

# *Energy Supply and Infrastructure*

2001 Aspen Energy Policy Forum  
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## *Foreword*

The summer of 2001 marked the 25th anniversary of the Aspen Institute's Energy Policy Forum. Born amidst the intense public interest in energy policy that followed the first oil embargo and price shock, the annual Forum has attracted a senior and diverse group of business, government, and other leaders to discuss topics of widespread interest and concern. The volatile energy prices and regional electricity blackouts in the months before this year's Forum, while causing less national reaction than the crises of the 70's, nevertheless created a level of public concern about energy not seen in the last two decades.

Whether energy is high on the public's agenda or interest is limited to experts, the Forum is designed to foster candid exchange among people of diverse viewpoints and backgrounds. They raise difficult policy questions that require cross-cutting, interdisciplinary examination. Although the participants are knowledgeable in their own businesses or disciplines, in wrestling with multidimensional challenges they are challenged to avoid easy or oversimplified responses that draw on a single area of expertise. The exchanges around the conference table are enhanced by an informal atmosphere and a not-for-attribution rule that nurture creative thinking and candid speaking. Additional opportunities for continued discussion are provided in social and recreational settings surrounding the meeting.

As he has often done in the past, James R. Schlesinger, former U.S. Secretary of Energy and Secretary of Defense, served as the distinguished chairman of the 2001 Forum. His broad experience enabled him to frame the discussion and guide the contributions from diverse expert participants, bringing focus and perspective to a broad topic. A highly qualified group of session chairs and speakers provided a wealth of information and a variety of perspectives, contributing substantially to the richness of the dialogue.

The Institute's Program on Energy, the Environment, and the Economy acknowledges and thanks our sponsors for their very important financial support. Without their generosity and commitment to our work, the Forum and other projects of the Program could not continue. Contributions were received during the past year from the following:

Accenture	Paul Dragoumis Associates
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Alstom Power	Enron
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Aramco Services	GPU
Areté Corporation	PEPCO
Boyd Foundation	Private Power
Cinergy	Ruhrigas
Consumers Energy Foundation	Sempra
Cornerstone Research	Verner, Liipfert, Bernhard,
Credit Suisse First Boston	McPherson & Hand

On behalf of the Program and the Forum participants, I also offer our thanks to Paul Runci, who served as rapporteur. He distilled the key themes and information from a wide-ranging discussion and masterfully captured the richness and diversity of opinion in this necessarily brief report.

Administrative preparations for the Forum were admirably handled by Katrin Thomas, who with Silvia Woodard managed the arrangements in Aspen. Their hard work and attention to detail, assisted by the helpful Aspen Meadows staff, were responsible for a

pleasant and smoothly run meeting. Along with the participants, I am grateful for their cheerful and efficient support.

The report is issued under the auspices of the Aspen Institute, and neither the Forum speakers, participants, or sponsors are responsible for its contents. Although it is an attempt to represent views expressed during the Forum, all views expressed were not unanimous and participants were not asked to agree to the wording.

John A. Riggs  
Executive Director  
Program on Energy, the Environment,  
and the Economy



# *Agenda*

## "Energy Supply and Infrastructure"

June 30 - July 4, 2001

**Forum Chair:** **James R. Schlesinger,**  
Chairman, The MITRE Corporation

Session I: Natural Gas — Problems and Prospects

**Chair:** **James R. Schlesinger,**

**Speakers:** **James K. Gray,** Chairman,  
Canadian Hunter Exploration Ltd.

**John Riordan,** CEO, Gas Technology Institute

**Fritz Gautschi,** CEO, Alstom Power

Session II: California Electricity — Lessons Learned

**Chair:** **William W. Hogan,**  
Professor of Public Policy & Administration  
Harvard University

**Speakers:** **Ralph Cavanagh,** Senior Attorney,  
Natural Resources Defense Council

**Anne Cleary**, President, Mirant - California

**S. David Freeman**, California Governor's Office

**Stephen E. Frank**, CEO, Southern California Edison

**Paul Joskow**, Professor of Economics, MIT

Session III: Restructuring — The Way Ahead

**Chair:** **John W. Rowe**, Co-CEO, Exelon

**Speakers:** **Callum McCarthy**, Chief Executive,  
Office of Gas & Electricity Markets, and Chairman  
of the Gas and Electricity Markets Authority, UK

