Progress toward a Resilient, Green Energy Future: Energy Storage to Energy Systems Approaches for Decarbonization

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Background/Objectives. There is an urgent national interest to develop a more resilient, lower carbon electric grid. However, there are multifaceted challenges to utilities, energy providers, and energy users today. Alternative energy efficiency and heating approaches, and integration of renewables and energy storage including vehicle to grid concepts, all provide significant opportunity yet add significant complexity for design of a new green energy future.

There are both energy storage and energy systems scale needs to progress towards a cleaner, greener electric grid. Faster charging electric vehicle batteries are needed to motivate transition away from fossil fuels and increase penetration of electric vehicles. New chemistry and materials science solutions are needed for large scale energy conversion and storage, with greater consideration for environmental abundance and safety considerations. At the energy systems level, there is great opportunity to integrate solar energy and wind energy, thus introducing a need for improved forecasting capability at the needed timescale and resolution to serve energy providers. This includes forecasting of both routine and extreme weather events, and consideration of disparate consumer and community energy use cases.

Approach/Activities. A multifaceted interdisciplinary science effort is underway to address these challenges at Brookhaven National Laboratory (BNL) and Stony Brook University (SBU). Experimental and modeling solutions are advancing understanding as well as developing new science and technology solutions for energy storage and energy systems. These activities are guided by the needs of diverse stakeholders, ranging from individual customers to utility providers emphasizing Northeast regional challenges.
New energy storage technologies relevant to both transportation and the electric grid are under active investigation. This includes a scalable, manufacturable approach for safer fast charging vehicle batteries and new chemistry and materials science solutions for safe large scale batteries. Engineering to reduce fossil fuels use from residential to commercial building applications is under investigation, with approaches ranging from renewable fuels to geothermal heating. Aspects of this work are supported by Brookhaven National Laboratory, the New York State Energy Research and Development Authority (NYSERDA), and the U.S. Department of Energy (DOE), including the Office of Science, Buildings Technology Office, Geothermal Technology Office, the Vehicle Technology Office, Office of Technology Transfer, and Office of Electricity.

At the energy systems level, a data-driven dynamic, granular and multi-day power outage forecasting tool is under development, leveraging BNL expertise in atmospheric science, power

grid engineering, machine learning applications and probabilistic risk assessment. This work builds on the models, algorithms, and tool developed by the BNL team under a NYSERDA funded project, jointly performed with Orange and Rockland Utilities and Central Hudson Gas and Electric, that developed a tool for nowcasting of weather-related damage to the power grid.

Results/Lessons Learned.
Examples of specific technology advances in these areas will be highlighted in this presentation. The science approaches used to gain the desired function will be described, along with illustration of the functional behavior under relevant use cases.