

A Bridge to the 21st Century

Rita A. Bajura
Director, Federal Energy Technology Center

Good Morning, Welcome to the Annual “Advanced Coal-Based Power and Environmental Systems Conference.” When we meet in the beautiful city of Pittsburgh — with its three rivers and all its bridges — bridges are an appropriate analogy for crossing the river to the 21st Century.

I will cover three topics:

- √ First, the hills on this side of the river — where we are in the Coal Power Systems R&D Program.
- √ The second topic deals with trends that impact the R&D Program as we approach the bridge to the 21st century.
- √ And last, I’ll describe the topography on the other side of the bridge — what I see as the future of the R&D Program.

Advanced Clean/Efficient Power Systems R&D Program

Let me start by describing one of the two hills on this side of the river — the Coal Power Systems R&D Program, which includes four power generation technologies:

- ***The Low Emission Boiler Systems Program (LEBS)***, which is funded at \$10 M in FY97. LEBS improves the efficiency and environment of pulverized coal, steam plants. The program addresses:
 - Advanced low-NO_x, high-throughput combustion systems,
 - Advanced SO_x and NO_x control technologies, and
 - Steam cycle improvement — supercritical or the Kalina steam and NH₃ Cycle.

In this meeting, our three major LEBS contractors will present papers: ABB-Combustion Engineering, Babcock & Wilcox, and D.B. Riley.

- ***High Performance Power Systems (HIPPS)*** — which is funded at \$10 M. HIPPS is a combined cycle which indirectly heats air for its gas turbines. The major HIPPS contractors are United Technologies and Foster Wheeler.
- ***Integrated Gasification Combined Cycle (IGCC)*** — This is funded at \$22 M in FY97. IGCC combines coal gasification with a gas turbine combined cycle.

- ***Pressurized Fluidized Bed Combustion (PFBC)*** — funded at \$18 M. PFBC targets the repowering market or opportunity fuels — such as high ash coal. The advanced PFBC includes a carbonizer or partial coal gasifier.

The R&D program for IGCC and PFBC focuses on high-temperature desulfurization and particulate removal systems. Much of our research is being done in the Power System Development Facility at Wilsonville, Alabama. Southern Company Services and others will present papers on the PSDF during this conference.

- ***Advanced Research*** is the fifth and final piece of the Power Systems R&D program. Advanced research supports the four major power systems and explores longer-term issues such as Biomass co-firing and CO₂ sequestration. This program is funded at \$9 million.

If you added up all the pieces, the FY97 funding for the Coal Power Systems R&D Program totals \$70 million. FETC also manages two natural-gas power systems:

- The Advanced Turbine System, a \$46 million per year program, and
- Fuel Cells, also a \$46 million per year program.

Turbines and fuel cells can be adapted to use in coal systems.

The Clean Coal Technology Program

The second hill on this side of the river is the Clean Coal Technology Program. For the past 10 years, the CCT program has been demonstrating new coal-based power technologies. Thirty-nine projects are in the program. Twenty of these have been completed; 10 are in operation; 2 are in construction; and 7 are in the design phase.

We completed five flue-gas desulfurization projects, five low-NO_x burner projects, and five combined SO₂ and NO_x control projects. We've shown that low-NO_x burners can reduce NO_x up to 50 percent for a wide spectrum of boiler types. We've shown that combined SO_x and NO_x processes can remove more than 90 percent of both pollutants.

Two fluidized bed combustion projects have also been completed — a 100-MW atmospheric FBC at Colorado-Ute, and a 70-MW pressurized FBC at American Electric Power's Tidd Station. Two other FBC projects are in the design phase.

Three IGCC projects are in the shakedown or demonstration phase: PSI's 265-MW Wabash River project, Tampa Electric's 250-MW IGCC Project, and the Sierra Pacific's 100-MW Piñon Pine project. All three projects use high-temperature particulate filters. The Piñon Pine and Tampa Electric plants also have high-temperature desulfurization systems.

The CCT Program is a unique partnership between DOE and industry. DOE contributed \$2.5 billion; industry contributed \$3.5 billion. The partnership has been a success!

- The projects are providing definitive cost and performance information — at commercial scale, and under commercial operating conditions.
- More than a dozen new technologies have emerged from the program, and are now in commercial use.
- *Power Magazine* bestowed the “Power Plant of the Year” award on five Clean Coal Projects. This year, the Tampa IGCC Project was honored with the award.

From the perspective of this conference, the CCT Program brought focus to the R&D Program. The real R&D issues — those performances or cost issues that impede commercialization — become abundantly clear when a technology is demonstrated at commercial scale.

Trends

My second topic covers six trends that impact the Coal R&D Program as we approach the bridge to the 21st century.

Environmental Pressure. Trend one is continued pressure to reduce environmental emissions — using market-based solutions — like SO₂ emission trading — to make the new regulations more palatable.

