

Energy . . .

It's something we use every day, but often take for granted. Yet energy is essential to how we live, work, and play, from turning on a light switch to using a computer, heating our homes, and powering our automobiles.

Fossil energy — coal, oil, and natural gas — is especially important to Americans: it provides 85 percent of all the energy we use daily, a role it will continue to play for years to come.

As a result, the **U.S. Department of Energy's Office of Fossil Energy (FE) research program** has a vital mission . . . *finding new ways of producing more energy from America's traditional fossil resources while keeping costs affordable and improving environmental performance.*

This is a challenge FE has successfully met for more than a quarter century and continues to fulfill today. In the process, FE's research has converted the **U.S. taxpayer's investment** into high-tech advances that in some way touch every American daily . . . and ultimately improve the quality of life for all people everywhere.

Please see inside for more on these successes — past, present, and future — the benefits they provide, and the foundation they have built for future innovation.



For more information on the Office of Fossil Energy, its activities, and research programs, please visit

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THE U.S. DEPARTMENT OF ENERGY'S OFFICE OF FOSSIL ENERGY **RESEARCH BENEFITS**

INNOVATIONS THAT ENHANCE AMERICAN LIFE





FE RESEARCH — THE RETURN ON INVESTMENT

- \$100 Billion in Benefits
- 2500% Return on Investment

A study by the Southern Company found that a federal investment of \$4 billion in coal research will return \$100 billion in benefits to the U.S. economy through 2020. The return on investment is \$25 for every \$1 spent.

- Less NO_x, SO₂ Pollution
- Less Acid Rain
- Healthier Air Quality

FE-developed technology now in wide commercial use includes low-nitrogen oxide (NO_x) burners, flue gas desulfurization scrubbers, and clean Fluidized-Bed Combustors. All significantly reduce pollution contributing to acid rain and have resulted in air quality improvements.

- Pollution Avoided:
 - 25 Million Tons of NO_x
 - 2 Million Tons of SO₂

The National Academies of Sciences' National Research Council found the realized environmental benefits of FE-developed technologies totaled \$200 million for sulfur dioxide (SO₂) pollution avoided and \$60 billion for NO_x pollution avoided.

- Lower-Cost Pollution Control
- Lower Electric Bills

FE research has resulted in a 93 percent drop in the cost of removing NO_x from emissions — from \$3,000 a ton in the 1970s to \$200 today. SO₂ removal cost 66 percent less. FE technology development enabled the achievement of world-leading pollution control without steep increases in electric bills.

- Clean, Efficient FBC Technology Commercialized
- 900% Return on Investment

FE research and demonstrations ushered in to commercial use the inherently clean Fluidized Bed Combustion (FBC) process. Today more than 170 of these units are operating in the United States and 400 worldwide, with a value totaling \$9 billion. The economic return is \$9 for every \$1 spent.

- Fuel Cell R&D Underway
- 250 KW Fuel Cell Reduces Air Pollution Equal to Removing 120 Cars

Among FE's projects for the future are fuel cells. An FE partnership has resulted in development of a 250-kilowatt (KW) fuel cell system for commercial use. Each 250-KW fuel cell reduces air pollution to levels equal to taking 120 cars off the road.

PROTECTING AIR QUALITY

CLEARING THE AIR — Clean air is important to everyone. That's why FE research has focused on developing technologies to help power plants emit **little or no** nitrogen oxide, sulfur dioxide, or carbon dioxide (CO₂), while operating at higher efficiencies. The goal — to cut harmful emissions from coal power plants by nearly 70 percent by 2018.



A WELL-GROUNDED SOLUTION — Climate change may be a major environmental challenge of the 21st century. Technology holds the key to reducing human greenhouse gas contributions while meeting increased energy demand. FE's **National Energy Technology Laboratory (NETL)** is managing projects that are exploring ways to effectively "capture" CO₂ before it is emitted and permanently store it underground. FE aims to demonstrate cutting-edge carbon capture and storage (CCS) technology at multiple clean coal power plants that, once operational, will have the potential to sequester carbon dioxide at a rate of approximately 1 million tons per year. FE researchers are also successfully testing ways of injecting CO₂ into existing oil fields to increase production. Recent FE studies concluded CO₂ injection could raise domestic oil reserves to almost 100 billion barrels — nearly four times today's estimated total. NETL manages DOE's **Regional Carbon Sequestration Partnerships**, a consortium seeking the best CO₂ storage solutions for each region of the country.

A PRIZE CATCH — Millions of Americans enjoy fishing for recreation. But **mercury** from power plant emissions can end up in oceans, lakes, and streams, and eventually in fish consumed by humans and wildlife. NETL researchers are developing controls that will help coal-based power plants meet stringent new caps on mercury, as well as reduce other polluting emissions.

PROTECTING WATER RESOURCES

FREE-FLOWING IDEAS — Water quality and supply affect not only people, but also the ecosystem's plant and animal life, and economic development. Power plants use water to make steam that helps produce electricity. Taking fossil fuels from the ground can also affect water resources. **FE research** is developing advanced technologies to both meet the growing need for more energy and expectations for protecting the nation's water supplies. These include ways to lower the use of water in power generation; treat power plant wastewater, as well as water encountered in natural gas drilling operations, to remove pollutants; and extract clean water from power plant chimney (flue) gases.



SECURING YOUR FUTURE

THE FUTURE IS NOW — Coal gasification — one of the cleanest and most versatile ways to extract energy from coal — is likely to be a **core technology** for future power plants. The first gasification plants are already operational in the United States and in other nations. Combined with CCS technologies, FE is getting closer to realizing its concept for the ultimate class of innovative coal-based energy plants that are fuel flexible, highly efficient, cost competitive, and virtually emissions free.



INCREASING DOMESTIC SUPPLIES

SEEING BELOW THE SURFACE — Domestic oil and natural gas supplies are still plentiful, but increasingly found in hard-to-reach or complex geologic formations. FE research has historically focused on **raising domestic production** of these fuels to lessen reliance on foreign sources and enhance U.S. energy security. This has included developing low-cost technologies to prolong existing well life; tapping previously bypassed reservoirs; using "smart" technology to drill safer and more productive wells; and improving monitoring of pipeline conditions to detect and repair problems before they become dangerous.

EXPLORING NEW RESOURCES

ICE THAT BURNS — "Methane hydrates" are molecules of natural gas trapped in ice crystals. They are located in arctic regions and under the oceans and represent a **potentially vast energy resource** — they may contain twice as much energy as all of the world's other fossil fuels combined. Recent FE research has been aimed at developing commercial methane production from domestic hydrate deposits. It has also focused on ensuring the safety of deep-water drilling operations. This includes identifying and evaluating recoverable resources, drilling test wells, and developing advanced sampling and analysis technologies.

FE RESEARCH — SMART INVESTMENT...BY THE NUMBERS

\$7.4 BILLION	600,000	75%	\$1.4 TRILLION
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According to a 2001 **National Academies of Science** report, the economic benefits in real dollars provided by FE research between 1986-2000, for an investment in tax dollars of \$4.5 billion.

The number of jobs in the U.S. power equipment industry that the more than 700 patents awarded through the **FE research program** will allow U.S. industry to compete for over the next 30 years.

The percentage of existing U.S. coal-based generating units that have been or are currently being fitted with **low-nitrogen oxide burners** developed through the FE research program.

The estimated benefits of coal research and development to U.S. consumers during the period 2007-2050, according to a study by the **Electric Power Research Institute**.