

INNOVATIONS FOR EXISTING PLANTS

ENABLING CLEAN, ABUNDANT, AND AFFORDABLE POWER FOR THE NATION

In the United States, coal-fired power plants generate over 300 gigawatts of electricity. They represent the baseload supply of stable and affordable energy that has fueled the nation's economic growth and prosperity for decades.

The majority of these power plants were designed and built before current air emission requirements became law. Although great progress has been made in enhancing their environmental performance, further improvements are needed. Moreover, as recommended in the National Energy Policy (NEP), future energy decisions will need to be closely aligned with environmental goals and objectives.

The Innovations for Existing Plants (IEP) Program seeks to create technology options that will enable the current fleet of coal-fired power plants and gasification systems to comply with future environmental regulations at a low cost. The program has two major products:

- Advanced environmental control technology for coal-fired power plants
- High-quality scientific data and analysis for use in policy and regulatory decision making

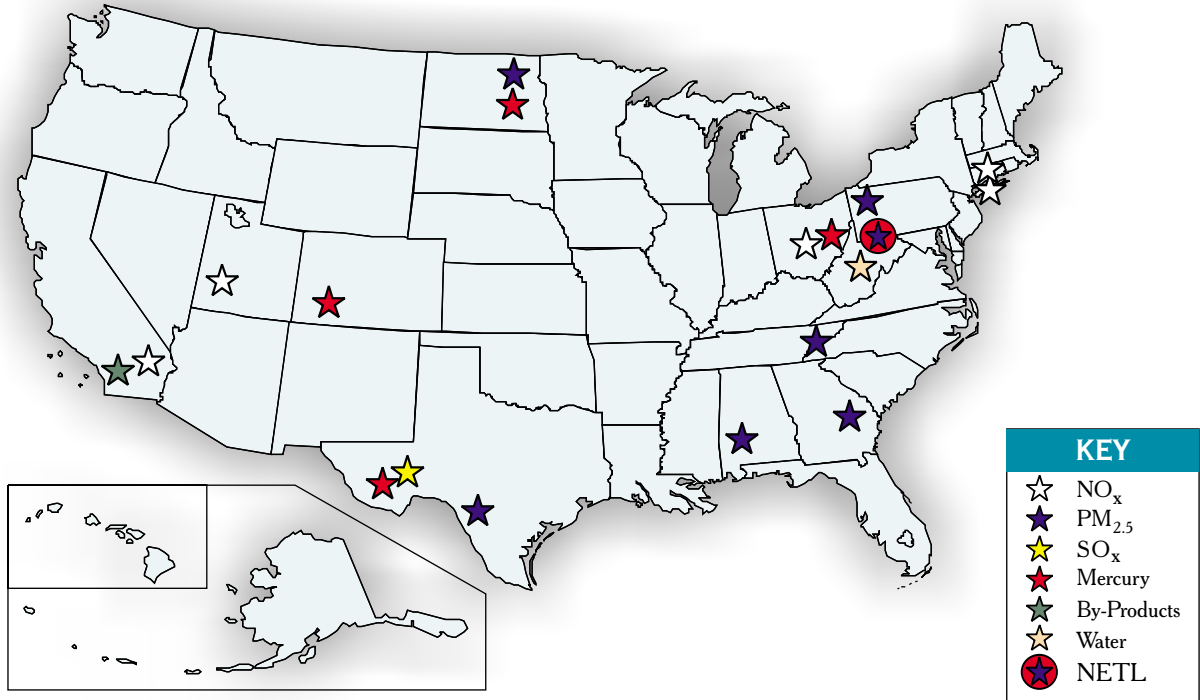
MARKET AND REGULATORY DRIVERS

The drivers for the program reflect changes in power markets and environmental regulation.

- *Environmental regulations* are becoming more stringent. Power plant emissions of sulfur dioxide (SO₂), nitrogen oxides (NO_x), and mercury will likely be addressed in the near future in response to concerns about ambient air quality, visibility, and related environmental issues. Water use and solid by-products from power plants may also be regulated more strictly in the future as well.
- *Economic growth* and increased demand for energy compound the need for improved environmental performance. The amount of coal burned in the United States today is double the level of thirty years ago. As such, emissions per pound of coal burned must be reduced to limit aggregate emissions levels and meet national emissions caps.
- *Energy supply* concerns and questions regarding the long-term supply of affordable electric power point to increased use of coal in the future. Recent electrical power disruptions in California and spikes in natural gas prices nationwide highlight these concerns.

