CoalFleet for Tomorrow
An Industry Initiative to Accelerate the Deployment of Advanced Coal-based Generation Plants

Program Summary
September 30, 2004

*CoalFleet for Tomorrow* is an industry initiative formed to accelerate the deployment and commercialization of clean, efficient, advanced coal power systems, thereby preserving coal as a vital component in the electric generation mix. The “CoalFleet” initiative will tackle the technical and economic/institutional challenges to making advanced coal power plants a prudent investment option both in the short term and in the long term, while taking into account the potential for future CO₂ emissions regulations. Over the program lifetime, CoalFleet will address a balanced portfolio of advanced coal technologies, including Integrated Gasification Combined Cycle (IGCC), Ultra-Supercritical PC (USC), and Supercritical Circulating Fluidized Bed Combustion (SC CFBC) and other technologies identified by the CoalFleet participants. CoalFleet will focus ninety percent of its efforts on IGCC and ten percent on other technologies during the first year (Phase 1). USC, SC CFBC and other advanced technologies will be addressed fully in later phases and in anticipation of industry deployment of these technologies.

The Strategic Importance of Coal Power

Coal-based power plants have long been the workhorse of the electricity generation system. Although coal is an abundant and least expensive fossil fuel, few new coal power plants have been built over the past decade, largely because electricity market deregulation favored low-capital-cost gas plants that were relatively quick to permit and build. But times have changed. Oil and natural gas prices have hit record highs over the past four years, and many gas-fired combined cycle plants are being dispatched at only a fraction of their planned capacity factor, yielding poor financial performance. Growing security concerns over the importation of oil and liquefied natural gas as well as demand/supply issues associated with natural gas are likely to keep gas prices high. As a result, coal power is again attractive, both to government agencies concerned with long-term energy security and power generators interested in keeping electricity affordable. Conversely, environmental agencies and advocacy groups continue to step up pressure on coal plant operators to further reduce emissions, including CO₂.

Advanced Coal Plant Deployment Must Begin Now

Today’s coal plants operate reliably and economically, but these plants may become uncompetitive in the next decade due to the difficulty in economically meeting new environmental requirements. The resulting retirements, coupled with demand growth and the prospect of prolonged high gas prices, are expected to trigger significant growth in coal plant construction. CO₂ reduction requirements may also come into effect around this time, either voluntarily or by legislative mandate.

A new generation of commercially viable, advanced coal power systems must be available to meet this coming demand if coal is to retain its critical role as the foundation of the electricity generation system. However, advanced coal technologies cannot reach commercial maturity until they have been proven in full-scale operation, under “real world” conditions, for a sufficient time period to assure expectations of performance and reliability. This is essential to convincing prospective investors that costs and risks are sufficiently understood. In effect, a full-supply-chain advanced coal infrastructure must be established, including users (power generators) manufacturers, design...
and construction service providers, financiers, insurers, regulators, and maintenance/repair contractors.

Such a complete infrastructure does not currently exist. Thus the advanced coal conundrum is “agreement on its ultimate need and value, and on the magnitude of investment and leadtime required to achieve commercial fruition, yet without the adequate commitment of resources by any vested party.” CoalFleet seeks to collaborate with the power industry to break this impasse by creating a vehicle for mutual cooperation in accelerating advanced coal plant deployment and in introducing next-generation designs.

Work must begin now to ensure that advanced coal technologies can establish a solid track record before large numbers of coal plant replacements become necessary. Early adopters—companies willing to shoulder some of the risks associated with implementing new technology—are critical to this effort, as is formulating appropriate incentives for attracting and compensating them.

**CoalFleet Promotes a Robust Portfolio of Advanced Coal Options**

Given the diversity of regional electricity markets and the wide variation in coal properties of regionally economical coals, effective deployment of advanced coal power systems will require a portfolio of technologies, including Integrated Gasification Combined Cycle (IGCC), Ultra-Supercritical PC (USC) and Supercritical Circulating Fluidized-Bed Combustion (SC CFBC) and other technologies identified by the CoalFleet participants.

IGCC technology combines the high efficiency and low emissions of gas turbine power systems with the ability to run on coal and other low-cost solid or heavy liquid fuels. Its relative competitiveness may be greatest for bituminous coal users if the ability to remove CO₂ is needed. Studies by EPRI and others have found that the incremental cost and energy penalty for CO₂ removal from high-pressure IGCC “synthesis gas,” or syngas, are much lower than those for conventional coal flue gas. At the Power Systems Development Facility, researchers are using the transport gasifier to test advanced, high-efficiency gasification systems. New coal-based IGCC plant designs promise to reduce the historically high capital and O&M costs of today’s IGCC plants.

IGCC economics are not as good for subbituminous coal or lignite. For regions where these fuels predominate, USC and SC CFBC may offer cost-effective alternatives. USC plants, generally defined by CoalFleet to be units with main steam conditions exceeding 3600 psi (250 bar) and 1050°F (565°C), are essentially pulverized coal plants with premium boiler and turbine materials that are less susceptible to creep and thereby able to accommodate higher temperatures. Plants above the USC threshold are approaching commercial maturity in Japan and parts of Europe, where high fuel prices have placed a premium on efficiency. [CO₂ restrictions could replicate this price driver in the United States.] Comparable designs (or designs at higher steam conditions) could deliver both performance benefits and emissions reductions in the US. Likewise, new supercritical CFBC plant designs could provide a high-performance, cost-effective option for large-scale plants burning very low-grade fuels.