- For Hazardous Air Pollutants (HAPs), FETC worked with the EPA and the EPRI to measure HAPs emissions from coal-fired plants with equipment configurations. The study concluded that HAPs emissions were lower than previously thought and that, except possibly for mercury, gross control is generally not required. This saved the electric industry an estimated \$6 billion. But the EPA is still considering limits on HAPs, particularly mercury emissions.
- For NO_x, a few weeks ago the Ozone Transport Assessment Group (OTAG) recommended reducing NO_x emissions in the eastern U.S. to meet current ozone standards.
- Last Wednesday, the EPA issued its final rules revising the National Ambient Air Quality Standards for ozone and fine particles — PM 2.5. These are primarily aerosols of SO₂ and NO_x.

Global Warming. Trend two is a related environmental issue — global warming. There is no question that CO₂ concentrations in the atmosphere are increasing. The issue is — does this impact our climate? A United Nation’s Intergovernmental Panel, consisting of 2,500 experts from more than 80 countries, studied this issue. The Panel issued their report in mid-1996. While there was controversy over the final wording, the report stated:

The balance of evidence suggests a discernible human influence on global climate.

Where do we go from here? The U.S. tried voluntary control: the Climate Change Action Plan was initiated in 1993. U.S. businesses pledged to significantly reduce greenhouse gas emissions — and they did! But our robust economy resulted in higher emissions than originally projected! Thus, CO₂ emissions are projected to be 30-percent higher in the year 2000 than in 1990. Currently, the Administration is negotiating an agreement with 130 nations for binding limits on greenhouse gas emissions. The goal is to sign the agreement in a meeting in Kyoto, Japan, this December.

Smaller Government. Trend three is a nationwide trend, in the words of President Clinton, toward a “smaller, humbler Government.” The pressure to balance the budget is real! Thus, we are unlikely to have another large demonstration program — like the CCT Program — in the foreseeable future.

Another ramification is a demand for greater accountability in the R&D program. Congress is demanding that Government-funded R&D contribute to measurable, desirable outcomes — for example, tons per year of pollutant reduced. The outcomes must benefit the public — and be something that the private sector cannot or will not do on its own. This translates into more careful program planning, more documentation on the benefits of the R&D program.

The merger of the former PETC and the former METC into the Federal Energy Technology Center was driven by the thrust for a smaller government. On July 2, we at the FETC celebrated our half-year birthday as a merged organization. We manage the two sites as if they were co-located — 65 miles is not that far. A common management team serves both sites. We have consolidated all of our administrative and program functions — everything we do — into one organization! Our goal is to provide you, our customers and stakeholders, with seamless service.

A New Model for R&D. Trend four is a new model for structuring R&D programs. Over the past few years, Congress and the Administration have had diametrically opposed views of R&D.

- √ *Congress* held that “basic research is good, applied research is bad — it’s corporate welfare.”
- √ The *Administration* championed “technology partnerships with industry” as the cornerstone of economic development.

To solve this impasse, Congressional leaders are attempting to reach a consensus on a new R&D model — a model that would blur the border between basic and applied research. The emerging model is summed up by the concept of partnerships among government, universities, and industry. The view is partnership leverage opportunities to get the biggest bang from its investment in R&D. The model also calls for the government to focus on:

- Smaller companies whose research could lead to important new products.
- Consortia across an industry that would share ideas among companies of all sizes.
- Programs that would involve states in the selection process — thereby producing political support.

A Flat Market for New Power Plants in the U.S. The fifth trend is a nearly flat, near-term market for new power plants in the U.S., particularly coal-fired plants. The next speaker is the authority on this topic and I defer to him.

Major Growth in the International Market. And the last trend is a burgeoning international market for power generation, particularly in Pacific Rim nations. The demand is constrained only by the availability of capital. Coal will be a major fuel for these new plants. Developing countries are selecting the lowest capital cost technology which, for coal systems, is 1970s technology.

The Future of the Coal Power Program

What do all these trends mean for the coal R&D program? In my last topic, I want to describe the topography on the other side of the bridge to the 21st century — what I see as the future shape of the R&D program.

Phase II CAAA. We will continue to work on low-cost techniques to comply with Phase II revisions to the 1990 Clean Air Act Amendments. Since 1970, the electric industry has made dramatic progress in reducing emissions from our 220 gigawatts of aging, coal-fired plants. Low-NO_x burners installed in 1/4 of U.S. plants are helping to limit NO_x emissions. On a national basis, particulate emissions are down more than 90%! SO₂ emissions are down 25 percent, even though coal use has more than doubled! DOE's RD&D program contributed to these reductions.

But work is still needed in three areas:

- SO₂ reduction **combined** with deep NO_x reductions.
- Hazardous Air Pollutants or HAPS. We are continuing to measure mercury and other HAPs emissions from both conventional and advanced coal plants. We are also developing processes to remove mercury.
- Fine particulates. Flue gas cleanup may be needed to simultaneously address SO₂, NO_x, PM 2.5, and mercury emissions. This program may be funded through \$3 million that the House Appropriations Committee added to DOE's FY98 budget for "data monitoring in support of the new PM 2.5 air quality regulations proposed by the EPA."

