

ADVANCING INTELLIGENT BUILDING TECHNOLOGY



Dialogue Summary

Jennifer Layke

Executive Director, Institute for Building Efficiency

Thomas Simchak

Business Council for Sustainable Energy

INTRODUCTION

What will it take to mainstream intelligent efficiency? A roundtable dialogue hosted by Johnson Controls and its Institute for Building Efficiency recently posed to a group of technology companies, energy consumers and partners. Energy efficiency typically has focused on the energy performance of specific components or equipment – a window or a boiler, for example. Intelligent efficiency goes beyond individual elements of a building and its operations; it incorporates information and communications technologies (ICT) to optimize building performance. As such, intelligent efficiency presents the opportunity for a step-change in the energy efficiency space, empowering owners and occupants with actionable performance data and information in real time. Intelligent efficiency supports dynamic building analytics and avoids systems and equipment failures through advanced diagnostics.

The Roundtable focused on the commercial technologies available today that can transform buildings. ACEEE describes it as a, “systems-based, holistic approach to energy savings” that integrates ICT and is “adaptive, anticipatory, and networked.”¹ Such systems can be integrated at a range of scales, from equipment and components through campus-wide intelligent capabilities. The analysis on intelligent buildings by IBE,² and ongoing work by The American Council for an Energy Efficient Economy (ACEEE),³ provided background to participants on this topic.

The discussion focused on key issues related to intelligent building technology, analytics and decision making. Participants included:

- Alison Smith, Broadscale Group
- Ben Freas, Navigant Research
- Brandon Tinianov, View
- Clay Nesler, Johnson Controls
- Greg Merritt, Cree
- Jason Ye, Center for Climate and Energy Solutions
- Jennifer Layke, Johnson Controls
- John Bush, Hitachi Consulting
- Jordan Doria, Ingersoll Rand
- Julia Rubino, Bayer MaterialScience
- Ken Kolkebeck, First Fuel
- Kevin Self, Johnson Controls
- Lisa Jacobson, Business Council for Sustainable Energy

¹ Elliott, Molina, and Trombley. *A Defining Framework for Intelligent Efficiency*. ACEEE. June 2012, p. iii.

² Ruiz, Nesler, and Managan. *Intelligent Efficiency: Improvement Measures and Investment Analysis Framework*. Institute for Building Efficiency. April 2014.

³ Elliott, Molina, and Trombley. *A Defining Framework for Intelligent Efficiency*. ACEEE. June 2012.

Lisa Tryson, Danfoss
Matt Frey, Optimum Energy
Matt Jones, Nth Power
Neal Elliott, ACEEE
Renee Clair, Johnson Controls
Robert Wilkins, Danfoss
Sameer Kwatra, ACEEE
Tim McCormick, Cisco Systems
Todd Price, Hitachi Consulting
Tom Simchak, consultant to Business Council for Sustainable Energy
Tushar Dave, Enlighted

Elliott and Nesler set out key elements of intelligent efficiency and provided examples of facilities where intelligent efficiency is integrated into system, building, and campus design.

OPPORTUNITIES ENABLED BY INTELLIGENT EFFICIENCY

Substantial energy savings can be made with intelligent efficiency technologies, according to estimates of potential. For example, ACEEE studies have estimated that industrial process sensors could save 4 to 17 percent of process energy use and that residential advanced metering and feedback systems could reduce household electricity consumption by 4 to 12 percent.

Intelligent efficiency can help improve building performance in a wide variety of ways. They include:

Direct improvements in energy productivity. Intelligent efficiency can make building systems run at more nearly optimal levels, reducing energy usage while improving performance.

Energy use data access and display. Data transparency enables owners and occupants to visualize their energy usage, encouraging them to adopt energy-saving behaviors.

Awareness of equipment status and fault detection. More effective and continuous monitoring of system performance ensures greater persistence of energy savings over time. Possible deterioration of system performance can be rapidly identified and fixed, instead of relying on periodic (and perhaps infrequent) building recommissioning.

Adaptability to occupant needs, particularly automatic adaptability. For example, occupancy and light sensors could adjust window shading to align with occupants' needs, reducing used of artificial light and solar heat gain.

Substantial energy savings can be made with intelligent efficiency technologies, according to estimates of potential. For example, ACEEE studies have estimated that industrial process sensors could save 4 to 17 percent of process energy use⁴ and that residential advanced metering and feedback systems could reduce household electricity consumption by 4 to 12 percent.⁵

⁴ Elliott et al. Emerging Energy-Efficient Industrial Technologies. ACEEE. 2000.

