ENERGY STORAGE GRAND CHALLENGE
U.S. DEPARTMENT OF ENERGY

DATE: 07/30/2020

SUBJECT: Request for Information - Energy Storage Grand Challenge

RESPONSES DUE: 08/31/2020

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SUMMARY: The U.S. Department of Energy's (DOE or the Department), is issuing this Request for Information (RFI) solely for information and planning purposes and does not constitute a Request for Proposal (RFP). Information received may be used to assist the DOE in planning the scope of future technology studies, deployment, or technology commercialization efforts and may be shared with other federal agencies. The DOE may also use this RFI to gain public input on its efforts, expand and facilitate public access to the DOE's resources, and to mobilize investment in U.S. energy storage technologies as well as ancillary technologies and efforts that will enable commercialization and widespread adoption. The information collected may be used for internal DOE planning and decision-making to ensure that future activities maximize public benefit while advancing the Administration's goals for leading the

world in building a competitive, clean energy economy; securing America's energy future; reducing carbon pollution; and creating domestic jobs.

DATES: Written comments and information are requested on or before August 31, 2020.

ADDRESSES: Comments must be submitted electronically to *rticstorage@hq.doe.gov*. ***Responses must be provided as a Microsoft Word (.doc) or (.docx) attachment to the email with no more than 10 pages in length for each section listed in the RFI. Only electronic responses will be accepted.***

Response Guidance Please identify your answers by responding to a specific question or topic if possible. Respondents may answer as many or as few questions as they wish.

FOR FURTHER INFORMATION CONTACT: Requests for additional information may be submitted electronically to Rima Oueid at *rticstorage@hq.doe.gov* at (202) 586-5000.

SUPPLEMENTARY INFORMATION:

BACKGROUND

In September 2018, Congress passed the Department of Energy Research and Innovation Act (Public Law 115-242) No. 114-246, codifying the efforts of the DOE's Research and Technology and Investment Committee (RTIC). The Energy Storage Subcommittee of the RTIC is co-chaired by the Office of Energy Efficiency and Renewable Energy and Office of Electricity and includes the Office of Science, Office of Fossil Energy, Office of Nuclear Energy, Office of Technology Transitions (OTT), ARPA-E, Office of Strategic Planning and Policy, the Loan Programs Office, and the Office of the Chief Financial Officer.

In January of 2020, the DOE announced the Energy Storage Grand Challenge (ESGC), a comprehensive program to accelerate the development, commercialization, and utilization of next-generation energy storage technologies and sustain American global leadership in energy storage. The ESGC builds on the $158 million Advanced Energy Storage Initiative announced in President Trump's Fiscal Year 2020 budget request.

The vision for the ESGC is to create and sustain global leadership in energy storage utilization and exports with a secure domestic manufacturing supply chain that is independent of foreign sources of critical materials by 2030. While research and development (R&D) is the foundation of advancing energy storage technologies, the DOE recognizes that global leadership also requires addressing associated challenges that lead to commercialization and widespread adoption of energy storage technologies.

The ESGC is a cross-cutting effort managed by RTIC. The DOE established the RTIC in 2019 to convene the key elements of the DOE that support R&D activities, coordinate their strategic research priorities, identify potential cross-cutting opportunities in both basic and applied science and technology, and accelerate commercialization.

Using a coordinated suite of R&D funding opportunities, prizes, partnerships, and other programs, the ESGC established the following five cross-cutting tracks: (i) Technology R&D, (ii) Manufacturing and Supply Chain, (iii) Technology Transitions, (iv) Policy and Valuation, and (v) Workforce. These five cross-cutting tracks have developed a draft Roadmap that will be updated based on feedback from this RFI as well as other ongoing DOE efforts, such as workshops, webinars, and other engagements with stakeholders. The roadmap identifies six use cases as neutral guideposts to provide a framework for the ESGC. These use cases include (i) facilitating an evolving grid, (ii) serving remote communities, (iii) electrified mobility, (iv) interdependent network infrastructure, (v) critical services, and (vi) facility flexibility, efficiency and value enhancement. More information on the use cases and the draft

Roadmap can be found here *https://www.energy.gov/energy-storage-grand-challenge/downloads/energy-storage-grand-challenge-roadmap*.

Each track has developed a set of RFI questions related to their respective areas and target audience. This RFI is divided into five sections that represent each track as follows:

The purpose of the **Technology Development Track** covered in Section 1 is to develop and implement an R&D ecosystem that strengthens and maintains U.S. leadership in energy storage innovation. To help realize the vision of U.S. energy storage leadership, the Technology Development track will establish user-centric use cases and technology pathways to guide near-term acceleration and long-term leadership in energy storage technologies. A set of future energy storage use cases, enabled by aggressive cost reductions and performance improvements, will help guide R&D objectives across a diversity of storage and enabling technologies. A full description of the use case framework is discussed in the draft Roadmap. After identifying a portfolio of technologies that have the potential to achieve major functional improvements, ensuring long-term leadership includes augmenting the R&D ecosystem to enable constant innovation. The ecosystem includes partnerships, consortia, infrastructure, and other long-term resources that accelerate the journey from concept to commercialization.

The purpose of the **Manufacturing and Supply Chain Track** covered in Section 2 is to strengthen U.S. leadership in energy storage through strengthening the manufacturing supply chains that produce state-of-the-art and emerging energy storage technologies, including supporting technologies that enable seamless integration into larger systems and the grid. Strengthening U.S. manufacturing of energy storage technologies occurs through commercializing and scaling innovations that make domestic manufacturers more competitive. Increasing U.S. manufacturing competitiveness can come through multiple ways, including directly lowering the cost of manufacturing, lowering the lifecycle cost of technologies through improved performance and/or longer service lifetimes, diversifying sources for critical materials – particularly increasing domestic sources – and through accelerating the process in which new materials or components are integrated into systems and reliably produced at commercial scales to meet rapid deployment/demand.

The purpose of the **Technology Transitions Track** discussed in Section 3 is to support the ESGC and strengthen U.S. leadership in energy storage by accelerating commercialization and deployment of energy storage innovations through validation, financing, and collaboration. This Track focuses on potentially bankable business models that build off of the Technology R&D use cases, and may also consider other use cases that are ready for commercialization and could support widespread adoption of storage. These include behind the meter and utility-scale storage, as well as stationary and mobile storage. The approach will concentrate on addressing barriers to bankability and attracting private investment. Where appropriate, lessons learned will be leveraged from previous work on standardization of solar contracts and capital market access for renewables. For example, minimizing perceived risk, such as uncertain technology performance through formalized data sharing, can lower risk premiums, improve warranties, and spur new insurance products that may attract more cost effective investment. Policies, incentives, and analysis tools that support bankability will also be considered.

