



U.S. Department of Energy

Categorical Exclusion Determination Form

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Proposed Action Title: Mining Innovations for Negative Emissions Resource Recovery (MINER) Program (FOA No. DE-FOA-0002707 and DE-FOA-0002708)

Program or Field Office: Advanced Research Projects Agency - Energy

Location(s) (City/County/State): AZ, CA, CO, IL, MA, MD, MI, MN, MO, NM, NV, NY, TX, UT, VA, WA

Proposed Action Description:

SECOND AMENDED PROGRAMMATIC NEPA DETERMINATION (See attached original Programmatic Determination, dated December 20, 2022 and First Amended Determination, dated January 12, 2023). The MINER Program seeks to increase the U.S. domestic supplies of copper, nickel, lithium, cobalt, and other rare earth elements. Specifically, projects funded under the MINER Program aim to (1) decrease comminution energy by 50% compared to state-of-the-art; (2) increase yield of energy-relevant minerals by reducing unrecovered energy-relevant minerals in the tailings by 50% compared to state-of-the-art; and (3) enable the negative emissions production of key minerals by sequestering >10 wt.% CO₂e per metric ton of carbon dioxide-reactive ore processed. If successful, the commercial-ready technologies developed under the MINER projects will decrease energy use of mineral processing and increase the yield of energy-relevant minerals via novel net-zero or negative emission technologies. The MINER Program is composed of 17 small-scale research and development projects that will be conducted by universities, for-profit entities, and federal laboratories. This Second Amended Determination adds 1 project (University of Arizona) (see Attachment A for all 9 projects covered by this and the prior Determinations). This project is covered by and fits within the class of actions identified under the DOE Categorical Exclusions identified below. This assessment was based on a review of the proposed scope of work and the potential environmental impacts of each project. The prime recipient has certified that all project tasks will be conducted in accordance with established safety and materials/waste management protocols and pursuant to applicable Federal, State, and Local regulatory requirements.

Categorical Exclusion(s) Applied:

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

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: Signed via email

Date Determined: January 31, 2023



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Proposed Action Title: Mining Innovations for Negative Emissions Resource Recovery (MINER) Program (FOA No. DE-FOA-0002707 and DE-FOA-0002708)

Program or Field Office: Advanced Research Projects Agency - Energy

Location(s) (City/County/State): CA, CO, IL, MA, MD, MI, MN, MO, NM, NV, NY, TX, UT, VA

Proposed Action Description:

FIRST AMENDED PROGRAMMATIC NEPA DETERMINATION (See attached original Programmatic Determination, dated December 20, 2022). The MINER Program seeks to increase the U.S. domestic supplies of copper, nickel, lithium, cobalt, and other rare earth elements. Specifically, projects funded under the MINER Program aim to (1) decrease comminution energy by 50% compared to state-of-the-art; (2) increase yield of energy-relevant minerals by reducing unrecovered energy-relevant minerals in the tailings by 50% compared to state-of-the-art; and (3) enable the negative emissions production of key minerals by sequestering >10 wt.% CO₂e per metric ton of carbon dioxide-reactive ore processed. If successful, the commercial-ready technologies developed under the MINER projects will decrease energy use of mineral processing and increase the yield of energy-relevant minerals via novel net-zero or negative emission technologies. The MINER Program is composed of 17 small-scale research and development projects that will be conducted by universities, for-profit entities, and federal laboratories. This First Amended Determination adds 7 projects (Columbia University, Colorado School of Mines, Johns Hopkins University, Michigan Technological University, Missouri University of Science and Technology, Phoenix Tailings, Inc., and University of Nevada, Reno) (see Attachment A for all 8 projects covered by this and the prior Determination). This project is covered by and fits within the class of actions identified under the DOE Categorical Exclusions identified below. This assessment was based on a review of the proposed scope of work and the potential environmental impacts of each project. The prime recipient has certified that all project tasks will be conducted in accordance with established safety and materials/waste management protocols and pursuant to applicable Federal, State, and Local regulatory requirements +

