Comments of the

National Electrical Manufacturers Association (NEMA)

to US Department of Energy, Office of Energy Efficiency & Renewable Energy

Request for Information (RFI): Research and Development Opportunities in Energy Management Control Systems
DE-FOA-0002723

July 18, 2022

The National Electrical Manufacturers Association (NEMA) is the leading U.S. trade association representing electrical equipment and medical imaging manufacturers, which are at the forefront of sustainability, resiliency, and energy efficiency. Our nearly 325 Member companies provide a range of products for high-performance buildings, electric vehicles, and the utility sectors. Collectively our membership provides some 370,000 American manufacturing jobs in more than 6,100 facilities, with worldwide industry sales exceeding $130 billion[1]. The electroindustry has a robust domestic manufacturing base and supports the fundamental goal of creating good-paying American jobs and shoring up our domestic supply chains.

The Biden-Harris Administration has taken quick action to implement the historic Infrastructure Investment and Jobs Act (IIJA). The IIJA represents an important milestone in the transformation of U.S. infrastructure systems toward accessible, electrified transportation systems, modernized buildings and lighting, a more resilient grid, and increased efficiency of expanded U.S. manufacturing. The legislation also includes important Build America, Buy America (BABA) provisions that, in the long term, will allow for more resilient and equitable domestic supply chains and support the creation of high-paying American jobs. The ambitious timelines outlined in the law combined with the difficulties faced by U.S. manufacturers in obtaining raw materials and supplies used to support infrastructure projects in our current global geopolitical environment, underscores the need for a nimble and strategic approach to implementation.

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[1] For more information, please visit: https://www.nema.org/.

NEMA Comments

Hardware

In general, upgrading old and inefficient building technologies can help the administration achieve their decarbonization goals and reduce total energy consumption. The application of proven, cross-cutting technologies is a realistic step to reaching energy efficiency goals and realizing equitable and responsible electrification. This includes when LED lighting products are integrated with 'smart building' lighting systems and designs. It is important to understand that adding intelligence, memory, connectivity, and self-diagnostics to every piece of equipment while trying to keep software updated to guard against cybersecurity threats adds significant costs and complexity to a system. Having an energy management system serve as a hub that can communicate with each component cuts equipment costs and future waste considerably. It also provides a single point for software updates, security, processing, and memory storage. The energy efficiency of a building can be increased substantially when energy management systems are installed.

Buildings Management Systems (BMS) are included in NEMAs Connected Building Systems (CBS)[2] equipment group. Which consists of integrated systems of hardware, software, and two-way communications that automatically monitor and control building subsystems (such as HVAC, lighting, power, plug loads, fire, access control, and security). This maximizes energy efficiency, reduces costs, improves comfort, and otherwise optimizes a building's performance. Through automation and advanced monitoring (e.g., smart plugs or advanced power strips that sense loads and facilitate power control systems), building operators can monitor and schedule plug loads remotely and integrate them into the BMS.

A 2021 Department of Motor Systems Market Assessment Report[3] highlighted that outdated mechanical systems for controlling water and ventilation loads are currently installed in almost 90% of buildings. The investment in advanced BMS systems capable of merging with an existing building's infrastructure will lead to immediate energy and cost savings. Other benefits of these systems include their wide availability, ability to manage the electricity demand, reduction of maintenance costs, and ability to fit within existing installations with limited effort.

Lighting control technologies should also be implemented in exterior industrial settings, which would further increase energy efficiency, worker safety, and building security. The DOE's *Energy Savings Forecast of Solid-State Lighting in General Illumination Applications*[4] report

[2] https://www.nema.org/directory/products/view/connected-building-systems
[3] 2021 Department of Motor Systems Assessment Report
[4] Energy Savings Forecast of Solid-State Lighting in General Illumination Applications

anticipates that only 33% of facilities will utilize outdoor smart lighting controls by 2035. NEMA believes that closing this gap presents a considerable opportunity to decarbonize the industrial sector.

NEMA also suggests that DOE consider market-based incentives and programs to entice building owners and operators to invest in high performance lighting systems and energy management systems for industrial facilities.

Education on which building systems are available for electrification, energy efficiency upgrades, and new BMS systems is another valuable tool to reduce energy consumption. According to the U.S. Environmental Protection Agency[5], 30% of the energy used in commercial buildings is wasted even though practical energy-saving solutions from the electroindustry are commercially available. The next generation of electrical product engineers and equipment installers must be trained in order for BMS systems to reach optimum performance. NEMA recommends that DOE allocate workforce develop resources to provide and promote education of energy efficient electrical equipment such as BMS.

Software

An information and knowledge gap exists not just regarding building hardware, but also the software programs created to manage equipment. Software platforms are available to assist with efficiency and automation, providing far more access through web-based automation. These connected technologies lead to direct cost reductions and energy savings through predictive maintenance. Software implementation for BMS enables the smart and secure predictive maintenance of building systems leading to a reduction in service calls, costs, and staff work hours. Software packages currently available are capable of identifying energy saving opportunities within buildings without an individual on site. The BMS is the hub of these applications, but an installer must consider several critical factors when commissioning such a system.

A key adoption barrier for building systems is having the appropriate communication portal. Building Automation Systems allow buildings to be efficient by communicating to its devices and systems to regulate lighting, appliances, HVAC, etc. BACnet has become the most popular communication protocol for buildings, as it is specified in over 80% of US projects and is now an ANSI and ISO standard. The adoption of BACnet for certain devices (drives, etc.) can be a challenge from translating existing communication protocols already installed, such as Modbus. This adoption can take time and resources to complete.