This track has identified a potential need for proactive market validation, demonstration, standards, and dissemination of information to give market participants confidence in energy storage assets, thus reducing project risk, lowering project costs, increasing investment, and accelerating market demand.

The purpose of the **Policy and Valuation (P&V) Track** discussed in Section 4 is to provide information and analysis to appropriately value energy storage in the power, transportation, buildings, and industrial sectors. The P&V track will develop a coordinated, DOE-wide program that leverages the expertise and capabilities of the national laboratories to provide stakeholders with cutting-edge data, tools, and analysis to enhance their policy, regulatory, and technical decisions. Stakeholder engagement will be systematic and recurring to guarantee the DOE provides tailored solutions for high priority needs. Providing stakeholders with the necessary information and capabilities to make informed decisions will help ensure that storage is properly valued, effectively sited, optimally operated, and cost-effectively used to improve grid and end-user reliability and resilience.

The purpose of the **Workforce Development Track** covered in Section 5 is to focus the DOE's technical education and workforce development programs to train and educate the workforce, who can then research, develop, design, manufacture, and operate energy storage systems widely within U.S. industry. The lack of trained workers has been identified as a concern for growth of the U.S. industrial base, including many areas of energy storage. To have world-leading programs in energy storage, a pipeline of trained research and development staff, as well as workers, is needed. For workforce development in energy storage, the DOE will support opportunities to develop the broad workforce required for research, development, design, manufacture and operation. The DOE can play a critical role in facilitating the development of a workforce that is necessary to carry out the DOE's specialized mission. Energy storage is a highly specialized area of work and yet not a focus of 2 or 4 year college curricula. Therefore, it is appropriate that the DOE take the lead in strengthening a pipeline of qualified individuals who can fulfill employment needs at all stages of energy storage development, production and deployment.

Purpose: The purpose of this RFI is to solicit feedback from interested individuals and entities, such as, industry, academia, research laboratories, government agencies, and other stakeholders to assist the

ESGC with identifying market opportunities and challenges – both technical and financial -- for the development, commercialization, production, and deployment of energy storage technologies. This is solely a request for information. In issuing this RFI, the DOE is not seeking to obtain or utilize consensus advice and/or recommendations. The DOE is not accepting applications at this time as part of the ESGC.

Disclaimer and Important Notes: This RFI is not a Funding Opportunity Announcement (FOA) or RFP for a procurement contract; therefore, the ESGC is not accepting applications or proposals at this time. The ESGC may develop programs in the future and solicit contracts based on or related to the content and responses to this RFI. However, the DOE may also elect not to incorporate responses into its programs and tool designs. There is no guarantee that an RFP or FOA will be issued as a result of this RFI. Responding to this RFI does not provide any advantage or disadvantage to potential applicants if the DOE chooses to issue a FOA or solicit a contract related to the subject matter.

Any information obtained through this RFI is intended to be used by the government on a non-attribution basis for planning and strategy development, and/or for information purposes. The DOE will review and consider all responses as it formulates program strategies related to the subjects within this request. In accordance with Federal Acquisition Regulations, 48 CFR 15.201(e), responses to this notice are not offers and cannot be accepted by the government to form a binding contract. The DOE will not provide reimbursement for costs incurred in responding to this RFI. Respondents are advised that the DOE is under no obligation to acknowledge receipt of the information received or provide feedback to respondents with respect to any information submitted. Responses to this RFI do not bind the DOE to any further actions related to this topic.

The DOE will not respond to individual submissions or publish a public compendium of responses. A response to this RFI will not be viewed as a binding commitment to develop or pursue the project or ideas discussed. However, responses will be used to assist the DOE with identifying market opportunities and challenges for the commercialization and deployment of energy storage technologies.

Respondents are requested to provide the following information at the start of their response to this RFI:

- Company / institution name;
- Company / institution contact;
- Contact's address, phone number, and e-mail address.

Proprietary Information: Because information received in response to this RFI may be used to structure future programs and/or otherwise be made available to the public, **respondents should clearly mark any information in the response to this RFI that might be considered proprietary or confidential**. Information labeled proprietary or confidential will not be released by the DOE, but may be used to inform the DOE's planning. Responses must be submitted with the understanding that their contents may be publicly disclosed unless properly labeled as proprietary or confidential. In the event of a public disclosure, the DOE will NOT notify respondents or provide any opportunity to revise or redact submitted information. Public disclosures by the DOE will not attribute content to a specific respondent.

Marketing Information: Any submissions that could be considered advertising or marketing for a specific product will be excluded.

Review by Federal and Non-Federal Personnel: Federal employees are subject to the non-disclosure requirements of a criminal statute, the Trade Secrets Act, 18 U.S.C. 1905. The government may seek the advice of qualified non-federal personnel. The government may also use non-federal personnel to conduct routine, non-discretionary administrative activities. The respondents, by submitting their response(s), consent to the DOE providing their response(s) to non-federal parties. Non-federal parties given access to responses must be subject to an appropriate obligation of confidentiality prior to being given the access. Submissions may be reviewed by support contractors and private consultants.

Section 1 Technology Development

Background/Context

To develop and maintain a guiding R&D framework for all storage technologies, the Technology Development Track is arranged around three main activities:

1. Develop stakeholder-informed use cases that identify and update technology-neutral performance and cost targets through 2030 and beyond.
2. Identify a portfolio of energy storage technologies that have a R&D pathway to achieve significant progress towards these cost targets by 2030.
3. Bolster all stages (from fundamental research to pre-commercial demonstrations) of the U.S. innovation ecosystem (including national labs, universities, startups) for these pathways through funding and support mechanisms appropriate to each stage.

Details of each activity are provided in the draft Roadmap. Stakeholders are invited to provide feedback on the draft Roadmap by addressing the questions below.

Information Requested

The following questions may guide, but should not restrict, responses:

D.1 Use Cases

D1.1 Scope

D.1.1.1 What are long term individual/business/local/state/regional energy and infrastructure goals with a major energy component?

D.1.1.2 What are the major technology barriers to achieving these goals?

D.1.1.3 Do any of these objectives or barriers align with the proposed DOE Use Cases?

D.1.1.3.1 How might the DOE modify or add to the use cases to better support achievement of these goals?

D.1.1.4 What kinds of “boundary conditions” for today’s electric power system could increase in prominence by 2030?

D.1.1.5 What are other important storage uses or applications are not included in the use cases?

D1.2 Process and Evolution

D.1.2.1 What is an appropriate update frequency for the use cases, their functional requirements, and associated cost and performance targets?

D1.3 Cost, Value, and Market Sizing

D.1.3.1 If storage is not available, what other solutions or workarounds would be used to meet a use case? What are the costs of these alternatives?

D.1.3.2 Given today’s market value and technology costs, what is the likely addressable market size for each use case?

