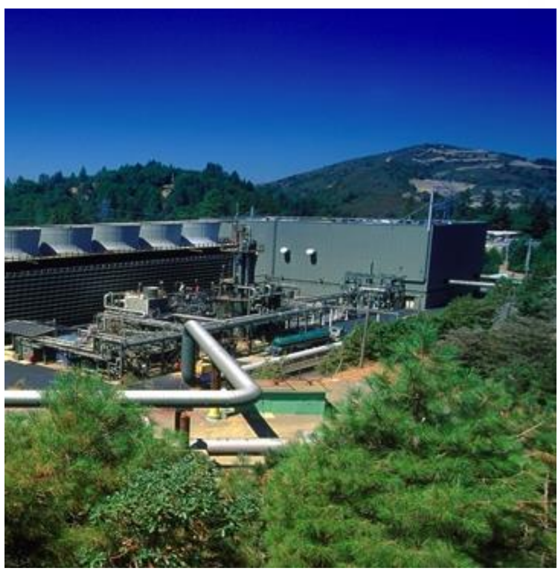
EAC
ELECTRICITY ADVISORY COMMITTEE

Recommendations Regarding the Energy Storage Grand Challenge

A Submission by
The Electricity Advisory Committee
August 2020

EAC Response to the Energy Storage Grand Challenge Request for Information

Introduction

The Electricity Advisory Committee (EAC) is providing these recommendations to be considered for the implementation of the Energy Storage Grand Challenge (ESCG). The EAC is a federal advisory committee composed of experts from across the electric power, natural gas, and other industries. As directed by the 2007 Energy Independence and Security Act, every 5 years the EAC assists the U.S. Department of Energy (DOE or the Department) in developing a strategic roadmap for its energy storage research and development (R&D) program to ensure that the United States retains a globally competitive domestic energy storage industry for electric drive vehicles, stationary applications, and electricity transmission and distribution. These comments will serve as part of the 2021 roadmap, while also responding to several issues the Department raised raised in a recent request for information (RFI) regarding the ESCG. These comments are informed by numerous conversations among the members of the EAC and with stakeholders across the entire energy supply chain as we know it today and believe it will develop in the future.

The EAC commends DOE for pursuing departmental coordination through the Energy Storage Grand Challenge. The ESGC is an important initiative and it comes at an important time. Energy storage is increasingly being used by the electric power industry and is increasingly seen as an essential tool to add flexibility and resilience to the nation's grid. As indicated by the U.S. Energy Information Administration's Annual Energy Outlook, variable energy resources (VERs) are growing substantially, and energy storage is critical to successfully incorporating VERs in the country's electricity portfolio. In addition, it is vital for the country to retain its leadership in this area so that it can achieve a greater level of energy independence and security.

Many challenges remain, however, and a well-coordinated and focused R&D program that directly responds to the practical needs of the industry is needed to overcome existing challenges.

The EAC wants to draw attention to the following issues that it considers to be particularly important as the Department develops and executes its 10-year roadmap.

- To be effective in developing a **strategic roadmap that serves the nation, responds to all of its sectors' needs, is well-integrated, and anticipates future challenges**, the EAC encourages the Department to continue to take an approach that includes a strategic vision which ensures that the United States retains a globally competitive energy storage industry; a business vision that includes all generation, transmission, distribution supply chain, and industrial sector participants; and a customer vision that takes into account the needs of the different customer segments and their desire for safe, reliable, environmentally friendly, readily available, and affordable electricity. Input should be solicited broadly from the private and public sectors to understand needs, crystalize the vision, and validate assumptions.

