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Hanging in the Balance: American Leadership in Global Crises

Texas A&M University

Policy Proposal

Guarding the Grid:
Fostering America's Energy Independence

TO: The Honorable Jennifer M. Granholm, United States Secretary of Energy

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SPONSORING ORGANIZATION: United States Department of Energy

SUBJECT: Ensuring Storage Solutions to Booster Grid Resiliency and Sustainability

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Introduction

In the 2022 National Security Strategy, President Biden said, "The future of America's success in the world depends upon our strength and resilience at home."[1] The Bipartisan Infrastructure Law and Inflation Reduction Act both recognize the need for American energy to become cleaner and modernized while maintaining a competitive and commercial advantage.

The U.S. economy, prosperity, and security is predicated on a stable and dependable electric grid. Millions of Americans have experienced frequent blackouts from inadequate grid resiliency. Destabilizing climate trends and escalating geopolitical instability continue to threaten the grid and require comprehensive solutions across the energy continuum (i.e., production, storage, and distribution). The key to strengthening American energy independence lies in the substantial investment in new storage solutions for carbon-neutral energy.

Background

When disaster strikes, energy storage technologies provide grid operational support through frequency regulation, contingency reserves, voltage support, and back-start capabilities. Investing in the research and commercialization of storage solutions addresses challenges to international supply chains by diversifying technology and resource imports. Such investments also address the inadequate capacity of both state and regional grids to store their energy, as evidenced by differences across states in grid-connected energy storage projects. (See Figure 1)[2] To bolster grid resiliency, it is crucial to highlight emerging storage technologies and implement commercial and legislative infrastructure to support them.

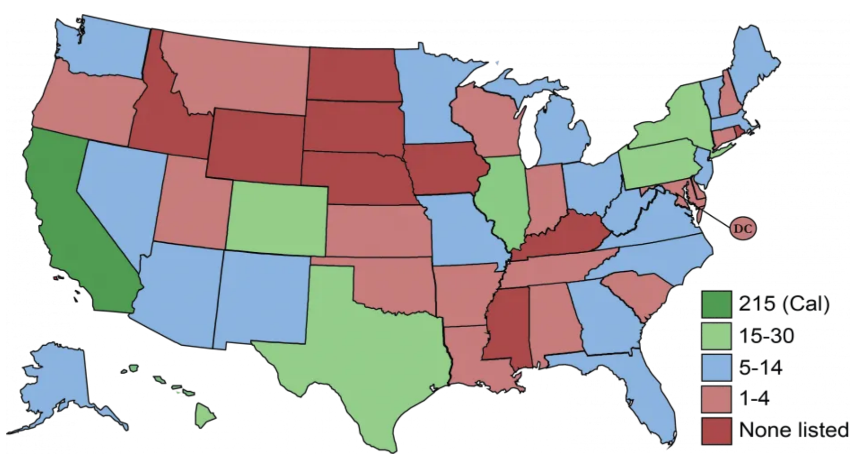

Figure 1. *Number of grid-connected energy storage projects by state* (Source: University of Michigan)

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[1] "National Security Strategy," (White House, Washington D.C, October 12th, 2022), pg. 14, https://www.whitehouse.gov/wp-content/uploads/2022/11/8-November-Combined-PDF-for-Upload.pdf.

[2] "U.S. Energy Storage Factsheet." Center for Sustainable Systems. University of Michigan. 2021. Pub. No. CSS15-17. https://css.umich.edu/publications/factsheets/energy/us-grid-energy-storage-factsheet.

Infrastructure
The need for energy storage arises as we transition to post-coal solutions to effectively store excess energy generated during peak production times for use during emergencies. The United States does not have enough storage capacity, with projections falling short of planned capacity for 2025.[3] (Figure 2) Currently, most states do not have sufficient Electrical Energy Storage projects connected to their grids, with over half having fewer than four active projects.[4] There is an asymmetry between the future demand for energy storage compared to the planned infrastructure and capacity. Decarbonizing American energy production will require a significant investment in storage infrastructure.