**Herbert H. Tate**, Professor,  
NJ Institute of Technology, and former President,  
NJ Board of Public Utilities

**James E. Rogers**, CEO, Cinergy

Session IV: Oil Markets — Problems and Prospects

**Chair:** **Robert Priddle**, Executive Director,  
International Energy Agency

**Speakers:** **Philip K. Verleger**, President, PK Verleger LLC

**Irwin Stelzer**, Director of Regulatory Studies,  
Hudson Institute

**Red Cavaney**, CEO, American Petroleum Institute

**Robert Perciasepe**, Senior Vice President,  
The IT Group

Session V: Conclusions

**Chair:** **Vicky A. Bailey**, President, PSI Energy

**Breakout Group Moderators:**

**Catherine G. Abbott**, CEO,  
Columbia Gas Transmission Corp.

**D. Louis Peoples**, CEO (Ret.),  
Orange and Rockland Utilities

**Robert N. Schock**, Senior Fellow,  
Lawrence Livermore Lab



## *Introduction*

While Aspen Energy Policy Forum participants often disagree with one another on matters of substance, there was consensus at the 2001 Forum that these are "interesting times" for anyone concerned with energy. Over the past two years there have been several high-profile energy problems touching major parts of the energy industry: natural gas, electricity, gasoline, home heating oil, and energy infrastructure. After several relatively quiet years during the 1990s, questions of energy security, price volatility, and the long-term effects of industry restructuring are making daily headlines again.

In many ways this latest energy crisis, precipitated by oil, gas, and electricity price increases and by fallout from the restructuring in California provides a useful vehicle for thinking about the broader, long-term energy challenges facing the U.S. as a whole. While California's energy troubles are related to the electric power industry, a complex set of causes including natural gas supply issues, infrastructure limitations, and energy and environmental regulations all played key roles in setting the stage. The California case brings together many of the most pressing energy questions the U.S. now faces.

It was only fitting, then, that one session of the 2001 Forum was devoted to California electricity, while others addressed related questions concerning the nation as a whole. These discussions

addressed natural gas supply and infrastructure, oil markets, and the future of electricity industry restructuring, respectively.

The 2001 Forum also coincided with a meeting of the Organization of Petroleum Exporting Countries (OPEC) in Vienna and took place against the backdrop of the Bush Administration's publication of its National Energy Policy and the introduction of other major proposals in Congress. Energy is now very much back "in play" from a policy perspective.

## ***Session I:***

# ***Natural Gas—Problems and Prospects***

During the 1990s, a variety of factors, including low prices, technological improvements, and environmental concerns coincided to make natural gas the fuel of choice for new electric power production in the U.S. Yet, as natural gas demand began to surge, low prices discouraged the industry from making the upstream investments needed to ensure that supplies would remain abundant in the future. Consequently, natural gas prices and supplies in the U.S. have proven more volatile than many industry analysts thought just a few years ago.

Since developments in the natural gas market have confounded expectations of experts and consumers alike, the 2001 Forum devoted its initial session to an effort to understand key issues for the future of natural gas in the U.S. As the discussion brought to light, the future competitiveness of natural gas in North America will be a function of investment in both gas resource development and gas transportation infrastructure, the adequacy of support for research and development in upcoming years, and future environmental regulations favoring gas for its relatively low emissions of carbon dioxide and other air pollutants.