- The Department should consider **basing its strategic roadmap on both existing and future needs**. To better identify the future needs of the nation, the Department should improve its modeling and forecasting capabilities. This is particularly important when addressing long-term, long-duration storage: for example, for various fuel mix scenarios at regional and national levels, how much long-duration storage will be needed? For how long?
- **Coordinating R&D efforts** across offices and departments is also essential to achieve a well-integrated program. The EAC urges the Department to continue to look for synergies and exercise its power to convene within its offices, and also across agencies and other public and private organizations that are conducting research on various aspects of energy storage.
- The EAC encourages the Department to seek **industry collaboration** as often as possible, especially when developing new programs and conducting demonstration projects that are essential to successful technology adoption and transfer.
- The EAC encourages the Department to include **existing initiatives, current technologies, and existing policies** that impact the operations and performance of technologies in its roadmap. The Department should pay special attention to areas where significant decisions have already been made that may influence innovative applications, and work on determining future improvements. For example, in 2018, Federal Energy Regulatory Commission (FERC) Order 841 required regional transmission organizations (RTOs) to remove barriers that may prohibit distributed and behind-the-meter energy storage from participating in wholesale markets. RTOs have since developed extensive market/business rules in response to this order. In addition, other business rule changes are under consideration in RTOs that involve energy storage participation, such as rules surrounding hybrid resources, as well as utilization of storage as a transmission asset.
- Moreover, the EAC encourages the Department to take a **holistic approach** that does not artificially, or unintentionally, constrain the development of possible applications for energy storage; takes into account the fact that there may be applications, or combinations of applications, that have not yet been identified; and takes an expansive view when thinking about incorporating energy storage in non-conventional areas, services, or products, which would allow for extracting additional value steams. For example, some types of infrastructure can be used for commercial, industrial, recreational, or educational purposes. Pumped hydro can serve as water supply reserves, a recreational opportunity, a training facility, traditional catchment, a commercial site for a restaurant or brewery, and so forth.
- Lastly, the EAC urges the Department to always take into account that any energy storage asset can be a **controllable grid asset**, regardless of its operational characteristics or situation on the electric grid. All energy storage programs, whether R&D or technical assistance, should strive to enable the operational benefits and

address technical or regulatory barriers that hinder a particular energy storage asset from being a controllable grid asset.

Recommendations

Section 1. Technology Development

The EAC recommends that the Department focus on developing an R&D program that is pragmatic about the potential roles for energy storage and can address the following issues:

Responding to real system needs, both current and future.

When developing an effective R&D program in energy storage, it is critically important to ensure that it is aimed at addressing and responding to *existing* system needs, not artificially creating a market for new technologies that may or may not be needed or helpful to support the electricity system.

For these reasons, it is also critically important to be able to identify the energy storage use cases that provide the most benefit for national security and those that can most cost-effectively keep the lights on for the greatest number of customers.

The Department should look at different time frames incorporating current and future grid needs. For example, as stated above, the Department should recognize existing technologies, such as pumped storage (PS) hydro. PS exists today and does not require any significant new R&D. The industry is now using PS for long-duration storage until new technologies are developed. Advanced PS, incorporating variable-speed pumping drives and inverter-coupled generation, holds even further potential flexibility for supplying immediate grid needs (such as high-speed ramping) while filling the longer term storage role.

As referenced in the EAC's 2020 Biennial Energy Storage Review,[1] "a key challenge that DOE must address through its [research, development, and demonstration] activities is the development of viable technologies for long-duration and seasonal energy storage. More resources and greater emphasis should be devoted to these areas."

Power-to-gas innovation takes excess zero-carbon electricity and creates zero-carbon hydrogen and methane for injection into natural gas pipelines. The existing natural gas infrastructure can effectively integrate high-value sources of energy through renewable energy storage and the delivery of renewable gases derived from biogenic sources and zero-carbon electricity.

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1 https://www.energy.gov/sites/prod/files/2020/06/f75/EAC_2020%20Biennial%20Energy%20Storage%20Review_FINAL.pdf

For nearly a decade, the European Union has placed an emphasis on "energy storage" within the context of liquefied natural gas (LNG); the leading driver for supply reliability has been power generation. LNG and liquid hydrogen storage provide near-market opportunities. There is potential in the use of existing cryogenic storage facilities and technologies, including suitable LNG storage capacities and equipment, as well as atmospheric pressure storage of hydrogen, both at production and end-use points along the system, to fuel electricity generation. Near-term solutions may consider natural gas options while longer term solutions involving hydrogen are developed.

Electricity to hydrogen holds great promise for long-term energy storage and requires careful examination and R&D efforts; however, interim steps toward a hydrogen economy should not be overlooked as they may offer more immediate benefits. If hydrogen production from solar, wind, or other sources is coupled with local storage and hydrogen-fueled combustion turbines, a proof of concept for hydrogen production can be done relatively soon without waiting for the construction of hydrogen transportation infrastructure. If such facilities are located on the sites of retiring coal- or oil-fired plants, the cost of installing the necessary electric transmission system can be minimized.

