November 16, 2108

Cathy Tripodi
Acting Assistant Secretary and Principal Deputy Assistant Secretary
U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
1000 Independence Avenue, SW
Washington, District of Columbia 20585

Re: Energy Conservation Program: Request for Information on the Emerging Smart Technology Appliance and Equipment Market

Dear Ms. Tripodi:

Thank you for the opportunity to submit comments in response to the U.S. Department of Energy's (DOE's) September 17, 2018, request for information (RFI) about market trends and issues in the emerging market for appliances and commercial equipment that incorporate "smart" technology (Docket Number EERE_FRDOC_0001-1358). For the purposes of this letter, we will use the term "connected" products to refer to devices that are networked to a centralized system, and the term "smart" products to refer to types of connected devices that also have two-way connectivity and internal logic.

The Alliance to Save Energy is a nonprofit, bipartisan coalition of business, government, civil society and academic leaders who work together to drive greater U.S. energy productivity to achieve economic growth, a cleaner environment, and greater energy security, affordability and reliability. Since the Alliance was founded in the wake of the oil crises of the 1970s, the U.S. has made huge strides in driving energy efficiency throughout our economy through research, development, and deployment of new technologies; significant public- and private-sector investments; and sound policies. Thanks in part to federal energy efficiency policy, the U.S. today extracts twice as much gross domestic product from each unit of energy we consume when compared to 1980. One of the most successful policies that has advanced energy efficiency—and currently delivers annual savings worth more than $60 billion—is the implementation of energy conservation standards for appliances, equipment, and lighting.

Perspective on Industry Trends

The RFI seeks feedback on factors that are driving the market for connected products as well as specific technologies available or currently under development that allow "for options such as remote control access, automatic supply replenishment, and intelligent energy consumption." We appreciate DOE's forward-looking approach to consider the growth of connected devices and its impact on the energy efficiency of appliances and equipment. The use of connected devices continues to grow every year. For example, U.S. demand for smart and connected thermostats is forecast to increase 18% per year through 2022, achieving more than 70% of the market over lower-technology connected thermostats by that time.[1] In addition, the global home automation market, including automated applications for safety, security, and control of entertainment, lighting, and heating, ventilation, and air conditioning (HVAC) systems, is expected to grow 11% annually, reaching $75 billion by 2022.[2]

As homes, buildings, and even the grid become "smarter," opportunities to manage energy use and provide value to consumers will likewise increase. Connected products, including advanced and adaptive controls, represent a growing opportunity to achieve significant efficiency gains -- especially when they are applied at the system level. As DOE notes on their "About Buildings-to-Grid Integration" webpage, smart sensing, metering, and control technology allow home owners to see and adjust energy usage on their smart phones.[3] Connected appliances can learn from consumer habits and schedules to automatically adjust functions like lighting and temperature according to their preferences. Grid-enabled connected devices provide additional value and flexibility for demand response as they can adjust energy usage during peak demand times, reducing energy for those end uses that are least valuable to the consumer. The convergence of smart sensing, metering, and control technology with remote and wireless connectivity, and data analytics for buildings and the grid, enables buildings to act as distributed energy assets by adjusting loads depending on the needs of the grid.

Energy savings are a significant market-driver for connected devices in the residential and commercial sectors, and many other benefits—including increased convenience, enhanced security, and improved home value—are also helping advance the market.[4] While the growth of connected devices is partly driven by their ability to unlock additional energy savings, there is still untapped potential for increased systems-level energy efficiency and for savings through the utilization of grid-enabled connected devices. These added savings and benefits could be realized through better documentation of reliable energy savings and the development of system-level metrics, which would further encourage investment in connected devices and increase their appeal.

Systems Efficiency

In addition to market trends, the RFI seeks feedback on the impact of smart features on energy efficiency and usage of appliances and equipment. Connected devices enable significant efficiency gains—beyond the efficiency gains possible at the component level—by facilitating "systems efficiency." The term "systems efficiency" refers to, with respect to the built environment, the co-optimization of multiple energy-consuming or -producing technologies and

