facilities.

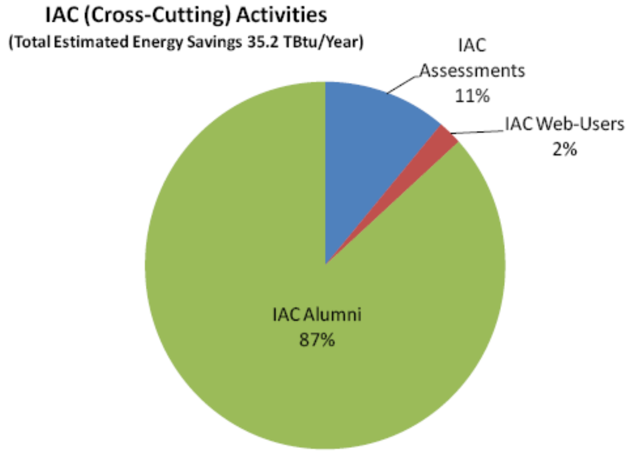
To date, the IACs have performed over 14,500 energy assessments in all 50 states (IAC Database 2010). For each assessment, a group of students analyzes the company's utility bills before visiting the facility. The assessment includes a plant tour and meetings with key company representatives, from maintenance workers to plant managers to presidents and CEOs. The students regularly identify 10-20% energy savings in a single day at a facility by working with plant personnel to find the most cost-effective projects with the greatest chance of being implemented. The students collect data on the same day and then write a technical report detailing the energy savings recommendations, which is provided to the company at no charge. The IACs have issued more than 100,000 individual recommendations, and almost half of them have been implemented by industry. Every year, manufacturing firms implement IAC recommendations that save a total of nearly $40 million per year, or over $70,000 per assessment (IAC Database 2010).

While the Industrial Assessment Center program could be justified based on direct savings alone, it has numerous other benefits. By situating the IACs at universities, engineering professors are funded to study energy efficiency. As a result, many of the IAC directors offer courses in energy systems and energy efficiency. The IAC program administration has estimated that for every student that goes through the IAC program, three additional students attend these classes and are exposed to energy issues (Muller 2009). Furthermore, many universities encourage or require research, leading IAC directors and students to contribute to the field of energy efficiency science and research by publishing studies in peer-reviewed papers and journals.

Perhaps the IAC's greatest assets are its alumni. The program's university connections provide a much-needed direct pipeline through which engineering students are prepared for careers focused on energy management and efficiency. It is this role that is so critical to the continued growth and strengthening of energy efficiency investments in the industrial sector. Over 2,500 students have been part of the IAC program, and over 60% take jobs directly dealing with energy issues (IAC Forum 2010). The demand for these well-educated, highly skilled and adept energy engineers far outstrips the supply. Not only are IAC graduates in high demand, but data collected by Oak Ridge National Laboratory also show that energy savings by IAC alumni dwarf savings by the current students in the program, as seen in Figure 2.

[2] Defined as having total annual utility bills between $100,000 and $2 million and fewer than 500 employees.

Figure 2. Energy Savings from IAC Alumni vs. IAC Assessments



Source: Wenning 2010

IAC graduates are highly sought as plant energy managers, energy efficiency consultants, and energy-efficient design engineers, and for good reason. They are well-versed in the most up-to-date and cutting edge technologies and have a keen sense for improving energy efficiency in a wide range of applications including product design, project engineering, and organizational/facility energy management. On average, IAC students complete 18 assessments during their tenure, but many students complete as many as 30 or 40, and a few complete over 100 (IAC Forum 2010). This hands-on experience in various industrial settings (chemical, paper products, food, primary metals, assembly, etc.) gives them an edge over other graduates. IAC students are required to write detailed reports and present recommendations to plant personnel ranging from maintenance workers to CEOs. This helps the students develop excellent verbal and written communication skills, further setting them apart.

All things considered, the program has been among the most cost-effective and impactful of the federal energy efficiency programs. Despite the outstanding energy and cost savings by industry, unparalleled workforce development, and other auxiliary benefits, in recent years the IAC program has seen its budget cut in half from $8 million per year to $4 million per year. This reduced funding means fewer audits for industry and less experience for the students, but it also leaves the program struggling to stay afloat.

Proposal for the Building Assessment Centers

In early 2009, ACEEE, recognizing the need for buildings technicians and engineers fluent in energy efficiency, developed a proposal for *Building Training and Assessment Centers* based on the IAC program (ACEEE 2009). This proposal was the basis for legislation included in the *American Clean Energy and Security Act of 2009* (ACES), also known as the Waxman-Markey Climate Bill. As of this writing, the legislation is still pending, although it was passed by the House of Representatives in June of 2009.