### The U.S. Natural Gas Market: Past and Future Considerations

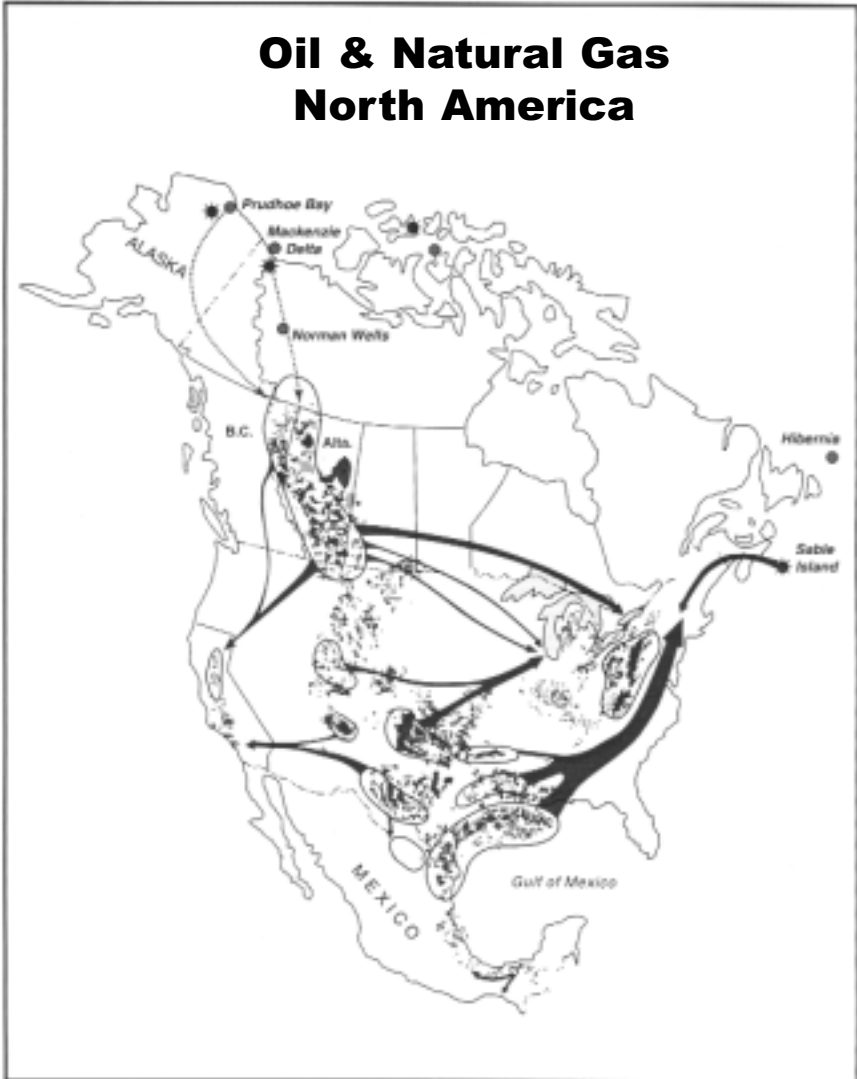
Over the past year, natural gas prices rose sharply and unexpectedly before falling back toward the lower price levels of previous

years. Many experts now believe, however, that gas prices are likely to stabilize, for the next few years at least, at levels approximately 100% higher than those of 1998. A combination of short- and longer-term developments is responsible for this assessment.

With regard to longer-term factors, there have clearly been large rises in U.S. gas demand over the past two decades, due in large part to a major expansion of gas use for electricity production that has more than offset substantial improvements in the efficiency of gas turbine technologies and in conservation. Looking to the near- and medium-term future, many analysts have predicted that almost all new electricity generating capacity in the U.S. will be gas-fired. By the same analysis, over 200 GW of gas-fired capacity will be added in the U.S. between 2001-2005, with every 10 gigawatts representing a 1 billion cubic feet per day (bcf/d) increase in gas consumption. However, any of several factors—including the playing out of traditional sources of supply, unexpected changes in fuel prices, developments in environmental policy and regulation, technological innovation, and changes in economic growth rates—could intervene to alter the outlook for domestic growth in gas use.

A key short-term factor that contributed to the sharp climb in gas prices over the past year was a shortfall in stored gas for the winter of 2000-01. A symptom of the larger problem of diminished deliverability, this shortfall put strong upward pressure on prices. Since those stocks have now largely recovered, the likelihood of similar incidents in the near term is small. Recent warm winters had disguised a growth in demand, and the past cold winter added to the upward pressure on prices. The sustained growth in U.S. gas demand raises important questions about the future of supply. Rising imports from Canada (now nearly 3.5 trillion cubic feet (tcf)/year, or 15% of U.S. consumption) have facilitated growth in consumption; but Canada has been producing and exporting at peak capacity for several years and is also striving to keep pace with rising domestic gas use. Changes in Canadian gas demand and exports could further tighten North American gas markets in coming years.

Figure 1



Source: J.K. Gray, Canadian Hunter Exploration Ltd.

Another important concern is the onset of decline in the Gulf of Mexico shelf's best quality gas reserves. While the high porosity of the region's gas formations is among its most geologically advantageous features, this characteristic also suggests that the decline of gas resources there is likely to proceed quickly. For example, while shelf wells declined by 25% on average in 1990, by 1997 that rate had climbed to 45%. While these reserves could be offset by those in the deep water of the Gulf, especially if prices remain high, remaining resources are largely "slow gas" formations that will require large amounts of capital, new wells, and technology to develop. "Slow gas" resources, as the term suggests, produce steadily but slowly, and their production cannot be ramped up as quickly as those from the now-mature premium areas were ramped up and are now declining.