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[1] Business Wire. (2018, October 10). Smart & Connected Thermostats in the U.S. to 2025: Market Leaders Implement Strategies to Penetrate New Consumer Markets. Retrieved from https://www.businesswire.com/news/home/20181010005442/en/Smart-Connected-Thermostats-U.S.-2025-Market-Leaders
[2] Global Home Automation Market to Reach $75.2 Billion By 2022. (2017, October 30). Retrieved from https://www.achrnews.com/articles/139094-global-home-automation-market-to-reach-752-billion-by-2022
[3] U.S. Department of Energy. About Buildings-to-Grid Integration. Retrieved from https://www.energy.gov/eere/buildings/about-buildings-grid-integration
[4] Strother, Neil. (2016, May 9). Smart Home Products Resonate with Consumers, and Utilities Should Take Note. Retrieved from https://navigantresearch.com/news-and-views/smart-home-products-resonate-with-consumers-and-utilities-should-take-note

structures to maximize energy efficiency, conservation, and productivity at the building system, building subsystem, multi-building system, whole-building, neighborhood, microgrid, or electricity distribution grid level. As defined in the Alliance's "Greater than the Sum of its Parts" report, a systems-efficient building is a building in which multiple building systems (e.g., lighting, HVAC) are designed, installed, and operated to optimize performance collectively to provide a high level of service or functionality for a given level of energy use or input.

High-efficiency products, including those covered by energy conservation standards, are a critical building block for systems efficiency. But even when those products and components are properly installed, that combination might not yield an optimally-efficient building without the support of connected products, including controls. Connected products enable the interactions among components that are necessary to maximize energy savings.

There is significant opportunity for federal leadership in supporting systems efficiency, building on DOE's current energy efficiency programs. While not the subject of the RFI, which is focused on the energy conservation standards program, DOE has other policies and programs at its disposal to encourage systems efficiency, including the Building Energy Codes Program and (in cooperation with the Environmental Protection Agency (EPA)) the ENERGY STAR® program. DOE can also encourage states and local governments to pursue market-transformational policies such as benchmarking and disclosure. **DOE should partner with states, local governments, utility companies, manufacturers, and other stakeholders on pilot programs to advance systems efficiency.**

In order to support investment and innovation in connected products, there is a need for better quantification of the energy use and energy savings potential associated with connected devices and systems. The connectivity features of connected products have their own energy requirements that come from maintaining communications, and the industry should work to limit growth in energy used by connectivity features as more connected devices come online. **To minimize energy consumption, the Alliance encourages DOE to consider the best practices outlined by the Connected Devices Alliance in "Design & Policy Principles for Energy Efficient Connected Devices," which are included as an enclosure.[5]** At the same time, it is also important to recognize that connected products have the potential to achieve system-level energy savings that outweigh their added energy requirements. **The Alliance encourages DOE to pursue research to better understand the energy consumption and energy savings potential due to network connectivity of connected products, including realistic additional device energy needs to support the system savings.**

Another area for DOE to assess is the value of connectivity and load controllability in improving energy system reliability, as an additional feature of connected products. Currently, energy conservation standards are concerned mainly with minimum efficiency and annual kilowatt-hours (and in some cases, peak kilowatt) savings. However, connectivity and load controllability, made possible through connected products, expands the quantifiable benefits of efficiency to include improved overall energy system reliability and efficient grid operation;

[5] Connected Devices Alliance. (2016, October). CDA Design & Policy Principles for Energy Efficient Connected Devices. Retrieved from https://cda.iea-4e.org/cda-principles

reduced needs for costly new generation, transmission, and distribution assets; and potential for great savings for consumers.[6] **The Alliance encourages DOE to explore how appliance and equipment standards might incorporate the added value of connected products that offer load controllability or features that enhance energy system reliability without sacrificing energy efficiency.**

In addition to quantifying the value of connected products, there is a need for a better understanding of the potential of connected products to enhance energy management systems to facilitate building-to-grid interactions. **The Alliance encourages DOE to conduct research and development into how energy management systems can best take advantage of the potential of connected products to enhance customer-side load flexibility. The Alliance also encourages DOE to continue to support EPA's Smart Home Energy Management Systems (SHEMS) program to incentivize successful energy management systems supported by connected products.**[7,8]

While smaller buildings may have smaller individual loads and may not have the resources to invest in building-to-grid technologies, their loads are significant in the aggregate and should not be overlooked. There is a need to facilitate participation by individual, small commercial, and multi-family buildings in building-to-grid interactions in order to achieve greater energy savings. It is primarily up to state utility regulators to authorize or direct utilities to undertake pilot projects on demand-response and demand-side participation for these building types, to better quantify the energy and non-energy benefits of device/building/grid connectivity. However, DOE can play a role to further support the development of device/building/grid connectivity by providing well documented examples of energy savings from connected products. **DOE, in cooperation with states, utilities, and industry, should undertake research, development, and demonstration projects on ways to ensure that smaller commercial and multi-family buildings, as well as smaller individual loads can participate fully in building-to-grid transactions, enabled by connected products.**

Because connected products have the potential to connect a wide variety of appliances and equipment, and as more and more different connected products come into the market, there is a strong need for widespread collaboration among diverse stakeholders to ensure that efficiency opportunities are not overlooked. Standardizing data collection and sharing collected data are critical for developing and disseminating best practices related to connected products. For example, DOE's existing Building Performance Database could be expanded to include a building-to-grid data repository.

