U.S. Department of Energy
Categorical Exclusion Determination Form

Program or Field Office: Advanced Research Projects Agency - Energy (ARPA-E)

Project Title: 25A1089 - Electroville: High-Amperage Energy Storage Device-Energy Storage for the Neighborhood

Location: Massachusetts

Proposed Action or Project Description: American Recovery and Reinvestment Act: ☒

The question to be answered can be quite simply posed: is a liquid-metal battery technically feasible at the size scale of a neighborhood, i.e., 1-MWh? Inspired by the Hall- Héroult cell used in the production of aluminum, the PI three years ago invented a new concept in electrochemical energy storage: reversible ambipolar electrolysis, i.e., electrolytic production of metal at both the cathode and the anode! This established the scientific basis for an all-liquid battery consisting of three layers . Large-scale storage of electrical energy is a huge problem in an array of fields from load leveling of power grids to providing uninterruptible backup power for manufacturing facilities and hospitals. Furthermore, large-scale energy storage is a crucial technology to enable the use of renewables as a means of reliably meeting the electricity needs of our military forces by providing a large scale (MWh on a small footprint), rapid recharge (MWrate over a period of hours) charge-storage capability. While there have been striking improvements in batteries in recent decades, there is no technology capable of meeting the demanding performance requirements of this demanding application. These include service lifetime spanning many years and thousands of cycles at deep depth of discharge (>80%), very high current rates, and very low cost (<$50 kWh). Other attempts to develop large-scale energy storage

Categorical Exclusion(s) Applied:

X - B3.6 Siting/construction/operation/decommissioning of facilities for bench-scale research, conventional laboratory operations, small-scale research and development and pilot projects

*-For the complete DOE National Environmental Policy Act regulations regarding categorical exclusions, see Subpart D of 10 CFR10 21 Click Here

This action would not: threaten a violation of applicable statutory, regulatory, or permit requirements for environment, safety, and health, including DOE and/or Executive Orders; require siting, construction, or major expansion of waste storage, disposal, recovery, or treatment facilities, but may include such categorically excluded facilities; disturb hazardous substances, pollutants, contaminants, or CERCLA-excluded petroleum and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases; or adversely affect environmentally sensitive resources (including but not limited to those listed in paragraph B.(4)) of Appendix B to Subpart D of 10 CFR 1021). Furthermore, there are no extraordinary circumstances related to this action that may affect the significance of the environmental effects of the action; this action is not "connected" to other actions with potentially significant impacts, is not related to other proposed actions with cumulatively significant impacts, and is not precluded by 40 CFR 1506.1 or 10 CFR 1021.211.

Based on my review of information conveyed to me and in my possession (or attached) concerning the proposed action, as NEPA Compliance Officer (as authorized under DOE Order 451.1B), I have determined that the proposed action fits within the specified class(es) of action, the other regulatory requirements set forth above are met, and the proposed action is hereby categorically excluded from further NEPA review.

NEPA Compliance Officer: /s/ William J. Bierbower Digitally signed by William J. Bierbower DN: cn=William J. Bierbower, o, ou, email=william.bierbower@hq.doe.gov, c=US Date: 2010.01.15 12:04:52 -05'00' Date Determined: 01/15/2010

Comments: Webmaster:

have taken the approach of redesigning an existing battery so as to endow it with greater current carrying capability. In contrast, the PI has taken the approach of starting with a device that intrinsically has giant current carrying capability and modifying it so as to endow it with the ability to store charge. Specifically, the idea is to convert a metal-producing, industrial-scale electrolysis cell into a battery. For example, the Hall-Héroult cell, which is used for the production of aluminum, consumes huge quantities of electricity at very high amperage (300,000 A at ~4 V), i.e., this operates as a colossal current sink. However, the Hall-Héroult cell cannot be run in reverse so as to act as a colossal current source. Thus, the goal here is to design a self-contained variant of such a cell so that the products of electrolysis remain available to react and recombine, thereby generating electric current on demand. Metal producing cells cannot do the latter because the by-product at the anode is always a gas, which is vented and therefore unavailable for the reverse reaction. What is novel in the present invention is that the products of the electrochemical reactions on the cathode as well as on the anode are liquid metals with densities rank ordered so as to form three immiscible layers in the self assembling sequence, anode product / electrolyte / cathode product. The three liquids are thus properly configured to act as a high-amperage current source (battery) when the anode product and cathode product are put in electrical contact across a load in a circuit external to the cell. The technology is at the stage of cycle-testing laboratory-scale cells of volumetric capacity ~100 mL. The design, construction, testing, and long-term operation of a largerscale embodiment of the technology is proposed. The deliverables will be the design parameters as well as a working prototype that can store and deliver energy on the order of 5-kWh. The device will use cheap and domestically abundant materials and is expected to attain unprecedented current density and lifespan at an acceptably low cost. We call this project “Electroville.”