Technology has the potential to change the outlook for North American gas dramatically and steady production declines, as the traditional Hubbert curve would suggest, are not at all inevitable. There are many, large resources remaining (such as the "slow gas" reserves mentioned above) and, undoubtedly, some high quality reserves have yet to be found. However, most of the known "elephants"—the large, premium-quality reserves—are now mature and will decline in coming years. Several analysts believe that the industry will be unable to find and drill enough small wells to prevent serious and rapid erosion of production from the region in the short-term at least, and U.S. and Canadian gas futures prices now reflect this view as well.

In theory Mexico's resources could dramatically change the outlook for North American gas supply. However, as the only North American country not open to risk contracting in the oil and gas industries, Mexico lacks the capital with which to develop its enormous resources. Thus, even though Mexico's gas reserves are comparable to Canada's, it is a net importer of gas from the U.S. Moreover, while U.S. firms' proposed construction in Baja California of receiving ports for LNG shipments from abroad is a development welcomed by Mexican officials, foreign involvement in Mexico's oil and gas upstream remains politically unacceptable.

In coming years, conservation and efficiency will be among the most effective tools for gas demand management, which will, in turn, be driven by energy prices. By the same token, many experts believe that gas resources themselves are effectively limitless and may be considered in many respects like renewable resources. But conventional reserves may be much smaller than traditionally thought, and production will be a function of price, technology, and the economics of energy alternatives.

### Energy R&D in an Era of Liberalized and Volatile Energy Markets

In the gas industry as in other energy industries, innovation will play a determining role in the question of future supply. Some Forum participants voiced concern that the volatility of gas and electricity markets following liberalization and restructuring created strong disincentives for investment in long-term research and development (R&D) activities. Would it be likely, for example, that firms would make the sustained commitments to R&D necessary to produce the "breakthrough" energy technologies of tomorrow? These participants suggested that there is a continuing role for government involvement in the deregulated energy industries to ensure the provision of public goods such as energy R&D over the long-term. As one observer noted, many of the relatively new technologies now considered essential to the industries' future, including three dimensional seismic imaging and combined cycle gas turbines, all were the products of government R&D programs.

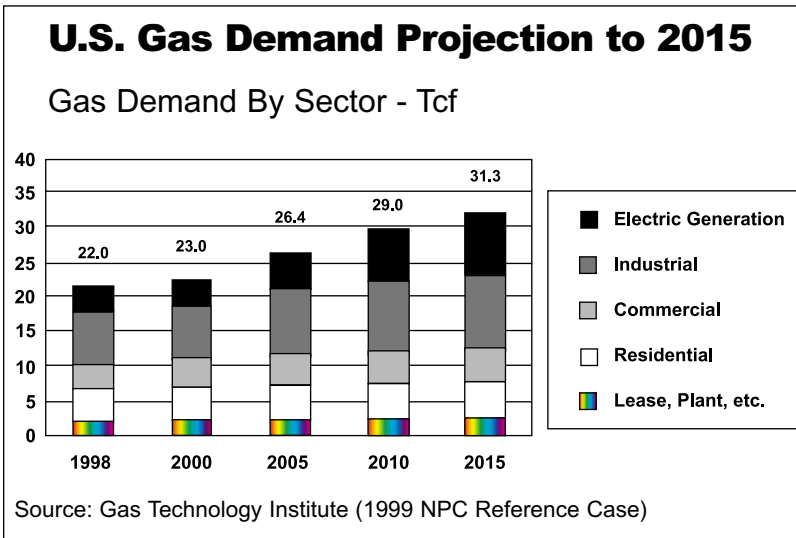
Other participants, however, expressed reservation regarding the appropriateness of government R&D programs that may attempt to pick the future's technology winners. According to these participants the market resembles a "headless herd" that runs in many directions simultaneously. In their opinion, government involvement in the long-term public interest would best be limited to indirect involvement, for example through tax credits that would encourage firms to invest in R&D, yet that would stop short of endorsements of specific technologies.