D.1.3.3 How does the size of the addressable market change over time, with decreasing technology costs, changing conditions, or other factors?

D.1.3.4

D1.4 Specific Use Cases

D.1.4.1 Facilitating an Evolving Grid

D.1.4.1.1 What kinds of emerging individual/business/local/state/regional goals could be supported by this use case?

D.1.4.1.2 What performance requirements for storage would be required to achieve these goals?

D.1.4.1.3 How might the DOE modify or add to this case to better support achievement of these goals?

D.1.4.2 Serving Remote Communities

D.1.4.2.1 What kinds of emerging individual/business/local/state/regional goals could be supported by this use case?

D.1.4.2.2 What performance requirements for storage would be required to achieve these goals?

D.1.4.2.3 How might the DOE modify or add to this case to better support achievement of these goals?

D.1.4.3 Electrified Mobility

D.1.4.3.1 What kinds of emerging individual/business/local/state/regional goals could be supported by this use case?

D.1.4.3.2 What performance requirements for storage would be required to achieve these goals?

D.1.4.3.3 How might the DOE modify or add to this case to better support achievement of these goals?

D.1.4.4 Interdependent Network Infrastructure

D.1.4.4.1 What kinds of emerging individual/business/local/state/regional goals could be supported by this use case?

D.1.4.4.2 What performance requirements for storage would be required to achieve these goals?

D.1.4.4.3 How might DOE modify or add to this case to better support achievement of these goals?

D.1.4.5 Critical Service Resilience

D.1.4.5.1 What kinds of emerging individual/business/local/state/regional goals could be supported by this use case?

D.1.4.5.2 What performance requirements for storage would be required to achieve these goals?

D.1.4.5.3 How might DOE modify or add to this case to better support achievement of these goals?

D.1.4.6 Facility Flexibility

D.1.4.6.1 What kinds of emerging individual/business/local/state/regional goals could be supported by this use case?

D.1.4.6.2 What performance requirements for storage would be required to achieve these goals?

D.1.4.6.3 How might DOE modify or add to this case to better support achievement of these goals?

D.1.4.6.4 Are energy storage systems relevant for improving industrial facility operations?

D.1.4.6.5 If so, what measurable improvements are expected?

D.1.4.6.6 What are optimal storage time durations for adopting facility-based storage?

D.1.4.6.7 If a facility were to use its operational flexibility as a form of virtual energy storage, how much potential "virtual storage" capabilities are currently available across facility processes and immediate operational?

D.1.4.6.7.1 What are the opportunities for facility flexibility to provide or enable energy storage? For example:
Operational changes process delay/sequencing,
Material flows (from input to output)

D.1.4.6.8 What are the risks and limitation to the facility that limits a facility's adoption of energy storage?

D.1.4.6.9 What would it take to retool process equipment and/or core-processes to enable greater flexibility (with an energy impact)?

D.1.4.6.10 What technologies/strategies would be needed to make a particular manufacturing process more flexible in terms of production rate or saving energy or being able to produce a variety of products in rapid response to market forces?

D.1.4.6.10.1 Could the storage of energy or materials contribute to increased flexibility, and in what way?

D.2 Technology Portfolios

D2.1 Functionality

D.2.1.1 What are the unique performance, maintenance, environmental, safety, or other requirements of a specific use case?

D2.2 Metrics

D.2.2.1 How can the Levelized Cost of Storage metric be further refined to compare costs across technologies?

D.2.2.2 What other metrics would assist measuring technology advancement, cost, and value to the end user?

D.3 Technology Pathways

D3.1 The ESGC road map appendix identifies current R&D DOE activities on a variety of storage technologies. What additional technologies and R&D pathways have the potential to meet the use case requirements?

D3.2 For a given technology (e.g. flow batteries, thermal storage, compressed air, balance of system/ power conversion technologies etc.):

D.3.2.1 What are the major challenges to commercial viability?

D.3.2.2 What additional testing capacity or capabilities would help accelerate technology development?

D.3.2.3 What types of validation are required? See Appendix 2 in the Roadmap for criteria.

D.3.2.4 At what point does a new technology sufficiently diverge from existing technologies as to require validation through in-field demonstration? For a given technology pathway, what is the likely scale of a field demonstration? What are the limits of validation through simulation or extrapolation?

D.3.2.5 What is the scale (financial, energy/power capacity) required for the validation efforts above?

D.3.2.6 What is the half-life of a technology's competitive advantage? How often would to the new technology require more lab work and have to be jump-started?

D3.3 How does a technology and a vendor become ready to bid on commercial opportunities?

Section 2 Domestic Manufacturing

Background/Context

The DOE can play a critical role in accelerating the progress of emerging technologies through the development and deployment, bridging the many gaps in support that may arise from discovery to manufacturing, so innovations important to sustained competitiveness make it into the market. These activities advance development of materials and components that are applicable across multiple energy storage technologies and applications, advance platform technologies that enable the manufacturing of energy storage systems, establish partnerships to promote technology innovation, and transfer knowledge through dissemination of tools and training. The manufacturing and supply chain pillar of the ESGC aims to develop technologies, processes, and strategies for U.S. manufacturing that support and strengthen U.S. leadership in energy storage innovation and continued at-scale manufacturing of energy storage materials, components, and systems.

Different energy storage technologies face different sets of challenges to improving their manufacturability and strengthening their supply chains. Different uses will require different technologies, and the manufacturing & supply chain track will examine the manufacturing issues related to all of them. For each question in this section, please specify which of the energy storage technology class or classes – described in the ESGC Roadmap – the answers are addressing.

Information Requested

The following questions may guide, but should not restrict, responses:

M.1 Manufacturing Innovations for Materials & Components Questions

- M.1.1 What materials or components represent the largest barriers to directly lowering the cost of production for total energy storage system?

M.1.1.1 What are their current manufacturing costs and/or throughput rates (units/day)?

M.1.1.2 What aspects of material or component sourcing or manufacturing are the cause of this (these) barrier(s)?

M.1.2 What existing manufacturing innovations for specific components or materials could have the largest impact on directly lowering the system production cost, if implemented?

M.1.2.1 What is the impact that their implementation would have?

M.1.3 Are there any new or emerging materials and/or components that could have major impacts on directly lowering the production cost of energy storage systems?

M.1.3.1 What are the likely impacts if these materials and/or components were to be integrated into existing state-of-the-art systems?

M.1.3.2 What are the most significant barriers to manufacturing at scale and integrating these materials and/or components into energy storage systems?

M.1.3.3 Using existing knowledge about current barriers and the resources and time likely required to overcome them, which new or emerging materials and/or component should be rated as being readily commercialized.

