**Oral Testimony of**

**Daniel Scherson**

**Subcommittee on Energy**

**Committee on Science, Space, and Technology**

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Chairman Weber, Ranking Member Grayson, and Members of the Subcommittee, thank you for the opportunity to testify in today’s hearing on Innovation in Solar Fuels, Electricity Storage, and Advanced Materials

My name is Daniel Scherson, and I am the Frank Hovorka Professor of Chemistry and Director of the Ernest B. Yeager Center for Electrochemical Sciences at Case Western Reserve University in Cleveland, OH, and as of a few days ago President of The Electrochemical Society.

Electrochemistry, a two centuries old discipline, has reemerged in recent years as key to achieve sustainability and improve human welfare. The scientific and technological domain of electrochemistry is very wide, extending from the corrosive effects of the weather on the safety and integrity of our bridges and roads, to the management of diabetes and Parkinson disease, and to the fabrication of three-dimensional circuitry of ever smaller and more complex architecture. In addition, electrochemistry is becoming central to the way in which we generate, store, and manage electricity derived from such intermittent energy sources as the sun and wind.

Among the most ubiquitous electrochemical devices ever invented are batteries. Mostly hidden from sight, batteries convert chemical into electrical energy used to power cell phones and portable electronics, which are critical to the way we communicate and store information, as well as electrical vehicles expected to mitigate the dangers posed by the release of green-house gases into the atmosphere. I have been asked to focus my testimony this morning on aspects of electrochemistry that relate to energy storage, which are expected to greatly impact, not only the transportation sector, but also, the management and optimization of the electrical grid, which combined account for two thirds of all energy used in the United States. Scientific and technological advancements in these areas will bring about a reduction in operating costs, spur economic growth and create new jobs, and promote US innovation in the global marketplace.

The advent of ever more powerful computers and advanced theoretical methods, have made it possible to predict with increased accuracy the behavior not only of materials, but also of interfaces. The latter play a key role in the chemical industry where there is strong pressure to develop effective catalysts to increase yields and lower energy demands. This is also true in the area of electrocatalysis, which is critical to the optimization of electrolyzers and fuel cells, yet another class of electrochemical energy conversion devices.

In the area of transportation, any new developments aimed at augmenting reliability, safety and comfort, must be made without compromising performance. Today, batteries for electric cars cannot match already established standards for range per tank of gasoline powered vehicles. In simple terms, the energy a battery can store depends on the charge capacity and its voltage. Whereas the energy is dictated by thermodynamics, the power batteries can deliver is given by the current times the voltage. To illustrate, lithium ion batteries rely on only a single electron per atom of electrode material to store energy and deliver power. One obvious solution to increase the energy is to double or, better yet, triple the number of electrons per atom of storage material without decreasing its voltage. Although the viability of such a concept has been demonstrated for the case of magnesium, a divalent metal, using a purely empirical approach, its performance is still below that required for meeting the demands of the largest markets. Theoretical work at the Joint Center for Electrochemical Storage Research, JCESR, DOE’s energy hub led by Argonne National Laboratory, has unveiled new, yet to be synthesized materials that display promising characteristics. Results have shown that the primary bottleneck resides in the mobility of divalent magnesium ion within the host cathode lattice, which is greatly enhanced in materials where the ion sits in energetically unfavorable sites as compared to sites along the path of migration. Such design rules have been validated in the laboratory for known materials and arrangements have been made with partner laboratories to synthesize the new promising materials. Equally important is the search of new organic electrolytes exhibiting large voltage windows of stability, including ionic solvation.

From an overall perspective, the problems that remain to be resolved toward achieving sustainability demand a fundamental understanding of the basic processes underlying energy conversion and energy storage at a microscopic level and the development of spectroscopic and structural probes with highly spatial and temporal resolution to monitor individual atomic and molecular events. Such knowledge can only come from new generations of scientists trained at our colleges, Universities and National laboratories, which will require increased research support from the Government.