A portfolio of proven technologies, ranging from more recent chemical battery technologies to time-tested mechanical and thermal technologies, should be leveraged and further developed in parallel with the development of newer options.

At the other end of the spectrum, the Department should carefully consider and examine technologies that are less developed but that, with more R&D, could have a wide variety of compelling use cases in many sectors of the economy. Hydrogen is a prime example. Establishing a viable test facility may support development efforts, expedite the innovation cycle, and enhance technology adoption rates. Another technology is marine hydrokinetic (MHK) plus storage. MHK technology is a renewable and predictably stable (in terms of the power curve) source of energy that has the potential to be dispatchable with integrated energy storage. MHK plus storage also offers an opportunity to serve offshore shipping vessels with "green hydrogen"[2] as chemical energy storage or direct electric energy. To overcome some of the unique siting and deployment challenges of MHK and energy storage integration, efficiency improvement, and large-scale commercialization, more advanced research, development, and at-scale deployment efforts are necessary. Field validation and field demonstration of integrated MHK/energy storage are necessary for accelerated technology adoption and commercialization. It is also important to establish U.S.-based manufacturing, engineering solutions, and workforce training for MHK and energy storage integration (workforce development). Such an integrated technology has the potential to be an accelerator for

[2] Green hydrogen is produced using renewable energy sources.

economic development and energy resilience in the coastal communities, islands, and remote sites. It can also serve as an enabling or contributory element of the "blue economy."[3]

Addressing reliability and resilience

As noted above, any Department R&D program should start by identifying the challenges that need to be addressed while keeping an eye on the immediate needs that can be met with existing, proven technologies. A few potential examples include (1) repurposing synchronous condensers from retiring fossil plants to maintain rotational inertia and provide reactive power, voltage support, and synchronizing torque to address those reliability issues; (2) repurposing submarine batteries and using them in conjunction with solar; and (3) developing communications to use domestic water heaters and electric vehicle charging as a base for community storage.

In addition to contributing to resilience, energy storage can have a direct impact on the grid's everyday reliability and operational flexibility, spanning wholesale markets and integrated resource planning regimes. Some energy storage roles already identified include the following:

- Absorbing energy to align output with load, thereby preventing overgeneration from uncontrolled distributed energy resources
- Energy injection to perform ramping services
    - Supplement generation during severe upward ramps
    - Absorb energy during downward ramps
- Continuous proportional response to frequency deviations
    - Frequency control services
- High-speed energy injection following a loss of resources (fast frequency response)
    - Helps to offset higher rates of change of frequency caused by a loss of system inertia due to displacement or retirement of synchronous generation
    - High-speed response during the arresting phase of a frequency event
    - Response proportional to the change in frequency and rate of change in frequency
- Relieving transmission and distribution (T&D) constraints, thereby deferring traditional T&D capital investments
- Providing customer energy management services to improve power quality, improve reliability, shift retail electric usage to off-peak, and perform demand-side management services
- Improving frequency, reliability, and providing voltage regulation

Energy storage systems offer a tremendous advantage over other technologies for controlling frequency and supporting grid reliability. For example, a battery energy storage system (BESS)

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[3] According to the World Bank, the "blue economy" is based on "sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and ocean ecosystem health." (https://www.worldbank.org/en/news/infographic/2017/06/06/blue-economy)

can operate in two quadrants of the power control operation by absorbing power from the grid to charge itself and then discharging power to the grid as needed.

