CABA™

Intelligent Building Energy Management Systems

LANDMARK RESEARCH PROJECT

EXECUTIVE SUMMARY

CABA AND THE FOLLOWING CABA MEMBERS FUNDED THIS RESEARCH PROJECT:

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Disclaimer

Intelligent Building Energy Management Systems

This report was prepared for CABA by Harbor Research.

Harbor Research

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RESEARCH BACKGROUND & INTRODUCTION

The Continental Automated Buildings Association (CABA) commissioned Harbor Research to provide a comprehensive examination of the Intelligent Building Energy Management Systems (IBEMS) market. This report seeks to understand how use cases, customer environments, buying behaviors, and ecosystem interactions all impact and influence the development of the IBEMS market.

Harbor Research and the Steering Committee first convened via a webinar in Spring 2020 and established a regular schedule of discussion and collaboration for the duration of the project. The findings presented in this report showcase the results of primary and secondary research, including in-depth executive interviews and dual online stakeholder surveys.

The outcomes of this collaborative research project will provide a clear understanding of the trends and forces driving the evolution of IBEMS, as well as lay out potential paths and maneuvers for stakeholders looking to take advantage of the market opportunities that exist. Harbor Research and CABA would like to acknowledge and sincerely thank the following organizations for funding this research:

Figure ES1 Landmark Study Funders

SILVER

Automated Logic · BC Hydro · Cadillac Fairview · CanmetÉNERGIE VARENNES CanmetENERGY · Carrier · CyberPower · Greensoil PropTech Ventures · Honeywell · Hydro Québec · ICONICS · iota · Kimberly-Clark Professional · KMC Controls · legrand · Rheem · SIEMENS Ingenuity for life · Southwire · Steelcase · UL

BRONZE

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Role of the Steering Committee

The Steering Committee represents a cross-section of solution providers in the Intelligent Buildings marketplace. Representatives from each organization joined Harbor Research and CABA on regular collaboration calls to ensure the research scope met the project objectives. The Steering Committee played a vital role in outlining the research product in terms of defining the required content as well in collaboration on the research approach including development of the interview scripts and surveys.

Each CABA Landmark Research project is directed by a Steering Committee made up of the Silver level project funders. The Steering Committee provides feedback and input throughout the course of the research to help define the scope, direction, and methodology. CABA and the project's Steering Committee commission a research firm to conduct the research, while CABA provides project management and leadership.

Figure ES2 Steering Committee Members

About CABA

The Continental Automated Buildings Association (CABA) is an international not-for-profit industry association, founded in 1988, composed of over 380+ major private and public technology organizations dedicated to the advancement of connected home and building technologies. These organizations include private firms involved in the design, manufacture, installation and retailing of products, as well as public utilities and governments responsible for regulations and incentives that affect home and building automation. CABA is a leader in developing collaborative research across building stakeholder types and encourages the development of standards that accelerate market development. More information is available at **CABA.org**.

About Harbor Research

Founded in 1984, Harbor Research Inc. has more than 30 years of experience in providing strategic consulting, design, and research services that enable our clients to understand and capitalize on emergent and disruptive opportunities driven by information and communications technology.

Harbor Research has been involved in the development of the smart systems and Internet of Things (IoT) market opportunity since 1998. The firm has established a unique competence in developing business models and strategy for the convergence of pervasive computing, global networking and smart systems. Harbor Research's extensive involvement in developing this market opportunity, through research and consulting, has allowed the firm to engage with clients in the technology supplier community—both large and emergent players—as well as a diverse spectrum of device OEMs and services providers as well as broad end customer interactions. Please visit **harborresearch.com** for more information.

Research Goals

The goal of this research is to examine various aspects of energy management systems as they relate to the Intelligent Building industry. In particular, the main goal is to define "Intelligent Building Energy Management Systems (IBEMS)" and explore the current state of the IBEMS market, technical barriers and opportunities related to its evolution, and key emerging use cases and technologies.

The outcomes of this collaborative research project will provide a clearer understanding of the IBEMS market and opportunities available to drive revenues. This study will assist organizations to make sound business decisions using reliable third-party qualitative and quantitative data. Harbor Research has examined the opportunities provided by IoT for Intelligent Building stakeholders, including: operators, integrators and architects, technology manufacturers, equipment manufacturers, and service providers—including utility companies, standards bodies, and property management firms.

To meet these goals, Harbor Research has conducted a detailed analysis about the current and future state of IBEMS, including key trends, buying behaviors, technology challenges, and opportunities. From this analysis, perspectives were developed on how IBEMS will evolve, the key pain points and barriers to its evolution, and how its advent will impact business models and operators.

Research Methods

The methodology for defining, identifying, and analyzing technical and business opportunities followed the procedures below:

- **Review Existing Intelligent Building and Energy Management Research:** Review and analyze existing CABA and industry research on the Intelligent Building market as it relates to design and implementation, cost structure and pricing models, impacts of BAS, technology, and market development roadmaps, and North America Intelligent Buildings market sizing.
- **Review Previous Harbor Research Analyses:** Review and analyze previous Harbor Research reports on Intelligent Buildings, energy and utilities, ecosystem development, IoT platforms, data management and analytics, network connectivity, and cybersecurity.
- **Conduct Interviews with Thought Leaders:** Identify and organize a list of key stakeholders and conduct interviews with industry thought leaders and Steering Committee members.