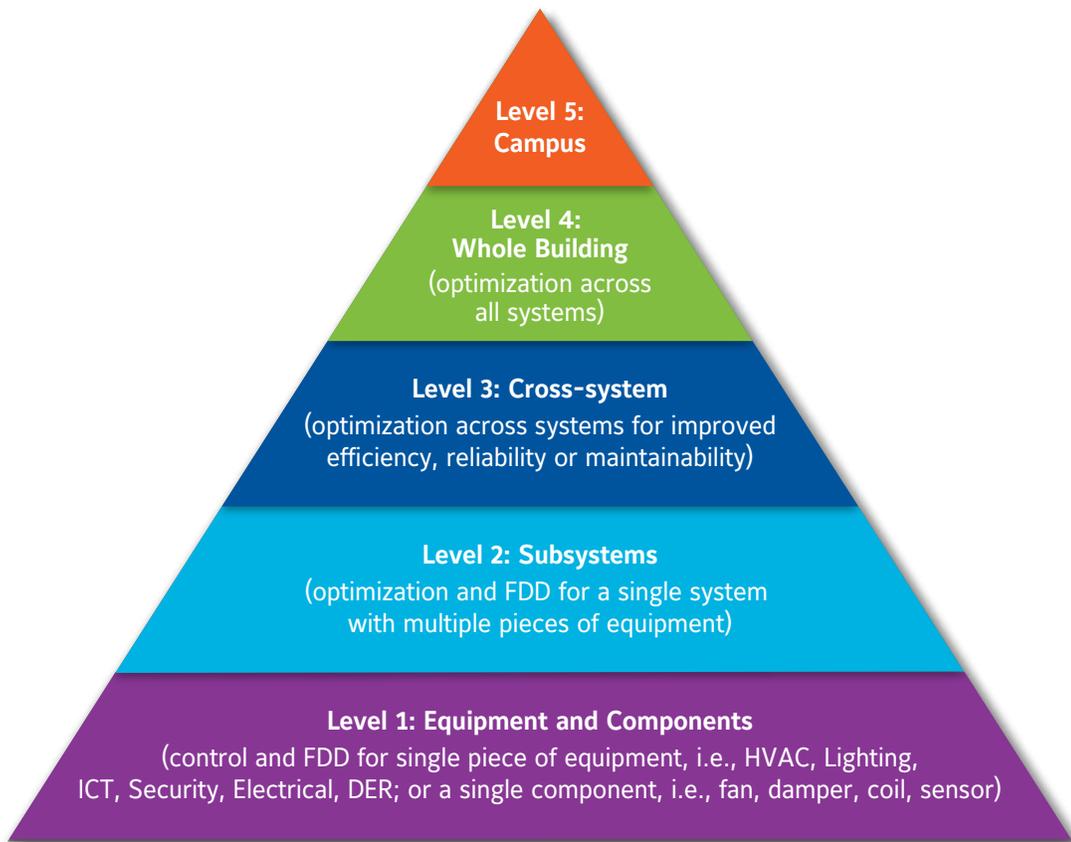
⁵ Erhardt, et al. Advanced Metering Initiatives and Residential Feedback Programs. ACEEE. 2010

Enabling new value streams, including demand response and managing peak pricing. Greater automatic control of building systems enables greater demand response (DR) capabilities, or simply helps reduce consumption during peak pricing periods (assuming a variable-rate electricity tariff). Participation in utilities' DR programs creates a revenue stream for the facility while reducing or shifting consumption when variable electricity prices are high reduces costs. Centralized building control systems can automatically respond to utility signals through a range of load-reduction (or load shifting) methods and respond to occupants' needs during these periods.

Ease of measurement and verification. Enhanced sub-metering, greater access to operational data, and centralized data management bring more data into the hands of those assessing energy efficiency projects. These capabilities also enable better evaluation of system-wide performance, as opposed to the performance of individual components. Performance can be benchmarked against system simulations.

Non-energy benefits. Beyond saving energy, intelligent systems integration can help reduce maintenance costs and equipment failures by identifying problems early. It also can improve workplace environments by being more responsive to occupants' needs or reducing hazards, such as excess waste heat at an industrial site.