Categorical Exclusion(s) Applied:

- 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

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:

Approved via email

(This form will be locked for editing upon signature)

Date Determined: January 12, 2023



U.S. Department of Energy Categorical Exclusion Determination Form

Submit by E-mail

Proposed Action Title: Mining Innovations for Negative Emissions Resource Recovery (MINER) Program (FOA No. DE-FOA-0002707 and DE-FOA-0002708)

Program or Field Office: Advanced Research Projects Agency - Energy

Location(s) (City/County/State): Arlington, Texas; Los Angeles, California

Proposed Action Description:

The MINER Program seeks to increase the U.S. domestic supplies of copper, nickel, lithium, cobalt, and other rare earth elements. Specifically, projects funded under the MINER Program aim to (1) decrease comminution energy by 50% compared to state-of-the-art; (2) increase yield of energy-relevant minerals by reducing unrecovered energy-relevant minerals in the tailings by 50% compared to state-of-the-art; and (3) enable the negative emissions production of key minerals by sequestering >10 wt.% CO₂e per metric ton of carbon dioxide-reactive ore processed. If successful, the commercial-ready technologies developed under the MINER projects will decrease energy use of mineral processing and increase the yield of energy-relevant minerals via novel net-zero or negative emission technologies.

The MINER Program is composed of 16 small-scale research and development projects that will be conducted by universities, for-profit entities, and federal laboratories. This Determination covers 1 of the 16 projects (University of Texas - Arlington) (see Attachment A). This project is covered by and fits within the class of actions identified under the DOE Categorical Exclusions identified below. This assessment was based on a review of the proposed scope of work and the potential environmental impacts of each project. All project tasks will be conducted in accordance with established safety and materials/waste management protocols and pursuant to applicable Federal, State, and Local regulatory requirements

Categorical Exclusion(s) Applied:

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

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: Approved via email

Date Determined: December 20, 2022

Attachment A: Projects in the MINER (FOA No. DE-FOA-0002707 and DE-FOA-0002708) Program

Prime Recipient (Control No.)	Project Title	Project Description	Categorical Exclusion
<p>Arizona State University (2702-1515)</p>	<p>Re-Mining Red Mud Waste for CO2 Capture and Storage and Critical Element Recovery (RMCCS-CER)</p>	<p>Arizona State University in partnership with Pacific Northwest National Laboratory will advance in-situ and ex-situ techniques to determine the solubility and thermodynamic properties of various sodium rare earth element (REE) carbonates, REE (hydroxy)carbonates, REE phosphate, and REE (oxy)hydroxides in various solutions and pressures and temperature conditions, with or without the presence of carbon dioxide (CO2). The team will use the results to construct a database for optimizing conditions that efficiently recover energy-relevant minerals in red mud waste. This project is limited to bench-scale laboratory activities, with no outdoor or field-testing component, and has already obtained the required EH&S (Environmental, Health and Safety) approvals necessary for use of all the materials that it will need over the course of this project.</p>	<p>A9, B3.6</p>
<p>Colorado School of Mines (2707-1553)</p>	<p>Block Modeling of the Carbonation Potential of Ore Deposits Using Cutting-Edge Core Scanning Technology and Advanced Machine Learning Algorithms</p>	<p>The Colorado School of Mines will develop a novel technological solution to enable mining companies to quantitatively model the carbonation potential of CO2-reactive copper-nickel-platinum-group element ore deposits using cutting-edge X-ray fluorescence core scanning technology and advanced machine learning techniques. The quantitative models will allow the first of its kind cost-benefit analysis of the total carbonation potential of ore deposits to demonstrate that adapting negative emission technologies will become an integral part of mine feasibility studies. This project is limited to bench-scale laboratory activities, with no outdoor or field-testing component, and has already obtained the required EH&S (Environmental, Health and Safety) approvals necessary for use of all the materials that it will need over the course of this project.</p>	<p>A9, B3.6</p>
<p>Columbia University (2707-1561)</p>	<p>Innovative Stirred Media Mill Reactor with Integrated Carbon Mineralization and Electrochemical Separation of Critical Metals (critical SMIM-e)</p>	<p>Columbia University will develop a more energy efficient, highly integrated renewable-energy-driven carbon mineralization and metal recovery technology from low-grade ores. The concept will enable concurrent metal valorization and CO2 sequestration via an autogenous, reactive comminution reactor system that can simultaneously provide high specific surface area mineral particles and accelerate mineral dissolution by removing silicon-rich passivation layers. This approach reduces comminution energy consumption and can be coupled with sustainable carbon mineralization and electrochemical recovery of key energy minerals using selective oxidation and reduction</p>	<p>A9, B3.6</p>

