

# Electricity

**WHO WILL BUILD NEW CAPACITY?**

2005 Aspen Institute Energy Policy Forum  
James E. Rogers, Chair



THE ASPEN INSTITUTE

Paul Runci, Rapporteur

John A. Riggs, Program Executive Director

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## *Foreword*

The Energy Information Administration projects that 62 gigawatts of new and replacement generating capacity will have to be built in the US in the next ten years, and another 173 GW in the ten years after that. The 2005 Aspen Energy Policy Forum considered several questions posed by this challenge. Who bears the responsibility for building new capacity in a partially deregulated market? Who has the incentive and the access to enough capital to build it? How are different state regulatory regimes or tensions between federal and state regulators affecting decisions to build? What impact will expected carbon constraints and technological advances have on what is built?

In keeping with the Aspen Institute's method of informed dialogue among people of diverse backgrounds and viewpoints, the Forum convenes leaders from business, finance, government, academia, and environmental and consumer groups to explore policy questions that require crosscutting, interdisciplinary approaches. Challenged to avoid easy answers, the participants seek to weigh competing values and approach policy issues holistically. A not-for-attribution rule encourages candor and the exploration of new ideas, and the informal atmosphere and collegiality encourage respect for different opinions.

The 2005 Forum was chaired by James E. Rogers, Chairman, President and CEO of Cinergy Corp. His many years as a utility executive and prior experience as a regulator gave him the knowl-

edge and experience to guide the discussion and to bring focus and perspective to a large topic. The Institute and the Forum participants are grateful to him.

The greatest strength of the Forum lies in the expert contributions from the various participants, but presentations from invited experts start each session, and knowledgeable session chairs guide the ensuing dialogue. The experts provided a wealth of information and a variety of perspectives, contributing immensely to the richness of the discussion, and the chairs helped frame the dialogue as well as adding their own substantial experience. We appreciate the contributions of these presenters and session chairs, who are listed in the agenda.

Paul Runci served as rapporteur and admirably captured, distilled and organized the highlights of a free-ranging discussion. Katrin Thomas managed the administrative details of the Forum with her customary good nature and efficiency.

The Institute's Program on Energy, the Environment, and the Economy is grateful for the generous support of our sponsors. Without their confidence in our work, this Forum would not be possible. We gratefully recognize and thank the following for their support during the past year.

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result of an extensive discussion and substantial agreement during the final session, participants were not asked to agree to every word and not all were present until the end.

John A. Riggs  
Executive Director  
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and the Economy

## *Introduction*

Many uncertainties surround the future of electric power supply in the United States. The current hybrid industry structure juxtaposes restructured and regulated states, reveals unclear and often conflicting state and federal regulatory jurisdictions, heightens risks to investors, and raises concerns about the continued viability of the electric power system. Because of the critical importance of this system, the 2005 Aspen Institute Energy Policy Forum focused on the question of future power supply.

A long-standing regulatory compact governed the U.S. power industry from the 1930s to the 1990s. Under this implicit agreement, regulators allowed electric utilities to earn a modest but stable return in exchange for a promise of universal service at reasonable rates. Many observers now fear, however, that the compact has disintegrated, a casualty of industry restructuring, deregulation, and ever-growing complexity of the industry's governance and operation. If true, the situation raises many important questions, including the following:

- Who will be responsible for the future of electric power infrastructure and what will be built? The country's aging power plants and transmission grid will have to be replaced, refurbished, or modernized. This question has taken on greater urgency in recent years, as concerns have grown regarding the many potential vulnerabilities of the power grid to terrorist attack. Yet it is unclear who will assume responsibility to

ensure that adequate and resilient infrastructure is built under current market rules and conditions.

- How effectively can an unintentional hybrid market operate? Since many observers believe that the current industry structure is likely to last for at least several years, it will be important to ensure that investor owned and municipal utilities, power cooperatives, merchant plants, industrial and other distributed generators, and others can operate side by side and attract sufficient investment capital to update and expand generation and transmission infrastructure. Some degree of harmonization among disparate regulatory structures, such as those in place in California versus those of the Pennsylvania-New Jersey-Maryland (PJM) wholesale power grid, will have to be achieved to facilitate uninterrupted, high-quality service.
- What are the implications of the regulation of carbon dioxide emissions and other pollutants (e.g., SO<sub>x</sub>, NO<sub>x</sub>, particulates, and mercury) for the future of the industry? Considering what many observers see as the inevitability of a carbon constraint on the industry, how might carbon best be managed and how might the industry, regulators, and consumers work together to find efficient and effective ways of reducing carbon emissions?
- How will current high fuel costs and new technology options affect industry planning? Over the past two years, gas prices have risen threefold and coal prices have also begun to rise. Considering that the industry already faces serious capital constraints and ongoing capital needs for system upgrades and environmental compliance, rising fuel costs may complicate the industry's construction planning. Short gas supplies and high prices are making coal plants attractive once again, with implications for carbon management. What are industry expectations regarding future fuel costs, technology choices, and consumer preferences?

Participants at the Aspen Energy Policy Forum addressed these and other important questions facing the electric power industry in the course of four half-day sessions. During their fifth and final discussion, they offered a series of five principle recommendations to assist policymakers, industry leaders, and investors in their future decision making. This report is organized around these recommendations.

It is important to note that consensus is not the primary goal of the Energy Policy Forum, and the findings here do not represent the unanimous recommendations of participants. Each finding does, however, reflect the opinion of a large majority of those present during the final session.

## *Market Design*

***Recommendation:*** Policymakers must move quickly to resolve wholesale market design issues in order to settle procurement rules and provide regulatory stability for new investments in transmission and generation. Wholesale and retail market design rules should be technologically neutral, facilitating market entry for a wide range of technologies, including renewables, combined heat and power, and distributed generation systems.