Figure 1. Deploying intelligent efficiency across multiple scales: Levels of influence



Deployment of intelligent solutions can be undertaken across varying scales, with different opportunities available in each and through linkages between systems at each scale: equipment managing distributed energy resources (DER), to fault detection and diagnostics (FDD) at a subsystem level all the way to optimization at a whole building level. Intelligence can be added to systems at each level of influence. For example, an HVAC unit could incorporate intelligent efficiency, but greater efficiencies could be achieved by integrating that unit with whole-building control systems that also adjust window shading, account for occupancy, etc.

BARRIERS TO GREATER DEPLOYMENT OF INTELLIGENT EFFICIENCY SOLUTIONS

As is often the case with deployment of new technologies and methods, there are various barriers to greater use of intelligent efficiency technologies. ACEEE groups these into societal, financial and structural barriers.

Societal barriers largely relate to lack of awareness or inertia. One roundtable participant described these as an attitude that “to do anything but waste energy is too complicated.” There is inertia to do things as they have always been done. Given its integrated nature, intelligent efficiency requires collaboration from a number of areas of facility (or campus or equipment) design and operation. Building managers and IT staff often do not know each other, and architects are not IT people. Yet all need to be brought together to implement systems and often to continue to operate them. Meanwhile all have traditional ways of doing their jobs and may resist change.

Financial barriers can hamper any capital-intensive project. While the savings from energy efficiency may be great, it requires an up-front investment in equipment and technologies. Payback periods for these investments may be too long for some. Yet IBE research⁶ based on the net present value (NPV) of energy savings paybacks shows significant short-term payback on numerous intelligent efficiency systems. However, demonstrating the wisdom of these intelligent efficiency investments may not always be easy, and such investments generally must compete with other projects that may be more aligned with a business’s core activities. Some elements of intelligent efficiency may also have an ‘asset tag’ problem: How does a firm account for things that are no longer physical assets? For example, a server closet will contain equipment that can easily be identified and owned, but when the services managed in that closet are moved to a cloud computing provider, it can difficult to change the capital asset into an operational asset.

Structural barriers are systemic problems that impede greater deployment of intelligent efficiency systems. Such barriers include lack of data on the capabilities and performance of energy efficiency technologies, or on energy use more generally (so as to be able to compare intelligent systems with their conventional counterparts, for instance). There may often be a short supply of people who have the vision and skills to implement intelligent systems. And concerns around data privacy may present further barriers.

⁶ Ruiz, et al. *Intelligent Efficiency: Improvement Measures and Investment Analysis Framework*. Institute for Building Efficiency. 2014.

TECHNOLOGIES IN INTELLIGENT BUILDINGS: FOUR CASE STUDIES

The IBE roundtable featured a panel discussion with representatives of four companies directly involved with the development and deployment of intelligent building efficiency solutions.

Ken Kolkebeck of **First Fuel** described the company's building analytics software, which seeks to leverage the data from high-frequency meters using deep data science, building science and software expertise. The analytics correlate meter data with occupancy data and weather conditions to "move energy efficiency forward" with several remote energy analytics offerings. The analytics provide much more than a dashboard with data displays, but instead help owners and operators with actionable energy savings recommendations and supporting workflow tools. A main focus is on overcoming hurdles to action at the start of the process by providing owners or utilities with insight on where the real opportunities for savings lie across a portfolio of buildings.

Tushar Dave told how **Enlighted** uses building sensors and analytics for real-time sensing and building control. He noted that in conversations, building managers indicated that "to do anything else" but waste energy "is too complicated." Building staff may not have broad enough expertise to address a building's energy waste. Enlighted develops and deploys extensive sensors and controls in large commercial buildings to reduce the demand for human action and to automate energy savings. Sensors note movement, occupancy, light levels and temperature in rooms. These can also be optimized for the type of task being performed in the space.

Brandon Tinianov of **View** described a new generation of electrochromic glass that is automatically controlled by a network system. The glass can optimize for user comfort and allows for human control, with building energy efficiency as a secondary goal. Tinianov notes, "We design for occupant satisfaction, and we sell based on efficiency." The technology had been deployed in 100 projects as of spring 2014 and resulted in a 30 percent reduction in air conditioning load at some sites.

Tim McCormick formerly of JewelX and now of **Cisco Systems**, a major international networking and ICT equipment company, discussed systems to monitor and manage the energy of any ICT device on a corporate network – much as more traditionally done with the networking of such devices for data transfer. This system allows significant visibility into plug loads based on time, location, and events. It does not require software to be loaded onto devices. The technology realizes the much-discussed "internet of everything" as a wider and wider range of devices become increasingly interconnected.