Attachment A: Projects in the MINER (FOA No. DE-FOA-0002707 and DE-FOA-0002708) Program

Prime Recipient (Control No.)	Project Title	Project Description	Categorical Exclusion
		<p>pathways. This project is limited to bench-scale laboratory activities, with no outdoor or field-testing component, and has already obtained the required EH&S (Environmental, Health and Safety) approvals necessary for use of all the materials that it will need over the course of this project.</p>	
<p>Johns Hopkins University (2707-1550)</p>	<p>Carbon-Negative Mining from Gangue Minerals Enabled by Energy-Efficient Electrosynthesis of Acid and Base</p>	<p>Johns Hopkins University will develop sustainable mining of critical elements, such as manganese (Mn), cobalt (Co), nickel (Ni), copper (Cu), etc., from gangue minerals. The technology is based on robust acid-base chemistries and renewable electricity as the power source. It will enable the use of unconventional mineral sources for mining of energy-relevant critical metals. It will also avoid high-temperature thermochemical processing, minimize the discharge of hazardous chemical wastes and substantially reduce the carbon emission of mining industries. The proposed process represents a sustainable approach toward increasing domestic supplies of critical materials required for the transition to clean energy. This project is limited to bench-scale laboratory activities, with no outdoor or field-testing component, and has already obtained the required EH&S (Environmental, Health and Safety) approvals necessary for use of all the materials that it will need over the course of this project.</p>	<p>A9, B3.6</p>
<p>Michigan Technological University (2707-1510)</p>	<p>Energy Reduction and Improved Critical Mineral Recovery from Low-Grade Disseminated Sulphide Deposits and Mine Tailings</p>	<p>Michigan Technological University (MTU) will achieve a decrease of 10 wt% CO2 equivalent per tonne of ore processed compared with the current methods for primary nickel extraction by storing CO2 in CO2-reactive minerals and recovering 80% of energy-relevant minerals from both sulfide and nickel-bearing silicate minerals in mine tailings. MTU will validate (1) 200 kg of CO2 storage per tonne of magnesium-rich and iron-rich silicate minerals in mine tailings within 4 hours after processing with 10% energy reduction compared with state-of-the-art, and (2) a recovery of 50-80% yield of nickel from domestic low-grade disseminated sulfide ores. An estimated 2.2 million tonnes of CO2 per year will be sequestered in mine tailings that are permanently and safely stored with a decrease of 100 kg of CO2 equivalent per tonne of ore processed. This project is limited to bench-scale laboratory activities, with no outdoor or field-testing component, and has already obtained the required EH&S (Environmental, Health and Safety) approvals necessary for use of all the materials that it will need over the course of this project.</p>	<p>A9, B3.6</p>

Attachment A: Projects in the MINER (FOA No. DE-FOA-0002707 and DE-FOA-0002708) Program