[5] EPA - Promoting Energy Efficiency with Energy Star

In recent years, the capabilities of remote monitoring equipment have increased rapidly, enabling buildings managers to perform web-based, relatively inexpensive predictive maintenance, with far fewer staff members. Many software and hardware solutions already exist so research resources should focus on inexpensive power meters that provide real-time data, next generation security, and software that can analyze and optimize building performance.

Research and Development Considerations

- Optimal Sensor Placement and Configuration

  While some BMS are simplistic and capable of commissioning themselves, others require significant input from a commissioning agent. This includes advanced lighting systems. Human input is required on several variables: defining how the lights are to be zoned, which lights should be affected by daylight sensors, the time occupancy sensors turn on and off, and determining what happens when there is a power loss. A lighting control system can have some basic programming assistance, but a human will always be required to take full advantage of advanced lighting controls and their full capabilities.

  Research into self-commissioning will have very little benefit for systems with a large number of devices, with unlimited variables and requirements based on how the space will be used. There are currently a variety of sensors that have a battery expected to exceed ten years. Energy harvesting sensors will still need a battery (or capacitor), otherwise they will not be able to function when the lights are off. Adding energy harvesting will add cost to the sensor but at some point, the battery (or capacitor) will still need to be replaced, lowering the benefit of using energy harvesting sensors.

  Researching optimal sensor placement and configuration algorithms would provide very little benefit as well. Several manufacturers of energy management systems already provide layout services showing optimal sensor placement. Some wireless occupancy/vacancy sensors that control lighting, HVAC and plug load systems have a test mode that allows an installer to temporarily place the sensor on the ceiling and then walk around the room testing whether the sensor is able to sense motion throughout an area. If the sensor detects motion it will light up showing that motion has been detected. This enables optimal sensor placement in real-world conditions. When using a floor plan and algorithm to determine sensor placement, obstructions such as projectors, pendant fixtures, and furniture, may not be considered.

  It is important to keep in mind that different types of sensors require different mounting locations for optimal placement. A daylight sensor should be placed close to a window so it can measure daylight. This would be a bad location for a temperature sensor because

daylight can affect the temperature reading. The ideal location for a daylight sensor and a temperature sensor might not work for an occupancy sensor that needs to be able to detect occupancy the moment someone passes through a door. Being aware of a few simple requirements for sensor placement makes it easy to develop a bill of materials and determine optimal sensor placement. Research into sensor placement is not likely to provide additional benefits as placement is easy to estimate.

- Artificial Intelligence

  Automated BMS and other energy management technologies present opportunities for schools, commercial, and residential buildings, to operate in ways that, if applied responsibly and to scale, could yield tremendous health, safety, economic, and environmental aggregate benefits. The effectiveness of these systems can be further amplified through the inclusion of artificial intelligence (AI) decision-making capabilities. AI can potentially help bridge societal gaps caused by historic income inequality, budget limitations, and underinvestment by allowing for process and operational efficiencies to occur where traditional methods cannot or do not exist.

  As mentioned above, proper operation of BMS requires significant input from a commissioning agent. Responsible and equitable use of AI technologies requires that automated decisions be based on comprehensive and diverse datasets in order to prevent outcomes that are bias or discriminatory in nature. Currently, one of the biggest hurdles and fears of AI adoption is the concern over learned bias, where the data received by a variety of sources, whether they be from sensors or from system developers and operators themselves, produces outcomes that create disparate impacts and other harms on certain individuals or communities. AI systems need to have effective governance rules which are overseen and updated by a commissioning agent or other trained technology professional. This helps ensure that the data used in automated decision-making is being analyzed, interpreted, and acted upon in ways that are fair and proper.

  AI technologies can only properly learn and provide correct outcomes if they are deployed in the communities and environments they are intended to support. In order to help disadvantaged communities through AI, the technologies must be afforded to them. Once AI is integrated into a community, it can collect data and learn local and other unique characteristics of that community; this will allow the technology to suggest and make actions which are “local” and that are not reliant upon system biases caused from outside influences. Further, the development, operation, governance oversight, and maintenance of AI systems must include proper representation of the members from the community the technology seeks to serve. Such local representation will reinforce data accuracy and prevent bias.

Properly developing and deploying AI-enabled management systems into schools and other communal buildings in disadvantaged or underserved areas can help reduce the societal inequalities, or at the very least prevent them from becoming greater. Also, the information gathered by these AI systems within these communities could yield suggestions and solutions to further achieve energy justice which currently are not being contemplated by policymakers. NEMA strongly encourages DOE to consider research and development projects which help BMS and energy management technologies utilize AI to ascertain equity outcomes in historically disadvantaged and/or underserved communities.

Summary

NEMA Members are active proponents of several focus points: health, safety, energy efficiency, electrification, and resiliency. The electroindustry is prepared to assist building owners and developers towards these improvement goals with electrical products and systems that provide safe and healthy learning environments. Through increased control systems, buildings can lower the carbon footprints and energy bills for their buildings, increase student and staff productivity, and automate all aspects of operations and maintenance. NEMA supports electrification in buildings and looks forward to assisting with efforts to reach energy efficiency goals in as many ways as possible.