ELECTRIC POWER
RESEARCH INSTITUTE

Carbon Reduction Options for Fossil Fleets

Executive Summary





Carbon Reduction Options for Fossil Fleets

"Global climate change continues to be a defining issue for our company and our world. As one of the largest emitters of carbon dioxide (CO_2) in the U.S., we take the challenge of reducing greenhouse gases very seriously. We aspire to cut our 2006 U.S. CO_2 emissions in half by 2030, and our vision is to do that by diversifying our fleet – replacing older, less-efficient coal plants with new, cleaner-burning coal technologies and other new assets – and improving the efficiency of all of our assets."

– David W. Mohler, vice president and chief of technology for Duke Energy

Transitioning to a low-carbon fleet

A critical challenge facing electricity generation companies is the transition to a portfolio of assets that can cost-effectively produce power while complying with increasingly stringent environmental regulations. Today, the rise of atmospheric greenhouse gas concentrations that could result in global climate change is among the top public and regulatory environmental concerns. The need to limit emissions of CO_2 and other greenhouse gases might require substantial changes in the way power is produced.

Carbon-reduction challenges

The change to a low-carbon-emissions power generation fleet poses significant challenges, including determining the most cost-effective transition plan and quantifying the magnitude and timing of required investments in existing and new technologies. The key strategic question is how to minimize carbon emissions while maintaining reliable, low-cost power.

Curbing emissions with proven technologies – and a transition strategy

Concerns about climate change and national and international efforts to reduce CO_2 emissions will drive power generating companies to build low-emission technologies, requiring substantial capital expenditures and time. The operational and economic value of existing generating plants will be substantial during the transition to lower-carbon generation. Strategic investments in improved operation and efficiency of existing plants can deliver significant carbon reductions while limiting capital expenditures for new assets.

Developing an effective fleet transition strategy will be complex, given that existing plants were built over several decades, using widely varying technologies — and each has its own operating history, dispatch costs, and remaining service life. Adding to this complexity is the fact that new low-carbon technologies are still emerging or evolving from prototypes to economically competitive versions.

From a fleet perspective, options for carbon reduction can be viewed in these major categories:

- **Run/retire** — Operate an existing plant in its current mode with limited low-cost carbon reduction improvements below the New Source Review threshold, or take the unit out of service.
- **Upgrade/retrofit** — Invest more significant capital in existing assets to increase thermodynamic efficiency and to reduce CO_2 emissions — for example, steam turbine replacements and retrofits of carbon capture and storage (CCS) systems.
- **Repower/new assets** — Develop new low-carbon assets, including repowered coal units using biomass, and construction of new assets such as combustion turbines/combined-cycle units or advanced coal plants with CCS.

Deployment of CCS will be critical to reducing carbon emissions, but several other strategies are also viable:

- Some power generation companies are replacing older units — those with larger "carbon footprints" — with new, lower-carbon assets such as natural gas-fired units. However, although gas offers lower CO_2 emissions than coal and might meet interim CO_2 reduction targets, expected emissions constraints eventually will require that these emissions will also have to be substantially reduced.

- Investing in existing assets to lower emissions can result in lower abatement costs compared to development and deployment of new assets or purchasing lower-emissions-intensity power. Asset decisions for existing fossil units must be coordinated with other key issues such as system needs, the integration of renewable generation, the presence of significant prior investments (for example, emissions controls), the need for peaking and ancillary services resources, expected electrical demand, and remaining unit life.

Near-term options alone will not be sufficient for effective, long-term carbon-reduction strategies. New developments constantly change the relative value of assets within a portfolio — technologies mature and their costs decrease, and new technologies and processes become economically competitive under new regulatory and market conditions. As multiple regulations emerge at different times, they change the entire asset value equation.

If companies are to develop cost-effective strategies to reduce carbon emissions, they will require reliable, up-to-date data and state-of-the-art methodologies to perform integrated analyses of the costs, benefits, and risks associated with asset decisions. This information creates a framework for systematically considering the impact of uncertainties associated with key issues. Ultimately, the critical capability is the ongoing management and assessment of different asset portfolio strategies.

R&D Enabled Solutions

In 2009, coal and natural gas provided 68% of U.S. electricity generation and 62% worldwide. EPRI has shown in its Prism and MERGE analyses (see EPRI documents 1015461, 1018341, and 1019563) that a "full portfolio" of innovative technology approaches is needed to make substantial CO_2 emissions reductions while minimizing economic impacts of emissions reduction policies.

The transition to a lower-carbon generation portfolio requires several technology options, many of which are currently unavailable or not fully developed. A key option will be commercially viable CO_2 capture and storage (CCS) for coal and natural gas generation by 2020. Research is also needed to develop new technologies and processes that support long-term unit- and fleet-level carbon-reduction strategies at reasonable costs.

Key considerations in developing a fleet transition strategy are the long lead times and advanced planning required to develop and deploy new technologies and assets. In addition, it is vital to assess risk inherent in the decisions comprising a fleet strategy, given the significant uncertainty surrounding many key factors, including future fuel prices, demand, and the timing and scope of new regulations.