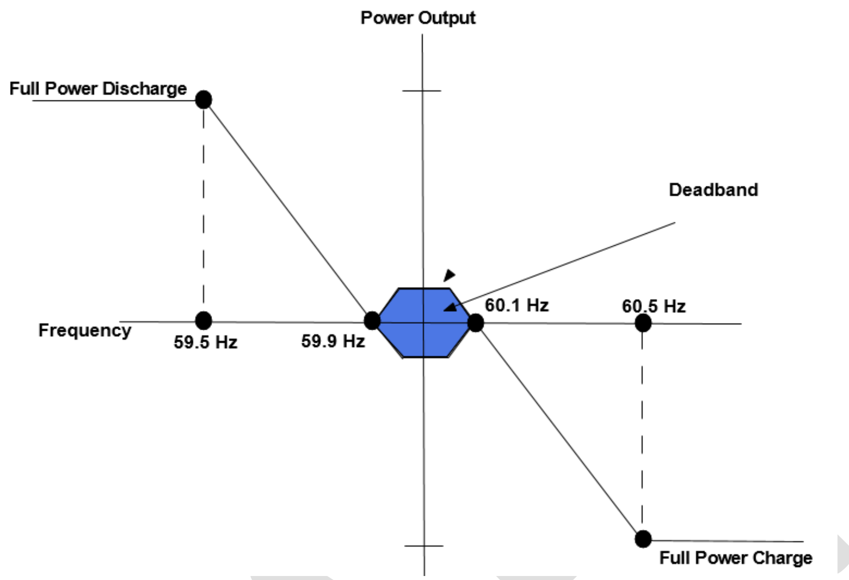

Figure 1. *Potential Operating Mode for Battery Charging/Discharging*

A BESS is similarly capable of providing or absorbing reactive power for voltage control.

A great deal of thought is going into the use of electric vehicles (EVs) and their chargers for grid support. These assets show great promise, and the Department should explore how best to use them to the grid's advantage. There needs to be a cohesive control strategy built into the EVs and chargers since the cars may be connected to different parts of the grid at different times of the day, and they may not always be controllable by the utilities or aggregators. EVs and their charging stations may not be appropriate assets for all grid services. The Department needs to refine this particularly important use case, providing guidance for managed charging and the capability to effectively integrate it into delivery system operations.

Distributed energy resource management systems (DERMS) are technology platforms that can be used to provide aggregated ancillary services to the grid from diverse distributed energy resources such as wind, solar, and energy storage (both customer and utility scale). The Department should investigate how customer-level energy storage systems can best be aggregated, managed, and utilized to provide grid-forming capability.

Energy storage systems such as BESS can provide black-start capability at the customer level or when aggregated by a DERMS; however, the DC to AC inverter must have "grid forming" capability, meaning that they can create their own reference voltage at 60 hertz. That capability of BESS is essential to its resiliency when offering backup power for critical facilities such as fire and police stations, or for other critical loads such as hospitals, cell towers, and water supplies. Most inverters associated with rooftop solar panels do not have that capability.

For system restoration after natural disasters, standardized electrical connection equipment for energy storage systems (by voltage class) would also be highly desirable. Modularization would also offer distinct advantages.

As with reliability, when trying to enhance grid resilience it is important to recognize that energy storage is only one tool in the resilience toolbox. Moreover, resilience can be achieved through the protection of individual customers or facilities; however, increased focus on resilience cannot ignore utility solutions that, for the reasons explained above (cost effectiveness and technical effectiveness), should be promoted and constantly improved.

To better incorporate these constraints into resilience conversations and solutions, good valuation and benefit-cost analysis frameworks are essential. Benefits are possible from multiple value streams; however, the underpinning control technology requires a philosophy and supporting architecture that provides coordinated autonomous and dispatchable capability.

Finally, consideration should be given to the industrial sector because they are a substantial part of the economy and can potentially be negatively impacted by power quality due to greater use of variable energy resources. Additionally, industrial end users can also play an important role in the use of energy storage technology. The industrial sector is unique in that it has tens of thousands of facilities across the United States, many of which operate 24/7 and have the skill set necessary to manage power off and on the grid, and their attributes have a role to play in the future of energy storage systems.

Section 2. Manufacturing and Supply Chain

Manufacturing and supply chain security considerations are critical issues. It is important to establish U.S.-based manufacturing and engineering solutions, and workforce training for energy storage whenever possible, along with energy storage integration (workforce development). Integration of energy storage technology manufacturing and supply chain needs within North America has the potential to be an accelerator for economic development and the enhanced grid reliability and resilience objectives desired by the Department.

The EAC, however, does want to stress that life cycle analysis, including the resources consumed for battery production, as well as end-of-life impacts such as recycling, is an important element to incorporate into any supply chain analysis and energy storage modeling. The disposal of batteries is a growing concern. DOE and industry have several initiatives related to repurposing recycled EV batteries for other applications, such as stationary storage and breaking batteries down into their component parts to be recycled. The Department should continue to support public and private solutions for this very important issue, with consideration as to whether there is sufficient domestic sourcing of critical materials used in storage technology to satisfy national security and reliability.

