ZINC/AIR – A LOW-COST, LONG-LIFE AND, SAFE BATTERY TECHNOLOGY

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ABSTRACT

Zinc (Zn)/Air batteries are inherently low-cost and energy-dense. The air electrode enables oxygen in ambient air to be used as the oxidizing cathode reactant that does not need to be carried on board – saving materials cost and volume. Eos Energy Storage will present its research and developments in Zn/ir battery architecture, electrolyte, catalyst, and materials that the company believes resolves Zn/Air's historic recharge limitation. With long life (potential up to 10,000 cycles/30 years at full depth of discharge) and with 6 hours storage, Eos believes that its Zn/Air technology could become one of the lowest-cost-per-kilowatt hour (kWh) battery technologies.

Our presentation will demonstrate the longest cycle life we believe has been achieved on a metal air battery to date (> 1,600 one-hour cycles thus far with no physical degradation) and the reasons why this technology could cost a fraction of the cost per kilowatt hour (kWh) of lithium (Li)-ion batteries, and also why it has the potential to become one of the safest and most energy-dense battery systems.

Technical issues addressed in our research include a system that does not utilize a membrane or separator and thus avoids what is an expensive and nondurable component. We have developed a neutral electrolyte that is not susceptible to dendrite formation and does not absorb CO_2 or carbonates, thus preserving the life of the air electrode. Our electrolyte additives result in minimal corrosion of zinc (Zn). We have developed an electrolyte management system that avoids pressure and rupture when electrolyte density changes with state of charge. Our neutral electrolyte is nontoxic and nonflammable. Safety has been one of our key areas of focus.

We have utilized only non-noble materials as catalyst and electrodes. For our metal current collectors, we developed a proprietary treatment to coat the surface to a stable and conductive material to ensure that neither corrosion nor oxidation reduces electrode conductivity over time. Eos has also implemented an architecture that makes our Zn/Air system amenable for mass production with low capital investment by utilizing common manufacturing methods including printing of air electrodes, injecting molding, and metal stamping of the remaining components.

With our materials, electrolyte, architecture, and manufacturing methods, and assuming reasonable performance assumptions, our detailed bill of materials shows a cost projection well below our projected market price of $160 per kWh even in the initial stages of production. Given the early stage of development of this technology, we believe that we could lower costs further and improve current density potentially by a large factor to bring costs to an even lower level. Our materials, architecture, and systems also give our Zn/Air system a potentially long life. Our electrolyte is safe, stable, and benign. We believe that this combination of innovations could lead to a battery system that could be transformative for utility and vehicle applications.

BIOGRAPHICAL NOTE

Conference presenter: Michael Oster, CEO of Eos Energy Storage (formerly Grid Storage Technologies). Mr. Oster co-founded Eos in 2007 to develop and commercialize a utility-scale Zinc/Air battery system, which is a low-cost, energy-dense and safe battery technology with 6+ hours of storage. Mr. Oster previously was one of the larger developers of solar power assets in the northeastern United States together with a major European utility. Mr. Oster began his career in strategy and business planning for IBM and later joined the international management consulting firm of A. T. Kearney. In the last decade, Mr. Oster formed and capitalized an early-stage venture capital firm in New York City. He was one of

the original partners to launch the global energy technology firm Oilspace/Aspect Enterprise, where he populated the board and investor group with OPEC oil ministers, U.S. cabinet members, and other energy industry leaders. Earlier, Mr. Oster moved to Russia as privatization started, built a real estate investment and development company, and later established the first institutional real estate investment fund in Russia with the AT&T pension fund and Nomura Bank. Mr. Oster received his MBA in finance from New York University his B.A. in economics from Brandeis University.