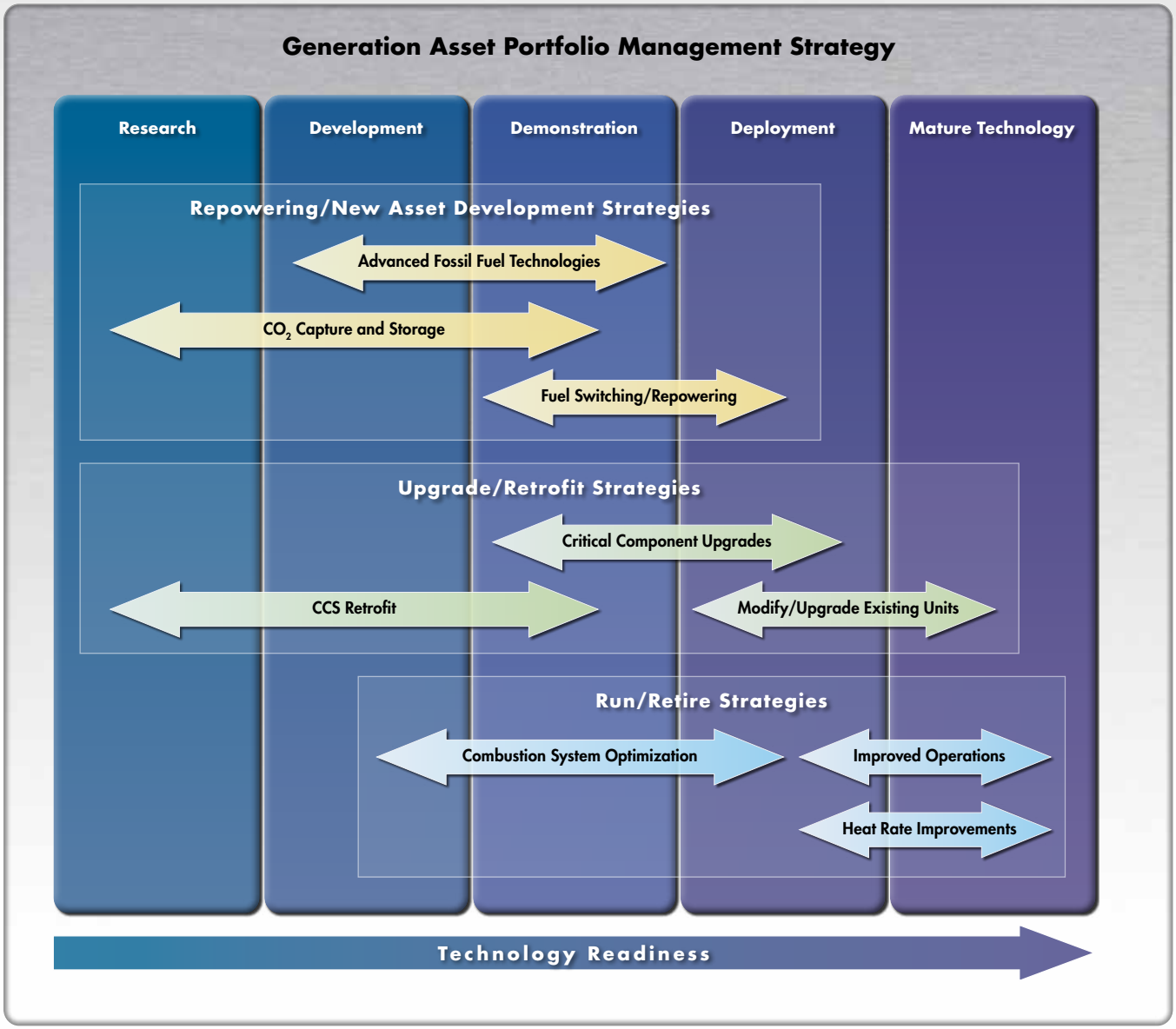
It is therefore very important to develop a basis for comparing the effects of different technology strategies for developing an economical, low-carbon asset portfolio. Given diverse issues such as reliability, overall cost, and CO_2 abatement cost, decisions regarding individual assets could combine in different ways to yield different strategies.

Different strategies can be evaluated through quantitative comparison of potential portfolios. Such comparisons can be based on characteristics such as portfolio valuation and level of financial risk and also can enable an assessment of sensitivities and the impact of different uncertainties on the viability of different portfolio management strategies.

EPRI's R&D portfolio focuses on enhancing decision-making associated with long-term management of the generation fleet. The goal is strategies that can significantly reduce costs and penalties associated with deploying key technologies. This research includes:

- Heat rate improvements
- Improved operations
- Combustion system optimization
- Critical component upgrades
- Carbon capture and storage development, including CCS retrofit
- Advanced fossil generation technologies
- Generation asset portfolio management strategies

The scope of EPRI research and development spans a range of options from low-cost existing fleet improvements to major investment in deploying new low-carbon generation technologies (see below). The objective: Enable decision-makers to employ integrated planning tools, identify low-carbon deployment options for both individual units and fleets, and optimize the economic and technical efficiency of reducing CO_2 emissions across a company's entire asset portfolio.



The Electric Power Research Institute, Inc.
(EPRI, www.epri.com) conducts research and development relating to the generation, delivery and use of electricity for the benefit of the public. An independent, nonprofit organization, EPRI brings together its scientists and engineers as well as experts from academia and industry to help address challenges in electricity, including reliability, efficiency, health, safety and the environment. EPRI also provides technology, policy and economic analyses to drive long-range research and development planning, and supports research in emerging technologies. EPRI's members represent more than 90 percent of the electricity generated and delivered in the United States, and international participation extends to 40 countries. EPRI's principal offices and laboratories are located in Palo Alto, Calif.; Charlotte, N.C.; Knoxville, Tenn.; and Lenox, Mass.

Printed on recycled paper in the United States of America

1021534

3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 • USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com