Other manufacturing and supply chain considerations include (1) reducing the time it takes from order to fulfillment; (2) increasing the domestic availability of components; (3) bolstering domestic manufacturing capability; (4) ensuring adequate maintenance support capability and the availability of parts; (5) development of insurance requirements and the availability of insurance; (6) safety standards development for delivery through commissioning and beyond; (7) technical standards development for more effective coordination and integration among providers of batteries, power conversion controls, machine interfaces, installers, and plant-level and enterprise-level controllers; and (8) integration capability among multiple energy storage solutions.

Section 3. Technology Transition

Effective technology transition and commercialization are essential for energy storage to become the tool that a flexible, reliable, and resilient grid needs. To achieve this, the EAC urges the Department to take the following points into consideration:

Continued collaboration with industry, customers, and other important stakeholders

To be successful, key industry groups involved in supplying relevant products and services, as well as the consumers who use and pay for power, must be part of the discussion about energy storage, its different uses, and actual deployment and commercialization strategies. The EAC agrees with the Department's approach that incorporates in its strategic plan the voice of the electric power and industrial sectors, as well as that of various customer segments.

Enhanced focus on demonstration projects

One of the best ways to commercialize new technologies continues to be through demonstration projects. Because testing energy storage involves demonstration of new technologies and technical configurations as much as new applications, the EAC urges the Department to accelerate demonstration programs that test energy storage at relevant scales and under real-world operating conditions. It will be critical to share the experiences and lessons learned to expand the knowledge and gain ultimate acceptance of energy storage technologies by the power industry, customers, and policymakers.

Focus on modeling and helping the power and industrial sectors make a business case for energy storage

Because of the flexibility of energy storage and the many ways in which it can be used, it is often difficult for electric and industrial companies to make the business case for deploying energy storage. Better, broader cost-benefit analyses and valuation tools are needed to help the various industry stakeholders understand the value of energy storage in different situations and build the business case for energy storage of short, medium, and especially long durations.

As referenced in the EAC's 2020 Biennial Energy Storage Review,

> "… some stakeholders, particularly those with limited resources to devote to their own customized modeling or those in regions of the country which are not familiar with these technologies or have seen limited deployments, find modeling exercises and tools that can be used for valuation of energy storage very helpful. Such information could inform their own investment decisions as well as engage key stakeholders and regulators of the value of energy storage in a variety of different applications. … DOE should continue and expand the dissemination of its work on tools that can be used for modeling the value, and performance of different applications and energy-storage technologies, in different energy-system contexts. For example, energy storage is cited often as a technology that can facilitate very high penetrations of variable renewable energy economically. However, this use of energy storage depends on the system context and the availability of other low-carbon technology options."

Section 4. Policy and Valuation

The EAC would like to stress the importance of building a roadmap based on existing industry needs and offers the following comments.

Energy Storage Cost, Performance, and Financing

Providing energy storage cost, performance, and financing data is critical to accelerating energy storage deployment. There is limited actual experience in developing and deploying energy storage projects, and much of the valuable cost and performance data is closely held. Having a way to anonymize the data and make it broadly available will be very helpful. Having granularity in the component costs, such as battery, inverter, control system, balance of plant, connection costs, and ongoing operation and maintenance costs, is very important. This would allow better validation of the component costs as each component could be validated, rather than just a cost per megawatt or megawatt-hour, to better target incremental improvements. For example, historic cost reductions have been from the storage module itself. However, balance of plant costs to more efficiently integrate energy storage systems with the grid and soft cost reductions from increased certainty, more favorable and aligned tax treatment, and value engineering may present more opportunities. Cost reduction is needed through innovation; understanding and using actual costs are critical. Many estimates today are based on vendor cost estimates, which can vary widely and do not consistently identify all component costs.