CO₂ Response. The second hill — on the 21st century side of the bridge — is climate change. FETC has been working in two areas:

1. First, we are working on high-efficiency power systems for the mid to longer term. LEBS, HIPPS, IGCC, and PFBC can reduce CO₂ emissions by 30 percent or more compared with current, baseline systems. Hybrid systems that couple gas turbines and fuel cells can slash emissions by 50 percent.

We can reduce CO₂ emissions even more by coupling high-efficiency power generation systems — with more efficient, end-use technologies — more efficient motors, buildings. DOE's Office of Energy Efficiency and Renewable Energy is developing these technologies.

In the longer term, we are working on the "Vision 21 power plant." This coal plant will have efficiencies approaching 60 percent and emit near-zero levels of pollutants — including CO₂. It assumes a CO₂ management or sequestration process.

2. CO₂ removal and sequestration is the second part of our CO₂ strategy. We are developing information on the real cost and performance implications of removing and sequestering CO₂. This is a long-term effort. Possible sequestration techniques include the following:
 - Deep ocean disposal.
 - Geologic disposal in depleted gas and oil reservoirs.
 - Disposal in deep, un-minable coal seams.

Three weeks ago, President Clinton addressed the UN General Assembly. He announced a Climate Change Technology Strategy. The President asked DOE to play a major role in developing this initiative — a technology initiative to seek low cost solutions to climate change. As we speak, DOE's laboratories — including FETC— are drafting this initiative.

The initiative will:

- (A) Define approaches for addressing global warming.
- (B) Identify technology targets.
- (C) Scope out the needed R&D.
- (D) Form industry-university-laboratory partnerships to carry out the R&D Program.

The scope of the initiative includes:

- Clean power generation.
- Energy efficiency in the transportation, building, and manufacturing sectors.
- Science-based technology solutions for beyond 2025.

The schedule for this initiative is aggressive. Last week, DOE delivered the framework for the initiative to the White House. I anticipate that DOE will officially announce the initiative

this week. DOE's goal is to deliver the completed plans for the initiative to the White House by October 1. Industry and universities will be invited to participate in this initiative. However, the mechanism for this is still being developed.

DOE plans to start work on the Climate Change Initiative in FY98! The program could initially involve only repackaging of our current R&D activity. Potentially, however, depending on the level of Congressional and public interest, this could evolve into a major program.

I see this initiative as an opportunity for FETC — in partnership with industry and universities — to develop breakthrough, low cost technologies to reduce greenhouse gas emissions.

The Energy Corridor. Developing an energy corridor is the third hill on the other side of the river. There is a huge potential market for energy equipment and services. The electric utility industry is on the threshold of deregulation in the United States. When the telecommunications, trucking, and airline industries were deregulated, they experienced exponential growth. We can logically expect that deregulation of the electric industry, particularly as it converges with the gas industry, will lead to a lot of new products and services that we can't even imagine.

We should also realize that clustering of any industry helps accelerate growth. Look at the Silicon Valley where the clustering of expertise and educational opportunities helped catalyze the exponential growth of the computer industry.

Now consider the local tri-state area — northern West Virginia, western Pennsylvania, eastern Ohio — this region is the cradle of the energy industry.

- Oil was first produced from Drake's Well in Oil City north of here.
- Coal has been produced in the region since the Revolutionary War.
- Natural gas has been produced for 50 years.
- There is nuclear manufacturing expertise.
- Photovoltaic and fuel cells are being developed here.
- Regional universities have strong energy programs.
- FETC is located here — in the center of the region that is the birthplace of the energy industry in the US.

The region is beginning to refer to itself as the "Energy Corridor." We invite those in the audience to explore regional partnerships that can tap into the energy expertise in this area to solve national energy and environmental problems — to create a synergy to accelerate development of new products.

New R&D Approaches. The last hill is new R&D approaches. I see a whole range of opportunities for industry, university, government consortia — in solving focused problems that fall under the broad umbrella of our major drivers:

- Revisions to the 1990 Clean Air Act Amendments.

- Greenhouse gases.

With the wind-down of the CCT demonstration program, I believe consortia will become much more common in Fossil Energy. We will be addressing focused R&D areas — for example, unburned carbon in fly ash, high-temperature gas filtration. I seek your ideas for identifying opportunities for this type of consortia.

Conclusion

I ask your help in helping us educate the American public about the importance of fossil energy R&D as we cross the bridge to the 21st century. Energy use has a major impact on the U.S. economy! Energy is a \$560 billion per year business, accounting for 8 percent of our Gross Domestic Product. We, along with the rest of the world, are going to use fossil fuels for the foreseeable future. Fossil fuels supply 85 percent percent of the energy we consume in the United States and this is projected to grow to 89 percent by 2015. Let's figure out how to use this fossil fuel cleanly and efficiently. The right decisions — to make sustained investments for the long term — will mean we **can** reconcile

- ★ Our economic imperative — an abundant supply of low cost energy that makes us competitive in world markets and contributes to our quality of life, with
- ★ Our environmental imperative — a nondespoiled earth for our children and grandchildren.