There was general agreement among Forum participants that market rules and the electric power system are not functioning well in the U.S. and demand urgent attention. The system is hampered by a number of its inherent features, many of which arise from the age of its infrastructure, rising power demand, huge capital needs, and from the complex rules governing its operation. These problems introduce market instability, inhibit long-term planning, create conflict among regulators, suppliers, and consumers, and endanger the primary mission of the electric power system: the provision of reliable, affordable, and universal service.

Alleviating market instability and price volatility, according to one Forum participant, is one of the most serious design challenges facing the U.S. electric power industry. In unstable markets, cash flows are volatile. Because the maximum amount of debt a compa-

ny can use is determined by the amount it can afford at minimum cash flows, stable markets without revenue “valleys” allow a higher ratio of debt to equity and therefore a lower weighted average cost of capital. This leads to lower capacity costs and allows more efficient generation technology, with higher initial capital costs but lower fuel costs, to be competitive.

Markets for additional generation and transmission capacity can be designed to provide stability, with ensuing lower prices for consumers. One form of capacity market design is the “demand curve” approach being used in New York and considered in New England and PJM. It moderates the volatility of capacity prices. Planners define the demand curve for each geographic market and decide what transmission enhancements are to be made, which in turn will affect the definition of the geographic markets. Someone must also decide when more capacity is needed, when capacity auctions will occur, for what year and term, and perhaps for what technology attributes (e.g. quick start and/or load-following capability). Some participants noted that the potential consumer benefits of such planning require a move away from market forces and may be offset by the loss of the benefits that are believed to flow from more robust competition.

Thus far capacity markets have been for the current year or the next year, but given the three or four years needed to build a new power plant, four-year markets are likely necessary to enable new entrants to participate and provide additional competition. Such an extension of market horizons could enable new entrants to participate, thereby providing additional competitive suppliers, more price stability, and assurances of sufficient capacity in the longer term. However, some participants felt that such an extension of the capacity market time horizon was unrealistic, and that other mechanisms—such as unrestricted prices and easier market entry and exit for producers—might offer more practical means of stabilization.

Despite the volatility of power markets, one participant showed that there has been steady growth in the number of proposals for new base load plants (representing some 60GW of new capacity) in recent years and that, in historical context, companies’ cost of capi-

tal is now relatively low. Although some analysts have been focusing their attention on the activities of merchant generators, which boomed and busted in the 1990s, there has been relative stability in the investment activities of more traditional power companies. Over the past six years, investors have found traditional utilities, transmission and distribution companies, and merchant utilities to be reliable investments capable of satisfying expectations of 10% annual returns.

Several Forum participants also called attention to the complications that regulatory federalism introduce to electricity markets and called for clarification of federal and state jurisdictional boundaries in the regulation of electric power. Many of these regulatory boundaries and structures are now long antiquated, dating back to the power market of the 1930s. Today's frequent struggles between state regulatory commissions and the Federal Energy Regulatory Commission (FERC) over transmission rules, for example, highlight the barriers to throughput in the system and underscore the need for reform of transmission governance. The persistent lack of clarity concerning their state and federal jurisdictional boundaries creates inefficiencies and uncertainties, and may discourage new investment and new entrants to the electric power industry. While both state and federal regulators have important roles to play, some participants emphasized the need for stronger FERC authority over what is essentially a national grid and others valued the role of states in experimenting with regulatory options.

The U.S. electric power system has become even more complex over the past decade, with the development of its current amalgam of traditionally regulated and more competitive restructured areas. This hybrid system of governance arose inadvertently, when the pace of industry restructuring ground to a halt following the California energy crisis. While the current status of the regulatory compact may be in question as a result of the complexity and lack of clarity in the governance of the industry, many participants agreed that, in the public's mind at least, local distribution utilities would bear the brunt of responsibility ultimately for ensuring future supply-and the blame for future interruptions.

Even though the side-by-side existence of traditional, regulated states and restructured states complicates the operation of a power system that was already viewed as excessively complex, most Forum participants believed that the hybrid system is here to stay for the foreseeable future. Several felt that the de facto hybrid market symbolizes the inability of all involved in the industry to resolve issues of market structure and regulation. They also appeared resigned to learning to live with it, since no alternative structure has yet gained widespread acceptance or the approval of elected leaders fearing a California-like result.

A major challenge for the industry will be finding ways to attract sufficient investment capital to the system in its hybridized state. In the aftermath of major financial failures over the past five years, credit quality standards are more stringent than ever and the bond ratings of even the largest independent power producers are at junk status. In order to build new plants, many utilities are finding it necessary to build on their own balance sheets by taking on high levels of imputed debt. This necessity threatens the credit ratings of the utilities themselves, and could further jeopardize the industry's ability to build new infrastructure.

Better integrating the traditionally regulated and restructured elements of the hybrid market will be a major challenge. Many public officials are unwilling to accept higher levels of exposure to wholesale power markets, for instance, and are seeking to insulate themselves from them. Having been hurt by their exposure to wholesale markets in the past, particularly during the California crisis, some utilities are trying to become self-reliant islands. To date, different areas have demonstrated different levels of willingness to bear risk. While some markets have removed price controls entirely, exposing consumers to the potential risks and benefits of market prices, most places are unwilling to allow power prices to rise beyond some usually undefined limit.

The viability of the hybrid market depends in large part on the strength and flexibility of the transmission system and its ability to manage the major differences between states. However, some par-

ticipants argued that regional transmission organizations (RTOs), which were created to ensure system access, fairness, and stability in deregulated markets, may now be augmenting the system's complexity and inhibiting its operation. They suggested that state commissions are likely to begin scrutinizing the costs and benefits of RTOs and may find that these entities, in their present form, are detracting value from the system. At the least, there may be a need for greater standardization among RTOs around the U.S. to streamline system rules and enable RTOs to work with one another more effectively.

