



Budget Overview FY 2022

The Fiscal Year (FY22) 2022 Budget Request for the Department of Energy's (DOE) Office of Fossil Energy and Carbon Management (FECM) is guided by FECM's commitment to addressing our Nation's climate, energy and environmental challenges. The FY22 Budget Request focuses on approaches across varying levels of technological readiness that help to ensure clean and affordable energy, while assisting in facilitating the transition toward a net-zero carbon economy and building a U.S. critical minerals supply chain.

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Fossil Energy and Carbon Management RDD&D

President Biden's FY 2022 Budget seeks \$890 million for the FECM Research, Development, Demonstration and Deployment (RDD&D) program. FECM's RDD&D focuses on technology challenges that present a significant degree of scientific, technical or economic risk, making it unlikely the private sector will invest on their own, at a scale or with a timeliness that maximizes progress toward a net-zero carbon economy.

By leveraging creative funding mechanisms—such as prizes, competitions, technical assistance and programs targeted to small businesses—the RDD&D funding will broaden the program's reach. This approach will enable the commercialization of clean energy innovations that will activate job creation, help address frontline community concerns often sourced from fossil-based activities and yield a more geographically diverse and impactful research portfolio. This request also includes funding for the stewardship of the National Energy Technology Laboratory (NETL), the efficient and responsible regulation of liquified natural gas (LNG) exports and FECM's basic operating costs.

Carbon Capture, Utilization and Storage (CCUS) and Power Systems (FY22 Request: \$531.5M)

Carbon Capture (FY22 Request: \$150M)

This subprogram represents a focus on point source carbon capture utilizing both new technologies and the demonstration of more proven approaches. Specific efforts will focus on three activities:



1. **Post-Combustion Capture** – This activity will focus on RDD&D for novel carbon dioxide (CO₂) capture technologies such as non-aqueous solvents, membranes and advanced sorbents, for both power and industrial sectors. For research and development (R&D) projects, advanced computational tools for rational material discovery and design of advanced capture systems components will be coupled to materials synthesis. For more proven capture approaches, the focus will be on demonstration-scale efforts coupled with robust life-cycle and techno-economic analysis in order to reduce risks and further ensure the sustainability of the project toward meeting net-zero carbon emissions goals.
2. **Pre-Combustion Capture** – This activity will focus on pursuing transformational capture goals that require capture greater than 95%. Technologies for pre-combustion capture complement ongoing research to create new fundamental knowledge for hydrogen production and other industrial processes.
3. **Emissions Control** – This activity will focus on reducing the costs and emissions of non-CO₂ pollutants associated with the use and combustion of carbon-containing fuels. This effort would conduct systems analyses and technical assessments to identify and address issues associated with non-CO₂ emissions from power plants as well as industrial applications (i.e., trace and heavy metal emissions in solid, liquid and gaseous effluents that are potential areas of concern).

Carbon Utilization (FY22 Request: \$38M)

This subprogram is focused on the development of technologies to recycle CO₂ into value-added products. Areas of research include, but are not limited to, new projects focused on the catalytic conversion to higher value products such as fuels, chemicals, polymers and nutraceuticals;

mineralization to building products; generation of solid carbon products; and algal systems designed to integrate CO₂. Specific focus on catalysts made from low-cost materials and improved reactor designs will be pursued to lower the energy penalty and capital cost of the conversion process.

**Carbon Storage
(FY22 Request: \$117M)**

This subprogram is focused on the development of technologies for the safe and secure geologic storage of captured CO₂. The RDD&D supported by the Carbon Storage subprogram will aim to improve storage and operational efficiency as well as improve our understanding of overall cost and de-risking strategies to reduce these costs. Achieving each of these elements is critical for enabling a CCUS industry that is safe, economically viable and environmentally benign. Specific efforts will focus on the following activities:

- 1.Storage Infrastructure – This activity will focus on broadening the availability of certified resources for geologic storage of CO₂ by deploying field projects that advance characterization and certification of storage complexes in regions where there is known storage capacity and regions where the storage resource potential is more prospective. Through this sub-activity, the storage program will also coordinate with FECM’s Capture Program to help promote the integration of capture/storage projects.
- 2.Advanced Storage RDD&D – This activity is focused on developing and validating CO₂ storage technologies that improve capabilities in plume detection, storage efficiency, secure storage verification, subsurface stress assessments and wellbore integrity monitoring and mitigation.

**Advanced Energy and Hydrogen Systems
(FY22 Request: \$82M)**

This subprogram aims to improve overall system efficiency, reduce capital and operating costs, increase hydrogen production and enabling affordable carbon capture. Its mission is to increase the availability, efficiency and reliability of carbon neutral power derived from fossil fuels and other feedstock such as waste biomass and plastics through RDD&D. Specific efforts will focus on the following activities

- 1.Gasification Systems – The approach for gasification technology development will focus on modularization and intensification, as well as solutions for process issues arising when wider feedstock combinations are deployed to support hydrogen production at \$1 per kilogram by 2030. The program will also focus on improving the efficiency and cost of small-scale gasification-based plants/systems to make them more attractive in the marketplace.