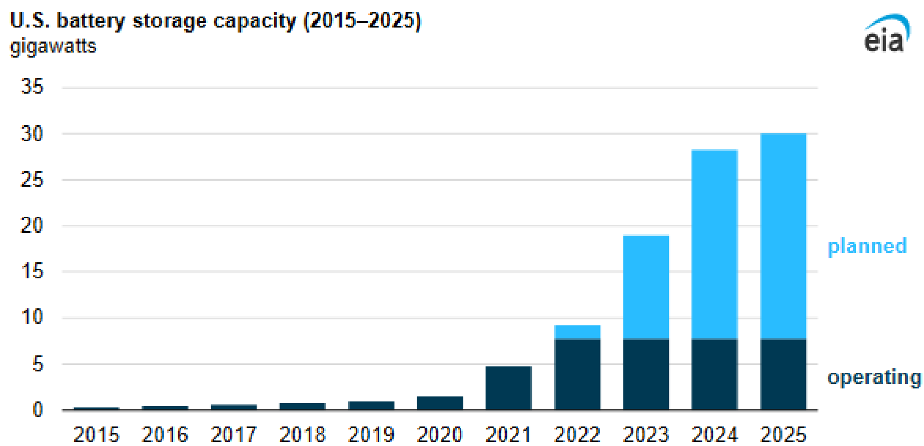

Figure 2. *Total U.S. battery storage capacity, 2021-25* (Source: Energy Information Administration)

Policy and Commercial Environment
The key legislation governing American energy security is the Energy Independence and Security Act of 2007. Concerning new technologies, the Bayh-Dole Act of 1980 regulates the commercialization of research, allowing private beneficiaries of federally-funded research to retain ownership of their inventions. Regarding more recent legislation, the IRA has allocated five billion dollars to the Energy Infrastructure Reinvestment (EIR) program. The Department of Energy (DOE) has several departments on commercialization, such as the Office of Technology Transitions (OTT).

Energy storage technology is heavily linked with international supply chains, such as using DRC-imported cobalt in lithium-ion batteries. The DOE has invested $27 million in researching alternatives to lithium-ion batteries. DOE labs have begun researching new storage technologies such as compressed air energy systems (CAES) and supercapacitors; however, the

[3] "US Battery Storage Capacity will increase significantly by 2025," US Energy Information Administration, accessed February 10th, 2023, https://www.eia.gov/todayinenergy/detail.php?id=54939#:~:text=As%20of%20October%202022%2C%207.8,the%20end%20of%20the%20year.

[4] "U.S. Energy Storage Factsheet." University of Michigan. 2021.

commercialization of these technologies is currently limited yet carries the potential to diversify current energy supply chains.

Current & Emerging Technologies

With a lifetime of 30 years, an efficiency rate of 85%, and minimal environmental impact, CAES is a proven technology supporting grid resiliency. Salt mines, caverns, empty natural gas reserves, and aquifers provide CAES opportunities. While CAES technology is relatively slow in withdrawing its stored power capacity, it has among the highest power ratings when compared to batteries and hydro storage. McIntosh, Alabama's CAES plant, produces 110 MW. Combined with supercapacitors, this could transform discarded areas into energy pools to support resilience in the grid.

Furthermore, implementing natural energy storage methods into urban environments can be accomplished with pumped-hydro energy storage, utilizing raised reservoirs (similar to water towers for plumbing), and, in an emergency, can be drained and converted to usable power via hydroelectric turbines. With CAES technology, 10 m^3 of compressed air powers one home for over 24 hours. Salt mines and caverns across the US can be repurposed for energy storage and attack deficit in America.

<u>Problem Analysis</u>

Studies showcase the need for greater energy reserves to counteract future emergencies, as evidenced by the Texas Winter Storm of 2021 and the 2015 Ukraine cyberattack. Without innovative and resilient storage solutions, the U.S. is unprepared to combat grid failures and vulnerabilities.

Cyber Weaknesses

The U.S. energy generation and transmission architecture "is becoming more vulnerable to cyberattacks via (1) industrial control systems, (2) consumer IoT devices connected to the grid's distribution network, and (3) the global positioning system (GPS)."[5] Figure 3 below demonstrates the proliferation of cybersecurity threats against critical industrial control systems (ICS) infrastructure. The Office of the Director of National Intelligence estimates that "China has the ability to disrupt a natural gas pipeline for days to weeks (which could disrupt grid operations), and Russia can disrupt an electrical distribution network for at least a few hours." Figure 3 below illustrates the proliferation of cybersecurity vulnerabilities in critical infrastructure.

[5] Government Accountability Office. *Critical Infrastructure Protection: Actions Needed to Address Significant Cybersecurity Risks Facing the Electric Grid.* February 2019. https://www.gao.gov/assets/gao-19-332.pdf.

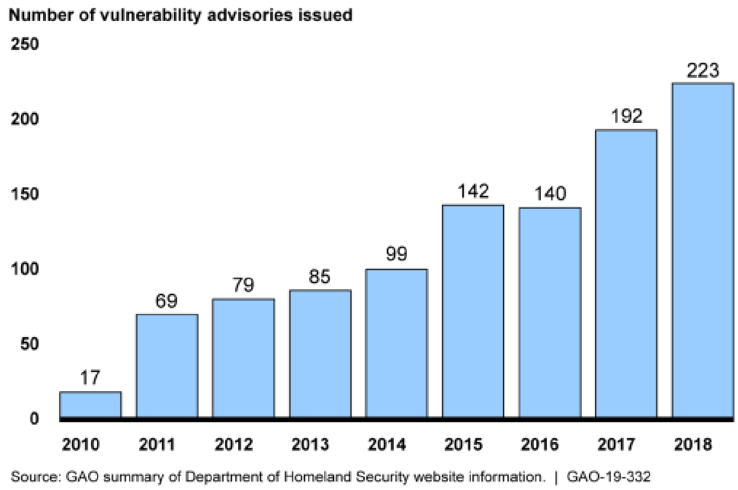

Figure 3. *Detected ICS vulnerability proliferation* (Source: Government Accountability Office).