Energy market volatility has also contributed to a shortage of skilled technicians that the industries need to operate. As market prices sagged in past years, thousands of exploration and production engineers exited the industry, having been laid off once or more by oil and gas companies. Similarly, industry restructuring has forced companies to reduce their payrolls to become leaner and more competitive. The shortage of technical skills—from oil field workers to petroleum geologists—is becoming a more important limitation on the petroleum industry’s ability to serve their clients and provide high-quality, reliable services.

The Future of Gas Delivery in the U.S.

Last year, U.S. gas consumption reached 23 tcf, its highest level in history. Since demand is expected to continue to rise, some industry experts estimate that a 40% increase in exploration and production may be needed over the next 15 years. Yet even if this exploration and production problem were solved, moving that gas to market presents the industry and the country with a separate and equally daunting series of challenges.

Figure 2



There are approximately 270,000 miles of gas pipeline in the U.S. today. The Department of Energy (DOE) estimates that an additional 35,000 to 40,000 miles of pipeline (and some \$35 billion in capital investment) will be needed by 2015, mainly in the northeastern U.S. While a large fraction of the network expansion will occur along existing pipeline routes, new routes would also be needed to bring gas from Alaska, the Gulf of Mexico and western Canada to the large, growing markets of the mid Atlantic and New England. Sixty-one pipeline projects are now being planned, of which 40 are expansions of existing pipelines, and 21 are new pipelines. The success of each project hinges in large part on the extent to which state and federal regulators and community activists offer resistance.

With rising gas demand and prices, expansion of the U.S. liquefied natural gas (LNG) infrastructure is also under consideration. In 2000 alone, LNG imports increased by 70% to 233 bcf, prompting several major firms (including Enron and El Paso Energy) to plan 6-7 new LNG receiving ports in the Bahamas, Mexico, and the continental U.S. However, community opposition to the siting of new LNG facilities, particularly in the U.S., may shut down the industry's efforts on that front.

Thus, the gas delivery industry faces a threefold challenge. It must (1) meet growing U.S. demand with gas from new sources, (2) expand the nation's gas infrastructure, and (3) maintain a strong record of safety and reliability. While the industry met a similar challenge when the country's gas use more than doubled between 1955 and 1965, the regulatory hurdles and public opposition to gas exploration on federal lands and to new pipeline construction make the current infrastructure expansion task especially challenging.

The sustained high gas prices necessary to develop additional infrastructure, however, could dampen demand and infrastructure expansion requirements in coming years. Should gas prices remain in the vicinity of \$4/mcf, as some analysts now predict, gas may find it harder to compete with other fuels for electricity production in the longer term. The extent to which this could limit the need for new pipeline infrastructure will depend in large part on the price of other fuels.

## Power Generation Technologies and the Demand for Gas

The interplay of economics and technology is one of the most important engines of progress and change in any industry. With regard to electric power production specifically, customers' constant economic pressure on companies to reduce energy prices drives energy providers to seek low operating costs, high levels of efficiency and reliability, and fuel flexibility. These pressures must be balanced against mounting environmental demands on the industry to use cleaner fuels or otherwise reduce its emissions of greenhouse gases and control other air pollutants.

Consider, for example, that 215 gigawatts (GW) of new generation capacity was on order worldwide in 2000. Fifty-three percent of those orders were for gas-fired capacity while an additional 16% were for steam turbines for combined cycle production. In short, 69% of new orders for generating capacity worldwide were for gas turbines. In the U.S., where environmental considerations have encouraged power generators to switch to cleaner fuels, 96% of new orders were for gas generation technologies.

An important economic factor to bear in mind, however, is that while installed generation assets compete for dispatch on marginal cost, new capacity must cover both capital and production costs, which is a challenging proposition in today's merchant power markets. Low fuel costs of installed coal and nuclear generation ensure low marginal costs and high load duration for these facilities. (Figure 3) Likewise, the marginal production costs of installed renewable generation (including geothermal, solar, wind, and hydropower) are close to zero. Assuming as many analysts do that gas prices will remain between \$2.50 and \$5/MMBtu, the higher fuel costs for combined cycle gas units will result in higher marginal production costs and decreased load duration for these facilities.

Considering both capital and marginal production costs, however, suggests that fossil generation technologies will remain very difficult to beat on cost. (Figure 4) At gas prices below about \$3.5/MMBtu, gas combined cycle generation appears to be the win-

ner. If gas prices are higher, or if extreme volatility continues, a switch back to coal as the fuel of choice for new electric power generation capacity is a possibility. Since the installed costs of nuclear and renewable capacity exceed the \$1500/KW competitive threshold, one observer noted, fossil-fuel technologies are likely to dominate the market for the foreseeable future.