To begin addressing future, environmental and security needs, US DOE has announced major demonstration projects, such as FutureGen (which if fully funded will involve several billion dollars) to commercialize advanced coal power systems with CO₂ removal and/or hydrogen coproduction capability. EPRI is working closely with US DOE and the Coal Utilization Research Council (CURC) to coordinate advanced coal RD&D and ensure inclusion of practical industry needs. But this is not enough. The power industry can play a major leading role in the
development and commercialization of nearer-term advanced coal power systems to ensure that new technologies are well suited to “real world” business needs and more immediate environmental goals.

CoalFleet for Tomorrow—An Initiative Planned with Visionaries and Pragmatists

During the past several months, EPRI has held a major workshop and has engaged in detailed discussions with many advanced coal plant stakeholders on the need for a robust collaborative initiative. These have included the EPRI Board of Directors, the EPRI Generation Council, many large coal-based power generators, US DOE, coal companies, OEMs, A/Es, and regulators, etc., and perspectives ranged from visionary to pragmatic. Consequently, the discussions confirmed the consensus that a robust collaborative initiative was needed to develop and manage a comprehensive program designed to accelerate and augment the research, development, demonstration and deployment of IGCC and other advanced coal generation technologies including options for CO2 capture and sequestration to ensure their commercial availability and operation by 2015 to 2020. Discussions also confirmed the urgent need to deploy IGCC/advanced coal plants as quickly as possible in the next 5-10 years, to focus initially on deployment and to work actively with early deployment owners.

As shown in Figure 1, CoalFleet will focus on the deployment of IGCC/advanced coal technologies in two major timeframes:

- Near-term deployment of IGCC/advanced coal technology plants to be operating in 5 to 10 years with consideration given to CO2 capture capabilities added in the future. This work will actively engage with Early Deployment Plant Owners.
- Longer-term deployment of IGCC/advanced coal technology plants that are CO2 capture-capable (pre-engineered for phased addition) or are CO2 capture equipped.

To provide technical oversight and direction for the initiative, CoalFleet will form a World-Class Expert Working Group from the Early Deployment Owners, Core Funders, Government experts, EPRI and selected Industry experts.

For near-term deployment, three to five Early Deployment Owners, who are participants in CoalFleet, will be developing site-specific designs for IGCC/advanced coal plants. The operating concept for CoalFleet will be to utilize a “learning by doing” approach and participate directly with these site-specific design projects by providing both IGCC/advanced coal plant expertise and information from previous EPRI, US DOE and industry efforts (formulated into an Advanced Coal Technologies Knowledge Base) during the technology selection and plant design processes. CoalFleet, with support from the Early Deployment Owners, appropriate Engineer-Procure-Construct (EPC) companies and technology suppliers will translate non-proprietary information from the site-specific design studies to create Plant Design Guidelines (such as User Design Basis Specifications and Generic Design Specifications) for use by all CoalFleet participants. Non-proprietary costs and project financial proformas for different organizational types will also be produced in this manner, allowing the Industry to obtain the anticipated benefits of standardization for IGCC and advanced coal technologies. The approach will include the creation of options for each Plant Design Guideline developed that facilitates tailoring of the guidelines to various power systems. For CoalFleet, this work will be generically incorporated into results and deliverables and make them practical, robust, used, and useful.

Technology from the US DOE RD&D programs in Clean Coal and CO2 capture and sequestration, along with CoalFleet results and industry RD&D are expected to be integrated into both early
deployment and next-generation units as shown in Figure 1. CoalFleet and the significant Clean Coal and CO₂ capture and sequestration programs of both US DOE and EPRI will feed technology results into both early deployment and commercial units. EPRI is aware of the significant contribution of US DOE’s Clean Coal RD&D programs and has been a part of many projects over the last two decades. Technical contributions from other countries will also help accelerate advanced plants. CoalFleet will coordinate very closely with and complement this work.

Figure 1. CoalFleet’s Strategy to Support Early Deployment Units and Accelerate Commercial Offering of “Next Generation” Advanced Coal Plants

CoalFleet Phase 1 Activities

CoalFleet’s first phase comprises three key elements, scheduled to take place over one year:


This element will perform a comprehensive evaluation of the plant permitting process and identify technical, regulatory and procedural issues that must be addressed up-front during the plant design in order to minimize plant permitting costs and schedules. It will also evaluate incentives to accelerate the deployment of IGCC/advanced coal plants as follows:

- **Task 1.1. Preliminary Examination of Early Plant Deployment Incentives.** This is a Rapid Start effort and will analyze incentive structures for encouraging deployment of IGCC/advanced coal plants. This initial effort will develop, demonstrate and refine technical approaches for assessing the benefits of a range of incentive structures to a variety of company types (e.g., private, regulated, merchant, public, cooperative) and will provide insights into the value of the incentives analyzed.