- **Define and Analyze the Evolution of IBEMS Hypotheses:** From the above blend of primary and secondary research, Harbor Research then created initial hypotheses about how IBEMS will evolve and the related business opportunities it will create.
- **Validate and Refine IBEMS Picture:** Once complete, Harbor will then conduct additional rounds of primary and secondary research focused on validating our hypotheses on how IBEMS will evolve and how it will affect each ecosystem participant.

Having identified and framed the opportunities via the process just described, Harbor Research performed this research by conducting primary research analysis along with supplementary market research and analysis. A consumer survey was developed and administered with more than 1,500 respondents, representing building operators and architects from the United States and Canada.

The results of this survey were utilized to identify the current state of the IBEMS market from an adoption and integration standpoint; uncover the most prevalent technical barriers, adoption challenges, and opportunities; reveal which IBEMS solution models are driving the most adoption today and in the near-future, and learn about Intelligent Building operator needs and pain points.

Harbor Research also conducted in-depth expert interviews with marketplace stakeholders to understand how technical requirements and user needs are shifting in the IBEMS market, along with how these stakeholders see product and service monetization models evolving in Intelligent Buildings.

In addition, Harbor Research leveraged previous work the firm has conducted, as well as CABA research, to identify key trends, players, IoT application evolution, and technical requirements for Intelligent Building stakeholders as IBEMS matures. From this analysis, a list of recommendations for each IBEMS ecosystem participant was developed.

Report Structure

The report begins by providing a base understanding of the trends and forces driving the development of IBEMS, and the adoption of smart devices in general across the Intelligent Building market. It also defines emerging business models and provides information that depicts the current state of IBEMS and the frustrations that have arisen from the perspective of operators and owners.

Needs, pain points, and adoption characteristics of architects and operators are the focus of the next section. After examining how architects and integrators consider energy management in the construction of buildings, the results are compared against the needs and pain points of operators. Then, a discussion of how much occupants and operators will pay for IBEMS-related solutions is provided.

The report goes on to examine the IBEMS market landscape and deployment models of IBEMS products. Then, it explores the emerging need for an IBEMS application overlay, and dives into how IBEMS solutions can integrate and interact with other key Intelligent Building systems. The third section concludes with an examination of recent innovations related to Intelligent Buildings safety standards, network communication, and power distribution.

The fourth section of the report is devoted to analyzing IBEMS in the broader context of North American power generation, distribution, and transmission. For the IBEMS market to mature, in-building energy management must account for and integrate with external utility infrastructures and onsite power generation. The section is devoted to exploring the emerging model of grid-interactivity, and how it can catalyze the evolution of energy management in Intelligent Buildings.

Finally, having analyzed the current and future state of IBEMS, the report provides a set of actionable short-, medium-, and long-term recommendations based on stakeholder type that are influenced by the combination of findings from primary and secondary research. After discussing the impact of COVID-19, the report concludes by recommending maneuvers and considerations by stakeholder type based on the outcomes that may affect the trajectory of how IBEMS is adopted.

SUMMARY OF FINDINGS

Introduction & Summary of Key Takeaways

According to the U.S. Department of Energy (DOE), the buildings sector consumes approximately 76 percent of the electricity consumed in America, but most of this energy is wasted—with some researchers suggesting that more than 20% of this energy consumption can be reduced with energy management practices and energy-efficient equipment.[1] However, since that DOE report was published in 2010, little has changed, and operators still pay for energy that they waste.

Emerging intelligent buildings provide a distributed control and information system that enables networks of intelligent devices to monitor and control the mechanical systems in a building while integrating data from existing building systems. These solutions are enabled by a new class of software tools and data frameworks that allow data to be aggregated from across the fractured vendor ecosystem. Advanced data management, analytics, AI and machine learning algorithms, when applied to integrated datasets, are identifying and capturing new efficiency gains from building systems. These innovative technologies and use cases are not only changing the way that buildings stakeholders operate, but also how they co-operate with each other.

Within the intelligent building market, two key applications have emerged to simplify building operation and control: “building management systems” (BMS) or “building automation systems” (BAS); and “intelligent building energy management systems” (IBEMS) or, more simply, “energy management systems” (EMS). These terms are often used interchangeably, but within this report, there are important distinctions, and these distinctions reflect the key changes impacting the intelligent building market.