While this prospect may raise concerns regarding future air and greenhouse gas emissions, fossil plant efficiencies have risen significantly and technological improvements (particularly in the coatings, materials, and cooling fields) may push these efficiencies even higher. On average, fossil plants are now approaching 50% thermal efficiency.

Aside from the economic factors illustrated by Figures 3 and 4, it is also clear that having a diversity of fuels and technologies in the generating mix builds resiliency and flexibility into the system. Considering the economic hurdles confronting many electricity generating technologies, policy will have an important role to play in preserving a broad generating portfolio. Ultimately, the balance between costs and emissions may drive choices of generation options, and policy pressure for emissions reductions may change the current economic profiles of each class of energy technology.

### Gas Prices and Gas Supplies

Fuel prices will be a primary driver of fuel diversity, security, and emissions in coming years. Should the possibility of sustained \$4/MMBtu gas prices prove true, for example, there will be ample supplies of gas in North America and the ability to bring them to market, despite current concerns regarding possible supply shortfalls. While increasing reserves and production is rarely easy, higher prices will allow companies to explore for and produce riskier resources, such as in the deep offshore Gulf of Mexico, and to develop pipelines from Alaska or the Mackenzie Delta in Canada. High prices, for that matter, also could help to promote diversity, making other options more attractive, and provide additional incentives for