For some observers, the fact that new generating capacity is being built almost exclusively in regulated areas is an unanticipated development. Although the restructuring and deregulation of the power industry was intended, in part, to make the industry more attractive to private investors, the volatility of deregulated markets may have had the opposite effect to date. Traditional regulated markets have fared better in attracting capital, probably because they have been able to offer investors more certain returns and less volatility than the restructured markets. In defense of the deregulated markets, however, some Forum participants argued that newer, restructured markets such as PJM are likely to become more attractive to investors once they have had more time to settle.

The current complexity and lack of clarity in grid governance indicates to some participants that the U.S. model is irreparable and must be reconceived in its entirety. The U.S. needs a smarter, more flexible grid that can incorporate a wider range of technologies and non-traditional generators, without building new transmission corridors or wires. For example, some observers suggested that a smaller grid with more distributed generation situated closer to end users would better serve the goals of efficiency, security, and reliability. Current grid regulations and RTO rules often prohibit new or non-traditional entrants (e.g., distributed generators, combined heat and power facilities) from entering the system and taking advantage of clear opportunities to improve system efficiency.

## *Energy Efficiency*

**Recommendation:** Federal and state policy makers should give high priority to incentives for accelerated energy efficiency improvements in the U.S.

Forum participants generally agreed that, despite impressive gains in recent decades, there are massive opportunities in the U.S. economy for additional cost-effective energy savings through efficiency. Even though the energy efficiency of the U.S. economy has improved by 1.5% annually on average over the past thirty years, there is still great potential for efficiency gains in all economic sectors. Some analysts consider this annual increment to be a natural rate of efficiency improvement, inherent in the gradual replacement of old capital stock and industrial processes with newer technologies. By some estimates, measures and policies designed to accelerate the efficiency of the U.S. economy could reduce overall U.S. energy demand by 40% or more per unit of economic activity over the next twenty years.

Energy efficiency serves several policy priorities. It contributes to national security by reducing import dependence and vulnerability to terrorism. It delivers environmental benefits, reduces the economic costs of energy for producers and consumers alike, and contributes to overall U.S. economic competitiveness. Many efficiency measures are inexpensive compared with any energy supply option,

and are long-lived once adopted. While efficiency alone will not be sufficient to address the energy challenges associated with global climate change, import dependence, and rising energy costs, there are strong reasons to take advantage of the existing potential for much higher levels of energy efficiency.

Efficiency is, in effect, the cheapest form of new energy supply, particularly for peak-load management, and deserves preferential policy and regulatory treatment. As one participant noted, some utilities are now recognizing this potential and are beginning to direct resources from their power supply capital funds to efficiency projects; historically, utilities have devoted resources from their considerably smaller “public goods” funds to energy efficiency, so the recognition of efficiency as a supply option may mark an important shift in industry thinking. State regulators in particular should re-examine their priorities; 48 states now allow a rate of return on expenditures for supply additions but not demand reductions.

While demand side management programs receive less attention today than they did a decade ago, several participants called attention to the potential that these programs still hold. Comparing the cost of energy efficiency to traditional power production reveals a range of potential opportunities, some less expensive, some more. In the buildings sector, for example, commercial lighting and HVAC retrofits with current technologies can be achieved at a cost of no more than 1.7 cents per kWh, assuming a ten-year life. By incorporating state-of-the-art efficiency technologies into new building designs, those costs can be as high as 9.7 cents per kWh. However, new building changes are more permanent and can reduce other costs, not included in these estimates. Such changes could clearly make dramatic changes in energy demand, costs, and related emissions.

Some regions of the country have been more active than others in promoting demand reduction through energy efficiency. For example, California and the New England states have per capita electricity use rates that are significantly lower than the national average. While the national rate is now approximately 11,000 kWh/year, per

capita use in California and New England is roughly 7,000 kWh annually. While there are regional differences in demand unrelated to efficiency, a combination of higher electricity rates, environmental regulations, and demand side management programs has contributed to the more rapid growth of efficiency in these areas.

Some participants argued that federal rules governing transmission often distort or dampen incentives for heightened system efficiency. For example, restrictions on the construction of private power lines prevent closely situated independent generators and consumers from benefiting from the potentially short transmission distances between themselves. Consequently, average system efficiency is still only around 33%, despite the much higher efficiencies of new generating technologies.

There is also huge potential for consumers to act. Most U.S. consumers are insulated from real-time price signals. Lacking information about their energy use, they are often unable to make better decisions. One participant noted that residential real-time metering in Australia and other countries has had a major impact on energy efficiency. By installing simple price metering technologies in homes, consumers have been able to monitor changes in the price of power and adjust their electricity use accordingly. Real-time monitoring has allowed customers to reduce energy use, especially during peak hours, and helped power companies to level loads. The flat tariffs paid by most U.S. consumers mask real prices, inhibiting changes in end-use decisions.

## *Innovation and Technology Choice*

**Recommendation:** Government should accelerate the development and deployment of new energy technologies to serve the goals of supply security, environmental protection, and system reliability. Policies should aim to be technology neutral, relying on market mechanisms to the extent possible to determine technology choices. To this end, a variety of policy tools might be used including: portfolio standards, tax credits, loan guarantees, direct subsidies, and government procurement policies.

Several Forum participants called attention to the importance of technology in transforming energy use in the U.S. and around the world. While they felt that there is an urgent need for a more aggressive government program to develop new generations of energy technologies, they saw current market and regulatory structures, rather than existing technical limitations, as some of the highest barriers to technological transformation in the electric power industry. To surmount these barriers, some participants advocated government incentives such as loan guarantees, regulatory risk insurance, and guaranteed rates of return to encourage new investment. These and other incentives, such as R&D and investment tax credits, will be especially important if rapid change is a priority. Also, while such a transformation may demand a long term vision and investment

strategy, the logic of markets and political cycles often dictate that decision makers focus principally on the short term. While the technological possibilities and economic elasticities of the long run are potentially unlimited, concerns grounded in the relatively inelastic short-term often carry the day.

The sacrifice of long-term benefits to short-term realities is often evident in the power industry's technology investment decisions. For example, low capital costs and short lead times have recently favored the construction of new natural gas plants, despite the fact that the cost of gas itself has tripled over the past three years. In fact, rising demand for gas for power production despite short supply is one of the major drivers of rising gas prices in the U.S.