- 2.Advanced Turbines – This activity recognizes that advanced technologies will be required to:
 - Improve flexible operations of combined and simple cycle gas turbines for power generation.
 - Support the requirements of an electric grid with increasing levels of variable renewable generation.
 - Use hydrogen and hydrogen-natural gas blends as a fuel; and
 - Design for optimized capture and geological storage of CO₂.
- 3.Reversible Solid Oxide Fuel Cells (R-SOFC) – FECM is shifting its funding to focus on areas that will achieve greater impact toward achieving a net-zero carbon economy by mid-century. R-SOFCs can use natural gas to produce electricity, water and CO₂ when operating in a fuel cell mode. R-SOFCs can be configured to operate in reverse as an electrolyzer using power, water and CO₂ as inputs to produce hydrogen, with by products of oxygen and carbon monoxide.
- 4.Advanced Energy Materials –This activity focuses primarily on fossil power generation applications with an objective of improving the flexibility and reliability of those applications while enabling high efficiency. The program also seeks to enhance the nation’s supply chain for high-temperature materials to support a competitive U.S. industry base and create a skilled workforce.

**Crosscutting Research
(FY22 Request: \$36.5M)**

This subprogram supports innovative early stage RDD&D for improving reliability, availability, efficiency and environmental performance. Focus is on technologies that aid in minimizing the environmental impact of society’s dependence on fossil fuels, which includes both power and industrial sectors, where the dependence is high today. The subprogram bridges basic and applied research by targeting concepts with the greatest potential for transformational breakthroughs. Specific efforts will focus on the following activities:

- 1.Sensors and Controls and other Novel Concepts – This activity provides funding for early stage RDD&D efforts on low-cost, reliable wired and wireless technologies to measure process temperature, pressure and concentration of gas species. With additional investment by industry, these technologies could be capable of providing real-time information critical to operation, reliability and efficiency.
- 2.Water Management RDD&D – The mission of this activity is to advance sustainable and efficient water use in various energy applications; develop cost-competitive technology solutions; and enhance understanding of the life-cycle relationship between energy and water resources.

3. Simulation Based Engineering (SBE) – The SBE program includes computational software development, high-performance computing, advanced optimization, techno-economic analysis and artificial intelligence and machine learning. Simulations generate information beyond the reach of experiments alone, rapidly and inexpensively. They enable the discovery of new materials, optimization and troubleshooting of novel devices and the design and optimization of complex process systems. Thus, the SBE program helps accelerate the development and deployment of next-generation fossil fuel technologies with significantly improved performance and low environmental impact. Key objectives include improving the reliability, flexibility and economics of carbon-neutral power generation in addition to low-carbon industrial sectors.
4. Energy Analyses – The Analysis division evaluates potential economic, jobs and environmental benefits and impacts from the deployment of carbon management and fossil technologies. This activity supports strategic planning by identifying major challenges and opportunities to improve efficiency, cost and environmental performance to speed deployments of carbon management applications.
5. University Training and Research Program – This activity focuses on developing the next generation of scientists and engineers to strengthen the workforce. Funding for this activity will provide a new competitive funding announcement for U.S. academic institutions of higher learning to support fundamental research that cuts across FECM’s research focus areas. Such funding aims to sustain a national university program of research in energy and environmental science and engineering that focuses on innovative and fundamental investigations pertinent to advancing Administration goals.
6. Energy Storage Grand Challenge Program – This activity focuses on the integration of long-duration energy storage technologies with a variety of fossil assets, including large-scale coal and gas power plants as well as smaller assets like single-cycle peaking gas turbines and microgrid applications. Co-locating energy storage with fossil assets provides many benefits including improved asset flexibility and efficiency, improved grid reliability, and reduced greenhouse gas emissions. Additionally, energy storage enables many heavily decarbonized use cases, for example, the integration of a hydrogen energy storage system with hydrogen turbine power production. Analytical results and stakeholder input suggest this activity will emphasize energy storage technologies that are thermal; chemical, including hydrogen; mechanical; or long-duration electrochemical (e.g., flow battery) in nature.
7. International Activities – This supports the deployment of U.S. technologies and resources to international markets that are seeking carbon capture, utilization and storage (CCUS) technologies and advanced high efficiency

power plants. Funding will support international efforts and technical studies with various international partners through bi-lateral and multi-lateral agreements.

**Carbon Dioxide Removal (CDR)
(FY22 Request: \$63M)**

The FECM CDR subprogram is a new budget line in the FY22 Budget Request, and funding is focused on direct air capture (DAC) coupled to reliable storage, bioenergy with carbon capture and storage (BECCS) and enhanced mineralization concepts. It builds upon past efforts that have been funded through FECM’s CCUS activities, such as past work on DAC, enhanced mineralization, co-firing of biomass and capture technology development.