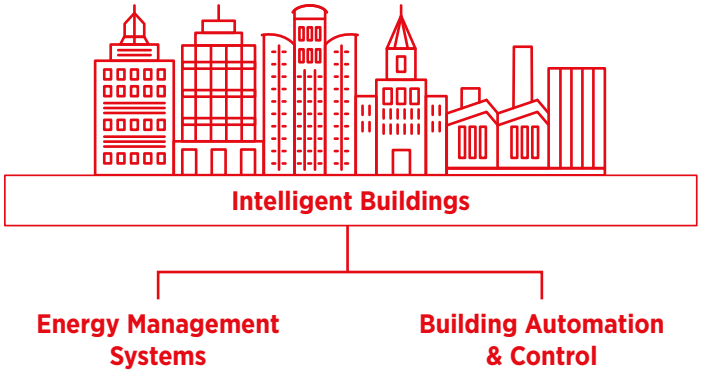
In addition, for building owners and operators to satisfy the changing needs of their occupants, they must increasingly prioritize sustainability and procure technologies (including IBEMS) that allow for the generation, distribution, and storage of distributed energy resources (DERs).

The portrayal shown on the next page depicts the dire need for operators to adopt IBEMS solutions.

Figure ES3 Buildings Across Industries Need to Prioritize Energy Management

Intelligent Building Energy Management Systems

Integrated Energy Intelligence With Building Management, Automation & Control



Why Energy Management Strategies are Critical

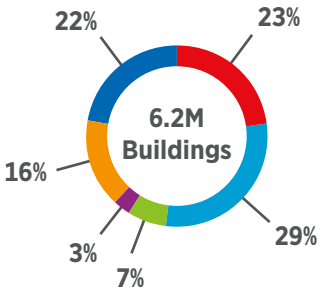
25-30%
of energy consumed in buildings is wasted

$100B
annual cost of emissions in the U.S.

30%
of total emissions from industrial sector

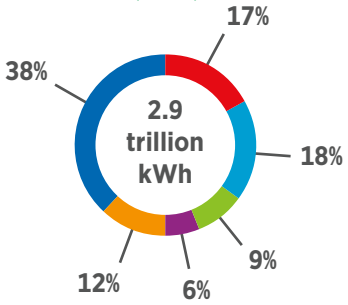
North America Building & Energy Demographics, 2020

Building Count by Type
(# of buildings)



Commercial
Medical
Retail & Hospitality
Institutional
Public Venues
Mission Critical

Energy Consumption by Type,
(kWh)



Commercial
Medical
Retail & Hospitality
Institutional
Public Venues
Mission Critical

Source: CABA Intelligent Building Energy Management Systems 2020 Report

Key Takeaways

The top insights gleaned from this report that outline the key considerations for stakeholders in the future smart home landscape include:

As Intelligent Building Technologies Evolve and Sustainability Becomes Prioritized, IBEMS Need to Evolve Beyond Simple Applications: Over the decade, the technological capabilities of IBEMS have grown exponentially and new ways of incorporating sustainable onsite power generation have emerged. However, most operators still struggle to gain value of their IBEMS products beyond simple scheduling and root-cause analysis functions.

Building Operators Struggle with Paying for and Prioritizing Technology Procurements: Operators lack the capital to invest in wholesale technology modernization efforts, so they are struggling to understand which investments to prioritize to generate value and improve occupant satisfaction. In addition, they often must rely on product installation guides to educate them about IBEMS.

While BACnet Adoption is Increasing, Further Protocol Consolidation and Data Labeling Standardization Need to Occur: Most suppliers now include BACnet compatibility in their products, as the protocol has overtaken Modbus and LonWorks, but electrical distribution systems are often only compatible with Modbus. In addition, buildings have trouble adopting a standard data labeling or naming convention, though organizations like Brick and Project Haystack seek to address this issue.

The IBEMS Market is Dominated by BAS/BMS Solutions from Large Suppliers: Large BAS/BMS suppliers, such as JCI, Trane, and Tridium, have a high adoption base of buildings who are locked-in to their brand of solutions. However, these suppliers are being challenged by digitally native, innovative solution provides who are positioning different technologies (e.g., digital twins, advanced analytics) to solve automation challenges in buildings. While no one solution has fully disrupted the market, incumbents and innovators need to continue to incorporate emerging technologies in buildings.

The Difficulty of Innovators to Displace IBEMS Incumbents Points to the Need for an IBEMS Application Overlay: While innovators are seeking to disrupt the IBEMS market by focusing on emerging technologies such as buildings analytics and digital twins, no solution has yet emerged. Buildings need an application overlay that can ingest data from existing BAS/BMS applications, while retaining the flexibility to integrate with DER systems and advanced metering infrastructure.

GEBs Can Help Operators Achieve Massive Cost and Energy Savings, but Utilities and Governments Must Support This Evolution: The emerging model of a grid-interactive efficient building (GEB) can automatically respond to utility price signals and allow for load flexibility. However, most buildings are not currently equipped for grid interactivity, so regulators and utilities need to work with these buildings to offer the right incentives to meet the technical requirements that GEBs demand.

The COVID-19 Pandemic Greatly Concerns Occupants and Operators, but its Ultimate Impact on IBEMS Remains Unclear: Across building types, occupants and operators are concerned with the potential for contracting COVID-19 in indoor spaces. While the pandemic will increase the overall costs to operate and construct buildings, as operators implement social distancing and expand sanitization, it still is unclear how the pandemic will ultimately affect energy management in buildings.