- **Task 1.2. Assess Impacts of Plant Design on the IGCC/Advanced Coal Plant Permitting and Licensing Process.** This task will assess the impacts of plant design on the IGCC plant licensing and permitting process. A comprehensive evaluation of the licensing and permitting process will be performed. It will identify the critical technical, regulatory and procedural issues that must be addressed up-front and throughout the plant design and equipment selection in order to minimize plant permitting costs and schedules. It will also
review the issues involved if technology were to be set as Best Available Control Technology

• Task 1.3. Examination of Advanced Coal Technology Deployment Incentives. This task will build upon the IGCC/advanced coal plant deployment incentives work performed in Task 1.1. It will provide expanded analyses considering a range of advanced coal technologies, additional incentive structures and additional locations.

• Task 1.4 Synthesize and Communicate Information on Costs, Risks, Benefits, and Incentives. In this task, a summary of key results will be provided through reports and in presentations for CoalFleet members to enable independent analysis.

High capital/construction costs, inadequate reliability, long project schedules, lack of standardization, and environmental permitting procedures are working against the selection of advanced coal technologies. Standardized Plant Design Guidelines will support early deployment and will reduce the time, costs, and risks of building advanced coal plants by optimizing, modularizing, and standardizing the plant designs for a range of technologies, coal types, regional issues, and organizations. They will provide a clear and complete set of User Design Basis Specifications and establish Generic Design Specifications for plant designers. The Expert Working Group will direct the work to develop the Generic Design Guidelines in coordination with actual plant design activities. An Advanced Coal Technologies Knowledge Base will be structured that includes EPRI advanced coal project experience, US DOE advanced coal technology projects and assessments, and industry information. Phase 1 will provide the Advanced Coal Technologies Knowledge Base, a User Design Basis Specification document for IGCC, outlines of IGCC Generic Design Specifications, and a Phase 2 Implementation Plan.

Element 3. Identify RD&D and Incentives Required to Accelerate Deployment of Advanced Coal Technologies. This element will create an industry focused RD&D plan with projects that augment and accelerate current RD&D activities so needed technology will be ready for early deployment plants and next-generation plants. CoalFleet will coordinate with existing research initiatives (such as US DOE’s FutureGen program) and strategic planning efforts (such as the US DOE/CURC/EPRI Roadmap) to ensure that its programs complement and accelerate ongoing industry and government work. The result of Phase 1 will be detailed plans for complementary collaborative R&D projects that in the near-term support early deployment plant needs and in the long-term meet both US DOE/CURC/EPRI Roadmap goals and next-generation unit deployment needs. These plans may include projects such as reliability improvement for syngas-fed combustion turbines and gasifier refractories, feed nozzles, heat rate improvement and large-scale, long-term CO₂ capture and sequestration demonstrations in different regions. Projects will also be developed that support human performance capabilities such as training simulators, maintenance guidelines and operating guidelines/best practices. Incentives will be identified that promote the performance of these RD&D projects by the supporting industry. Private and public partners will be identified to accelerate high-priority projects in the follow-on work.

CoalFleet Phase 2 Plans

CoalFleet’s second phase will support implementation of the permitting and incentive measures and vital RD&D projects identified in Phase 1. Phase 2 will also encompass detailed design and construction support for early deployment plant projects. Such projects will demonstrate the value of the User Design Basis Specifications and Generic Design Guidelines developed under Phase 1 and also provide feedback to refine and expand the guidelines under Phase 2, increasing their value.
to future project developers. Phase 2 may also cover engineering and construction of CO₂ capture technologies suited to advanced coal power system designs. The exact scope of Phase 2 activities will depend on the extent of secured funding and the number of early deployment plant hosts.

**CoalFleet Advisory Structure**

Like other EPRI projects, CoalFleet will receive direction from the Generation Council and the Advisory Structure. Major funders, early deployment plant owners, and EPRI will lead the CoalFleet initiative, with input from other funders, such as US DOE, power generators, OEMs, process suppliers, coal producers, A/Es, and constructors. Support will be provided by trade organizations, such as GTC, EEI, NRECA, APPA, and CII. CoalFleet will maintain communications with other stakeholders, such as regulators, financial institutions, academia, and NGOs. Figure 2 depicts a conceptual framework for the CoalFleet Advisory Structure.

![Figure 2. Conceptual Advisory Structure for the CoalFleet Initiative](image)

**Core** = Major Funders/Early Deployers, EPRI support  
**Other Funders** = Power Generators, DOE, OEMs, Process Suppliers, Coal Producers, A/Es Constructors, Others  
**Supporting Organizations** = Trade Associations—GTC, EEI, NRECA, APPA, CII, etc.  
**Links to Other Stakeholders** = Regulators, Financial Institutions, Academia, NGOs, etc.

**CoalFleet Value**

Keeping the coal fuel option in the mix of clean, efficient, economical power generation options is critical to the overall electricity needs of the future. Accelerating and deploying advanced coal generating technologies to ensure their commercial availability will build the confidence that clean, efficient power can be produced using coal in meeting our energy needs at an affordable price.

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