Planning Tools, Processes, and Data

The existing tools for analyzing and modeling the distribution and transmission systems are being extended to model energy storage and microgrid applications. Advancements in these tools could be useful; however, knowing what advancements are needed will take some effort to define. A more pressing problem may be the availability of needed data about the future performance of energy storage assets, including their real-life performance and operations and maintenance costs. There is very little real-world experience with this, so most modeling today depends on assumptions. One advancement could be the ability to run multiple scenarios quickly to provide sensitivity analysis. This could be helpful while the data availability issues are being addressed.

Demand-side resources can be synergistically paired with energy storage technologies. Successful pairing will require accurate assessments of the demand-side resources that may be dependent upon customer behavior rather than control systems. Assessing and optimizing the human-machine interface is important for energy storage integration in the same way as both human and machine interactions and the critical components of cybersecurity.

Data availability, ownership, and access requires attention. Even if tools are available or can be manipulated to perform the desired function, often the data to drive them is lacking. The Green Button Alliance is an example where energy use data was made available primarily using information from smart meters. Perhaps this best practice can be contemplated to make energy storage data more readily available and transparent for stakeholders. Modified load shapes using smart meter data can be aggregated with new tools that leverage big data techniques; however, there is often time series challenges when collecting and aggregating data effectively in an operating environment. Providing access and visibility to information about energy storage systems that are critical infrastructure can also be challenging given the restrictions that are applied to maintain cyber security.

Knowledge of the location, electrical connections, design specifications, operational characteristics, and operational status of all energy storage systems must be known by the distribution or transmission system owner/operators. This information must also be available to any advanced distribution management system (ADMS), distributed energy resource management system (DERMS), supervisory control and data acquisition (SCADA) system, or energy management system that is involved in its operation and control. The data is crucial for safe and reliable operation of the electrical system.

Valuing resilience

Stakeholders are just starting to value resilience related to investments. One gap is that there is not a clear link from resilience to dollar value. That makes financially based evaluations very challenging. Thus, finding a way to attach a dollar value to the resilience services offered by energy storage is important. One idea that is starting to gain momentum is recognizing the value of energy storage from its lowest application level all the way through the bulk electrical system when the smaller, lower level systems can be aggregated to optimize benefits at a system level. Market development is needed to fully value and incentivize the benefits that storage can provide for increased resiliency at the device, distribution, and bulk levels.

Market participation

There needs to be a reasonable opportunity for utilities, third-party developers, customers, municipalities, and so forth to investment in energy storage. Some existing policies and ownership arrangements involve barriers that keep the investor from being compensated for all the different benefits the asset provides. Alignment is needed for roles, responsibilities, and regulations among federal, state, and local policymakers.

Asset classification

Despite many efforts, there is still a lack of a common definition of what energy storage is and how it should be classified, both at the state and RTO levels. Energy storage is difficult to define and classify as it can provide benefits across multiple segments and system levels. For example, if planned and designed appropriately, energy storage deployed as a distribution or customer asset can potentially provide benefits to the transmission and generation systems. There may also be future cases we do not currently recognize (e.g., power factor). For example, utilities that have installed energy storage devices have often found benefits they did not expect.

The current lack of a common understanding of asset designation can be a barrier to the ownership of energy storage by certain actors and to understanding and maximizing all potential benefits of energy storage. Clear definitions and rules recognizing that energy storage can behave as a generation, transmission, or distribution asset, as well as load, would be beneficial to the effective deployment of energy storage. A separate asset class for energy storage may be an answer to this problem; however, policies with less restrictive requirements for asset class, uses, and benefit recognition can also be helpful.

Section 5. Workforce Development

Workforce development will be critical to effectively design, engineer, build, operate, and maintain energy storage systems. The Department should take an active role in developing effective and aligned energy storage training programs to develop the necessary workforce to fulfill energy storage roadmap objectives.

Safety training

Safety is an important consideration that can stifle the development of a technology. Continuing to work toward increasing the safety of energy storage devices is important, but so is increasing the education and professional training of the operators of energy storage devices, as well as that of first responders and emergency personnel. The Department should consider its role in helping to develop training programs.

To assist with that task, in June 2019, the EAC invited Gerard Fontana, Deputy Fire Chief, Boston Fire Department, to discuss the role of first responders in ensuring safe deployment of energy storage devices. That discussion resulted in two main takeaways:

First, fire departments and other first responders should be included in the regulatory process governing the deployment of energy storage and other distributed energy resources. Their insights about safety as the resources are being sited and deployed can be invaluable to avoid unnecessary hazards. For example, Mr. Fontana noted that sometimes solar farms were being placed near liquefied natural gas tanks within city limits, and that inverters in houses and in other facilities can pose significant risks that are often ignored.