The Changing Consumer: Maximizing EMS Value to Architects and Operators

To truly understand the current state and future direction of IBEMS, one must drill down from a macro level into the day-to-day needs, issues, and decision-making that occur during the real-world use of these systems. To better understand this aspect of the IBEMS market, Harbor Research deployed two parallel surveys—one to buildings architects, constructors, integrators, and engineers; and the other to buildings owners, facilities managers, and occupant office managers—which help us explore how IBEMS are considered during building construction and operation. In addition, these surveys allow us to pinpoint key differences in how different demographics and regions view and prioritize energy.

More than half of building owners and operators indicated that their building(s) had energy management software (either standalone or as part of a BAS/BMS) in place. However, a significant number of buildings (28 percent) still manage energy consumption with a manual process, which is labor-intensive and expensive. In addition, adoption alone does not beget results, as many users still have difficulties maximizing the value of their IBEMS.

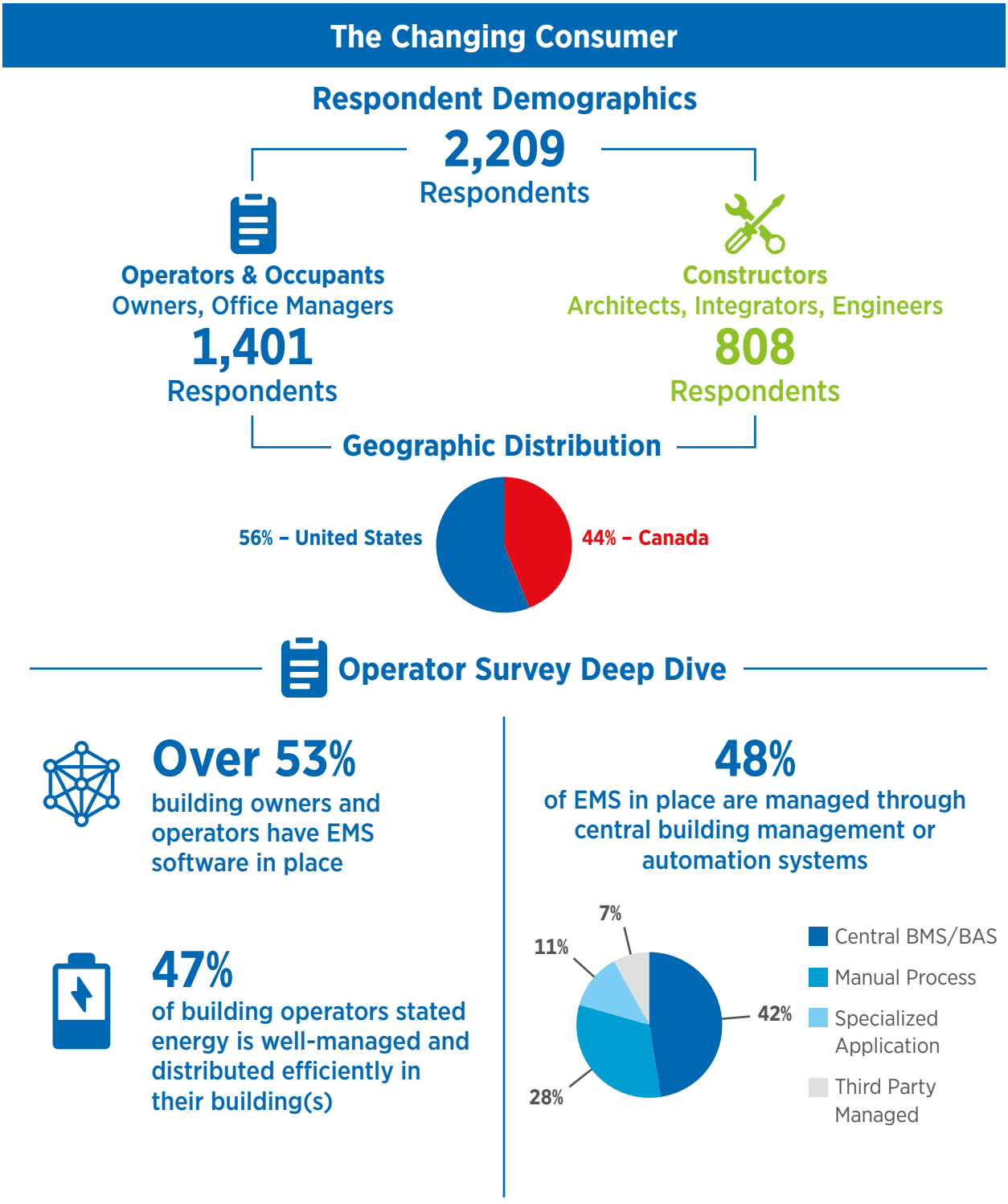
As buildings have embraced more complex technologies and systems, it has caused challenges in the design and integration process. Architects, who traditionally only focused on occupant convenience and structural integrity, now must consider energy efficiency, network communication, air quality monitoring, and other factors. In addition, system integrators are challenged with the need to promote seamless ease-of-use and data sharing between many devices from different manufacturers.