PARTNERS AND PERFORMERS—COLLABORATION FOR COMMON GOALS

Collaboration and partnership are critical to successfully achieving national goals of environmental quality and affordable, available, and reliable power. The IEP Program brings together not only R&D performers, but also a broad range of stakeholders, including EPA, energy planners, power producers, non-government organizations, and the public, to ensure that these goals are achieved. The map below provides a snapshot of the locations of some of the projects conducted under the auspices of the IEP program.

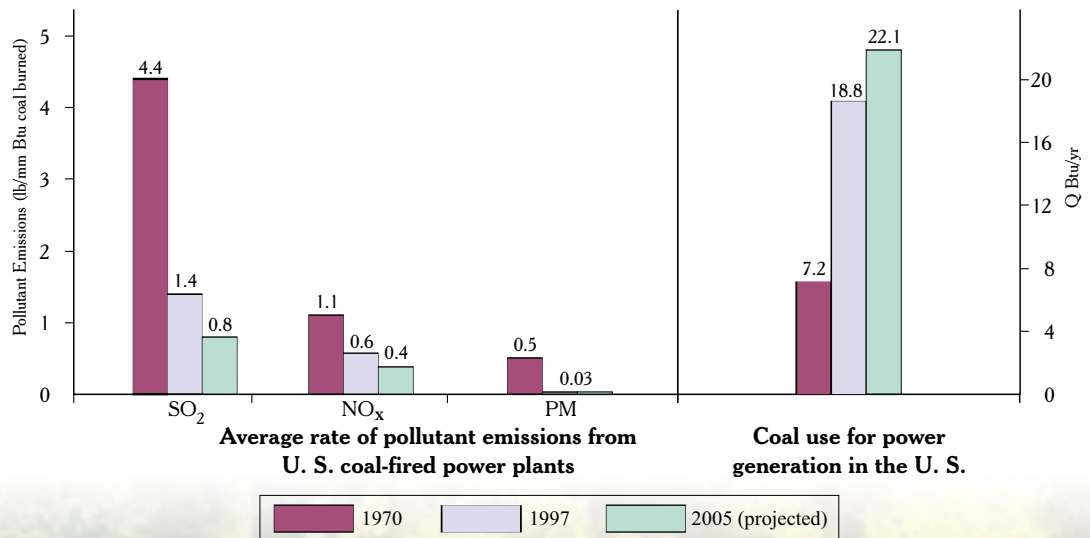


INTEGRATING ENVIRONMENT AND ENERGY POLICY

Low cost energy is the foundation of a strong U.S. economy. When setting national environmental policies, it is important to recognize the potential impact on energy supply. The figure below shows that coal use has more than doubled over the past thirty years. However, over the same period of time, pollutant emissions per unit of coal burned have come down, demonstrating the benefits of the advances in emission control technology being pursued by the IEP program.

Successes to date: pollutant emissions per unit of coal burned have decreased significantly

Challenges for the future: increased coal use has brought pressure to reduce emissions further



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A CHANGING REGULATORY LANDSCAPE

In 2000, the U.S. Environmental Protection Agency took a number of significant actions. It:

- Announced plans to regulate emissions of mercury from coal plants;
- Announced it will revisit current regulations that allows coal-combustion by-products (CCBs) to be disposed in landfills designed for non-hazardous wastes;
- Proposed cooling water intake structure regulations and opened discussions related to the interface between air emissions and water quality; and
- Engaged in debate with a number of generating companies over whether recent work performed at coal-fired power plants was significant enough to be judged as re-powering, which would force the facilities to comply with New Source Performance Standards.

These actions are in addition to existing acid rain emissions caps, NO_x State Implementation Plans, regional haze rules, and reporting requirements under the Toxic Release Inventory (TRI).

Legislatively, several draft bills in the United States Congress propose multi-pollutant control strategies that would establish national emissions caps for all major emission species. Such plans seek to: 1) allow market forces to drive down the cost of compliance; and 2) enable an integrated approach to emissions reduction. The NEP also recommends an integrated approach to managing SO₂, NO_x and mercury emissions.

As the political and regulatory landscape evolves, DOE's IEP Program has provided an integrated approach to developing both a scientific understanding of the issues and technology options for addressing them.

