Testimony before the

Hearing of the House Committee on Science, Space and Technology

Innovation in Battery Storage for Renewable Energy

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Chairman Smith, Ranking Member Johnson, and other Members of the Committee, thank you for this opportunity to share my perspectives on the opportunity for energy storage and the role of Federal energy leadership in today's energy industry.

I am the Chief Executive Officer, President and Board Member of Ambri Inc., an early-stage company commercializing a new type of energy storage technology – the Liquid Metal Battery (LMB) – invented at the Massachusetts Institute of Technology (MIT). I have worked in the energy industry for 39 years as a business manager, entrepreneur, and public servant. I started my career as an exploration geologist for Chevron; I was a management consultant for 20 years and led Mercer Management Consulting's Global Utilities practice (now known as Oliver Wyman); I was a founding Board Member and Senior Vice President at EnerNOC; and I was Undersecretary of Energy and Commissioner of the Department of Energy Resources for the Commonwealth of Massachusetts. I have also served the U.S. Department of Energy (DOE) as a Board Member for the State Energy Advisory Board for five years and as a committee member of the Energy Efficiency and Renewable Energy Advisory Committee (ERAC); I am a leadership group member for the U.S. Environmental Protection Agency (EPA) and the U.S. DOE's National Action Plan for Energy Efficiency.

I have a deep appreciation for the very many challenges the electricity industry faces and the role of public policy in energy, and I am encouraged about the potential for energy storage to be a transformative solution for many of the industry's challenges.

Energy storage promises to fundamentally transform the way our electricity system works by decoupling the supply and demand of electricity and enabling a more efficient, more reliable and less expensive system with significant quantities of renewable resources.

Today, electricity supply needs to meet electricity demand every instant of every day, everywhere. To do this, our electric system is built to meet peak demand plus a reserve margin. In many systems, 10 percent or more of the generating capacity and corresponding infrastructure is built to meet demand levels that occur in less than one

percent of the hours in the year.[1] In the U.S., 50 percent of simple cycle combustion turbines have capacity factors below 2 percent, meaning that those plants are operating less than 2 percent of the hours of the year.[2]

With energy storage, rather than building infrastructure to meet peak demand, we can accommodate fluctuations in demand with storage and as a result build our generation, transmission, and distribution infrastructure to meet our average demand. For instance our average electricity demand in the U.S., is approximately 60% less than our peak generating capacity.[3]

Energy storage promises a variety of benefits; there are many reports that have been published that enumerate the grid services energy storage provides.[4] These include, for example:

- Time shifting energy from one period to another; for example from a period when there is ample renewable output to a period when the sun isn't shining or the wind isn't blowing; or from a period when prices are low to a period when prices are high on a wholesale power market;
- Providing ancillary services like frequency regulation (to moderate the moderate second-to-second fluctuations in grid frequency and voltage to enhance reliability), ramping capability (to mitigate the impacts of intermittent renewable generation output on the grid) and voltage support;
- Reducing end user electricity costs by mitigating peak demand and optimizing time of use tariffs;
- Providing capacity to offset the need for traditional generation infrastructure;
- Reducing transmission and distribution (T&D) congestion to offset or defer the need for traditional T&D infrastructure; and
- Increasing reliability by enabling the electric grid stability to become much less critically dependent on distant generation and transmission system.

Ambri's story is one of a successful public-private partnership to date. Our experience and the challenges that remain are indicative of a set of policy considerations and recommendations we have for this Committee:

1. *Sustain and increase support for the DOE's Advanced Research Projects Agency for Energy (ARPA-E);*

2. *Increase support of DOE and Department of Defense (DoD) technology demonstration initiatives;*

[1] See, for example, ISO New England load data for 2014, where over 11 percent of capacity was required to supply the top one percent of hours; available at http://www.iso-ne.com/markets/hstdata/znl_info/hourly/smd_hourly.xls.
[2] U.S. Environmental Protection Agency Office of Air and Radiation, Capacity Factors for New Units, July 2010, p. 4; available at http://www.epa.gov/airtransport/pdfs/TSD_capacity_factors_analysis_for_new_units_7-6-10.pdf.
[3] See, U.S. annual electric power sales and peak demand data from the U.S. Energy Information Administration, available at http://www.eia.gov/electricity/annual/html/epa_01_02.html .
[4] See, for example, the "DOE/EPRI 2013 Electricity Storage Handbook" published by Sandia National Labs in July 2013; available at http://www.sandia.gov/ess/publications/SAND2013-5131.pdf.