M.1.3.3.1 in the near-term (< 2 years)

M.1.3.3.2 in the mid-term (2 years – 6 years)

M.1.3.3.3 in the long-term (> 6 years)

M.1.4 Which materials or components represent the largest barriers to lowering the total lifecycle cost for the energy storage system? Please specify if these are barriers to performance improvement, lifetime extension, or both.

M.1.4.1 If possible, please provide current baseline performance data and/or expected service lifetimes.

M.1.4.2 What about their design or manufacturing is the cause of this (these) barrier(s)?

M.1.5 Which existing manufacturing innovations for specific components or materials could have the largest impact on lowering the total system lifecycle cost, if implemented?

M.1.5.1 What impact would their implementation have? Please specify if this would be through performance improvement, through lifetime extension, or both.

M.1.6 Are there any new or emerging materials and/or components that could have major impacts on lowering the total system lifecycle cost?

M.1.6.1 What are the likely impacts if these materials and/or components were to be integrated into existing state-of-the-art systems? Please specify if impacts would be on performance improvement, lifetime extension, or both.

M.1.6.2 What are the most significant barriers to manufacturing at scale and integrating these materials and/or components into energy storage systems?

M.1.6.3 Using existing knowledge about current barriers and the resources and time likely required to overcome them, which materials and/or components should be rated as being readily commercialized.

M.1.6.3.1 in the near-term (< 2 years)

M.1.6.3.2 in the mid-term (2 years – 6 years)

M.1.6.3.3 In the long-term (> 6 years)

M.2 System-Level Innovations

M.2.1 Outside of the material and component specific innovations covered in the previous category, are there any aspects of the system-level design, manufacturing, validation, and integration process that are major barriers to directly lowering the energy storage system cost?

M.2.1.1 If these barriers were eliminated, was is the estimated impact that would have?

M.2.2 Are there any new or emerging innovations in designing, manufacturing, or integrating energy storage systems – outside of individual materials and/or components – that could have major direct impacts on lowering the energy storage system cost?

M.2.2.1 What are the likely impacts of implementing/adopting these innovations?

M.2.2.2 What are the most significant barriers to implementing/adopting these innovations?

M.2.3 Outside of the material and component specific innovations covered in the previous category, are there any aspects of the system-level design, manufacturing, validation, and integration process that are major barriers to lowering the total lifecycle cost of the system?

M.2.3.1 If these barriers were eliminated, what is the estimated impact that would have? Please specify if the impact would be on performance, lifetime extension, another as-yet unspecified impact on lifecycle cost, or multiple impacts.

M.2.4 Are there any new or emerging innovations in designing, manufacturing, or integrating energy storage systems – outside of individual materials and/or components – that could have major impacts on lowering the total lifecycle cost of the system?

M.2.4.1 What are the likely impacts of implementing/adopting these innovations? Please specify if the impact would be on performance, lifetime extension, another as-yet unspecified impact on lifecycle cost, or multiple impacts.

M.2.4.2 What are the most significant barriers to implementing/adopting these innovations?

M.2.5 Are there any other innovations that would improve and/or accelerate the overall process of iterating and validating improved energy storage systems that have not yet been covered in this section?

M.3 Supply Chain Resilience

M.3.1 Does the manufacturing supply chain for the energy storage system have a strong, reliable, sustainable, U.S. presence?

M.3.1.1 If not, which sections of the supply chain have the weakest, or no U.S. presence?

M.3.2 What are the most pressing challenges to creating and/or growing a reliable US presence in these supply chains?

M.3.3 Are U.S. storage manufacturing supply chains vulnerable to supply disruption of specific materials or components?

M.3.3.1 If so, which supply chains and which materials and components?

M.3.4 What R&D would help make material and component supply chains more resilient and robust?

M.4 Crosscutting Innovations

M.4.1 Which manufacturing methods would provide the greatest impact for energy storage technology?

Section 3 Technology Transitions

T.1 Stationary Grid Storage Business Model Questions

Background/Context

Stationary grid storage business model questions are meant to elicit ideas that consider a holistic approach to market access. For this section, stationary grid storage includes systems that can satisfy the functional requirements in the use cases: Facilitating an Evolving Grid, Resilience and Recovery, Interdependent Network Infrastructure, and Facility Flexibility. These systems can be connected at either the transmission level or the distribution level. For each question, please specify whether the answer applies to transmission level, distribution level, or both. Also, consider how responses may differ if the storage asset owner or provider is a utility, commercial and industrial entity (C&I), or residential entity. Please differentiate between commercial and industrial where appropriate. Although we encourage respondents to answer all questions, partial responses are welcome.

Information Requested

The following questions may guide, but should not restrict, responses:

T.1.1 Should and/or could stationary grid storage provide ancillary services or demand response to the power grid using any of these ownership/delivery models? Please include an explanation of why a choice was made or excluded. What other services could stationary storage provide in the short-, medium-, and long-term? How does ownership type affect these market opportunities?

- T.1.1.1 Individually
- T.1.1.2 Individually by a third-party
- T.1.1.3 Aggregated by the utility including energy generation, transmission, or distribution.
- T.1.1.4 Aggregated by a third-party.

T.1.2 What barriers impede market participation based on the models listed in the previous question?

T.1.3 Should and/or could stationary C&I sector storage provide ancillary services or demand response to the power grid using any of these ownership/delivery models? Please include an explanation of why a choice was made or excluded.

T.1.3.1 Individually

T.1.3.2 Individually by a third-party

T.1.3.3 Aggregated by the utility including energy generation, transmission, or distribution.

T.1.3.4 Aggregated by a third-party.

T.1.4 Should and/or could stationary residential sector storage provide ancillary services or demand response to the power grid using any of these ownership/delivery models? Please include an explanation of why a chose was made or excluded.

T.1.4.1 Individually

T.1.4.2 Individually by a third-party

T.1.4.3 Aggregated by the utility including energy generation, transmission, or distribution.

T.1.4.4 Aggregated by a third-party.

T.1.5 What barriers impede market participation based on the models listed in the previous question?

T.1.6 At what times and under what circumstances do utilities need grid support services (e.g., ancillary services, load shifting, and demand response)? What is the magnitude of the need, by service? How do seasonality and geographic location affect grid support needs?

T.1.7 Under what conditions would owners be willing to offer their electric vehicle (EV) charging infrastructure to provide such stationary storage services? How might this differ depending on whether the owner is a utility, C&I entity, residential entity, or third-party? To the extent possible, consider how regionality and market structures may affect an answer.

T.1.7.1 How much additional storage would be needed?

T.1.7.2 What is the additional marginal cost for the variety of storage options available relative to the additional potential revenue stream opportunities?

T.1.7.3 How might this vary by region, market structure (e.g. regulated vs unregulated markets), or location (e.g. based on resource mix)?

T.1.8 What is the best way to assess the additional marginal cost for bi-directional electric vehicle charging infrastructure or other stationary storage to become a microgrid and what is the added benefit from the additional potential revenue stream opportunities?