While technologies other than gas—such as coal gasification (IGCC) plants or even new nuclear power plants—potentially offer lower operating costs in the longer term, their high initial capital costs can be prohibitive. A state-of-the-art 600 MW IGCC plant typically costs between \$800 million and \$1 billion, for example. Yet, in the absence of guaranteed returns, large capital power projects face exceptionally high barriers. In an effort to lower some of these barriers, the 2005 energy bill passed by the Senate shortly before the Forum contained loan guarantee provisions for IGCC and industrial gasification plants, investment tax credits of 20%, and almost \$2 billion in funding for research and demonstration. Since the bill also requires that new plants have a guaranteed revenue stream to cover project costs and insists on borrowers' paying federal scoring costs, the new gasification plants remain a risky proposition for most investors.

Some participants advocated the federal adoption of a portfolio standard for utilities as one means of spurring the deployment of new technologies. Most recommended, however, that this approach include incentives for a wider range of fuels and technologies beyond those covered by current renewable energy portfolio standards. Considering the extensive set of energy-related problems confronting the U.S., there will be a need for advanced technologies in all areas including gas, renewables, nuclear, efficiency, and carbon

capture and sequestration with coal. Also, extending portfolio standards beyond renewables to other opportunities for cleaner energy would be particularly important in regions of the country where renewable resources are relatively scarce.

Despite resource limitations in some areas, ongoing advances in renewable energy technologies are helping wind, solar, and biomass technologies to make inroads in the U.S. For example, commercial biomass has grown rapidly over the past twenty years and now exceeds hydropower in its contribution to primary energy. New biomass installations can be as large as 1GW. Solar photovoltaic installations have also grown sharply, as the efficiencies of solar cells have improved with successive generations. Yet grid connected solar photovoltaic electricity still costs 20-30 cents per kWh.

Wind power continues to grow, primarily in the Western and Great Plains states where wind resources are most abundant and energy demand growth has been strong. Wind turbines there are often installed on farm lands, since many farmers welcome them as a revenue source. Wind's contribution is still comparatively small, but is making steady inroads into the nation's electricity generation fuel mix, having grown from almost zero in 1990 to 6.3 GW by 2004. One limiting factor in the current U.S. market is the fact that the most attractive wind sites are often on agricultural lands, far from consumers and in areas where access to transmission is scarce, or offshore, where costs are higher and where siting approval is difficult.

While wind is already cost competitive in some parts of the country at 3-5 cents per kWh at 15 mph under the best conditions, the industry's goal is to reduce wholesale prices to 3 cents per kWh at 13 mph by 2012. Turbines have grown steadily larger and more efficient, driving cost reductions, and the industry is now moving toward 750 kw turbines with 45 meter blades as the standard in high wind areas. Some analysts foresee turbines as large as 3.6 MW in coming years.

Some Forum participants recommended that federal R&D policy needs to change to reflect the importance of a portfolio approach as

discussed above. Today, for example, a large amount of federal resources (approximately half of the Department of Energy's technology development budget) is devoted to a single program, FutureGen, which aims to build the world's first coal-fired, zero emissions power plant. While no one suggested that FutureGen was unworthy of federal support, the contention was that many other worthy R&D areas are receiving too little support. Federal energy R&D investments have fallen sharply from their peak levels of the early 1980s; in the opinion of many participants, higher levels of investment will be needed to broaden the energy technology portfolio.

Changes to current transmission rules could also make key contributions to the technological transformation of the power industry. For example, exceptions or modifications to the prohibition on private transmission lines could facilitate the construction of decentralized generation facilities largely fueled by waste heat from industrial plants. Since many industrial plants with unused power generating potential are sited close to potential industrial power consumers, there could be significant opportunities for efficiency gains through shorter transmission distances between producers and consumers, approximately 50% lower construction costs per unit of additional generation capacity, and reduced pressure on the grid. Current rules strictly prohibit the construction of private wires, regardless of their potential to enhance system efficiency and stability. They may fail, as a result, to provide valuable public goods. Some participants strongly argued, however, that growing needs for transmission lines and the enormous challenges associated with the construction of new transmission corridors require changes to rules governing private lines for more localized, distributed generation.

Government investment incentives will be especially important if the U.S. is to have a new generation of nuclear power plants using state-of-the-art technology. Two vendors have recently received certification for new reactor designs and several others will be submitting new designs soon. It is unlikely however, that any of these designs will be deployed in new plants unless the government helps to manage the regulatory risks and high costs that potential investors face. One participant observed that changes made in federal licens-

ing guidelines during the 1990s could alleviate some of the regulatory risks potential investors in nuclear plants face. For example, operating licenses for new nuclear plants were historically granted mid-way through construction, creating the risk of large stranded investments should operating permits be denied. The 1992 Energy Policy Act's streamlining of the process created a "one-stop licensing" procedure, whereby operators could be granted a site permit, design certification, and combined construction and operating license prior to a project's commencement.

Some participants also felt that the prospects for nuclear power could be improved if there were assistance for the first adopters of new nuclear designs. "Pioneer plants" face higher costs than later adopters, since technology vendors seek to recover their R&D costs with the first few orders of a new design. These additional costs in conjunction with the risk of regulatory delays are, according to many analysts, the highest barriers to future nuclear installations. Direct assistance to early adopters, perhaps in the form of guaranteed rates of return, along with regulatory risk insurance underwritten by the federal government, may be indispensable in reviving the U.S. nuclear power industry. Other participants felt that nuclear power has already received greater subsidies than any other power source, that the market has rendered a clear verdict against new nuclear plants, and that incentives applied to efficiency or other supply sources would yield greater energy supply and carbon reduction benefits.

