U.S. Department of Energy
Categorical Exclusion Determination Form

Submit by E-mail

Proposed Action Title: University of Delaware - Durability Investigation for Quarternary Phosphonium Based Polymer Hydroxide Exchange Membranes/Quaternary Phosphonium Based Hydroxide Exchange Membranes for Efficient and Durable Electrolyzers

Program or Field Office: Advanced Research Projects Agency - Energy

Location(s) (City/County/State): Newark, DE

Proposed Action Description:

Funding will support two efforts: (1) durability testing and analysis of battery cells outfitted with the University of Delaware's novel phosphonium based polymer hydroxide exchange membrane, and (2) creation of a batch of phosphonium based polymer hydroxide exchange membranes for use in another ARPA-E project. Activities related to the creation of the membranes under this award are analyzed in this determination. NEPA analysis for the project to which the membranes are being provided, DE-AR0000121, is conducted in that project's NEPA Determination.

Proposed work for the first effort of this project will consist of (1) fabrication of small fuel cells containing the University of Delaware's novel exchange membrane, and (2) durability testing of those fuel cells to analyze the degradation mechanism of the exchange membrane.

Proposed work for the second effort will include (1) scaling-up of the hydroxide exchange membranes for use in another ARPA-E project, and (2) preparation of hydroxide exchange membranes of varying sizes and thicknesses for that project.

Categorical Exclusion(s) Applied:

B3.6 - Small-scale research and development, laboratory operations, and pilot projects

For the complete DOE National Environmental Policy Act regulations regarding categorical exclusions, including the full text of each categorical exclusion, see Subpart D of 10 CFR Part 1021.

Regulatory Requirements in 10 CFR 1021.410(b): (See full text in regulation)

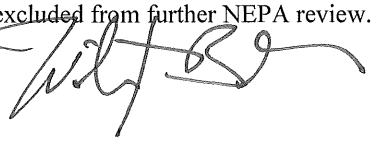
☑ The proposal fits within a class of actions that is listed in Appendix A or B to 10 CFR Part 1021, Subpart D.

To fit within the classes of actions listed in 10 CFR Part 1021, Subpart D, Appendix B, a proposal must be one that would not: (1) threaten a violation of applicable statutory, regulatory, or permit requirements for environment, safety, and health, or similar requirements of DOE or Executive Orders; (2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment facilities (including incinerators), but the proposal may include categorically excluded waste storage, disposal, recovery, or treatment actions or facilities; (3) disturb hazardous substances, pollutants, contaminants, or CERCLA-excluded petroleum and natural gas products that preexist in the environment such that there would be uncontrolled or unpermitted releases; (4) have the potential to cause significant impacts on environmentally sensitive resources, including, but not limited to, those listed in paragraph B(4) of 10 CFR Part 1021, Subpart D, Appendix B; (5) involve genetically engineered organisms, synthetic biology, governmentally designated noxious weeds, or invasive species, unless the proposed activity would be contained or confined in a manner designed and operated to prevent unauthorized release into the environment and conducted in accordance with applicable requirements, such as those listed in paragraph B(5) of 10 CFR Part 1021, Subpart D, Appendix B.

☑ There are no extraordinary circumstances related to the proposal that may affect the significance of the environmental effects of the proposal.

☑ The proposal has not been segmented to meet the definition of a categorical exclusion. This proposal is not connected to other actions with potentially significant impacts (40 CFR 1508.25(a)(1)), is not related to other actions with individually insignificant but cumulatively significant impacts (40 CFR 1508.27(b)(7)), and is not precluded by 40 CFR 1506.1 or 10 CFR 1021.211 concerning limitations on actions during preparation of an environmental impact statement.

Based on my review of 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: 

Date Determined: 09/18/2012

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.