[6] DOE is currently exploring these benefits with research and development on grid-interactive efficient buildings, as one component of the Grid Modernization Initiative.
[7] Incorporating connected devices with home energy management systems could enable the integration of supply and demand controls across multiple types of energy resources to optimize system performance in a home or a building, or across multiple buildings.
[8] In general, DOE should work with EPA to encourage ENERGY STAR to continue to recognize connected functionality credits and consider including the savings potential of improved demand response functionality.

Other Critical Areas of Investigation

The RFI also requests feedback on other issues relevant to the market but not expressly identified. We briefly discuss four issues: building system performance metrics, cybersecurity, miscellaneous electricity loads, and direct current (DC) power distribution.

Building System Performance Metrics

While the RFI seeks feedback on relevant market metrics for connected products, equally important is the need for better metrics for building system performance. Because connected products facilitate interactions among building components and systems, system-level metrics are often most appropriate to capture the impact of connected products on building system performance. Metrics for combinations of equipment would allow for the consideration of innovative solutions, made possible by connected products, that increase the efficiency of entire systems. System-level metrics could provide a framework for energy savings beyond those that can be achieved through component efficiency and could serve a significant role in justifying the value of the connected products that support systems efficiency. **The Alliance encourages DOE to work with industry stakeholders and standard-setting bodies to develop consensus on system-level metrics that capture the impact of connected products on building system performance.**

Cybersecurity

Connected products, which are addressable devices and often operate on expanded communications networks, within and outside the building, call for a higher level of attention to issues of data privacy and cybersecurity. The large amount of data collection enabled by connected products has the potential to increase vulnerability to cyberattacks. The Alliance **encourages DOE to work with equipment manufacturers, technology providers, and the National Institute of Standards and Technology to determine best practices for incorporating connectivity into appliances and equipment, taking into account lessons learned from appliances and equipment that already function as connected products.** Nevertheless, in the event of a cyberattack, connected technology has the potential to bolster defenses against a security breach. For example, connected technology can enable better energy management and coordination that could improve the overall resilience of the grid.

Miscellaneous Electric Loads

Miscellaneous electric loads (MELs) are often overlooked but are a major contributor to increasing building energy consumption. MELs—sometimes referred to as "plug" or "process loads"—are produced by hard-wired and plug-in electrical products not directly related to HVAC or lighting and can account for between 10% and 60% of building energy consumption.[9] The

[9] McKenney, K., M. Guernsey, R. Ponoum, and J. Rosenfield, TIAX LLC. (2010, May). Commercial Miscellaneous Electric Loads: Energy Consumption Characterization and Savings Potential in 2008 by Building Type. Retrieved from https://energy.gov/sites/prod/files/2016/07/f33/2010-05-26%20TIAX%20CMELs%20Final%20Report_0.pdf

U.S. Energy Information Administration estimates that building sector energy consumption from MELs could increase from 30% to 34% of total residential building energy use by 2030 and some estimate over 20 billion "Internet of Things" devices will be in use by 2020.[10,11] Connected products offer an opportunity to help manage MELs and curb their growth. **The Alliance encourages DOE to continue developing and updating energy conservation standards for new and existing products that contribute to MEL energy use in buildings, with an eye toward incorporating the value of connected products.** DOE has already promulgated standards aimed at reducing energy use by some MELs (e.g., vending machines (January 2016 final rule, 81 FR 1028) and battery chargers (June 2016 final rule, 81 FR 38266)) and others are coming due (e.g., microwave ovens).[12,13,14] Delayed action on pending standards for MEL products, which are steadily proliferating, will have a negative effect on building sector energy efficiency, and cost homeowners, consumers, and business more in needlessly high energy bills.