Today, energy costs are most expensive line item for most building operators after personnel/staff expenses, so it makes sense that constructors would prioritize energy efficiency in buildings, as they try to meet the needs of their clients. Slightly fewer respondents indicated that they prioritize sustainability, but most respondents still prioritize that need.

For IBEMS suppliers and building operators, these results provide guidance on how their products and best practices are implemented and considered during the building construction and design process. Clearly, building owners need to do a better job of educating architects and integrators as to the value and specificities of IBEMS implementation. In addition, suppliers play a key role in how IBEMS education is disseminated. By tailoring product installation guides to emerging IBEMS best practices and to individual building types, they can solve IBEMS issues before they manifest.

As shown in the below infographic, while IBEMS applications are well-adopted in buildings, operators and constructors do not glean much value out of these systems due to cost and complexity.

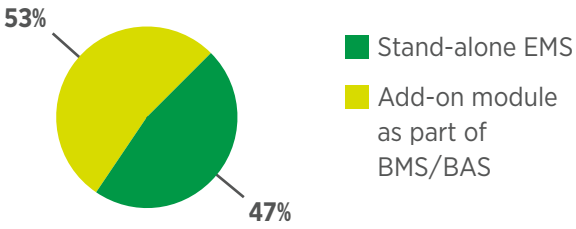
Figure ES4 Operators and Architects Struggle to Maximize the Value of IBEMS



The Changing Consumer

Constructors Survey Deep Dive

53%
are add-on modules or part of broader building management and automation systems



81%
of constructors stated energy management & sustainability as a major factor the building architecture

38%
of constructors indicated the buildings they develop have cutting-edge automation and digital technologies

Top Challenges for Operators & Constructors

1. Lack of capital to purchase and implement the system
2. Lack of capital to maintain systems
3. Systems are too complex

Across both survey groups, roughly **45% of respondents indicated lack of capital to purchase & install energy management systems** as the biggest challenge in realizing value from an energy management strategy.

Source: CABA Intelligent Building Energy Management Systems 2020 Report

The Evolution of IBEMS in Relation to In-Building Technologies

IBEMS can be characterized as a suite of software and platform tools that leverage data from control and automation systems, metering infrastructure, distributed sensor networks, and external business intelligence and utility systems. The growing demand for greater visibility and control around energy usage and consumption, in conjunction with the increasing availability of emerging technologies, has led to a consistent cycle of innovation and progress around IBEMS.

IBEMS have evolved in parallel to building control and automation, providing a layer of power network applications designed to around three core objectives: reduce and manage building energy use, reduce cost while increasing occupant comfort and productivity, and improve environmental stewardship and ensure compliance with sustainability regulations. These objectives are often driven by the desire to drive down overhead costs and meet corporate-defined carbon emission goals.

Currently, most buildings have adopted one of two key models of IBEMS—either standalone EMS software applications for buildings, or energy management capabilities and features that exist as part of a larger BMS or BAS. While the energy management functions of each deployment model are relatively similar, each path presents distinct challenges and benefits.

However, as Intelligent Buildings mature, energy management practices and systems must inherently work closely with automation and controls systems, allowing for automated adjustments to appliances to better manage energy and leverage DERs. While this would seem to point to the model of EMS integrated on BAS/BMS systems, it needs a more wholesale change to systems architecture in buildings. Specifically, a new layer must emerge—the application/analytics overlay.

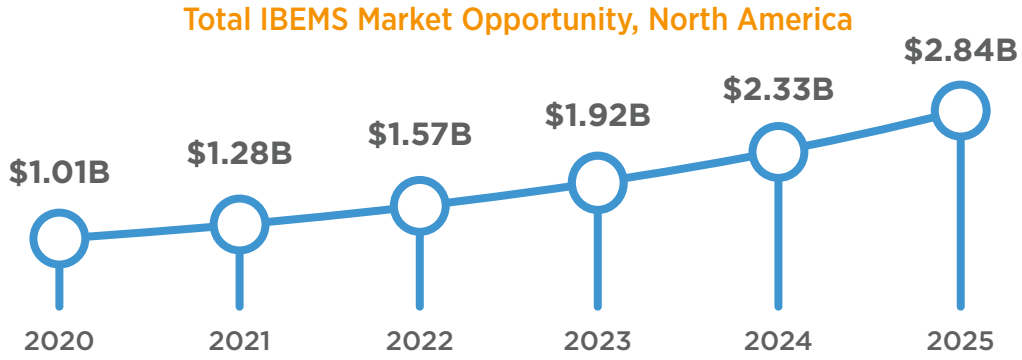
Currently, the IBEMS market landscape is fragmented, with many startups attempting to disrupt entrenched incumbents, whose systems are outdated, difficult to integrate, and do not incorporate emerging technologies. However, no single innovator has emerged as the market leader, and no business model has been adopted at scale to replace incumbents. The traditional buildings energy management value chain is transforming in the era of new intelligent buildings technologies. With the influx of new technologies, OEMs and service providers have new opportunities to provide value to customers through smart systems and services.