T.1.9 Where on the grid is there greatest potential value from storage for reliability (e.g. to offset intermittent renewables), resilience, and savings given current trends? For example, where would utilities and ISO/RTOs see value to help offset infrastructure upgrades? The following is a list of considerations:

T.1.9.1 Based on grid congestion

T.1.9.2 Based on other grid vulnerabilities

T.1.9.3 Based on access renewables (e.g. heat maps)

T.1.9.4 Based on savings to utilities to offset

T.1.9.5 Other factors?

T.1.10 How is or could stationary grid storage be used for locational energy arbitrage?

T.1.10.1 Can charging infrastructure investments anticipate locational pricing? If not, what would be required for this to be possible in the future?

T.1.10.1.1 At the transmission level?

T.1.10.1.2 At the distribution level?

T.1.10.2 How would locational pricing for resilience affect the prospects for bi-directional electric vehicle charging infrastructure?

T.1.11 Stationary grid storage used for responding to emergencies and for restarting the grid. Can or should black-start be provided by C&I, residential, or third-parties?

T.1.11.1 Would such infrequent events justify the needed capital investment?

T.1.11.2 Are EV charging infrastructure owners likely to comply with grid operator requests in an emergency?

T.1.11.3 Could aggregators be deployed under such circumstances?

T.1.11.4 What level of risk should be considered in developing responses to emergencies (frequency and impact)?

T.1.12 How significant is the market for bi-directional storage relative to other energy storage markets, in the short-, medium-, and long-term? What factors will affect the size of this market?

T.1.13 Are there other use cases that could or should be considered for stationary storage from utility, C&I, residential, or third-party providers?

T.1.14 What other services could be part of the value stacking of combining various use cases and revenue?

T.1.14.1 Should a prioritized value list be developed, e.g. emergency services, evacuation, medical services, water, wastewater, HVAC, etc.?

T.1.15 What other ancillary technologies are needed to support these use cases? For example, artificial intelligence for dynamic pricing, blockchain to support transactive services, software to enable aggregation or grid dispatch calls to stationary storage providers?

T.1.16 What options are there for stationary grid storage ownership? What are the pros and cons of each?

T.1.17 What are the different ownership models that exist or could ideally exist?

T.1.17.1 Could municipalities or other public entities either own or secure priority access to stationary storage for public services, residents, businesses, etc.?

T.1.18 Who should pay and for which component of the project (e.g. interconnection, operations, maintenance, etc.)? How does or should this differ depending on the sector providing the storage service (e.g. utility, C&I, residential, or third-party)?

T.1.19 Who ultimately pays and who should pay for the upfront cost of stationary grid storage that is beneficial to the grid; end users, ratepayers, or market participants? Why? Who actually reaps the operational benefits?

T.1.20 What limits deployment of stationary storage currently? Which policy, technology, or regulatory barriers are likely to be the most significant in the short-, medium-, and long-term? How do they differ at the transmission or distribution level? What about based on ownership types or market segments?

T.1.21 In light of recent lithium-ion battery incidents, how significant are concerns regarding safety of any storage technology? What performance, safety, or other data would be necessary to restart resources or invest in new resources? What other safety measures would be helpful and could be standardized to reduce risk and increase investor confidence?

T.1.21.1 Will advancements in battery technology impact explosion risk?

T.1.22 How much and what data would be necessary to reduce investment risk premiums in stationary storage?

T.1.23 What are some other novel strategies, tools, or resources that the federal government or others could implement or provide to facilitate the market for innovative uses of stationary storage?

T.2 Mobile Grid Storage Business Model Questions

Background/Context

Mobile grid storage business model questions are meant to elicit ideas that consider a holistic approach to market access. For this section, mobile grid storage includes the Electrified Mobility use case. This includes bidirectional battery electric vehicles (BEV), plug-in hybrids (PHEV) or hydrogen fuel cell electric vehicles (FCEV), as well as any other mobility option that would require mobile storage technology. Vehicles could include passenger vehicles, utility vehicles, transit, medium-duty (MD) or heavy-duty (HD) trucks, or other advanced transportation systems. These mobile storage units could act independently or as aggregated fleets owned by one or more entities or individuals that can be called upon and dispatched by a system operator. These mobile systems can be connected at the transmission level, distribution level, or building level. For each question, if possible, please specify if the answer applies to transmission level, distribution level, building level, or some combination. Also, consider how responses may differ if the mobile storage provider is a utility, fleet owner, individual entity, public entity, or third-party aggregator. Third-party aggregators could be utilities, automobile or battery manufacturers (OEMs), or other public or private entities. Please consider and note if a distinction affects a response. Although we encourage respondents to answer all questions, partial responses are welcome.

Information Requested

The following questions may guide, but should not restrict, responses:

T.2.1 Should and/or could mobile grid storage provide ancillary services or demand response to the power grid or other facilities using any of these ownership/delivery models? Please include an explanation of why a choice was made or excluded. What other services could mobile storage provide in the short-, medium-, and long-term? How does ownership type affect these market opportunities?

T.2.1.1 Individual

T.2.1.2 Fleet owner

T.2.1.3 Utility

T.2.1.4 Aggregated by the utility including energy generation, transmission, or distribution.

T.2.1.5 Aggregated by a third-party.

T.2.2 How does the response to the previous question differ depending whether the mobile storage service is provided at the transmission level, distribution level, or building level?

T.2.2.1 Should and/or could we consider services between mobile storage units?

T.2.3 At what times and under what circumstances do utilities need grid support services (e.g., ancillary services, load shifting, and demand response)? How do these differ by geographic location and seasons?

T.2.4 Under what conditions would owners or product warranty providers be willing to offer their mobile grid storage to provide such services? How does the response differ based on ownership (utility, fleet owner, individual entity, or third-party aggregator) or aggregator (utility vs third-party)?

T.2.5 Alternatively, given when mobile grid storage (e.g., electric vehicles) are likely to be connected, what is the value of grid services at that time? How predictable is this trend? How likely are mobile grid storage owners willing to participate? Consider how the response may differ depending on the ownership or aggregator type.

T.2.6 How do mobile grid battery storage use cases affect battery life? Is there enough publicly available data to inform market decisions? If not, what would be useful?

T.2.7 How would participation in the provision of grid services affect battery warranties provided by vehicle manufacturers and suppliers? For example, (a) the auto maker and (b) the battery suppliers to the auto makers, or (c) other participants in the vehicle supply chain

T.2.7.1 Could impact to battery warranty be mitigated by adjusting discharge rates?

T.2.8 Will advancements in battery technologies reduce risk to battery life?

