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(1.08.09.13)

U.S. DEPARTMENT OF ENERGY
OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY
NEPA DETERMINATION

RECIPIENT: Colorado School of Mines **STATE:** CO

PROJECT TITLE : High-Temperature Thermochemical Storage with Redox-Stable Perovskites of Concentrating Solar Power

Funding Opportunity Announcement Number	Procurement Instrument Number	NEPA Control Number	CID Number
DE-FOA-0000805	DE-EE0006537	GFO-0006537-001	

Based on my review of the information concerning the proposed action, as NEPA Compliance Officer (authorized under DOE Order 451.1A), I have made the following determination:

CX, EA, EIS APPENDIX AND NUMBER:
Description:

A9 Information gathering, analysis, and dissemination	Information gathering (including, but not limited to, literature surveys, inventories, site visits, and audits), data analysis (including, but not limited to, computer modeling), document preparation (including, but not limited to, conceptual design, feasibility studies, and analytical energy supply and demand studies), and information dissemination (including, but not limited to, document publication and distribution, and classroom training and informational programs), but not including site characterization or environmental monitoring. (See also B3.1 of appendix B to this subpart.)
B3.6 Small-scale research and development, laboratory operations, and pilot projects	Siting, construction, modification, operation, and decommissioning of facilities for smallscale research and development projects; conventional laboratory operations (such as preparation of chemical standards and sample analysis); and small-scale pilot projects (generally less than 2 years) frequently conducted to verify a concept before demonstration actions, provided that construction or modification would be within or contiguous to a previously disturbed or developed area (where active utilities and currently used roads are readily accessible). Not included in this category are demonstration actions, meaning actions that are undertaken at a scale to show whether a technology would be viable on a larger scale and suitable for commercial deployment.
B3.15 Small-scale indoor research and development projects using nanoscale materials	Siting, construction, modification, operation, and decommissioning of facilities for indoor small-scale research and development projects and small-scale pilot projects using nanoscale materials in accordance with applicable requirements (such as engineering, worker safety, procedural, and administrative regulations) necessary to ensure the containment of any hazardous materials. Construction and modification activities would be within or contiguous to a previously disturbed or developed area (where active utilities and currently used roads are readily accessible).

Rationale for determination:

The U.S. Department of Energy (DOE) is proposing to provide federal funding to the Colorado School of Mines to research, enhance and evaluate particle-based receiver and solar system process designs. DOE funding would be used to assemble and test a sub-scale particle receiver reactor device and a re-oxidation reactor to validate models and provide a basis for commercialization including a complete economic evaluation of such process modeling and engineering design.

The project is divided into two Budget Periods: 1 and 2. This NEPA determination applies to Budget Period 1 activities only. A Go/No Go decision will be made between Budget Periods 1 and 2. At that time, the recipient will be required to submit an application for Budget Period 2 activities, including further NEPA documentation.

During Budget Period 1, perovskites from less expensive, abundant elements with high specific thermochemical energy storage would be identified and characterized during tasks 1.1-1.6.

- Task 1.1: Identification and thermodynamic characterization would be performed to evaluate the combined sensible and chemical specific energy stored (TCES) of preferred perovskite.
- Task 1.2: Reduction and oxidation kinetics measurements would be assessed through accelerated redox cycling in a rapid heating IR furnace of preferred perovskite.
- Task 1.3: Demonstration of particle durability of novel perovskite materials in terms of phase stability, sintering resistance, and low attrition would be demonstrated in both a rapid-heating infrared imaging furnace and in a standard dilatometer.
- Task 1.4: Development and testing of TCES subsystem models of the TCES subsystem would be developed to serve as flexible tools to provide a basis for establishing process design and evaluating system performance.
- Task 1.5: CFD model development and simulation of the reactive particle receiver design would be modeled that promotes high efficiency radiative heat adsorption for effective reduction and energy storage of the perovskite.
- Task 1.6: Preliminary techno-economic analysis of TCES subsystem would be integrated into a full plant design and

translated into estimated costs.

Work would be completed at the following laboratories:

- Energy Storage and Conversion Laboratory, Colorado School of Mines, 1500 Illinois St, Golden, Colorado 80401
- Colorado Center for Advanced Ceramics, Colorado School of Mines, 1500 Illinois St, Golden, Colorado 80401
- High Flux Solar Facility (HFSF), National Renewable Energy Lab, 15013 Denver W Pkwy, Golden, Colorado 80401
- Thermal Systems Laboratory (TSL), National Renewable Energy Laboratory, 15013 Denver W Pkwy, Golden, Colorado 80401
- Particulate Solid Research, Inc., 4201 West 36th Street Suite 200, Chicago, Illinois 60632

No modifications would occur to existing buildings other than some electrical work to supply power to the infrared imaging furnace for redox-cycle stability and kinetics tests. One particle receiver reactor and one re-oxidation reactor would be fabricated at the High Flux Solar Furnace at NREL. The particle receiver reactor would be approximately 20 centimeters wide by 20 centimeters high. The reoxidation reactor would be a particle collector with a controlled, heated oxygen-rich flow into it and 2 liters in volume. A larger storage bin of 150-200 liters would be maintained for collecting the reoxidized particles. Upon completion of this project, the Colorado School of Mines would continue to use the prototype particle receiver and re-oxidation reactor during future projects and no equipment would be decommissioned.

The Colorado School of Mines has completed an R&D questionnaire addressing the protocols for laboratory safety, risk management, chemical handling and waste disposal. All hazardous materials would be managed in accordance with federal, state, and local environmental regulations and the proposed activities that would involve these materials would pose no risk to the public. The project also involves the use of nanoscale particles and should not pose any risks to human health or the environment. The University complies with standard safety procedures and no new permits, licenses, or authorizations would be required for this proposed project.

All work completed at DOE National Laboratories (NREL) may be subject to additional NEPA review by the appropriate DOE NEPA Compliance Officer.

Based on review of the project information and the above analysis, DOE has determined the research and development under Budget Period 1 (all tasks) would not have a significant individual or cumulative impact to human health and/or environment. DOE has determined the proposed project is consistent with actions contained in DOE categorical exclusion A9 "information gathering, analysis and dissemination," B3.6 "small-scale research and development, laboratory operations, and pilot projects," B3.15 "small-scale indoor research and development projects using nanoscale materials" and is categorically excluded from further NEPA review.

NEPA PROVISION

DOE has made a conditional NEPA determination for this award, and funding for certain tasks under this award is contingent upon the final NEPA determination.

Insert the following language in the award:

You are restricted from taking any action using federal funds, which would have an adverse affect on the environment or limit the choice of reasonable alternatives prior to DOE/NNSA providing either a NEPA clearance or a final NEPA decision regarding the project.

Prohibited actions include:
Budget Period 2 Activities.
This restriction does not preclude you from:
Budget Period 1 Activities.
If you move forward with activities that are not authorized for federal funding by the DOE Contracting Officer in advance of the final NEPA decision, you are doing so at risk of not receiving federal funding and such costs may not be recognized as allowable cost share.

Note to Specialist :

May Mock 03/12/2014
This NEPA determination requires a tailored NEPA review.

SIGNATURE OF THIS MEMORANDUM CONSTITUTES A RECORD OF THIS DECISION.

NEPA Compliance Officer Signature: _____ Date: 3/13/2014
NEPA Compliance Officer