Reducing Carbon Emissions from Electricity Generation

Conclusions:

• No single technology will solve the carbon reduction challenge on its own. A diversified, low-carbon generation portfolio, using all available technologies, needs to be developed and deployed to provide resource flexibility and lower fuel source risk, and subsequently, to slow increases in the cost of electricity to consumers.

• The failure to articulate clear targets and establish the proper regulatory framework for a low-carbon generation portfolio will likely result in an over reliance on natural gas and other unintended consequences.

• In terms of emissions, nuclear energy presents new value in a carbon constrained world. Issues involving safety, waste disposal, and proliferation, however, require continued attention.

• Renewable energy should play an increasing role in the generation mix, although many current aggressive deployment targets are unlikely to be met. Past lapses in policy support for renewable energy, such as the expiration of the renewable energy production tax credit, have led to “boom and bust” cycles that have impeded progress.
Carbon capture and storage is critical to stabilize atmospheric greenhouse gases, yet under the most optimistic assumptions, market-ready carbon capture technologies are at least a decade away. Government must urgently organize an effort to move beyond “paper studies” to undertake long-scale technology demonstrations that explore multiple approaches to pre- and post-combustion carbon capture.

New coal-fueled generating plants should be designed and built with the expectation that they will have to be retrofitted in the future to permit carbon capture. Carbon capture technology is not yet ready to incorporate in every new plant, but failure to take low-cost steps to plan for retrofit will have serious consequences on the affordability and operation of coal plants.

Government must organize an accelerated effort supporting long term carbon storage. Specifically, public and private interests must investigate a variety of geologic storage options by undertaking large scale testing with strong scientific underpinnings. The energy industry must establish a uniform legal regime that can deal with matters including liability, ownership and permitting related to carbon storage.

Choosing among Competing Technologies

The Forum considered analyses of how the country’s carbon footprint could be reduced with existing technology. In recent years, three policy drivers have come together to define aspects of electricity generation:

- Environmental concerns regarding climate change,
- International energy security and the price of oil and gas, and
- Economics of growing energy demand.
Combined with technological improvements, these policy drivers have served to increase policy support for clean energy and narrow the competitive advantage of some traditional fuels and technologies.

Government, leaders in the energy sector and others are in the process of negotiating policies that will account for the formerly externalized costs of carbon emissions and make action on carbon reduction not just the right thing to do, but a business necessity. This will further narrow the band of competitiveness among generation fuels and technologies as the cost of previously inexpensive fossil fuels rises. How the costs are shared by consumers, producers and taxpayers is the subject of much of the 2005 Energy Policy Act.

**Competing for Clean Generation**

Industry leaders realize that the clean energy race is on. According to one analyst, “It will be a marathon, not a sprint.” Clean energy technology must be in place by 2020 if society is to have a portfolio to address climate change. Competitive markets and good policies must be implemented much earlier for this to be accomplished.

There are new economics to power generation. In a shift from the last major electrical build-out in the 1970’s, the cost of new construction now often exceeds 50 percent of the value of a company’s entire power plant fleet. Costs are being driven up by global demand for the commodities and equipment necessary for heavy manufacturing. Key equipment vendors have consolidated and have limited manufacturing capacity worldwide, and this will add to costs and timelines. Additionally, the energy industry at large must face a shrinking workforce of qualified professionals as current employees reach retirement age. The energy industry is now developing education and training programs to introduce the next generation of skilled trades people, engineers and executives, but this will be a lengthy process.
New options for baseload generation that achieve low carbon emissions will hold other challenges. Utilities already have evidence that siting new plants and transmission lines will be difficult. Direct or indirect taxing of carbon emissions, considered to be a virtual certainty, will raise costs for coal-fired generation and, to a lesser extent, for gas.

These new factors pressure power producers to account for changing economics as they choose among generation options. While coal may be an abundant and affordable fuel, coal fired plants present investment risks if carbon controls are implemented. Awareness of these competitive issues is acute among utilities that have seen their nuclear fleets become the high performers for low carbon, baseload generation. As a result, 19 entities have expressed to the Nuclear Regulatory Commission interest in beginning the licensing process to construct 29 new reactors in the U.S.
A Low-Carbon Scenario

Forum participants agreed that the technical feasibility of CO₂ reductions is constrained by economically feasibility. An Electric Power Research Institute (EPRI) study provided the basis for discussion of these issues as participants responded to a scenario that illustrated how carbon emissions from electricity generation could be reduced.

CO₂ Reductions … Technical Feasibility.

An Electric Power Research Institute study concluded that a variety of technically feasible technologies could reduce CO₂ emissions from the U.S. electricity sector below 1990 levels by 2030.