**Mineral Sustainability
(FY22 Request: \$45M)**

The Mineral Sustainability subprogram will support domestic supply chain networks required for the economically, environmentally and geopolitically sustainable production of critical minerals (CM). The integration of extraction of carbon ore and CM is naturally part of the upstream process. The Critical Minerals and Carbon Ore Processing subprogram activities will result in more efficient and economic technology development and deployment. This mission will be accomplished by prioritizing the use of unconventional resources, such as coal waste and by-products from industry feedstocks, for domestic CM, rare earth elements (REE) and carbon ore to products production.

1. Critical Minerals – This activity focuses on the sustainable recovery of all CM, including REE, throughout the upstream, midstream and downstream supply chain by prioritizing the use of unconventional resources as the most environmentally sustainable primary feedstock resource for domestic production.
2. Carbon Ore Processing – This activity is focused on utilizing materials to be recycled from previously mined resources outside of traditional thermal and metallurgical markets that can contribute to the U.S. gross domestic product. This activity is focused on developing transformational technologies to enable domestic manufacturing of strategic materials from carbon ore at competitive market prices. These transformational technologies have minimal emissions, high-product performance and improved life cycle for new and existing products in the market.

**Natural Gas Technologies
(FY22 Request: \$130M)**

The Natural Gas Technologies Program addresses critical issues associated with the production and transmission of domestic natural gas. Specifically, the Program’s mission is to conduct RDD&D that reduces the environmental impact from the

development, transportation, distribution and storage of natural gas resources. The Program comprises four subprograms:

1. **Environmentally Prudent Development** – This subprogram will focus on addressing the environmental impacts from oil and natural gas development, to include unconventional development and offshore safety and spill prevention. The subprogram will build on research conducted and data collected from 17 Field Laboratory projects to inform future research. Research includes wellbore integrity, oil spill prevention and produced water treatment and reuse technologies.
2. **Emissions Mitigation from Midstream Infrastructure** – This subprogram will develop technologies to reduce emissions from natural gas transmission, distribution and storage facilities. This includes advanced materials, sensors, data management systems and more efficient and flexible compressors. The subprogram will develop advanced modular technologies, capable of being deployed near wellheads and natural gas processing and transportation infrastructure, for the purpose of beneficially utilizing otherwise flared, vented or stranded natural gas. It will also develop advanced sensor technologies to detect and locate emissions from pipelines, storage facilities and abandoned wells, and it will develop modular technologies, materials and solutions to aid in the remediation of orphaned wells.
3. **Emissions Quantification from Natural Gas Infrastructure** – This subprogram will focus on developing technologies to detect, locate and measure emissions. This includes the development and validation of measurement sensor technologies for the collection, dissemination and analysis of emissions data, which will inform efforts such as the EPA's Greenhouse Gas Inventory and orphan well remediation programs.
4. **Natural Gas Hydrogen Research** – This new subprogram will focus on technologies for carbon-neutral hydrogen production, as well as hydrogen (and ammonia) transportation and geologic storage technologies that leverage existing natural gas infrastructure. It will also support analytical tools and models. Hydrogen research will focus on improving natural gas steam methane reforming (SMR), blending hydrogen with natural gas, and leveraging existing transportation and storage infrastructure. The program will also develop analytical tools and models that are able to evaluate potential advanced technologies, technology performance metrics, technoeconomic and life-cycle analyses, and resource evaluations.

National Energy Technology Laboratory (FY22 Request: \$190.4M for NETL; and an additional \$38.1M for HQ Program Direction and Special Recruitment)

FECM is committed to supporting NETL's capabilities and competitiveness. NETL, whose primary funding source is FECM, is the only Government-Owned, Government-Operated (GOGO) Laboratory in the DOE National Laboratory system.

NETL Infrastructure (FY22 Request: \$78M)

The Budget Request supports the fixed costs of maintaining NETL's lab footprint in three geographic locations: Morgantown, WV; Pittsburgh, PA; and Albany, OR. These sites include approximately 240 acres of land, including 108 buildings with over 1,100,000 square feet of space. This level of funding includes \$25 million for the design and construction of a DAC at an NETL campus. This DAC Center will be utilized to lead agency-wide RDD&D projects to advance the development and commercialization of technologies to remove carbon from the air on a significant scale.

NETL Research and Operations (FY22 Request: \$83M)

The Budget Request supports the salaries, benefits, travel and other employee costs for the NETL staff of engineers and technical professionals who conduct project management for FECM RDD&D programs. This program also funds partnership, technology transfer and other collaborative research activities and supports the variable operating costs of NETL's research sites.

NETL and HQ Program Direction and Special Recruitment Programs (FY22 Request: \$67.5M)

The Budget Request of \$67.5 million (\$37.4 million for headquarters, \$29.4 million for NETL and \$0.7 million for Special Recruitment) provides for the FECM RDD&D organization's federal workforce and contractor support in the Washington, D.C. area, including salaries and benefits, support service contracts, travel, training, the working capital fund and other employee costs. These staff are responsible for the oversight and administration of the FECM RDD&D Programs and natural gas regulatory activities. In addition, funding for NETL federal technical staff and contractor support that provide acquisition, finance and legal functions is supported.