U.S. Department of Energy
Categorical Exclusion Determination Form

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

Project Title: 25A5311 - Quaternary Phosphonium Based Hydroxide Exchange Membranes

Location: California

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

By switching fuel cell electrochemical reactions from an acidic medium to a basic one and utilizing highly conductive hydroxide exchange membranes, the high-performance hydroxide exchange membrane fuel cells (HEMFCs) are a truly innovative technology and radically different from the proton exchange membrane fuel cells (PEMFCs) that have been intensively researched and developed in the past two decades. The most exciting ability of HEMFCs is to solve fundamentally the PEMFCs' serious problems of catalysts cost and durability, while achieving PEMFCs' high power and energy density simultaneously. What has been critically missing for HEMFCs is a polymeric hydroxide exchange membrane (HEM) with high hydroxide conductivity and stability. With the totally revolutionarily design of hydroxide conducting functional group (QPPOH), the quaternary phosphonium (QP)-based ionomers/membranes are drastically different from the typical and prevalent quaternary ammonium (QA)-based ones that have been extensively developed and used for more than half a century. Unlike the QA-based polymers, by having the critically needed electron-donating and bulky tertiary phosphine (TTMPP), the novel QP-based ionomers/membranes have unique properties including highest hydroxide-conductivity, highest alkaline stability, and excellent solubility in desired solvents among all HEMs, all QA-based, published today. When incorporated into membrane electrode assemblies (MEAs), the QP-based HEMFCs also have the best performance

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: 2009.12.15 12:05:40 -05'00' Date Determined: 12/15/2009

Comments: Webmaster:

based, published today. When incorporated into membrane electrode assemblies (MEAs), the QP-based HEMFCs also have the best performance among all HEMFCs, all QA-based, reported up to today. The technical objective of the ARPA-E project is to develop and master a series of technologies to prepare/produce the commercialization-ready high-performance QP-based HEMs that have high hydroxide conductivity, outstanding alkaline-stability, suitable dimension-stability, and high HEMFC performance. The QP-based HEMs will be used to prepare high-performance precious-metal-free HEMFCs, which will be dramatically cheaper than, but still have the potential to rival in terms of power outputs with almost-fully-developed Nafion based PEMFCs using the very expensive and unsustainable Pt-based-catalysts. Also electrolyzers will be considered. The project plans to take advantage of the exciting preliminary data already obtained and objective and comprehensive analysis, and then to conduct the three main research phases: modification of polymers (including polymer matrix selection, chemical modification, and production), preparation of membranes (including quaternary-phosphorization, crosslinking, and membrane preparation), and evaluation of performance (including non-precious catalysts incorporation, favorable electrodes design/incorporation, and HEMFC performance evaluation) by means of the intensive investigation and development for 36 months. The project will help the US maintain unquestionably the technological lead in developing and deploying advanced energy technologies. Also, the proposed technology can be used in altering petroleum to typical hydrogen for transportation and directly as a form of electricity generation during off-peak hours of wind/solar based electricity generation. If successful, our technology will save at least 163 million barrels of gasoline consumption and eliminate about 60 million metric tons of CO2 emission every year.