Technology suppliers are becoming a driving competitive force in this value chain, with growing influence on traditional suppliers and other buildings market participants. At the same time, building managers, owners and operators and utility providers across all building types are pressuring their suppliers to provide new products and support services, paired with more flexible, innovative payment methods. These forces are resulting in shifting competitive and ecosystem dynamics that require traditional equipment and service providers to take a new approach.

As depicted in the following infographic, players are taking different approaches to capture the robust, fast-growing IBEMS market opportunity.

Figure ES5 Players are Taking Different Approaches to Win the IBEMS Opportunity

The Evolution of the IBEMS Market



Large, Established BAS/BMS Incumbents

Schneider Electric, Johnson Controls, SIEMENS, Automated Logic, Honeywell

Large, established incumbents often sell EMS applications integrated into larger BMS or BAS applications, often as a separate module. While this removes the needs to separately integrate an EMS application with in-building devices and appliances, it promotes vendor lock-in and disincentivizes these players from innovating.

Utility Bill Tracking & Submetering Solutions

Dude Solutions, OnPoint, energyhippo, ENGIE Impact, GRIDPOINT

Utility bill tracking & submetering solution providers take a focused approach to energy management by simplifying the billing process and allowing for simple scheduling-based automation scripts. These solutions often do not involve automation or advanced analytics, but can help operators find and solve energy management "easy wins".

Buildings Analytics Specialists

CORTEX, riptide, SkySpark, SWITCH, ENTOUCH

Buildings analytics specialists leverage data science expertise to interface their applications with building data storage systems to create predictive analytics to identify peak loads and automate controls. However, a lack of common building data naming standards inhibits these applications from providing value to all buildings.

Automated Supervisory Control Applications

VERDIGRIS, BuildingIQ, Hank, BRAINBOX AI

Automated supervisory control applications create an additional layer on top of existing BAS/BMS products for cloud-based inferencing. Though these players add value over BAS/BMS applications, they often have difficulties convincing operators to switch from incumbent solutions.

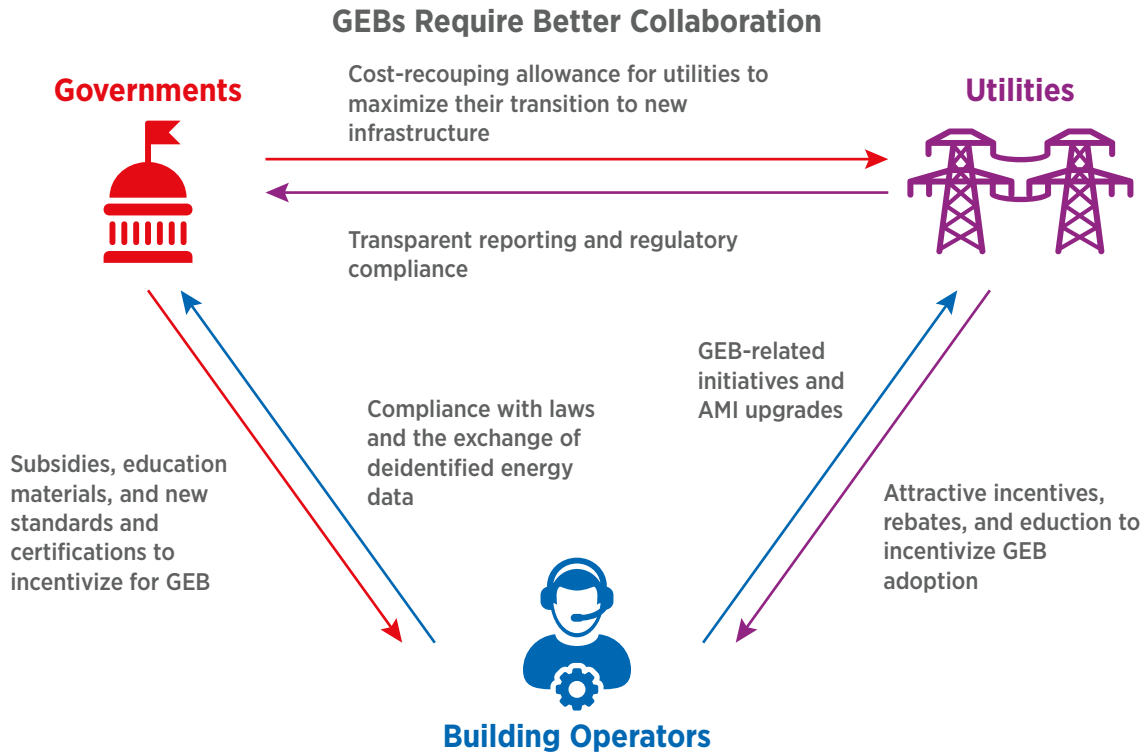
Source: CABA Intelligent Building Energy Management Systems 2020 Report

Grid Interactivity: Building-to-Grid Interactions

Legacy transmission and distribution infrastructure—such as power lines, feeders, and substations—are not only expensive to build and maintain, but they are also inflexible, requiring expensive and time-consuming labor for configuration changes. The difficulty of maintaining this infrastructure is exacerbated as more North Americans consume more energy, and the inflexibility of these systems becomes more of an issue as consumers demand sustainability and governments mandate energy reduction.