3. *Support DOE and Federal Energy Regulatory Commission (FERC) efforts to research and implement with the states supporting policies that enable energy storage to receive the full value for the services it provides;*

4. *Expand DOE's Loan Program Office's (LPO) Loan Guarantee Program to support energy storage projects and energy storage manufacturing by amending the authorizing legislation for the Renewable Energy and Energy Efficiency Loan Guarantee Program to mirror the Advanced Vehicle Manufacturing program;*

5. *Consider a declining, time-limited federal investment tax credit for energy storage to accelerate private sector investment in this nascent electricity technology; and*

6. *Support H.R. 1696 – Master Limited Partnerships Parity Act to expand Master Limited Partnership (MLP) designation to companies in the clean-tech industry.*

I'll address each one of these points in turn.

1) Sustained and increased support for ARPA-E

The DOE's ARPA-E program was pivotal for the development of the LMB technology; ARPA-E enabled significant basic science research on the LMB and the achievement of key milestones which were critical to forming the company Ambri Inc. and receiving funding from top-tier equity investors.

In 2006, Professor Donald Sadoway and his graduate student Dr. David Bradwell at MIT demonstrated the theoretical capability of the LMB in a paper study exploring the underlying electrochemical theory of the technology. This preliminary research was funded by a small grant from a private foundation. In 2009, Professor Sadoway received a $7 million grant from ARPA-E alongside cost-share from the Massachusetts Clean Energy Center. Importantly, this federal and state government funding catalyzed even more private sector funding for the on-campus research. Professor Sadoway was able to attract over $13 million in aggregate and grow his lab to more than 20 researchers. This team made substantial progress in understanding the basic science elements of the LMB technology and demonstrating its potential.

In 2010, Drs. Sadoway and Bradwell co-founded Ambri with initial investment from Bill Gates and Total. Ambri has raised over $50 million in equity financing in three rounds of investment, grown its workforce to 50 full-time employees, and expanded its footprint into two locations in Massachusetts, one for research and development in Cambridge and one for systems testing and manufacturing development in Marlborough. In addition to Bill Gates and Total, other investors include Khosla Ventures, KLP Enterprises (the family office of Karen Priztker and Michael Vlock) and Building Insurance Bern (GVB).

ARPA-E focuses on a critical stage in the development of high-potential energy technology and fills a funding gap between basic and applied research, where the theory has been demonstrated but is far from practical use. For the LMB, the ARPA-E grant came at a critical time in the development of the technology; there are other case

studies where this is similarly the case. Without ARPA-E, it is likely that the LMB would not have attracted the necessary research capital to demonstrate its potential. Commercial funding sources or other public funding are simply not available for promising albeit speculative energy technologies. It is worthwhile and critical to invest in promising new technologies, and the U.S. government has and should continue to play a key role as a catalyst.

2) Increased support of DOE and DoD technology demonstration initiatives

The U.S. government – and in particular the U.S. DoD as the largest energy consumer in the world – can and should continue to play a key role in demonstrating the capabilities of new energy technologies. It is a completely appropriate and important role for Federal leadership to include new energy solutions in the mix of their energy choices. It is risky to simply rely entirely on conventional energy solutions; by funding demonstration projects of new technologies, the government will gain access to new solutions and develop insights about these solutions which can propel technology adoption.

For Ambri, successful early-stage deployments funded by state and Federal grants will validate the performance characteristics of our product and enable the company to achieve important operational milestones, de-risking the technology for market entry.

Today, with funding from Federal and local governments, Ambri is preparing to deploy products to customers across the country, with a range of customer segments including the military, electric utilities and renewable resource developers. These projects will be at the following locations:

- Joint Base Cape Cod in Massachusetts with funds from the Massachusetts Clean Energy Center;
- Naval Submarine Base (SUBASE) in New London, Connecticut with funding provided by the U.S. Navy;
- Con Edison, an electric distribution utility in New York City with funding provided by the New York State Energy Research and Development Authority;
- Multiple partners in Hawaii including SunEdison and the Joint Base Pearl Harbor Hickam with funding from the Energy Excelerator, a contractor for the Office of Naval Research, and the Navy's Expeditionary Warfare Center;
- University of Alaska in Fairbanks with funding from the Alaska Energy Authority.

3) Support for DOE and FERC efforts to research and implement policies that fully value energy storage

Energy storage provides value across many elements of the entire electricity value chain – generation, transmission, distribution and behind-the-meter. However, in many markets, the benefits of energy storage are not easily recognized or compensated. Clear regulatory policies will be important to fully and quickly realize the potential for storage to address electric industry challenges. Congress should encourage efforts at the DOE's Office of Electricity and the FERC to fully value storage, to provide guidance on removing regulatory hurdles for energy storage, and to work with the states to

provide support and perspectives on helpful state regulations and policies for energy storage.