The EPRI study assessed the timeframes in which the industry could reduce its carbon footprint. It estimates that energy efficiency could reduce the expected rate of electricity growth by 30 percent by 2030. It assumes that renewable portfolio standards (RPS) will be met and extended, and that nuclear capacity will grow by as much as the equivalent of 50 new plants by 2030. The efficiency of new coal-fired generation will also be increased—to 46 percent by 2020 and 49 percent by 2030. Carbon capture and storage (CCS) plays a significant role after 2020. In addition 5 percent of today’s base load
electricity would be offset in 2030 by distributed solar photovoltaic and by plug-in hybrid vehicles, which would represent 40 percent of new car sales.

Achieving these goals relies on the industry’s ability to prepare the distribution grid to handle increased congestion and accommodate the two-way interface of new distributed energy resources (DER). Progress also requires successful relicensing of nuclear plants, introduction of advanced reactors, and orders for CCS by 2010 with commercial installation by 2020.

**Who Bears the Cost?**

Discussing alternatives to the EPRI scenario, Forum participants emphasized the tensions between competing interests. Decision makers face societal pressure on energy issues based not only on facts, but on opinions, distortions, self interest, and fear about the cost of climate change mitigation. The Forum participants generally agreed that today’s energy choices are likely to lead to higher consumer prices.

The availability of ongoing policy support will determine which new technologies and facilities can actually be brought on line and how quickly. In addition, the enhancement of the transmission system will be expensive. These associated costs, and whether they are paid by taxpayers, ratepayers or others, may change public attitudes towards various power generation options and consumer behaviors.

Investors seek to reduce the political and technology risks before backing the multi-billion dollar expenditures required to deploy new technologies. Whether through loan guarantees, production tax credits or renewable portfolio standards, capital markets are looking for clear and transparent rules. There is a tension between government and markets as together they must achieve national goals while avoiding mistakes or unintended consequences. Balancing idealism and practicality, the debate over including a “safety valve” on the price of carbon illustrates this tension.
In the design of a cap and trade system for reducing carbon emissions, a safety valve would place a regularly increasing ceiling on the price of carbon. This could make the passage of legislation easier and prevent unacceptable costs to the economy, but it could also preclude achievement of desired carbon reduction goals and make participation in a global trading scheme difficult.

Debates about America’s energy future begin to take concrete shape at such points, where regulators and policy makers must decide to how to set priorities or to fix problems in the market place. Three specific policies included in the Energy Policy Act of 2005 typify the controversies involved:

- **Loan guarantees** are generally reserved for the first few demonstrations of a commercial scale technology to show predictability to investors. These financial incentives are intended to make technologies that serve national interests commercially competitive. Loan guarantees remain controversial as policy makers debate whether these incentives are appropriate for incremental improvements to existing technologies, such as coal and nuclear plants, or should be reserved for new technologies such as cellulosic ethanol and tidal power.

- **Production tax credits** offer financial assistance only if and when power plants begin producing energy. Unlike loan guarantees, this mechanism protects the government against spending money for plants that never produce. For capital intensive projects, however, some contend these credits actually discourage lenders by implicitly suggesting there is a risk the plants will not come on line. The Energy Policy Act of 1992 enacted production tax credits for wind energy. However, the credits have been allowed to expire three times, causing the market for new wind capacity to collapse each time.

- **Renewable portfolio standards** set aggressive requirements for the percent of renewable energy used on a state by state basis and are designed to aggressively increase the use of renewable technologies. Arguments for federal integration of
these standards exist; however, some analysts fear that national requirements will be set lower than ambitious state goals. Others argue that national standards will disadvantage regions with a less attractive renewable resource base.

The outcomes of decision making in these policy areas will ultimately influence the price of electricity for consumers. For better or worse, market interventions serve to disguise the true cost of electricity. These decisions will also work for or against demand reduction goals. For example, loan guarantees and tax credits tend to reduce prices to ratepayers and therefore raise demand, while renewable portfolio standards can raise prices and thus reduce demand. Some observers characterize all three of the above incentives as ways the government attempts to “pick winners,” something they believe should be left to the market without intervention. The challenge remains in defining the appropriate role for government in allowing market forces to achieve national goals.

Creating Low-Carbon Generation Portfolios

The shift underway in the venture capital community demonstrates the influence of climate change on energy markets. The business potential of renewables appears to be catching up with longstanding positive public opinion toward them. New partners are emerging, and market participants are looking to see where the profits will materialize. Clean energy scenarios throughout the country offer many aggressive targets, although some industry analysts do not believe standards were set at levels regulators actually expect to meet.