DOE also should undertake research and development in collaboration with industry, to identify energy-efficient ways to improve the connectivity of MELs within a building, so that they can be controlled as a system rather than individually, device-by-device. As discussed, connectivity features have their own energy requirements to maintain communications and implement control signals, but this added energy use, for the large and growing number of small MEL devices in a home or commercial building must be balanced against the potential energy savings from integrated, systems-level control of MELs. Several studies have also suggested that occupant engagement and education are critical to reducing the energy use of MELs.[15] A National Renewable Energy Laboratory report titled "Plug-Load Control and Behavioral Change Research in GSA Office Buildings" found that energy savings are less certain if users are not educated on how to operate plug loads and how to save energy using them. The Alliance encourages **DOE to model and develop case studies on how connected products can support occupant engagement in MEL control/reduction measures.**

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[10] U.S. Energy Information Administration (2015, April). Annual Energy Outlook 2015 with Projections to 2040. Rep. No. DOE/EIA-0383(2015). Retrieved from https://www.eia.gov/outlooks/aeo/pdf/0383(2015).pdf
[11] Gartner, Inc. (2017, February 7). Gartner Says 8.4 Billion Connected "Things" Will Be in Use in 2017, Up 31 Percent From 2016. Retrieved from https://www.gartner.com/newsroom/id/3598917.
[12] Appliance Standards Awareness Project. (2017, November 8). DOE Appliance Standards Rulemakings Schedule," Retrieved from https://appliance-standards.org/sites/default/files/DOE_Schedule_by_Product_3.pdf.
[13] U.S. Department of Energy. Draft 5-Year Appliance Standards Rulemaking Schedule. Retrieved from https://energy.gov/sites/prod/files/2017/01/f34/5-year_current_and_future_rulemakings_asrac_01.18.2017.pdf. Last accessed February 13, 2018.
[14] Office of Management and Budget. Fall 2017 Regulatory Plan and the Unified Agenda of Federal Regulatory and Deregulatory Actions – Agency Rule List – Fall 2017 – Department of Energy. Retrieved fromhttps://www.reginfo.gov/public/do/eAgendaMain?operation=OPERATION_GET_AGENCY_RULE_LIST&currentPubId=201710&showStage=longterm&agencyCd=1900&Image58.x=58&Image58.y=15&Image58=Submit. Last accessed February 13, 2018.
[15] Metzger, I., et al. (2012, October). Plug-Load Control and Behavioral Change Research in GSA Office Buildings. Retrieved from https://www.nrel.gov/docs/fy13osti/55780.pdf

Direct Current Power

The Alliance encourages DOE to take steps to reduce barriers for whole-building-level and subsystem use of DC power to increase energy efficiency by reducing conversion and wiring losses and to promote innovation. Many common products, including home and office electronics, light-emitting diode (LED) lighting, and controls are already powered by DC power. But these devices each require a small power supply to convert mains-voltage AC power to lower-voltage DC. Every time power is converted, some is lost as heat and energy efficiency is reduced. As many connected devices, including controls, come online, enabling DC power would take advantage of the opportunity to efficiently power any connected products that are already designed to operate on DC power in order to save energy by eliminating conversion losses. There are also justifications beyond energy efficiency for DOE to lower barriers to DC power distribution: the growing markets for on-site renewable energy generation from solar photovoltaic (PV) panels, localized battery storage, and electric vehicle charging stations. The same DC distribution system that could be leveraged for greater energy efficiency would also facilitate connections to PV power, battery storage, and end-use DC products all while minimizing DC-AC-DC conversion losses.

DOE has considered DC power a research priority, at least in some applications: a 2014 consultant report identified DC-powered HVAC systems as a top priority recommendation, but little progress has been made.[16] **One way for DOE to take action would be to issue a report summarizing current assessments of potential savings and other advantages of DC power in covered products when combined with building-level DC power distribution, microgrids, on-site solar PV power, and battery storage, as well as any on-going demonstrations of DC-powered end-use-product consumption. DOE should also encourage manufacturers and other stakeholders to help identify current technical and market barriers to widespread adoption of DC power.**

DOE should then work with codes- and standards-setting bodies, manufacturers and design professionals, and efficiency advocates to create a roadmap of the R&D needed to fully exploit the potential for DC power to promote innovation and improve covered product and systems efficiency. Opportunities exist in both the commercial and residential building sectors. The eventual savings realized could be significant: one study by Lawrence Berkeley National Laboratory estimated savings from DC power distribution in residential buildings at more than 33%.[17]

There are specific near-term steps that DOE should take to permit flexibility and promote innovation in covered products capable of being powered by DC. **The Alliance encourages DOE, when reviewing and updating energy conservation test methods, to accommodate the use of DC power (exclusively or as part of hybrid alternating current (AC)/DC products**

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[16] Goetzler, W. et al., Navigant Consulting, Inc. (2014, October). Research & Development Roadmap for Emerging HVAC Technologies. Retrieved from https://www.energy.gov/sites/prod/files/2014/12/f19/Research%20and%20Development%20Roadmap%20for%20Emerging%20HVAC%20Technologies.pdf

[17] Vossos, V., K. Garbesi, and H. Shen. (2014, January). Energy Savings from Direct-DC in U.S. Residential Buildings. *Energy and Buildings*, 68, Part A (January 2014); pgs. 223–31.

