Updated: 29 July 2020


# Section 3: Technology Transitions Track

*This section is an excerpt of a larger Energy Storage Grand Challenge (ESGC) document, available on the ESGC website.*

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**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.

*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.*

***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?*