T.2.9 Assume batteries or vehicles are owned by a company, which are leased to the consumer. (Context: for electric vehicles, fuel cost is ~7% of overall vehicle cost per mile) (Lab, 2019). That leaves only a marginal incentive for owners to provide grid services. Company ownership may provide greater incentives for grid participation. Alternatively, companies could provide active management to extend battery life.)

T.2.9.1 At what price level would companies be willing to sacrifice battery life for grid services?

T.2.9.2 How might companies track the state of health of batteries leased to consumers?

T.2.9.3 Do OEMs see the provision of grid services as an appealing new revenue opportunity for electric vehicles? How do they think about this use case?

T.2.9.4 Are there other incentives companies could provide consumers, such as a fixed or variable monthly usage payment for grid services? Are these incentives likely to shift consumer behavior?

T.2.10 Under what conditions should or could mobile energy storage be used for locational energy arbitrage?

T.2.10.1 How do investors in charging infrastructure anticipate locational needs and pricing? How does the response differ at the generation, transmission, and distribution levels?

T.2.10.2 How might plans for locational pricing for resilience affect the prospects for bidirectional vehicles?

T.2.11 Should and/or could mobile energy storage be used for locational energy arbitrage at the building level? For example, to offset demand charges? Are there existing or planned examples?

T.2.12 Should and/or could mobile energy resources be used for responding to emergencies and for restarting the grid? Are there existing or planned examples?

T.2.12.1 Would such infrequent events justify the needed capital investment? Consider both frequency and potential impact in the response.

T.2.12.2 Are vehicle owners likely to comply to grid operator requests in an emergency? Could they be compelled to comply?

T.2.12.3 Could fleet operators be deployed under such circumstances? What technologies and infrastructure are needed to enable this? For example, artificial intelligence, digitization of substations?

T.2.13 Should and/or could mobile energy resources be used for responding to emergencies by providing back-up storage to critical facilities or buildings? Are there existing or planned examples?

T.2.13.1 Would such infrequent events justify the needed capital investment?

T.2.13.2 Are vehicle owners likely to comply in an emergency?

T.2.13.3 Could fleet operators be deployed under such circumstances? What technologies and infrastructure are needed to enable this? For example, artificial intelligence, mobile software?

T.2.14 Could fleet users of mobile grid storage such as bidirectional electric vehicles to maximize revenue by shifting from delivery of people and goods to grid services?

T.2.14.1 What types of fleet would have such scheduling flexibility?

T.2.14.2 What price is needed to persuade fleets to shift to grid services?

T.2.14.3 Are there times of the day when fleet operators would most likely shift? What grid services are needed at those times? Who are the most likely consumers, the grid, C&I, buildings, etc.?

T.2.15 What is the possibility that battery leasing or buy-back programs for mobile electric storage such as electric vehicles, degraded, but useable, batteries could be re-used for grid services?

T.2.15.1 What monitoring and modeling are needed for leasing companies to optimize the time of battery replacement? How do pricing structures affect those decisions? Are there any initial signs of an emerging secondary market for depleted batteries?

T.2.15.2 What could a "certified pre-owned" battery program look like to certify the state of health for batteries?

T.2.15.3 Would the ease and value of battery recycling be impacted?

T.2.15.4 What else is needed to enable this kind of business model?

T.2.16 What is the likelihood that business owners (including manufacturers) could pay employees to draw power from their electric vehicles to reduce demand charges?

T.2.16.1 How can employees be assured of having take-home power?

T.2.17 What evidence is there that bidirectional electric vehicle consumers are willing to consider different ownership models? If not currently available, what data and analysis could help understand this dynamic? What would it take for consumers to accept the levels of risk associated with different ownership models?

T.2.18 How willing are auto and battery makers to pursue new technologies and use cases? How might technology, policy, standardization or regulation mitigate those risks?

T.2.19 What public policies or regulation could encourage innovative uses for batteries? (For example, can consumers of electricity also be producers? Can utilities own generation? Is mobile energy storage classified as "generation"?) Would mobile storage compensation be dynamic?

T.2.20 How do concerns regarding safety affect innovative use of mobile storage technologies? Would performance and safety data for mobile storage alleviate these concerns? How much and what data would be necessary for mobile storage and related fast charging infrastructure? Will advancements in electric vehicle battery technology impact safety?

T.2.21 What are some novel strategies, tools, or resources that the federal government or others could implement or provide to facilitate the market for innovative uses of mobile storage?

T.3 Finance Questions

Background/Context

Finance questions are meant to illicit ideas that will enable bankability and attract investment in stationary and mobile storage as described in the previous sections. If appropriate, consider whether there is a benefit to capital market access and how this would affect the overall cost of capital to support the various use cases and business models proposed for stationary and mobile storage technologies. Also, consider how the responses may differ for various ownership models (including third-party aggregators), market segments (e.g. utility, C&I, residential or individual), and regions. As mentioned, we encourage respondents to answer all questions, however, partial responses are also welcomed.

Information Requested

The following questions may guide, but should not restrict, responses:

T.3.1 Are there useful publicly available business and finance models for storage, similar to what is available for solar? For example, to provide first-order approximation of the amount of revenue required by a non-residential stationary storage system under a variety of financing or ownership structures, sufficient for a comparative analysis.

T.3.2 What are the most commonly used finance models for taxable site hosts available thus far? Please note if any options are missing.

T.3.2.1 **Balance Sheet:** The site host finances the project on its balance sheet

T.3.2.2 **Operating Lease:** The site host finances the project through an operating lease

T.3.2.3 **Power Purchase Agreement (PPA) :** The site host enters into a PPA, which in turn is financed by a partnership

T.3.3 What are the most common used finance models for tax-exempt site hosts? Please note if any options are missing or if other options should be explored.

T.3.3.1 **Balance Sheet:** The site host finances the project on its balance sheet

T.3.3.2 **Municipal Bonds:** The site host finances the project using municipal debt, or with reserve funds that have an opportunity cost of capital approximated by municipal debt interest rates

T.3.3.3 **CREBs:** The site host finances the project using CREBs

T.3.3.4 **Tax-Exempt Lease:** The site host finances the project using a tax-exempt lease

T.3.3.5 **Service Contract (Partnership):** The site host enters into a service contract/PPA, which in turn is financed by a partnership.

T.3.3.6 **Pre-Paid Service Contract:** The site host enters into a pre-paid service contract.

T.3.4 What are common drivers for storage adoption?

T.3.4.1 Emergency backup or resilience?

T.3.4.2 Energy arbitrage?

T.3.4.3 To reduce costs (e.g. demand charges)?

T.3.4.4 Meeting state Renewable Portfolio Standard (e.g. Resource Adequacy like in California)?

T.3.4.5 Other?

T.3.5 What premium are customers willing to pay for storage and do they vary by customer type?

T.3.5.1 If so, how?