Technological innovation in the energy industries might be better served by other means than traditional government R&D programs, in the opinion of some participants. On the one hand, some suggested that innovation would be best served by a fundamental review of energy policy, particularly as it relates to electricity. U.S. electric power markets and regulations are constrained by the fact that the foundations of the system date from the 1930s. Every aspect of the electric power system, including technological innovation, would benefit from an extensive review of policy and an assessment of the extent to which the public good is served.

R&D collaboration—domestic and international networks involving science, industry, and government—must also become a more integral part of the innovation process. As one participant noted, the U.S. is not and should not strive to be the world leader in all areas of science and technology. New international science and engineering consortia, for example in high-level nuclear waste management, could play particularly key roles in addressing domestic and international energy and environmental problems.

## *Carbon Management*

***Recommendation:*** Federal, state and local governments should promptly adopt a carbon management policy that includes both sticks (i.e., some form of carbon control mandate) and carrots (such as incentives for broad investment in reduced-carbon supply and energy efficiency technologies).

Most Forum participants agreed that the federal government's adoption of a carbon management regime would be beneficial to U.S. industry and to the strength of U.S. world leadership. The adoption of a carbon policy would alleviate one major area of risk and uncertainty in the electric power industry, enabling investors, utilities, and regulators to make better long-term plans and decisions.

New developments, including the Senate energy bill passed just before the Forum, suggested to at least one participant that the current Congress and the Bush Administration might act to address carbon emissions. The bill contained a non-binding "sense of the Senate" that mandatory restrictions on emissions of carbon and other greenhouse gases are necessary. Most Forum participants correctly predicted, however, that this section of the bill would be unlikely to survive the conference with the House of Representatives.

Yet, the issues of climate change and carbon management appear to be gaining momentum in Congress, and this was reflected in the widespread observation among Forum participants that the tide had shifted perceptibly since the 2004 Forum. For example, the vote on the sense of the Senate amendment effectively superseded the vote on the 1997 Byrd-Hagel Resolution, which was adopted unanimously and prohibited binding U.S. action on climate change in the absence of developing country participation. Moreover, some participants noted that acid rain legislation, after strong opposition from President Reagan, was passed under the first President Bush in part because industry was more comfortable having the law and implementing regulations written with a Republican in the White House.

Several participants stressed the importance of prompt action to reduce U.S. emissions of carbon and other greenhouse gases. The economic costs of carbon emissions reductions necessary to achieve a given atmospheric concentration level escalate rapidly with a decrease in the amount of time available for reductions. In addition, the risk of irreversible climate impacts will grow faster in the absence of carbon control policies.

While urgent action is necessary to reduce carbon emissions, it is likely that some adverse climate impacts are now unavoidable. Thus, U.S. climate change strategy must also recognize the importance of adaptation to future climatic conditions and seek to augment the flexibility and resilience of the economy and society.

Concerning the electric power industry, an effective carbon management policy must include both government mandates and incentives for investment in efficiency and new supply technologies. Since energy consumption and related emissions are on an upward trajectory, a broad portfolio of technology options will be needed to meet rising demand while reducing emissions. Under one scenario presented, to carry out its share of actions to stabilize atmospheric carbon dioxide concentrations at 550 parts per million by 2100—about a doubling of pre-industrial levels—the U.S. would have to aggressively deploy nuclear and carbon capture and sequestration technologies to reduce emissions from the electric power industry. In

this scenario, stabilization would require 142 GW of new nuclear capacity in the U.S. and carbon capture and sequestration systems on all of the nation's 375 GW of coal capacity by 2065. Accelerated deployment of advanced energy efficiency, renewable energy, and natural gas technologies would also be needed to manage demand growth and emissions. Getting started on this stabilization path would demand that the U.S. assign a price to carbon via a carbon mandate by 2010 at the latest.

Most participants who favored a carbon limitation policy preferred an emissions cap and permit trading system over a carbon tax, since the latter is less politically feasible. Either mechanism could be used as a means of sending a carbon price signal, which would be a catalyst for immediate emissions reductions and an even more important driver of decisions on future capacity. Either mechanism, in the opinion of many participants, would be beneficial to the industry by helping to create an environment of greater regulatory certainty and lower risk. In fact, some utilities are already anticipating such changes to the regulatory environment by planning to build new coal gasification plants instead of conventional coal plants. In addition to their higher overall efficiencies, IGCC plants are more compatible with carbon capture systems and would be better suited to potential developments in environmental policy. Some segments of industry may ultimately help drive federal carbon policy through strategic decision making and capital investment planning.

The European Union's (EU) implementation of a carbon cap and trading system beginning in 2005 may ultimately ease U.S. apprehensions about the macroeconomic impacts of carbon mandates. While some leading U.S. policymakers have feared that a carbon policy would place a heavy burden on the economy, both economic models and the EU experience suggest otherwise. Carbon prices in the EU have risen higher than expected since the launch of the European cap and trade system, partly due to high gas prices, but have had a far smaller economic impact than oil price increases. Current CO<sub>2</sub> prices of around \$10/tonne are the equivalent of \$4.60/bbl crude oil or \$0.50/mcf natural gas. Using a similar emissions trading system to stabilize U.S. emissions at 1990 levels by 2020, according to one mod-

eling estimate, the annual cost to the U.S. economy would be approximately \$44 billion—less than one half of 1% of an annual GDP estimated at \$11 trillion. A well-designed carbon management system could make the economic costs of emissions reduction relatively easy to absorb; the projected impact on U.S. electricity prices would be approximately 1.7% on average.

According to many participants, the potential long-term costs of inaction on climate change would far outweigh the costs of carbon controls in the U.S. In addition, adopting carbon policies could have unexpected benefits, from the perspective of technological innovation and economic growth. New energy technologies could form the basis of new industries and new technologies spurred by climate policies could take on a momentum of their own, outpacing stated policy targets and goals. Rather than regarding carbon constraints as entailing mainly costs, the U.S. might be better off if it considered concurrently the potential benefits of climate change action.