Prime Recipient (Control No.)	Project Title	Project Description	Categorical Exclusion
Missouri University of Science and Technology (2707-1528)	Reduce Comminution Energy and Improve Energy Relevant Mineral Yield Using Carbon-Negative Oxalation Reactions	Missouri University of Science and Technology aims to establish a novel pathway to extract energy-relevant minerals, such as nickel and cobalt, from CO ₂ -reactive and low-grade silicate feedstock (e.g., lean ore, mine waste, and geologic formations) via a novel pretreatment using a CO ₂ - or biomass-derived organic acid that can dissolve silicates efficiently and liberate metals. The progressive dissolution will be followed by the precipitation of oxalate products, turning the bulky silicate rocks into micron-sized crystal particles and amorphous silica. The micron-sized crystal particles reduce the need for energy-intensive comminution during mineral beneficiation, and the separated crystalline oxalates will be further processed using hydrometallurgical approaches to separate the desired energy-relevant minerals. This project is limited to bench-scale laboratory activities, with no outdoor or field-testing component, and has already obtained the required EH&S (Environmental, Health and Safety) approvals necessary for use of all the materials that it will need over the course of this project.	A9, B3.6
Phoenix Tailings, Inc. (2708-1515)	CO ₂ GONE – CO ₂ Gasification of Ore for Nickel Extraction	Phoenix Tailings’s CO ₂ GONE process uses and recycles carbon dioxide (CO ₂) to extract energy-relevant minerals, primarily nickel (Ni) and magnesium (Mg), from iron- and aluminum-rich ore through carbonation with CO ₂ . Using CO ₂ with high pressures, temperatures and mixing breaks the rock structure and allows for greater extraction of energy relevant elements like Ni and Mg, which are then converted to metal carbonates (NiCO ₃ , MgCO ₃). The resulting NiCO ₃ and MgCO ₃ are chemically separated by ammonia (NH ₃) and refined to generate high-purity nickel oxide (NiO) and magnesium carbonate. The process is carbon negative, sequesters CO ₂ , and recycles CO ₂ and NH ₃ to keep the system operating efficiently. This project is limited to bench-scale laboratory activities, with no outdoor or field-testing component, and has already obtained the required EH&S (Environmental, Health and Safety) approvals necessary for use of all the materials that it will need over the course of this project.	A9, B3.6
University of Nevada, Reno (2707-1516)	Accelerated Reactive Carbonation Process (ARCP) for Energy Efficient Separation of Rare Earth Minerals	The University of Nevada, Reno, will develop and test an accelerated reactive carbonation process to enable improved mineral liberation, energy-efficient comminution (grinding), and enhanced separation of rare earth elements from low-grade bastnaesite-bearing ores. High-pressure grinding rolls will pre-crush the ores to generate internal micro-cracks that will facilitate the subsequent carbonation and	A9, B3.6

Attachment A: Projects in the MINER (FOA No. DE-FOA-0002707 and DE-FOA-0002708) Program

Prime Recipient (Control No.)	Project Title	Project Description	Categorical Exclusion
		<p>grinding process. The carbonation reaction will convert REE-bearing silicate minerals to REE-bearing carbonate minerals. The carbonation reaction from silicate to carbonate will soften the minerals, therefore reduce the comminution energy by 50% and increasing the total REEs yield by at least 20%. This project is limited to bench-scale laboratory activities, with no outdoor or field-testing component, and has already obtained the required EH&S (Environmental, Health and Safety) approvals necessary for use of all the materials that it will need over the course of this project.</p>	
<p>University of Texas – Arlington (2707-1507)</p>	<p>RECLAIM: Electrochemical Lithium and Nickel Extraction with Concurrent Carbon Dioxide Mineralization</p>	<p>The University of Texas at Arlington will develop acoustic stimulation and electrolytic proton production to produce lithium (Li) and nickel (Ni) from CO2-reactive minerals and rocks that contain calcium (Ca) and magnesium (Mg), while sequestering CO2 in the form of carbonate solids. First, an electric potential will be applied to water to simultaneously produce acidity and alkalinity. Then, solid feedstocks (Li/Ni/Ca/Mg-rich igneous and sedimentary minerals) will be dissolved in the acidic anolyte under acoustic stimulation. This project is limited to bench-scale laboratory activities, with no outdoor or field-testing component, and has already obtained the required EH&S (Environmental, Health and Safety) approvals necessary for use of all the materials that it will need over the course of this project.</p>	<p>A9, B3.6, B3.15</p>

Bold text indicates the one project added in the Second Amended CX.