4) Expand the purview of the DOE's Loan Guarantee Program to support domestic manufacturing of energy storage technologies

The DOE's Loan Guarantee Program has delivered on its mandate of facilitating the adoption of new energy technologies which are not yet appropriate for available conventional commercial financing. We applaud the Loan Program Office (LPO) for its successes, including catalyzing the growth of large-scale photovoltaic projects in the United States, and supporting the development of domestic advanced technology vehicle manufacturing at Ford and Nissan.[5] To date, the Loan Program has been a net positive for the U.S. Government, accumulating $780 million in losses while earning $810 million from interest payments.[6]

A modestly revised Loan Guarantee Program would accelerate the adoption of energy storage technology and storage manufacturing jobs in U.S.

a) *Reduce the barriers to applying for a loan guarantee to enable developers of smaller-scale projects to take advantage of the program.* Today, there exist significant barriers to entry to the program, including high application fees; facility and maintenance fees; [7] substantial costs for legal, consulting and engineering services; and a lengthy application and review process. The DOE website says, "the application, due diligence, negotiation, and approval processes are time and capital-intensive."[8] For an early-stage technology company like Ambri, even after we have executed several successful demonstration projects as described above, conventional project financiers' risk tolerance will inhibit adoption of storage. Cost effective support from the Loan Guarantee Program could be a very helpful tool to finance Ambri's first commercial projects as well as bring advanced storage manufacturing jobs to the US.

b) *Support U.S. energy storage manufacturing by expanding the language of Section 1703 of Title XVII of the Energy Policy Act of 2005 to mirror the flexibility of Section 136 of the Energy Independence and Security Act of 2007.* Today, the existing Loan Guarantee Programs for renewable energy and energy efficiency technologies

[5] See article published by The Pew Charitable Trusts. "In 2009, no solar PV facilities larger than 20 megawatts were operating in the United States because developers could not secure the funding necessary to build them. To address this market barrier, the office provided $4.6 billion in loan guarantees to support the first five PV arrays larger than 100 MW. Since the end of the program in September 2011, 17 more large-scale installations have been financed without guarantees, and industry officials expect another 5 gigawatts of utility-scale PV to be built in 2015 alone." Available at http://www.pewtrusts.org/en/about/news-room/news/2015/04/21/federal-investment-is-key-to-growth-of-clean-energy-industry?hd&utm_campaign=2015-04-27%20CEBN&utm_medium=email&utm_source=Eloqua.

[6] See DOE Loan Program website; available at http://www.energy.gov/articles/energy-department-s-loan-portfolio-continues-strong-performance-while-deploying-innovation

[7] The Phase 1 application fee is $50,000; the Phase 2 application fee is $100,000 or $350,000 depending on the size of the loan guarantee requested. The facility fee is 1% of the loan guarantee amount up to $150,000,000 and 0.6% thereafter. The maintenance fee is expected to be up to $500,000 per year. See, http://energy.gov/sites/prod/files/2014/07/f17/Renewable%20Energy%20and%20Efficient%20Energy%20Projects%20Solicitation%20FINAL.pdf.

[8] See DOE Loan Program Office Website; available at http://energy.gov/lpo/renewable-energy-efficient-energy-projects-solicitation-faq.

authorized by Section 1703 of Title XVII of the Energy Policy Act of 2005 do not support advanced manufacturing initiatives. However, the Advanced Technology Vehicles Manufacturing (ATVM) Loan Program authorized under Section 136 of the Energy Independence and Security Act of 2007 does support manufacturing initiatives.

5) Federal tax credits for energy storage

I firmly believe that the energy storage industry will not need subsidies or mandates to grow and thrive. However, an investment tax credit (ITC) for storage declining to zero over a prescribed period of years will accelerate storage development in U.S., encourage domestic companies to continue to run their businesses locally, and pull foreign companies to the U.S. for business resulting in more domestic jobs in manufacturing, engineering, and construction. Other countries such as Japan, Korea and Germany, acknowledging the industry's potential growth, have established significant subsidy programs for energy storage.[9] With a limited-time-horizon ITC, the United States will replace these countries as the world leader for energy storage and reap benefits long after the proposed ITC has expired.

6) *Support H.R. 1696 – Master Limited Partnerships Parity Act to expand MLP designation to companies in the clean-tech industry.*

MLPs enable corporations to avoid double taxation. That is, rather than being taxed once at the corporate level and once at the equity-holder level, and MLP will only be taxed at the equity-holder level. Today, MLP status is granted only to corporations involved in fossil fuel deployment, and this tax structure has attracted significant and relatively low-cost capital to the sector. Congress can pass H.R. 1696 enabling MLP status for corporations in the clean-tech sector to accelerate significant investment in a sector that is helping create a lower-cost and lower emissions energy future.

Thank you for taking the time to explore these issues, and I look forward to taking your questions.

[9] For example, in Japan, in January 2015, the Ministry of Economy, Trade and Industry introduced a $780 million program targeting energy storage and energy efficiency. South Korea in 2011 announced that it would invest US$5.94 billion by 2020 in developing the energy storage industry. Germany in May 2013 launched €25 million storage system incentive on new and retrofitted systems whereby up to 30 percent of equipment installation costs is subsidized, capped a 30 kW.