As one participant noted, effective carbon policy must also be sensitive to industry cost curves, given the long-lived nature of electricity infrastructure. While some carbon reductions will be economically feasible in the short- to medium-term, the longer-term capital stock turnover holds the largest potential for decarbonization. A carbon policy that imposed a strict mandate too early and forced the premature turnover of capital stock would increase significantly the economic costs of carbon emissions reduction.

Some participants objected to calls for a carbon control mandate. In their view, carbon controls would have widely divergent regional impacts, harming power producers in areas where the resource base might not readily permit fuel switching. From this perspective, any mandate would create a system of regional winners and losers in terms of rates and reliability. Accelerated government investment in energy R&D, according to this view, must precede the adoption of a mandate, to ensure that a wider portfolio of technology options would be available to power companies in more resource constrained areas. This viewpoint offered a counterpoint to the perspective of other participants who suggest that the adoption of a

mandate would, in fact, be the most effective catalyst of accelerated technological innovation.

While the Forum devoted much of its attention to carbon management policies at the national level, the discussions also addressed climate policies at the state, local, and international levels. State and local governments and state regulatory agencies have important roles to play in carbon management and several states have already gone much further than the federal government in adopting carbon policies and mandates. State and local governments can also exert great influence over the carbon profiles of all economic sectors through the creation and enforcement of codes and standards for buildings, appliances, and business activities in their jurisdictions.

Several states are, in fact, taking action on climate change by enacting their own carbon management policies. Governor Pataki of New York, for example, has proposed a comprehensive carbon management program for the northeastern region. Emissions control legislation has passed in California and New Mexico, while New Jersey, California, New Mexico, and Massachusetts all have adopted more stringent appliance standards to heighten efficiency and reduce carbon emissions.

Policies at the local level are also playing a role in carbon management. For example, at a recent Conference of U.S. Mayors, leaders from 164 cities and towns signed a proposal to reduce carbon emissions 7% below 1990 levels by 2012. For many of these leaders, carbon policies, coupled with incentives to develop and adopt new technologies, offer opportunities for economic development as much as for climate change mitigation.

Effective international action to mitigate climate change depends on U.S. leadership according to many Forum participants, and some recounted explicit statements by analysts and foreign officials to this effect. In the absence of significant U.S. action or participation in a binding international carbon management regime, for example, there is only a small chance of participation by rapidly growing developing countries such as India, China, and Brazil.

Others questioned the assumptions underlying calls for U.S. leadership in international climate change mitigation. They remain skeptical that U.S. action would in itself be sufficient motivation for developing countries to join as well. By this assessment, developing countries with large populations and high rates of poverty and unemployment may not recognize the potential for economic, health, and other advantages and would be unlikely to risk slowing their economic growth for shared environmental benefits in the distant future. One participant also expressed concern that by adopting a carbon mandate, the U.S. might force even more of its manufacturing jobs offshore; there could be serious unintended economic consequences from getting out in front of developing countries by adopting carbon controls.

A second assumption that elicited objections was the notion that developing countries are using dirty and obsolete technologies to serve their growing energy demands. In fact, many new power plants in major developing countries are among the most advanced in the world. Some of the most advanced and efficient supercritical plants in the world are now found in China, for example. In the past two years, more than 35% of orders for new coal units in China have been for supercritical steam cycle plants. Among the latest orders are two 1000 MW supercritical plants that will operate at 275 bar and 605 degree Celcius steam temperatures, making them among the most advanced in the world. While there are older and less efficient plants in the developing world, the fact that developing countries are not burdened with large, legacy infrastructures and regulatory regimes may give them significant advantages over industrialized countries in creating cleaner, more efficient, and more resilient electric power systems.

## *Infrastructure Security*

**Recommendation:** The federal government should accelerate measures to assure infrastructure resilience in the face of terrorist threats, accidents, and natural disasters.

The U.S. electric power system has many points that are vulnerable to terrorism and other potential sources of service interruption. In the light of these vulnerabilities, there is a pressing need for an enhanced federal government role in safeguarding the system. Many Forum participants thought that enhancing the security of the system would require an expansion of FERC's authority, while others also saw a role for the Department of Homeland Security in ensuring system security, particularly in reducing vulnerability to terrorist attack.

Participants noted several system features that must be addressed, perhaps via a national electric power infrastructure security project, to enhance system security. For example, the current system's multiple control areas create major challenges to coordination for system resilience.

Also, the lack of standardization in vital system components, such as large transformers, and the lack of a standing inventory of spare components could hinder a rapid recovery from a terrorist attack on these critical parts of the network. These system components remain

largely unsecured and could be knocked out of service by means readily available such as improvised explosives or Teflon-tipped bullets. Moreover, breaches of computer networks have shown that control systems are also vulnerable to terrorist infiltration and demand higher levels of security. Should individuals or terrorist groups target critical system components, recovery could take days or weeks, depending on the speed with which new components could be sourced and installed. Currently, however, despite ongoing industry discussions, it is not evident that terrorist interruptions of electric power supply have figured sufficiently in power companies' strategic planning. Since a breach of any part of the grid effectively places the entire system at risk, there is an important role for the federal government to play in overseeing grid security.

One participant called attention to the many resources already in place that could be used to improve resilience and reduce system vulnerability. There is approximately 90 GW of private standby power in the U.S. built to power elevators and other machinery in the event of a grid failure. These resources are not parallel with the grid today, but could be connected as a redundant system if current transmission rules could be changed to facilitate such connections. In general, if U.S. power producers and consumers were situated closer to one another and the power grid were less centralized, vulnerability to large-scale outages due to terrorism would be substantially lower than they are today.

The federal government must also address the risk of nuclear proliferation posed by the nuclear fuel cycle. While this risk is already being addressed, the government must also consider the security implications of a renaissance of the nuclear power industry, which some analysts believe is likely in the coming years. In fact, resolving waste storage and the problems of safeguarding nuclear materials may be key preconditions of the nuclear industry's rebirth in the U.S. In addition, a new international regime for nuclear waste management and non-proliferation that is more comprehensive and effective than the current Nuclear Nonproliferation Treaty (NPT) must become a security priority for the U.S. in the light of the potential spread of nuclear power to additional countries. A new interna-

tional nuclear control regime must place restrictions on fuel enrichment and reprocessing; neither of these topics is addressed in the NPT, which was drafted before these issues posed an international security threat.