PROGRAM GOAL AND STRATEGY

The IEP program goal is to develop fully integrated pollutant control systems that address air, water, and solid waste effluents in an affordable manner. The program strategy is to work collaboratively with industry (power producers and technology developers), the research community (public and private-sector), and the planners and regulators (EPA) in developing reliable data and cost-effective R&D products. There are three key elements of this strategy.

- Develop high-quality data on environmental releases and technology performance that are accepted as an "honest-broker" information base for policy and regulatory decisions.
- Use a systems approach to integrate air, water, and solid waste management issues and to identify the critical areas for research and development.
- Maintain a science-based program grounded in a fundamental understanding of pollutant generation and control, emissions transport, and by-product utilization and disposal.

Research and development conducted under the IEP Program has produced measurable results, such as significant reductions in the cost of sulfur dioxide (SO₂) scrubbers and low-NO_x burners. Most recently, the program has made great strides towards reducing the cost of mercury control systems. The task of bringing coal-fired power plants and gasification technology into compliance with existing and future environmental regulations is enormous. However, the potential national economic benefits associated with reducing the cost are on the order of billions of dollars per year.

R&D AREAS

Each of the technology areas associated with the program is briefly discussed below. The map on the back page shows that the IEP program is working with partners nationwide.

Nitrogen Oxides (NO_x)

NO_x refers to oxides of nitrogen (NO, NO₂). NO_x has been identified as a precursor to both ground-level ozone and secondary fine particulate matter (PM_{2.5}). NO_x can also contribute to acid rain and other water-related perturbations such as eutrofication. The IEP Program is currently focused on the development of technology that can achieve 0.15 lb NO_x/million Btu or less at ¾ the cost of selective catalytic reduction.

Sulfur Oxides (SO_x)

SO_x refers to both SO₂ and SO₃ -- compounds that can cause acid rain and serve as a precursor to PM_{2.5}. In the next 5-10 years, coal-fired power plants may be required to reduce SO_x emissions well below current levels in response to visibility and ambient PM_{2.5} issues. The TRI could also lead to calls for reductions in SO₃ emissions. The IEP program will continue to analyze SO_x control technology needs while focusing on approaches to reduce SO₃ and other acid gas emissions.

Fine Particulate Matter (PM_{2.5})

PM_{2.5} (particulate matter with a diameter of less than 2.5 microns) in ambient air causes reduced visibility and may be linked to adverse human health impacts. There are two types of PM_{2.5}: (1) primary - discrete particles entrained in flue gas, and (2) secondary particulates formed in the atmosphere by reactions involving NO_x, SO_x, and other chemical species. Ambient monitoring and related source-receptor research will continue as part of the program, along with the development of technology capable of achieving 99.99% or greater capture of primary PM_{2.5}.

Mercury

Mercury is a neurotoxin that bio-accumulates. Forty states currently have advisories for mercury contamination in fish. EPA issued a decision to reduce mercury emissions from coal-fired power plants, which represent roughly 1/3 of all U.S. mercury emissions, in December 2000. The IEP program is working to develop technology to lower the cost of mercury control. Two field-scale projects are currently underway to demonstrate 50%-70% mercury removal using activated carbon injection and wet scrubbers at 1/2 to ¾ the cost of existing technology. In addition, six advanced concepts are under development that could achieve 90% or greater control of mercury.

Coal By-Products

Fly ash, bottom ash, and scrubber by-product make up the bulk of coal combustion by-products (CCBs). In 1999 coal-fired power plants generated 100 million tons of CCBs, with only 30% utilized commercially. The IEP Program is directed at ensuring the environmental acceptability of CCBs while achieving a goal of 40% utilization by 2010. A current focus of research is to assess and understand the potential impact of advanced emissions control technology on the reuse and disposal of CCBs. Solid residues from gasification systems are also being studied.

Water Resources Management

Power production using fossil fuels is water intensive; about three gallons of water are needed for each kWh generated. Water availability may become a more serious problem in the future, particularly in the West. Several water-related issues have been raised, including the use of cooling water, acid mine drainage, and the link between air emissions and water quality, that could impact coal-fired power plants in the near- and mid-term. The IEP program is assessing these issues to develop, as needed, the science and technology to allow for compliance with future water-related regulations. The program is currently focused on the Clean Water Act's cooling water intake structure and total maximum daily load requirements.