The proposed Building Assessment Center program would establish centers at universities across the country to train students in energy efficiency and provide technical support to building owners. Seven specific areas are called out in the legislation:

"SEC. 173. BUILDING ASSESSMENT CENTERS.

(a) IN GENERAL.—The Secretary of Energy (in this section referred to as the ''Secretary'') shall provide funding to institutions of higher education for Building Assessment Centers to—

(1) identify opportunities for optimizing energy efficiency and environmental performance in existing buildings;
(2) promote high-efficiency building construction techniques and materials options;
(3) promote applications of emerging concepts and technologies in commercial and institutional buildings;
(4) train engineers, architects, building scientists, and building technicians in energy-efficient design and operation;
(5) assist local community colleges, trade schools, registered apprenticeship programs and other accredited training programs in training building technicians;
(6) promote research and development for the of alternative energy sources to supply heat and power, for buildings, particularly energy-intensive buildings; and
(7) coordinate with and assist State-accredited technical training centers and community colleges, while ensuring appropriate services to all regions United States."

(U.S. House of Representatives 2009)

As proposed, the BAC program is intended to yield direct energy savings through building energy assessments, transform markets for energy-efficient technologies and practices, and provide or support development of the next generation of engineers, technicians, operators, and related trades to ensure continuing improvement in building energy performance.

The commercial and institutional building stock is characterized by diversity in size, vintage, ownership, location, and end-use. While the building services market—including design, construction, retrofit, commissioning/retrocommissioning, and other services—is well-established, it is also extremely fragmented and the quality of services available to different segments of the market varies. To be effective in achieving both energy savings and workforce development objectives, the BAC program will serve the full spectrum of buildings with a broad range of services. This will require flexibility, a broad reach, and significant stakeholder involvement.

Coordinating efforts with a wide variety of interested parties will be crucial to starting and maintaining the BAC program for two reasons. First, because some activities of the BAC program will overlap with current public and private organizations, it will be important for these firms to support the program. In addition, working with current service providers to identify gaps in the market will allow the BAC to work in areas that are not well served. Some examples of these key stakeholder groups are private firms offering building energy audit services, community colleges with training programs that cover energy efficiency, utilities, and unions (such as the Sheet Metal and Air Conditioning Contractors' National Association and the International Brotherhood Of Electrical Workers).

IAC-BAC Differences

Even though the Building Assessment Centers will be modeled after the Industrial Assessment Centers, some important differences must be recognized. These include differences in the market for audits, the educational scope, and the energy use characteristics of buildings versus industrial facilities.

A significant difference between the IACs and BACs is the current market for audits. In the industrial sector, there are few private firms that target small to medium-sized manufacturers. The lack of audit services to this market segment has two primary causes. First, the manufacturing sector is very heterogeneous, meaning there is a high need for unique sub-sector expertise. While there are a number of crosscutting energy systems across the sector, such as lighting and compressed air, achieving significant savings requires knowledge of different manufacturing processes. Second, small to medium-sized manufacturers are by definition relatively smaller than other manufacturers, and thus have less total savings potential. Firms that do offer audit services tend to focus on larger companies where the return on investment is often greater. The buildings sector, however, is much more homogenous. There is a more uniform knowledge base, making the market easier for private firms to penetrate (although it does have its own complexities, which are discussed later). On the other hand, there are far more buildings than there are manufacturing plants, so it is harder to cover as many facilities. The existence of healthy markets in certain areas will complicate the role of the BAC compared to the IAC. It is important for the BAC, as a federally funded program, not to compete directly with the private sector. The current market for building audits and how the BAC can provide the most value will be discussed later.

Another significant difference between the IAC and BAC is the educational scope. The IACs currently only work with graduate and undergraduate engineering students. While similar pending legislation would enable the IACs to partner with community colleges and trade schools to train operators, installers, and maintenance technicians, this is outside their existing scope. These partnerships will be a major part of the BAC program from the start, however. Balancing and coordinating between the different skill sets will be a difficult task. In addition to installation, operation, and maintenance, the BACs will also include building designers and architects. Building design is much more important to building efficiency than industrial efficiency. In the industrial sector, facilities consume the vast majority of their energy in the process and process support systems, and relatively little on space conditioning and lighting. In contrast, space conditioning and lighting account for more than 40% of commercial and institutional building energy use, making energy-efficient building shell and equipment design critical from the start.

