Building Efficiency and Digitalization: Industry Stakeholder Perspectives

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Background

Digitalization has been applied to improve energy efficiency in buildings since the first building automation systems were introduced in the 1970s. Since then, there have been many advances in technology, policies, and programs driving adoption of intelligent efficiency in buildings. The International Energy Agency estimates that further adoption of digital technologies and services in buildings could reduce building energy consumption by 10 percent by 2040.[1] To better understand industry priorities in achieving the untapped potential savings, two workshops were held in 2022 with 35 building efficiency stakeholders to explore current digitalization challenges and future opportunities.

The workshops were jointly organized by the Energy Efficiency Hub's Digitalisation Working Group[2] and the American Council for an Energy Efficient Economy. The stakeholders represented a diverse set of industry leaders from control manufacturers, energy service providers, facility management companies, real estate developers, information technology providers, utilities, energy consulting firms, non-profits, and national laboratories.

The workshop discussions centered around challenges and opportunities related to emerging technologies and enabling practices and programs. Key challenges from the workshop discussions included **real-time utility data access, system interoperability, and workforce development.** Opportunities included **building-to-grid integration, building performance management, multi-system**

[1] https://iea.blob.core.windows.net/assets/b1e6600c-4e40-4d9c-809d-1d1724c763d5/DigitalizationandEnergy3.pdf

[2] The Energy Efficiency Hub is a platform for global collaboration on energy efficiency hosted at the International Energy Agency. The United States leads the Digitalization Working Group, which includes Australia, Brazil, Canada, Denmark, France, Germany, Japan, and the European Commission. The group's initial focus is on energy efficiency in residential and commercial buildings as well as digital integration of buildings with the electrical grid.

data standards, and performance-based building codes and standards. These challenges are described in more detail in the rest of this article.

Data Standards and Access

The next generation of building energy management and control systems will require **real-time grid emissions data and energy pricing** to optimize building decarbonization performance. Several organizations have committed to 24x7 **carbon-free electricity use** across their building portfolio. This will require sophisticated digital monitoring and control of building electrical demand and distributed energy resources, including solar photovoltaic (PV), energy storage, and electric vehicle (EV) charging. Access to this type of real-time grid data isn't widely available, especially in standard formats.

Another challenge is the lack of a **common, harmonized data standard for buildings**. While there are several industry efforts underway to develop common building data standards, it is difficult to consolidate the many new and existing data standards in the market. An additional complication is that building data standards don't generally include data from distributed energy resources. Power system data standards vary widely, even within a single utility, and are different from building data standards. A recommendation was that data standardization should focus on a few common, high-value integrated use cases that leverage building, distributed energy, and power system data to optimize both building and grid performance.

Digitalization Workforce

The lack of a **skilled workforce** to design, install, operate, and maintain smart building systems is also a challenge. Data-integrated building systems are fragile and difficult to maintain. Digitalization of buildings and the grid is making system integration harder. A change in data communications protocol in any one connected system can negatively impact overall system performance. Sophisticated, and sometimes counterintuitive, optimizing control strategies can result in advanced functionality being disabled or overridden by building operators. Also, **cybersecurity and data privacy** concerns need to be incorporated in any new or upgraded system.

Energy Performance Management

There is an opportunity for energy management and control systems to monitor the real-time performance of the buildings they are installed in. While many systems can meter and monitor energy use in real time, very few can accurately **estimate energy savings in real time** (or at all). Project or utility program measurement and verification requires data from multiple systems, temporary sub-metering, and manual calculations.

Considering that building control systems can deliver over 25% energy savings on their own with a 3 to 4-year payback, using the energy management and control system to track energy savings would be a valuable capability. Smart equipment, such as chillers and heat pumps, can include controls that internally monitor large numbers of sensors and devices to improve reliability and optimize control, but the control systems rarely estimate the energy saved through the equipment's use. Building performance standards (BPS) require building owners to meet increasingly ambitious carbon or energy reduction targets. Building digitalization could provide information critical for predicting and **managing compliance with a BPS** throughout the year, rather than analyzing end-of-the-year utility bills.

Being able to digitally measure and manage building energy use, emissions and savings would be a key enabler for **performance-based building codes and standards**. Future building codes which will target near-zero carbon emission levels will, out of necessity, be performance-based. It would be challenging to develop prescriptive code language to achieve these higher levels of performance. Greater digitalization of building systems and equipment would not only help achieve these high operational performance levels, but it could also be used to measure and verify the energy performance of new and existing buildings for code compliance purposes.

Data Communication Protocols

Policies and programs to drive building digitalization in building codes and standards have been challenging for a variety of reasons. First, specifying data communications protocols[3], such as BACnet or LonWorks, do not assure system interoperability. There is significant flexibility built into these standards which makes "plug and play" elusive. Also, advanced control system functionality, such as OpenADR compatible communications, are rarely implemented in projects. Residential heat pump water heater standard communications protocol compatibility, while required, currently has few systems or devices to communicate with.

Building Codes and Standards

Successful implementation of sensing and control technology in building codes have been limited to day lighting, use of occupancy sensors, carbon dioxide sensors for ventilation monitoring and fault diagnostics for outdoor air economizers. The ENERGY STAR connected thermostat certification relies on statistical field test performance verification using control groups which work for standard products and applications. For commercial building controls, application diversity and program customization provide few alternatives to in-building performance measurement as verification of compliance.

Maximizing the potential benefits of grid integration and demand flexibility will require advanced digital technology as well as enabling government policies and programs. Open standards will be required for measurement and verification, especially for establishing demand flexibility baselines. Standard metrics for demand flexibility will have to be defined and included in commercial building benchmarking and building performance standards. Methods for measuring overall grid benefits will be needed to justify utility investment and performance-based program and tax incentives will be needed to encourage building owner investments in digital solutions.

The buildings industry stakeholders were generally optimistic about the role digitalization technology can play in accelerating building and grid decarbonization efforts, especially when supported by common building/grid data standards and performance-based policies and programs.

[3] For more information please see, Lohia, K., Jain, Y., Patel, C., & Doshi, N. (2019). Open communication protocols for building automation systems. *Procedia Computer Science*, *160*, 723-727, https://www.sciencedirect.com/science/article/pii/S187705091931720X.