T.3.5.2 Does the risk premium change whether it is stationary or mobile storage (e.g. an electric vehicle, assuming it is UL certified and enabled for bidirectional use)?

T.3.6 Would standardization of utility scale stationary storage be useful? How should they be standardized? Similar to solar PPA's?

T.3.7 Would standardization of contracts for aggregated mobile storage be useful? How should they be standardized? Are there comparable models to use as a starting point?

T.3.8 What kinds of technology standards would be most helpful for stationary storage? Would any of these standards differ based on interconnection at the transmission level vs at the distribution level?

T.3.9 What kinds of technology standards would be most helpful to make mobile storage bankable?

T.3.10 What kinds of technology standards would be most helpful to make aggregated mobile storage bankable?

T.3.11 Are there good examples of interconnection standards that could be used for stationary storage?

T.3.12 What are reasonable interconnection standards that could be used for aggregated mobile storage?

T.3.12.1 Should this be done at the EV charging station level to provide grid services?

T.3.12.2 Would that standards differ if the connection is at the building or facility level to off-set demand charges?

T.3.13 What are the various risk premiums that apply to stationary storage that could be reduced through contract standardization and data sharing?

T.3.14 Is there enough data and/or performance information to help inform investors and better ascertain investment risk for stationary storage? If not, what data is needed and who could provide it?

T.3.15 What data and/or performance information would be helpful to investors to determine investment risk for aggregated mobile storage? If not, what data is needed and who could provide it?

T.3.15.1 Would grid operators be willing to pay to third parties to aggregate the data?

T.3.15.2 Would the data be proprietary?

T.3.16 Are there scenarios or models that would lower the cost of capital for different types of storage projects, such as securitization? For example, what would work for large utility scale stationary storage vs aggregated mobile storage? What benefits would these approaches provide?

T.3.16.1 Will storage change capital investment trends in the energy sector?

T.3.17 What ownership structures for aggregated mobile storage would be conducive to securitization? For example, would a third-party aggregator need to own the batteries in electric vehicles to reduce risk premiums?

T.4 Open

Background/Context

OTT recognizes that there may be other ideas, concepts, or tools other than those discussed in this RFI that may be useful to helping improve bankability and commercialize stationary and mobile storage technologies. This category serves as an open call for suggestions on how to capture market input to inform the OTT and the DOE on the market needs and help advance the overarching Administration's goals.

Information Requested

The following questions may guide, but should not restrict, responses:

T.4.1 What are the greatest concerns with investing in the storage technology space? What sort of information/assistance would provide greater comfort with this investment area?

T.4.2 In general, how can the federal government most effectively help to catalyze further storage investment and market development beyond R&D? In particular, how can DOE most effectively advance the following goals:

T.4.2.1 Unlock new sources of capital and foster more effective investment models to scale storage technology and related technology companies;

T.4.2.2 Facilitate demand creation and/or match-making between early-stage companies and potential investors and customers;

T.4.2.3 Support the development of innovative new business models;

T.4.2.4 Facilitate coordination between OEMs, utilities, and other key stakeholders such as state DOTs or other potential government customers/partners;

T.4.2.5 Encourage more storage and related technology investment focused on U.S.-based companies with high potential for domestic economic benefit; and

T.4.2.6 Leverage existing programs (e.g., SBIR, Opportunity Zones, New Market Tax Credits, Loan Guarantees) to be of best use to the storage investment community.

T.4.3 Is there any other information, other approaches, or other data that would be useful to investors, developers, customers, utilities, and OEMs to further business models and financing of storage?

T.4.4 Are there any other tools that would be useful to investors, customers or key stakeholders that were not discussed above?

T.4.5 What are the greatest challenges when it comes to investing in stationary or mobile storage?

T.4.6 Are there international models that the U.S. should review and consider?

T.4.7 Is there a need for international standardization?

T.4.8 Are there regulatory or permitting barriers?

Section 4 Policy and Valuation

Background/Context

Energy Storage can invigorate the U.S. economy as both an end-use product and a source of industrial competitiveness. Cost-effective energy storage can increase system and end-user resilience against a variety of threats, improve the operation and value of existing grid assets, reduce the cost of integrating new assets, catalyze new innovation and commercialization, create a new domestic manufacturing sector, and decrease the overall cost of energy for consumers. However, these impacts can only be realized if storage is appropriately valued, so that energy storage benefit the grid and end-users across the U.S. energy system. The ESGC's Policy and Valuation track will develop a coordinated, DOE-wide program to provide stakeholders with the information and tools to appropriately analyze and value energy storage. DOE will not promote or encourage specific policy objectives.

Information Requested

The following questions may guide, but should not restrict, responses:

P.1 Energy Storage Cost, Performance, and Financing

P.1.1 What current or future, stationary or transportation-related, energy storage cost, performance, and/or financing data would improve the decision-making processes, and why?

P.1.2 What is the most effective way for DOE to provide stakeholders data? For example, a centralized database updated annually, reports that provide additional analysis of the data, etc. How should data be validated?

P.1.3 How should DOE integrate private OEM and developer/owner data with modeled cost, performance, and financing data? What types of data need to come from the real world? How should data be anonymized and protected to encourage OEM and developer/owner participation?

P.2 Valuation Methodology

P.2.1 Do current valuation methodologies used by planners, regulators, grid operators, end-users, and policy makers accurately account for energy storage? If not, what other cost and value factors should be included in the methodologies, and why? How or do these valuation methodologies vary by region and market, and why?

P.2.2 How should the grid value long-duration (multi-day to seasonal) storage technologies relative to shorter-duration storage? What methodologies are needed to value long-duration storage, and what types of DOE/national lab data, tools, analysis would be useful for stakeholders?

P.3 Planning Tools and Processes

P.3.1 What tools/models are used today for near-term/ operational planning (e.g. power flow, system stability, optimal dispatch/production cost, system sizing and siting) and long-term planning and scenario analysis (e.g. capacity and transmission expansion), in both macro- and micro- grid applications? Which are better? Do these existing tools offer the proper level of temporal and spatial granularity and/or accurately represent the cost and performance of all storage technologies? What improvements could be made?

P.3.2 How can DOE help enhance the tools and capabilities in the hands of stakeholders? E.g., should DOE build new open-source tools and offer trainings/ support, should DOE work with vendors to improve existing tools, or should DOE provide some other type of support?

P.3.3 What methodologies, data, tools, and analysis would be needed to integrate power system, distribution, and transportation planning? What technology and system interactions are important to include when conducting integrated planning? How can DOE provide support to help stakeholders better integrate their planning processes?

P.3.4 Can demand-side resources be synergistically paired with energy storage technologies? Are they currently being properly evaluated together in planning processes? What new information would enable higher-levels of integration of demand- and supply-side flexibility options in planning processes?