By 2030, some estimate that renewable energy’s portion of the overall electricity mix may max out at 10 percent. The renewables sector may be limited in its potential by the diminishing quality of its resource base. As companies exploit the best geothermal, solar, and wind sites first, subsequent expenses may rise. Utilities may struggle to meet renewable requirements as less desirable sites are left and required ties into the transmission grid become more difficult to site.
The Forum also looked at bridge technologies that could be deployed while new technologies develop. Although the use of biofuels currently represents less than one percent of the global transport fuel market, the U.S. is mandating a minimum amount of ethanol use. Meanwhile, Brazil is a conspicuous success. Some investors anticipate a fundamental increase in support for this type of technology. Considered a “social fuel trend,” these technologies have already seen significant support in European markets, and investors expect global renewable capacity to grow.

Capital markets have been excited about solar photovoltaic (PV) technology as well. While PV is restricted to very small end-uses today, this technology could be a potential market disruptor if cost goes down. Manufacturers are seeking to reduce the amount and cost of semi-conducting material needed and to increase efficiency, which could drive costs down to $1-2 per watt from the current $3.
Nuclear power will remain an important piece of the U.S. energy portfolio. Most people think that, in a carbon constrained world, new nuclear is an attractive option. Industry leaders agree that existing plants are vital to the U.S electricity markets. They support uprates to increase the productivity of plants and life extensions that will keep existing plants productive. However, concerns remain about economics and proliferation risks of new nuclear construction. Waste disposal issues present the largest differences of opinion on nuclear power. Some skeptics oppose geological disposal altogether, while others oppose simply the Yucca Mountain site. Opponents of on-site storage support a centralized repository and seek to resolve concerns about waste transportation. The result of these disparate opinions is that construction of new nuclear plants may wait until spent fuel issues are resolved to the public’s satisfaction. However, the price that may be set on carbon could also greatly influence the pace of nuclear construction, letting market principles influence whether investors will carry more of the risk of new nuclear.

The likelihood of mandatory carbon constraints is driving the ethic of energy productivity. Anticipated carbon controls may take the form of taxes, trading costs or storage fees. Under any CO₂ control scenario, businesses will look to low carbon generation options to offer competitive advantage. As one Forum participant quipped, “The cheapest ton of CO₂ is the one that is not produced.”

Integrated gasification combined cycle or supercritical pulverized coal technologies present attractive options to limit carbon emissions from electricity production. However, while these technologies are ready or nearly ready for deployment and can reduce CO₂ emissions by 20-25 percent, they are more costly than conventional pulverized coal plants and they will probably not offer a reduction significant enough to allow the use of coal without CCS.

One Forum participant asked, “What should a utility executive who has low-cost capital available do with coal plants that have exhausted conventional methods of carbon reduction?” A consultant advised that a utility might consider deploying that capital to reduce further the carbon footprints of those units with biomass.
Using existing technology, the consultant explained, producers could incorporate biomass into the fuel stream to reduce emissions. Technical improvements could be made to lower the heat rate and increase the efficiency of these co-fired plants. Coal plants would still produce CO₂ but at a lower rate, and emissions of other regulated pollutants would be reduced.

For generators looking for long-term solutions for cleaner coal plants, a Forum presenter recommended another option available today—support carbon capture demonstrations. CCS technology is moving forward, but it has not yet been fully demonstrated at commercial scale. U.S. companies and public utilities anticipating a future price on carbon are looking to invest in or deploy capture-ready coal plants. As CO₂ capture solutions are proven on a commercial scale, ongoing efforts must be made to prove carbon storage techniques as well. The U.S. has good geological options for siting storage; however, uncertainty regarding legal issues and public acceptance will inhibit investment. The challenge for equipment suppliers is finding the investors willing to demonstrate this technology before anyone is ready to buy it.

**CO₂ Capture Solutions: Time-line of CO₂ Capture Processes.**

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Source: ALSTOM

Different processes for capturing carbon are at different stages of readiness. Several could be ready for commercial deployment within a decade. Some U.S. companies and public utilities are investing in pilot or demonstration projects.
The U.S is not alone in its investigation of clean coal options. Worldwide, 64 percent of the coal used is for electricity production, and climate change concerns inspire various responses. For example, the European Union will require certification of all coal plants as “capture ready” by 2018. Existing plants will therefore need to be retrofitted. For operators, the expense is significant. Plant executives recommend better preparation to accommodate retrofits in the future. Specifically, they want to avoid the need to break into thick walled steam piping and to manage the lengthy outages. The retrofits present significant lost time, and advanced planning prevents deeper and more costly modifications to the system.