SOLUTIONS FOR INTELLIGENT EFFICIENCY DEPLOYMENT

Bringing intelligent efficiency to scale will require new technologies as well as new approaches and new collaboration throughout the design and operation of equipment, systems, buildings, and campuses. Greater collaboration between energy efficiency experts, ICT experts, and building occupants will be needed throughout the design and operation of facilities. Improved communication and collaboration between energy efficiency companies (such as Johnson Controls, Siemens, Schneider Electric) and major IT players (such as Cisco Systems and Intel) will ensure the interoperability of the equipment needed to make the most out of intelligent efficiency's potential.

As facility owners and operators better understand the energy savings that intelligent efficiency solutions can bring, they will be more likely to incorporate it. Owners and operators will need to help ensure

the use of data analytics to monitor these systems, verify performance and ensure that the value of intelligent efficiency is delivered. All data is valuable from basic utility data (electric, steam, gas, oil, etc.) to performance variables available from building system components temperature/humidity/pressure/flow/etc., damper and valve position, run time, etc.)

There is a need for studies that identify the systems that show the most promise in terms of financial payback, such as the work done by the IBE on the NPV of a range of intelligent efficiency technologies. The results of those studies then need to be communicated to show the potential for the technologies to be cost-effective.

To date, incentives for energy efficiency and the programs to encourage it have largely focused on energy efficient components and equipment. These incentives and programs, be they tax credits, recognition programs like EPA's ENERGY STAR, or mandates for utilities to encourage efficiency among their ratepayers, need to recognize the energy savings potential of intelligent efficiency systems. Doing so may be more difficult than a prescriptive component-by-component approach, as the programs will need to recognize the system-based savings potential of intelligent efficiency solutions.

Given the general unfamiliarity of intelligent efficiency, the messaging and communications around it will be important to enabling greater deployment. Inevitably, the messages targeted at key stakeholders will vary. While the financial side of energy savings will be a selling point for COOs and those approving capital investments, design for occupant satisfaction will be a key part of engagement with facility users. Other selling points will be the greater opportunity for measurement and verification and improved understanding of the performance of building operations, systems, and components.

EMERGING INTELLIGENT EFFICIENCY SOLUTIONS

Intelligent efficiency solutions are both cutting edge technology and also enabled by new infrastructure that was unavailable just a few years ago, such as cloud supercomputing facilities. Roundtable participants identified a number of intelligent efficiency elements they expected to see increasingly developed and deployed in the coming decade. These included:

- Simulations to improve ability to identify components and systems that are out of design specification
- Larger suite of control options available to occupants, bolstered by greater access to near-real-time energy data and encouraged by greater integration of ICT solutions in everyday life
- Integration of disparate systems into centralized controls and operating systems tied to corporate networks (with consideration of security issues).
- Integration of distributed generation and storage, including renewables and combined heat and power, into building energy and ICT systems
- Organizational intelligence to make these sorts of solutions happen
- Creating value streams from building system intelligence, such as by taking advantage of demand response programs and real-time energy pricing
- ICT-oriented businesses, including security, cable TV, and telecommunications companies, crossing over into the energy management space to generate new revenue through new products. Meanwhile traditional utilities will have to evolve from deliverers of electrons to managers of electricity services.

CONCLUSION

Intelligent efficiency offers great opportunities for increased energy productivity while better meeting the needs of building occupants. Incorporating ICT into systems will enable greater energy savings than traditional component and equipment efficiency efforts have achieved in isolation from one another. But incorporation of these capabilities into building design (including retrofits) will require collaboration among designers, ICT experts, operators, and users to ensure that systems are integrated with one another and meet the needs of occupants and operators. And to ensure that these new technologies are accepted and deployed, further analyses of costs and payback will be needed to demonstrate the real benefits they can bring.

The Institute for Building Efficiency is an initiative of Johnson Controls providing information and analysis of technologies, policies, and practices for efficient, high performance buildings and smart energy systems around the world. The Institute leverages the company's 125 years of global experience providing energy efficient solutions for buildings to support and complement the efforts of nonprofit organizations and industry associations. The Institute focuses on practical solutions that are innovative, cost-effective and scalable.

If you are interested in contacting the authors, or engaging with the Institute for Building Efficiency, please email us at: InstituteforBE@jci.com.

institute
for **building**
efficiency
an initiative of Johnson Controls