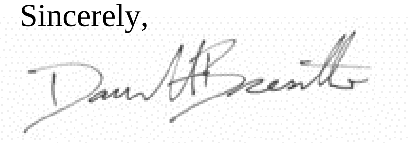
that can use either type of input power). An alternative approach to modifying test methods individually for each covered product would be for DOE to consider adopting a "horizontal standard" to permit the use of DC power in any existing AC power test method.[18]

Conclusion

Thank you for the opportunity to comment on DOE's smart products RFI. Within the confines of current statute, there are several approaches available to DOE to allow greater flexibility and encourage innovation. The energy conservation standards program is a pillar of federal energy policy and should remain a top priority. The evolution of systems efficiency, enabled by the communications and technology revolution of the past few decades, presents a new opportunity for DOE to achieve many of the stated goals of the RFI.

The Alliance looks forward to the results of this work and stands ready to support DOE's efforts to continue to advance energy efficiency and improve U.S. energy productivity.

Sincerely,



Daniel Bresette
Vice President of Policy

Enclosure: CDA Design & Policy Principles for Energy Efficient Connected Devices

[18] For reference, consider the cross-cutting approach in International Electrotechnical Commission (IEC) Standard 62301 for measuring standby power across a range of products.

Enclosure:

Excerpt from CDA Design & Policy Principles for Energy Efficient Connected Devices

(Connected Devices Alliance. 2016, October. Retrieved from https://cda.iea-4e.org/cda-principles)

CDA DESIGN PRINCIPLES FOR ENERGY EFFICIENT CONNECTED DEVICES

1. Networked device design should follow standards-based communication and power management protocols to ensure compatibility and interoperability, and should take advantage of standards and protocols that actively support energy efficiency.
2. Networked devices should not impede the efficient operation of a network (for example by injecting bottlenecks or faults, or impeding power management activities in other devices).
3. Network-wide energy efficiency optimization should be a key development consideration. Network power management should coordinate with individual device power management techniques to achieve this.
4. Connection to a network should not impede a device from implementing its internal power management activities.
5. Networks should be designed such that legacy or incompatible devices do not prevent other networked devices on the network from effective power management activities.
6. Networks and networked devices should have the ability to scale power levels in response to the amount of the service (level of functionality) required by the system.
7. Edge devices without networking functionality should enter network standby, if not inappropriate[a], after a reasonable period of time when not being used. Edge devices with networking functionality should provide power management capabilities for each function consistent with that function's role in the network[b].
8. Networking and networked infrastructure devices should, when work load allows, autonomously minimise power consumption.
9. Consumers should be informed about, and have control over, device power management, including any impacts on the energy consumption of the devise and of any dependent devices, and changes to the user experience.
10. The design and operation of networked devices should be compatible with, and promote the positive effects of, using consumer electronics and information and communication technology (ICT) to enable energy to be used more efficiently, often referred to as "Intelligent Efficiency."
    a. Edge devices whose role is to complete a task, conduct no other service and can tolerate an extended resume sequence, should autonomously go into network standby.
    b. Power management consistent with its role in the network: e.g. an edge device with networking functionality such as a printer with an integrated access point controller may put edge device functionality (printer) into a network standby state while maintaining operation of networking functionality (access point).

CDA POLICY PRINCIPLES FOR ENERGY EFFICIENT CONNECTED DEVICES

1. Government and industry should seek harmonized policy approaches that benefit the global marketplace for consumer and commercial technology products and services, and that enhance the productivity and efficiencies achieved via networks.
2. Policy, including government procurement and best-practice sharing, should support continued device, network and intelligent efficiency innovation.
3. Energy efficiency requirements should be technology neutral. Policy should account for the different capabilities and performance of networked devices.
4. Policy should neither impede the functionality of networked devices or efficiency of the network nor impair device or network security.