U.S. Department of Energy
Categorical Exclusion Determination Form

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

Project Title: 25A2876 - Upgrading Refinery Off-gas to High-Octane Alkylate

Location: *- Multiple States - New Jersey, Pennsylvania, Oklahoma

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

Oil refining is the most efficient industry at converting a chemical feedstock, oil, into finished products. Less waste is produced per ton of product in refining than in petrochemicals, fine chemicals, or pharmaceuticals. This high level of efficiency is absolutely necessary given the enormous volumes of material processed. Because of the scale of refining in the US, small percentage inefficiencies equate to massive real losses of potential fuel and unnecessarily emitted greenhouse gases. In the US, one such source of loss is the olefin content of refinery off-gas, or ROG. ROG is the waste generated from fluid catalytic cracking and other similar operations. It consists of light paraffins and olefins, particularly ethane and ethylene. For refineries outside the petrochemical hub along the US Gulf Coast, few markets for light olefins like ethylene and propylene are accessible, and separating the olefin is difficult and expensive, so this valuable material must be burned in the refinery. This ARPA-E project seeks to develop a step-out technology to increase refinery efficiency, reduce CO2 emissions, and produce more gasoline from each barrel of oil by converting the olefinic portion of ROG into alkylate, a clean-burning, high-octane component of gasoline. The technology will develop a novel solid catalyst capable of promoting isoparaffin alkylation using dilute ethylene, the primary olefin contained in ROG. The process will be designed to use ROG directly, without the need to conduct energy-intensive separations of the olefins first.

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: 2009.11.20 11:30:01 -05'00' Date Determined: 11/20/2009

Comments: Webmaster:

The process will be designed to use ROG directly, without the need to conduct energy-intensive separations of the olefins first.

This technology represents a transformational step forward in refining technology. No current alkylation technology is capable of operating using ROG as the olefin source. The ability to alkylate ROG would allow approximately 42 wt% of the ROG stream to be converted into an additional 46 million barrels per year of gasoline. The result is an equal quantity of carbon emissions eliminated from the refinery, a reduction in the carbon intensity of oil refining, and an improved yield of motor fuel from each barrel of oil. By raising the yield of motor fuel per barrel, fuel cost to the consumer is reduced and the refiner's profitability is increased. The project is divided into three technology development phases. First, the catalyst and reactor will be designed and optimized to achieve the desired level of activity and product quality. The novel solid acid catalyst will be engineered on multiple levels to enable it to effectively utilize dilute ethylene and other lower olefins. Mathematical modeling of the reaction system will compliment the experimental work and provide a sound foundation for subsequent designs. The basic reaction has already been demonstrated, placing this technology at TRL 3.Phase I will build on the existing work to move the technology to TRL 4, where the level of performance in commercial units can begin to be predicted. In the second project phase, a series of process development steps will move the technology to TRL 5 while demonstrating its performance using commercial conditions and feeds. Catalyst manufacturing studies and detailed economic analyses ensure that the final process is commercially competitive. The project concludes with Phase III in which the process is piloted at the lab scale to demonstrate long-term stability and to produce enough alkylate to be used for third party testing. Successfully completing Phase III represents the progress of the technology to TRL 6, where it is ready for pre-commercial scale demonstration.