These issues burden utilities, who are often owned, regulated, or controlled by Governments and therefore often lack the agility and profitability of private corporations—which can make it difficult for them to change business models and service offerings. However, solutions to these issues are arising, namely demand response, non-wire alternatives, and the emerging model of grid-interactive efficient buildings (GEBs). GEBs refer to the ability of buildings to predict their energy needs and communicate it external grid operators, allowing for better demand response. While federal organizations have recently accelerated the development of GEB-related research and associated policies, implementing these changes is an expensive undertaking that requires systematic changes. The portrayal below depicts collaboration interactions that need to occur for GEBs.

Figure ES6 Collaboration is Required to Enable GEBs



Source: CABA Intelligent Building Energy Management Systems 2020 Report

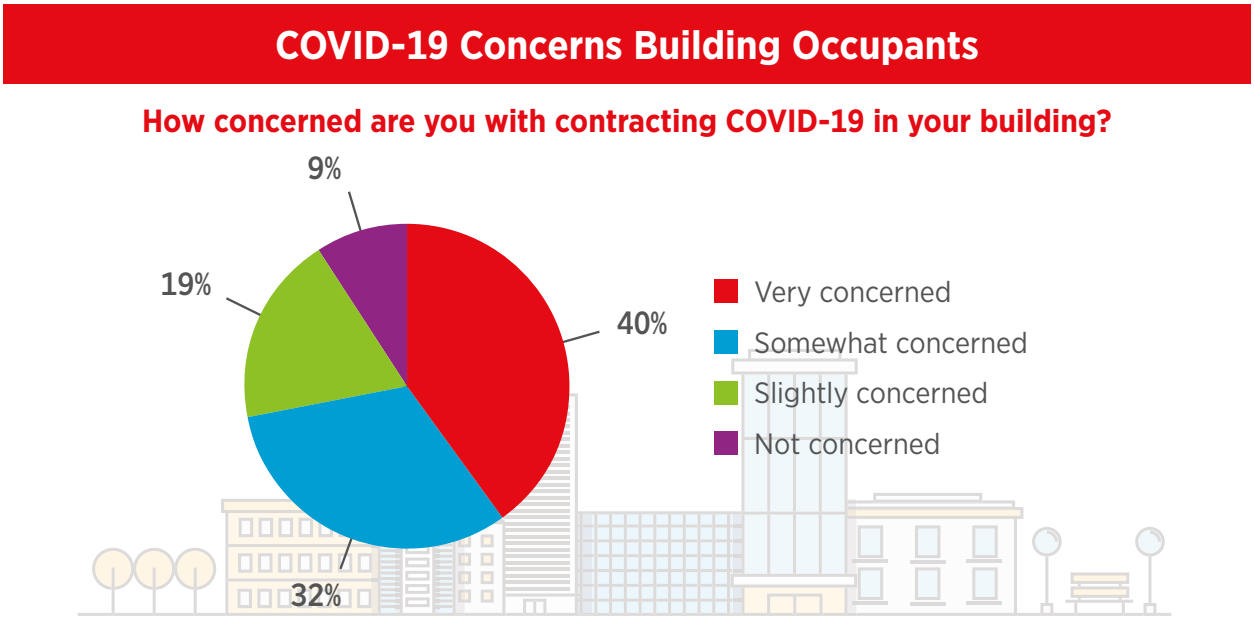
In-building energy generation and storage, and supply-side utilities strategies are converging to drive a new business model for IBEMS—the grid-interactive efficient building (GEB). Currently promoted by GSA, GEBs are defined by grid-interactivity—the ability of

buildings to establish and use real-time two-way communication with utilities. The emphasis on time-value is key to GEBs, as it allows building to flexibly respond to changes in occupant energy demand and utility price signal fluctuations.

The Impact of COVID-19 and Conclusions & Recommendations

In Spring 2020, the COVID-19 pandemic struck North America, shuttering business, and buildings across the continent as governments enforced lockdowns and stay-at-home orders. Now, as occupants begin to return to work, they are re-entering buildings with new needs, concerns, and fears. Building operators, even those skeptical of modern technologies, are looking to follow public health recommendations and mitigate the spread of the virus by implementing new business practices and emerging technologies. However, the true effects of this change on IBEMS remains unclear. The portrayal shown on the next page demonstrates how technology can make key building functions safer and more efficient.