Considering the demonstrated ability of the U.S. to change its entire manufacturing base within three years of the attack on Pearl Harbor and entry into World War II in 1941, the fact that the U.S. electricity power system remains structurally unchanged almost four years after the attacks of September 11, 2001 suggests that there has not yet been a true recognition of the system's importance and its vulnerability to terrorist attack.

# *Agenda*

## **“Electricity: Who Will Build New Capacity?”**

Aspen, Colorado

July 1-5, 2005

EIA forecasts that 62 gigawatts of generating capacity will be built (new and replacement) in the U.S. in the next ten years, and another 173 GW in the ten years after that. Who bears the responsibility for ensuring it is built? Who is likely to build it? The 2005 Aspen Energy Policy Forum will consider these questions and explore some of the main factors that will influence the choices of potential builders.

**Forum Chair:** **James E. Rogers**, CEO, Cinergy Corp.

### **SESSION I: View from the Industry**

Various segments of industry approach capacity additions from different circumstances. What do some industry leaders see as the critical factors affecting their decisions?

**Chair:** **James E. Rogers**, CEO, Cinergy Corp.

**Speakers:** **Wayne H. Brunetti**, CEO, Xcel Energy

**Thomas R. Casten**, CEO, Primary Energy Ventures

**Jan Schori**, General Manager and CEO, Sacramento Municipal Utility District

## **SESSION II: Climate Policy Constraints**

Among the key uncertainties affecting industry decisions are the likelihood, the magnitude, and the timing of mandatory carbon constraints. How will these decisions affect capacity additions?

**Chair:**           **Frank Loy**, former Undersecretary of State

**Speakers:**   **Eileen Claussen**, President, Pew Center on Global Climate Change, *“Milestones and Mechanisms”*

**A. Denny Ellerman**, Executive Director, Center for Energy & Environmental Policy Research. MIT, *“Costs of Mitigation”*

**Margaret Kriz**, Environmental and Energy Correspondent, National Journal, *“The Politics of Climate - State and Federal”*

## **SESSION III: Regulatory and Financial Constraints**

Federal and state regulation and tensions between the two, and the financial community's views of different companies or segments of the industry, can affect decisions to add capacity. How do these institutions view the future of capacity additions?

**Chair:**           **Nora Brownell**, Commissioner, Federal Energy Regulatory Commission

**Speakers:**   **Samuel J. Ervin IV**, Chairman, North Carolina Utilities Commission, *“The Role of the States”*

**Hoff Stauffer**, Senior Director, Energy Practice, Global Insight, *“Market Structure, Price Volatility, and Technology Choice”*

**Christine Tezak**, Senior Vice President, Stanford Washington Research Group, *“Resource Adequacy and Environmental Policies as Investment Drivers”*

**Parker Weil**, Managing Director and Co-Head of the Energy & Power Group, Merrill Lynch, *“Financing New Capacity”*

#### **SESSION IV: Technology Constraints and Opportunities**

When decisions are made to build, what technologies and fuels are most likely to be used? Will we be satisfied with these choices, or would we suggest additional government action to favor specific fuels or technologies? To what extent can greater efficiencies of production, transmission, and end-use be expected to affect the capacity needed?

**Chair:** **John H. Gibbons**, former Science Advisor to the President

**Speakers:** **Stanley R. Bull**, Associate Director, National Renewables Energy Lab, *“The Promise and Potential of Renewables”*

**Clark Gellings**, VP for Innovation, EPRI, *“The Potential of Efficiency”*

**Richard A. Meserve**, President, Carnegie Institution, *“New Nuclear Capacity”*

**William G. Rosenberg**, Harvard and Carnegie Mellon Universities, *“IGCC and Polygeneration”*

#### **SESSION V: Conclusions**

Forum participants will discuss a draft list of key conclusions and recommendations based on key points raised during the preceding sessions.

**Chair:** **James E. Rogers**

**Synthesizer:** **Philip R. Sharp**, Senior Advisor, Van Ness Feldman

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## *Selected Publications*

# *Program on Energy, the Environment and the Economy*

### **A Silent Tsunami: The Urgent Need for Clean Water and Sanitation**

Based on a 2005 dialogue co-sponsored by the Nicholas Institute for Environmental Policy Solutions at Duke University, this report provides a series of recommendations for governments, businesses, and other organizations. Co-chairs William K. Reilly and Harriett C. Babbitt highlight the urgency of the challenge and the array of public and private initiatives to tackle it. This report notes that “for lack of clean water and sanitation, as many poor people are dying each month as perished during the Southeast Asian tsunami.” A letter from the co-chairs to the organizers of the March 2006, Fourth World Water Forum in Mexico City is also included.

2005. 40 pages, ISBN# 0-89843-435-1 \$12 per copy

### **Conserving Biodiversity**

Co-chaired by Bruce Babbitt, former U.S. Secretary of Interior, and José Sarukhán, Professor of Ecology and former President of the National University of Mexico (UNAM), the dialogue was based on commissioned discussion papers and focused primarily on the policy drivers of ecosystem degradation and biodiversity loss. With this report, the group seeks to educate policy makers and opinion leaders on the loss of critical

ecosystems and biodiversity and to recommend specific changes in policies that may affect biodiversity, such as trade, aid, and lending policies.

2005. ISBN#0-89843-421-1 \$12 per copy

### **A Climate Policy Framework: Balancing Policy and Politics**

The Aspen Institute, in association with the Pew Center on Global Climate Change, convened a diverse group of leaders to develop a politically feasible framework for a mandatory U.S. climate change policy. Co-chaired by Eileen Claussen and Robert W. Fri, the group did not discuss whether mandatory action is now warranted. It did, however, reach consensus on several fundamental elements of a national policy, if one is adopted.