Second, the need for adequate training is critical. Mr. Fontana referred to the Boston Fire Department Training Academy, which would train firefighters, building inspectors, and utility workers. The National Fire Protection Association was involved in developing the curriculum for the training facility.

Another example is the Massachusetts Clean Energy Center, which offers training for firefighters and others on a variety of issues, including energy storage systems, their chemistries, and the applicable codes and standards, as well as the proper response in emergency situations. The Center trains officers who then train their respective departments.

It is important to note that energy storage devices and inverter-based technologies are being installed in all areas of the country. Therefore, training of first responders and emergency personnel is not only required in large cities, but also in the most rural areas. The EAC urges the Department to work with local authorities and communities to determine how best to help them design and implement safety training programs.

The Department should also provide guidance on jurisdictional responsibilities for electrical equipment inspections. There is a good deal of confusion as to whether equipment must comply with the National Electrical Code, which focuses on systems on the customer side of the meter, or the National Electrical Safety Code, which focuses on the end-to-end safety of utility systems from the generator, across transmission and distribution facilities, ending at the "service point." Additional confusion is now occurring with energy storage systems being added at commercial and industrial sites, especially when the storage systems approach utility scale in size. There is also confusion about when Underwriters Laboratories' certification is needed for equipment. Since energy storage systems run the full gamut from residential applications to utility-scale systems, it is important to ensure that the correct standard is applied for electrical inspections.

Elements of a workforce development program

There are many efforts across the nation to build effective workforce development programs. The EAC urges the Department to define skill gaps in the marketplace and develop plans to address them. Existing successful programs should be identified and built on. For example, a workforce development program should:

- Assess industry energy storage needs and opportunities to focus educational and training developmental efforts that align with needed skills/capabilities to deploy, maintain, and effectively manage energy storage. Skill gaps are likely for those who are entering the energy storage market and for those who are currently involved.
- Consider that safety is important for technology innovation and adoption. Continuing to work toward increasing the safety of energy storage devices is important. And the education and professional training of operators, first responders, and emergency personnel is a critical component.

- Cultivate partnerships as a foundation for the growth of regional energy storage educational clusters that map to industry needs. At the intersection of workforce, economic, and small business development, leverage energy storage assets and manufacturing to build clusters that will prepare a workforce that can scale energy storage innovation and align business needs/employer interests with training efforts.
- Encourage federally funded R&D centers that focus on energy storage development to develop the training, curriculum, and infrastructure necessary to meet energy storage roadmap objectives.
- Encourage the enrollment of workers in skilled trades and encourage cross-cutting training and engagement among skilled trades, engineers, control technicians, materials scientists, and end users to help develop a “big picture” vision and awareness of energy storage for all participants.
- Recognize the roles of both generalists and specialists, ranging from the agile “street smart” jack-of-all-trade skills of farmyard/machine shop innovators to the high technology of the national labs and science community, in developing interfaces when possible.
- Include supporting industries, such as hard technologists, materials scientists, programmers, field engineers (integrators), digital communications and data management experts, market analysts and economists, and game theorists, for strategic positioning of U.S. technology leadership. Soft technologies are also critical, including policy advisors, relationship experts (public, media, and customer), human resource managers, and developers.
- Consider educational outreach to grade school classes by providing visual, hands-on access to energy industry concepts, and opportunities across the employment spectrum. Internships—particularly cross-cutting ones, such as engineers in construction ditches, tradesmen at laboratories, and so forth—can recruit in general, cross-recruit, and cross-develop.
- Consider prizes and competitions (e.g., XPRIZE) to promote visibility and encourage a career shift toward energy technologies.
- Consider internships or technologists embedded in key ecosystems, such as manufacturers, utilities, or regulatory environments, for projects or sabbaticals.
- Consider outreach to Native American youth, military veterans, and other targeted demographics since energy storage has high value in microgrids and high renewable-penetration ecosystems (e.g., tribes and reservations, island systems [coastal islands], Alaska, Hawaii, U.S. Department of Defense installations).