P.3.5 What are critical future scenarios, assumptions, and technology-tradeoffs DOE/the national labs need to analyze?

P.4 Resilience

P.4.1 How have stakeholders started to value resilience related investments? How do stakeholders measure an individual investment's contribution to system resilience?

P.4.2 How can stationary or transportation-related energy storage systems improve system-level or end-user resilience?

P.4.3 Is there a certain level of resilience against a certain group or probability of threats that stakeholders should plan for?

P.4.4 Does the United States need specific resilience standards that use standardized metrics? Would these vary by sector? What entities should lead that effort? Should DOE lead this effort, and if so, what entities should it collaborate with?

P.4.5 What types of data, tools, and analysis can DOE provide to support stakeholders' resilience decision making?

P.5 Transportation and Cross-Sectoral Issues

P.5.1 Transportation assets (electric and fuel cell vehicles) may be able to provide storage or other flexibility services to the grid. What new information, models, and/ or analysis would enable this? For example, vehicle performance/degradation given duty cycle, charging/refueling cycles, infrastructure performance, optimal rate structures, consumer behavior, etc.

P.5.2 Current EV manufacturer warranty standards prohibit the use of EV batteries for grid applications. Is there a role for DOE to play in facilitating the development of standards that will allow for limited vehicle-to-grid applications?

P.5.3 Should DOE analyze manufacturing polices for stationary storage or transportation technologies that encourage domestic production, secure supply chains, and market growth? If so, what policies should be analyzed, and what types of information should DOE provide to stakeholders?

P.5.4 Are there specific gaps in existing transportation-related storage data, tools, and analysis that DOE can help fill?

P.5.5 Have stakeholders started to incorporate cross-sectoral storage feedbacks into their planning processes? E.g., electric vehicle deployment with increased electricity demand/variable load profiles, or hydrogen being supplied for both long-duration grid services and as a fuel for transportation/industry? What types of data, tools, and analysis can help stakeholders incorporate cross-sectoral storage interactions into their planning processes?

P.5.6 End-use consumers may invest in storage that provides grid services or provide flexibility through load control. What new information, models, and/ or analysis would enable this? What types of data, tools, and analysis can help stakeholders incorporate these interactions into their planning processes?

P.6 Policy, Regulatory, and Market Considerations

P.6.1 Are there specific federal, state, or local policies that could be enacted to help the U.S. become a leader in energy storage, and why? Please consider policies that might support storage deployment, and also policies to support supply-chain development. How should these policies be prioritized? How can DOE best inform policy development?

P.6.2 Are there near-, medium-, and long-term changes that competitive wholesale markets or electric utilities need to make to better enable storage to participate and/or be accurately compensated? How should these changes be prioritized? What types of data, tools, and analysis can DOE provide to assist stakeholders?

P.6.3 Energy storage is increasingly being coupled with generation technologies to create hybrid systems. What technical and/or market barriers do hybrid technologies face? What types of data, tools, and analysis can DOE provide to support the inclusion of hybrid systems in competitive markets and vertically integrated utilities?

P.6.4 Grid operations are generally divided into three functions: generation, transmission, and distribution. Storage can provide services within any one of these functions, but does not neatly fit into the definition of any one of them. Should storage be a different asset class? If so, why?

P.6.5 Energy storage assets have generally been deployed as bolt-on additions to the grid to provide energy, capacity, and ancillary services. Some have argued that the true value of energy storage would be in acting as a buffer to decouple supply and demand on the grid, and that storage should therefore be viewed as an embedded grid asset similar to a substation or a transformer. Should storage be an embedded grid asset with shared costs? If so, why? What types of policies or standards would be needed to facilitate that treatment?

P.7 P&V Stakeholder Engagement

P.7.1 Reoccurring engagement with stakeholders is crucial for identifying and prioritizing key energy storage data, tools, and analysis needs related to policy and valuation issues. What is the best method for ensuring systematic engagement and preventing redundancy with existing or new DOE technical assistance programs? E.g., would annual DOE-sponsored workshops be helpful?

Section 5 Workforce Development

Background/Context

In order to maintain global leadership in energy storage, the United States will need to develop and maintain a well-qualified workforce in the right areas in a timely manner at all levels of education.

Innovate Here: In order to maintain global leadership in storage R&D, DOE's ongoing efforts will be leveraged to grow the pipeline of candidates qualified to lead the field in research. This includes supporting innovative research at universities and national laboratories, along with building and operating world-class user facilities, all of which help train the workforce of the future.

Build Here: As illustrated by the diversity of the use cases, there is a wide range of potential technology requirements spanning from small to large systems; factory built to bespoke, site-built installations; and chemically to thermally based storage. For the United States to lead in these technologies, there will be a need from trades (machinists, welders, designers), to engineers (mechanical, chemical, electrical), to research scientists (materials science, chemistry).

Deploy Everywhere: In order to build, use and maintain energy storage systems as an integrated part of our country's energy systems, there will need to be a workforce that can understand how these pieces fit together and can be optimized for the particular application. This will require not just technicians, operators and engineers but analysts who can model and optimize these systems.

Leadership in storage requires a skilled, nimble, and innovative workforce. The ESGC can impact the development of the workforce through a spread of activities such as skills development and enhanced employment opportunities. Similarly, the development of a workforce with the appropriate skill set can allow industries such as battery manufacturers, chemical producers and utilities to increase national leadership in these areas.

The industry and workforce must develop hand in hand. As the industry grows, there will be more opportunities for a skilled workforce across a wide range of skill sets. These will include trade professionals, chemical engineers, mechanical engineers and scientists from a host of disciplines. The ESGC will enable the development of an appropriate workforce of the future through programs across DOE targeted at the spread of workforce development needs.

Based on the concepts mentioned above, DOE seeks additional information from stakeholders across the spectrum to better understand areas in which there exists a current sufficient workforce, where there are gaps in skills or education, and thoughts on what activities DOE could help with that stakeholders would find useful for their needs as they seek to expand.

Information Requested

The following questions may guide, but should not restrict, responses:

W.1 Current Needs

- W.1.1 Where are there gaps in the skills and education of the workforce for existing and short-term technologies (development, manufacture and deployment)?
- W.1.2 Are there workforce issues in the industry as a lack of broad-based skill sets or narrower gaps in specific areas?

W.2 Future Developments

- W.2.1 As the industry grows to meet the needs spelled out in the ESGC, what are anticipated growth needs where the workforce pool is lacking?

W.3 Education and Workforce Programs

- W.3.1 What current education and workforce development activities are worth noting? How effective are each of them?

W.3.2 What programs might be effective to support education and workforce development for energy storage and for which constituencies?

W.3.3 How much investment has been made in education and workforce development by the company? By the individual? Has it been enough?

W.3.4 Are there specific workforce development programs in energy storage that do not exist and should be developed?