Natural Weaknesses

The national energy grid is vulnerable to natural disasters. Energy reserves become the crutch to lean on during times of crisis. Lack of electricity due to extended blackouts has cost the U.S. billions of dollars and human lives. In some cases, it has taken years for power to be generated in-state again, and these impacts are felt by both critical and non-critical infrastructure alike. The grid is vulnerable, but the potential of storage technologies and implementation by relevant departments and agencies, like the DOE, can make a resilient and redundant power grid.

<u>Recommendation</u>

We recommend that the DOE expand the commercialization of storage technologies, utilizing funds from the EIR provision of the IRA. Specifically, we recommend creating a Storage Commercialization Network (SCoNe) under the OTT and an integrated plan that collaborates with several existing initiatives and programs in the DOE. Here are the points the plan ought to address:

1. How to prioritize promising technologies from the Energy Storage Demonstration and Pilot Grant Program[6], currently budgeted at $355 million, for market access.
2. How to encourage the adoption of these technologies among state and regional grids.
3. How to make these storage technologies affordable for all Americans and connect with programs such as the Energy Storage for Social Equity (ES4SE) Initiative.

In essence, SCoNE would be a new point in the DoE's development continuum, bridging research and commerce for storage technologies (Figure 4).

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[6] "Energy Storage Demonstration and Pilot Grant Program," Department of Energy, Accessed February 11th, 2023, https://www.energy.gov/oced/energy-storage-demonstration-and-pilot-grant-program.

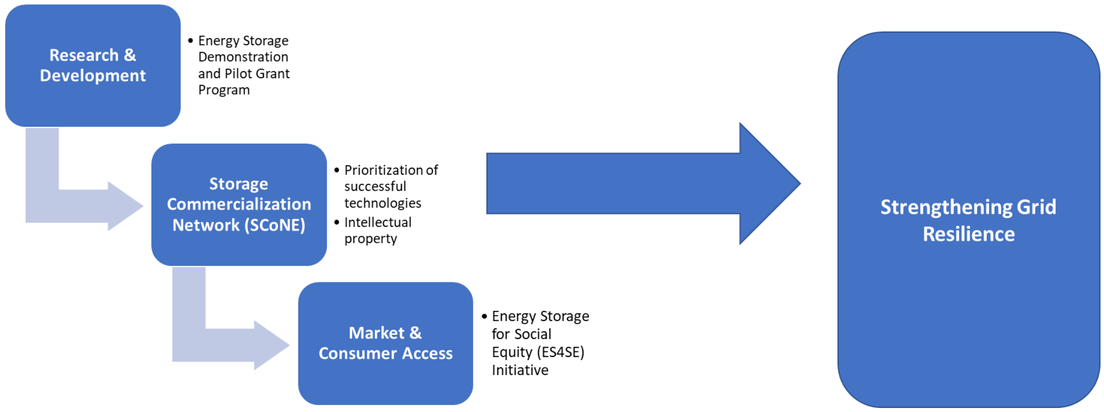

Figure 4. *Proposed new development continuum for storage technologies*

Mandating stratified internal networks without remote access capabilities, separating ICS and business systems, onshoring ICS manufacturing operations, and regulating cybersecurity standards industrywide would supplement grid resilience. In conjunction with hardened cybersecurity standards across storage infrastructure, the above framework would optimize the widespread adoption of safe and secure storage technologies. Examples of systems and technologies that SCoNE may prioritize include, among others, integrating CAES with supercapacitors.[7]

Conclusion

To meet the current administration's goal to transition to renewable energy by 2050, the United States must take strides in enhancing energy storage methods and resources by 2025 to bridge the gap. Fusing storage and enhanced cybersecurity protections into DOE and U.S. policy is critical as the nation strives to ensure grid resilience and combat the climate crisis. Creating and integrating SCoNe with existing commercialization and research/development initiatives is necessary to secure access to continued and dependable energy.

[7] "Compressed Air Storage (CAES)." UN Climate Technology Center & Network. Accessed February 10th, 2023. https://www.ctc-n.org/technologies/compressed-air-energy-storage-caes.

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