2004. 100 pages, ISBN# 0-89843-397-5, \$12 per copy

### **Tackling the Critical Conundrum: How Do Business, Government and Media Balance Economic Growth and a Healthy Environment?**

Former EPA Administrator Christine Todd Whitman and former Undersecretary of State Frank Loy co-chaired a Forum in Aspen on balancing economic growth and a healthy environment. This report includes their conclusions and discussion papers exploring the tradeoffs from the perspectives of business leaders, elected officials, investment firms, journalists, and economists.

2004. 102 pages, ISBN# 0-89843-435-1, \$12 per copy.

### **Fossil Fuels, the Hydrogen Economy, and Energy Policy**

The 28th annual Energy Policy Forum considered key variables affecting supply and demand for each of the fossil fuels, domestically and globally, including new technologies and the competition offered by alternatives such as renewables and nuclear. It then examined the problems and potential of hydrogen, including its primary

fuel source. Finally, based on these discussions, it suggested guidance for the development of near-term government energy policy. Red Cavaney, President and CEO of the American Petroleum Institute, and Susan Tomasky, Executive Vice President and CFO of American Electric Power Company, co-chaired the Forum.

2004. 62 pages, ISBN# 0-89843-422-X, \$8 per copy.

### **Electricity Restructuring**

The 2003 Energy Policy Forum focused on electricity restructuring. Chaired by former Director of Central Intelligence and Undersecretary of Energy John Deutch, participants discussed the advantages and disadvantages of national rules governing transmission, economic and market power issues affecting ownership, whether the market's choice of fuel is in the national interest, whether natural gas supplies are adequate, and how restructuring will affect the future of nuclear power, renewables, efficiency, and distributed generation. A series of Electricity Recommendations were sent to Congressional and Administration leaders following the Forum.

2003. 55 pages, ISBN#: 0-89843-389-4, \$8 per copy.

### **U.S. Policy on Climate Change: What Next?**

Following U.S. withdrawal from the Kyoto Protocol, the Aspen Institute invited a distinguished group of scientists, business leaders, and environmental experts to discuss what the U.S. should do next. The non-technical discussion papers provide useful background and innovative policy suggestions. Forum co-chairs Frank Loy, Undersecretary of State under President Clinton, and Bruce Smart, Undersecretary of Commerce under President Reagan, summarize the discussion and the Forum's conclusions in a compelling introductory essay. The group concluded that the U.S. government needs to send a signal now that carbon emissions will have a cost in the future.

2002. 200 pages, ISBN# 0-89843-344-4, \$16 per copy.

## **Vulnerability and Resilience**

The 2002 Aspen Energy Policy Forum convened at a time of heightened urgency regarding energy vulnerability and resilience. The recent California crisis, the increasing volatility of oil and gas prices, and the sudden collapse of Enron and other energy companies focused attention on the nation's enduring energy problems. In addition, the events of September 11, 2001, raised a host of new questions about the vulnerability of energy systems and moved the threat of terrorism to the top of the list of energy challenges. The Forum, chaired by former Senator J. Bennett Johnston, addressed the question of energy vulnerability and resilience in the context of four key issues: the development of the energy systems of the future; the evolving geopolitics of energy; the reduction of America's reliance on oil; and the creation of a resilient electricity industry. Rapporteur, Paul Runci.

2002. 51 pages, ISBN# 0-89843-366-5, \$8 per copy.

## **Dam Removal: A New Option for a New Century**

This report offers a series of recommendations and practical advice to make it easier to integrate the consideration of dam removal into river management decisions, and to evaluate fairly and, if appropriate, to implement dam removal effectively. It is the product of a two-year dialogue among a group of people who represent a wide range of interests and disciplines. The imprimatur of this diverse group, with interests that are often at odds, lends a unique weight to the wide-ranging and practical recommendations.

2002. 68 pages, ISBN# 0-89843-360-6, \$12 per copy.

## **Energy Supply and Infrastructure**

In 2001, in the wake of a year of energy price volatility, serious electricity supply and price problems in California, and new proposals for energy legislation, the 25th annual Energy Policy Forum exam-

ined factors affecting energy supply and infrastructure. Former Energy and Defense Secretary James R. Schlesinger chaired the Forum, which included sessions on natural gas supply, the California electricity crisis, the future of electricity restructuring elsewhere, and domestic and world oil markets.

2001. 57 pages, ISBN#0-89843-328-2, \$8 per copy.

### **U.S. Policy and the Global Environment: Memos to the President**

Prior to the 2000 election the Aspen Institute convened a distinguished group of leaders as a hypothetical committee to advise the new President on global environmental policy. Experts prepared this set of policy memos to tell the President, concisely and in understandable language, “what he should know” and “what he should do” about climate change, biodiversity, population, oceans, water, food and agriculture, and other problems. A thematic summary of the group’s conclusions, written by co-chairs Donald Kennedy of Stanford University and Roger Sant of the AES Corporation, communicates the urgency of the challenges, the complexity of the inter-related issues, and the optimism necessary to tackle them. Editors, Donald Kennedy and John A. Riggs.

2000. 220 pages, ISBN#0-89843-303-7, \$16 per copy.

### **With All Deliberate Speed: Electricity Restructuring in Asia**

The 1999 Pacific Rim Energy Workshop was held in Kanagawa, Japan, co-sponsored and hosted by The Asia-Pacific Energy Research Centre (APEREC), the energy research arm of the Asia Pacific Economic Council (APEC). Representatives of 17 countries or economies discussed electricity restructuring and fuels trade in the region. This report of the meeting concludes that the theoretical and observed benefits of deregulation are quite powerful, but there are concerns about the impacts of making the transition from

national monopoly systems to deregulated or privatized systems.  
Moderator and rapporteur, Loren Cox.

1999. 23 pages, ISBN#0-89843-278-2, \$8 per copy.

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