Figure ES7 The COVID-19 Pandemic Concerns Occupants



Technologies to Enable COVID-19 Response in Buildings

Working & Collaboration	Entry	Breaks & Socializing	Comfort & Cleanliness	Getting Around
Virtual Meetings	Keyless & Touchless Entry	Contactless Payment	Air Circulation & Monitoring	Touchless & On-Demand Elevators
E-Learning & Training	Facemask Detection	Digital Ordering	Ambient Temperature Control	Automated Room Access
Virtual Whiteboards	Fever Detection	Voice-Enabled Coffee Makers	UV & Disinfecting Robotics	People Counting & Spacing Analytics
	Contact Tracing	Contactless Vending Machines	Touchless Hand Sanitizer Stations	

Source: CABA Intelligent Building Energy Management Systems 2020 Report

New technologies in buildings can enable contactless functions and consistent air quality circulation and filtration. In addition, the combination of these technologies can enable healthier buildings while improving the efficiency of buildings functions. For example, an automatic temperature screening system with biometric access control capabilities can recognize an entrant, clear them of COVID-19 symptoms, and then automatically call an elevator to take them to the correct floor—all without having the entrant to touch any surface or have a face-to-face interaction with building staff/personnel.

As the fragmented, value-inhibiting IBEMS market begins to consolidate and evolve, players across the intelligent building ecosystem will have the opportunity to emerge as key enablers of this market and unlock new, higher-margin energy streams from emerging services and analytics. IBEMS market participants need to improve the value of their IBEMS solutions while fostering a collaborative ecosystem aligned on IBEMS standards and best practices.

For **OEMs**, the value of building appliances and equipment will shift to the software and services that leverage the data that these systems produce. Although it might seem counter-intuitive in the near term, breaking up closed ecosystems and enabling "plug-and-play" based interoperability between devices and systems will help spur the overall IBEMS market and incentivize operators to purchase more complex, expensive systems over time. As this occurs, OEMs can embed their systems with energy usage monitoring and sensing. In the long-term, edge analytics and AI inferencing will allow OEMs to drive significantly higher margins from their products.

For **utility operators**, IBEMS is not just a new revenue opportunity—it is a necessity for survival. Disrupted by sustainability demands and aging, expensive infrastructure, utilities must significantly change their business models if they are to survive long into the future. To accomplish this, utilities need to integrate DERs and invest in demand-response programs. In addition, they should aggressively work with buildings and regulatory bodies to increase the adoption of DERs, onsite energy generation and storage, and grid interactivity analytics and communication capabilities.

IBEMS software providers today are hindered by market fragmentation and a lack of insight into real-world building operations and specifics. First, these providers should promote the adoption of a common IBEMS naming standard, which over time can position them to offer more advanced applications. Software providers need to either develop their systems as modules/add-on features to existing BAS/BMS applications, or they need to ensure easy interoperability between their applications and building controls systems. By continuing to develop applications in siloes, software providers will increasingly be pushed out the market in favor of large diversified OEMs and automation providers.

Lastly, **building owners and property managers** need to continue to prioritize energy management and sustainability at all stages of building construction and operation. They need to educate tenants and building staff as to the benefits of IBEMS and lay out clear strategies to meet energy and carbon emission goals established by the tenants or governments. Ultimately, building owners need to be creative about how they can upgrade their building's technology infrastructure and capabilities in a cost-effective manner. Therefore, governments and utility operators can help catalyze GEB adoption with incentives and rebates for buildings to adopt IBEMS and onsite generation dispatch controllers.

In conclusion, the IBEMS market is fragmented today, with operators struggling to choose between many products that require a significant amount of technical knowledge. Although IBEMS adoption is relatively high, both with standalone EMS software applications and integrated in larger BAS/BMS systems, operators are struggling to gain value from these systems.

Currently, IBEMS solutions frustrate operators due to their prohibitive costs, difficulty of use, lack of easy integration with buildings data, and their ultimate inability to articulate

their value or provide an immediate, tangible return on investment (ROI). These issues all stem from a lack of visibility of the suppliers into real-world building operations, pain points, and specific data types. Greater two-way knowledge and collaboration can help these devices provide more value to buildings.

For IBEMS applications to truly mature, they need to consider the context of the buildings with reference to external electrical power generation, distribution, and transmissions system in North America. In addition, they must evolve to incorporate onsite generation and energy storage, which will reduce energy consumption from the grid while providing a more resilient non-interruptible source of electricity. Massive energy savings and an effect integration of renewable energy generation and storage requires close collaboration and two-way data sharing between utilities and buildings. For this new business model to emerge—that of grid-interactive efficient buildings (GEBs)—utilities, governments, and building operators need to align on the proper incentives and develop a feasible roadmap.

Like almost every aspect of modern life, the IBEMS market evolution has been impacted by the COVID-19 global pandemic, as occupants fear for their health and operators clamor to adopt contactless technologies and better air quality filtration systems. While the true effect of COVID-19 on the prioritization of energy management and sustainability is still unclear, energy management will continue to be a huge part of buildings as more energy-intensive technologies are adopted.

For buildings, the path to energy efficiency exists, but it may not be clear how to achieve it. Therefore, all Intelligent Building ecosystem participants need to come together and collaborate on energy management best practices. The future of Smart Cities and the health of the environment depend on it.

Notes

1 U.S. Department of Energy. (2015, September). An Assessment of Energy Technologies and Research Opportunities, Chapter 5. *Quadrennial Technology Review*. https://www.energy.gov/sites/prod/files/2017/03/f34/qtr-2015-chapter5.pdf

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