In addition, principle differences between IACs and BACs would emerge because of the differences in energy-using characteristics of manufacturers and buildings. Manufacturing is relatively energy intensive. Mid-sized manufacturers who qualify for IAC assessments must have annual energy costs between $100,000 and $2,500,000 per year. According the Commercial Building Energy Consumption Survey, the average energy cost for an office building is \$1.60 /ft^2 (EIA 2006). Thus, for a relatively large 100,000 ft^2 office building, annual energy costs would be only $160,000 per year, which would barely qualify for an IAC assessment. Additionally, the average IAC audit between 2003 and 2007 recommended over $200,000 in energy, waste, and productivity savings (IAC Database 2010). The typical BAC audit will necessarily be much smaller for all but the largest or most complex buildings.

The relative lack of energy intensity in the buildings sector, combined with the vast number of existing buildings which could benefit from an energy assessment, would suggest several differences in how the BACs would operate relative to the IACs:

1. Currently 26 IACs, strategically located in industrial areas, serve a significant number of the nation's mid-sized manufacturing companies. This same model would not be appropriate for BACs, since there are far more buildings than manufacturing facilities and buildings are more ubiquitous. Thus, as suggested, BACs could be located in far more than 26 universities and community colleges.
2. Because of the relatively small energy use in buildings and the relatively large costs of replacing equipment or improving building envelopes, it less likely that IAC-style energy audits—in which a team of engineers spends an entire day in a single facility—would regularly identify enough cost savings to justify the assessment, especially in smaller facilities. Thus, BACs will have to use electricity data, fuel billing data, and other pre-assessment data more intelligently to focus attention on the most promising buildings and to reduce the time spent on site. It is likely that this data analysis effort, when practiced on a wide-scale, will lead to significant improvements in our understanding of building energy savings potential.
3. Although building energy systems are probably more uniform than manufacturing systems, the building energy assessment process is not inherently simpler than the manufacturing energy assessment process. This is because building energy systems are often distributed throughout a facility, and relatively few of these systems are instrumented in a way that makes energy performance easy to determine. In addition, without dedicated data logging equipment, energy performance during one season or occupancy period is hard to determine during another season or occupancy period. This also makes extrapolation of site visit measurements and observations results more difficult in the buildings sector. Thus, to deal successfully with these challenges, BACs may develop new assessment approaches more akin to energy management consultants, in which BACs provide an ongoing resource for building operators and help operators track energy use and correlate changes in energy use with changes in operation.

Lessons from the IAC

These differences aside, the IAC is an important model for the BAC program. The IAC successfully reduces energy use and other costs in manufacturing, trains the next generation of industrial energy engineers, and helps advance the science of industrial energy efficiency. BACs would extend these effects to buildings sector and more young engineers. In addition, and perhaps equally important in the long run, IACs provide a structure which makes it possible for professors and universities to develop courses, expertise and research in energy systems. For example, at the University of Dayton the IAC program has launched a Building Energy Center and a new Master Degree program in Renewable and Clean Energy. This Center and program now support several new faculty and students who now perform research and services in other energy fields. Moreover, the fundamental understanding of energy systems afforded by the IAC provides a depth and breadth of experience by repeatedly applying various engineering principles to the actual realities on the plant floor. Students are then able to easily apply these lessons to other energy and engineering systems. BACs would share and extend these important benefits and features.

Another important aspect of the IAC program is the flexibility each center has to operate. The number of students, mix of graduate and undergraduate, number of expert professors involved, coordination with local stakeholders, and technical focus of each center is different. While a number of metrics are used to ensure the quality of assessments and training, this flexibility allows each center to respond to its own unique needs and situations, such as developing expertise in the regional industries. This flexibility will be even more important for the BAC program, as it will allow each center to adapt to the different markets and focus on different parts of the program, such as offering more audits to institutional buildings or having a more in-depth internship program with established firms.

Conclusion

Energy efficiency continues to grow in popularity and importance as energy prices rise and action on global warming becomes more urgent. Building up to achieve the available and necessary savings will require an increasingly large and knowledgeable workforce. However, waiting for the current markets to drive training programs may not be enough. A coordinated, nationwide education and training effort is needed. There are a number of training programs focusing on building trades currently run by unions, community colleges, universities, and other organizations, but none that connect the different skills needed in a cohesive way. The proposed *Building Assessment Center* program has the potential to do just that. In order to live up to this potential, though, the program designers and implementers will have to not only look at what is currently being done, but at how the market for building operation and energy efficiency is currently structured and how it is likely to change.

One of the most important and relevant current programs is DOE's *Industrial Assessment Center* program. While it is only active in the industrial sector, its structure of professor-lead, university-based centers training engineering students to perform free audits for its clients is a well suited and successful model for the BAC program. By following key aspects of the IAC model and recognizing where the program must differ, the BAC program can be successful at reducing building energy use, training the next generation of building efficiency experts, and helping advance the science of building energy efficiency.

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