Figure 3

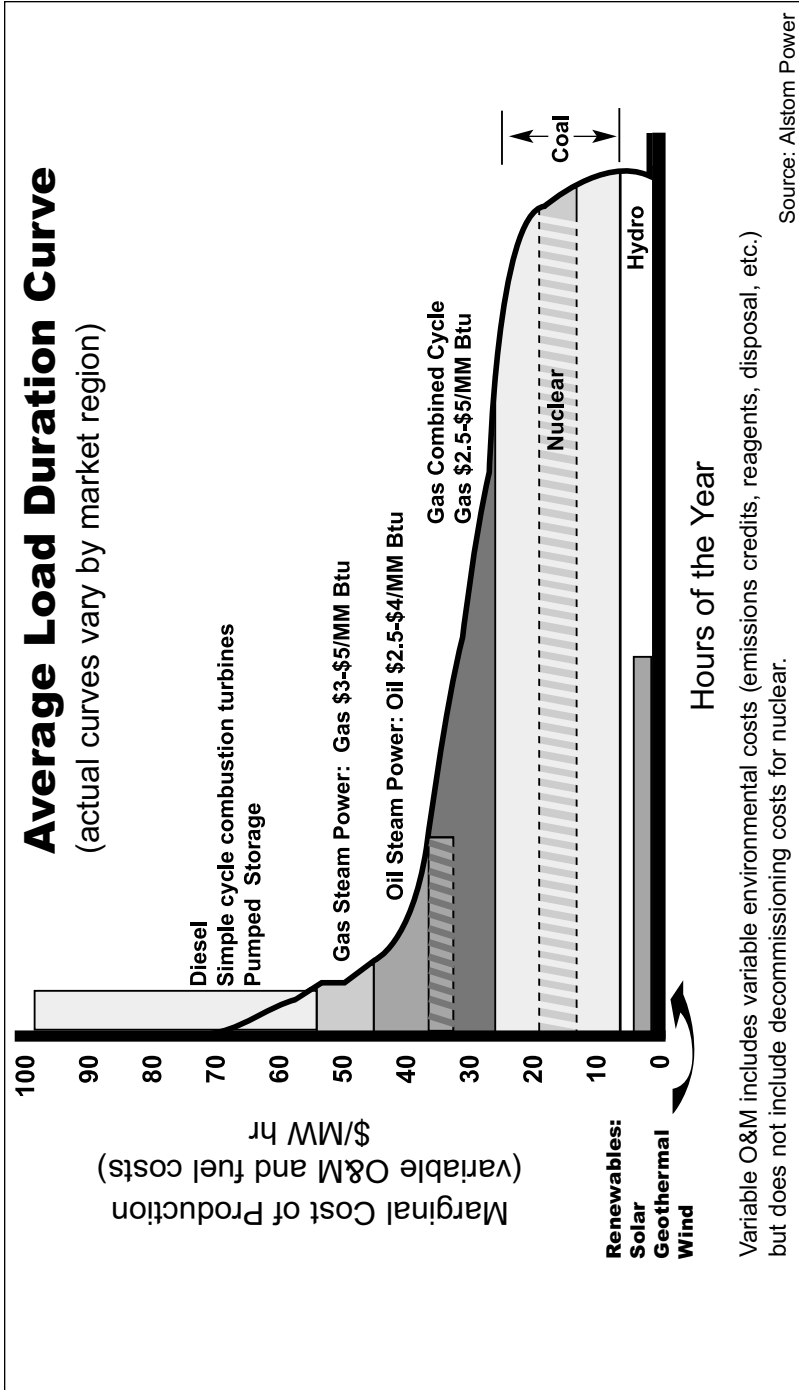
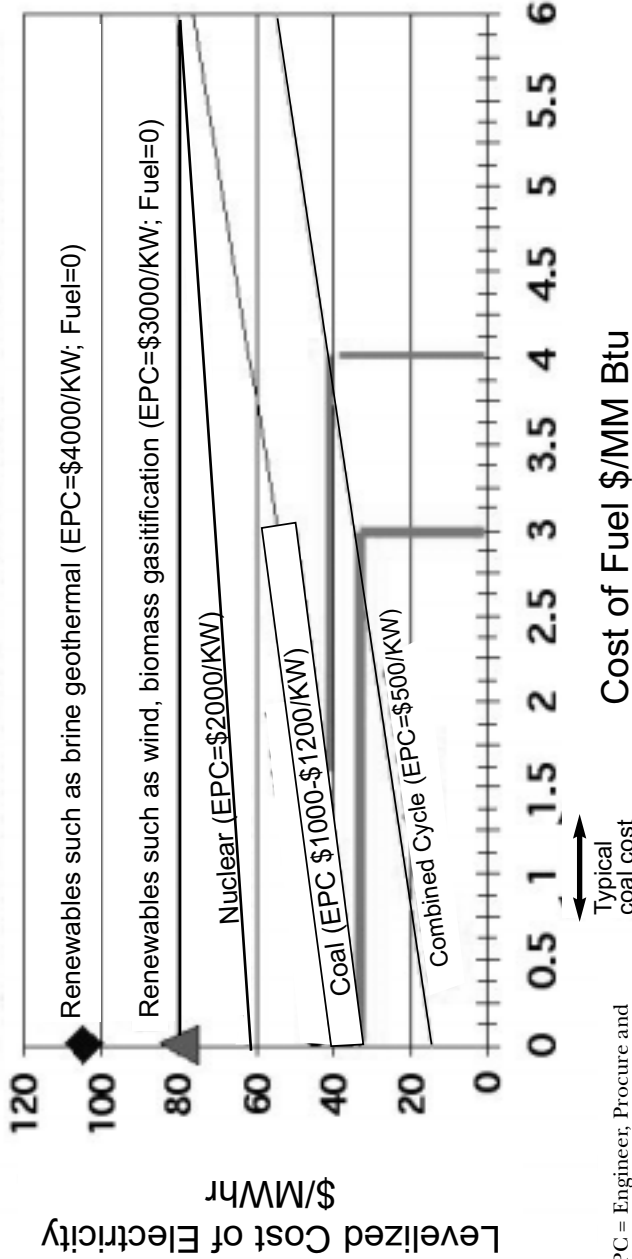


Figure 4

**New generation must cover capital and production costs  
...very difficult in today's merchant power markets.**



EPC = Engineer, Procure and Construct costs

Assumptions: Merchant plant financing; 20-year analysis; 80/20 debt/equity. Model uses total plant cost (EPC + owners' cost) in calculations.

Source: Alstom Power

conservation and efficiency. In California, for example, electricity consumption declined by 14% from June 2000 to June 2001 due in part to a substantial economic downturn but also to the effect of price hikes, rolling blackouts, and overall heightened public awareness of energy issues.

The greater challenge would be to meet rising gas demand at low prices or, more likely, under volatile conditions. Under such conditions, some participants reiterated the importance of government R&D sponsorship to ensure continuity in energy technology innovation. Along similar lines, the government has been, and can be, a helpful industry partner and ally. State and federal government played important facilitating roles in clearing the way for LNG terminals in the U.S., for instance. On the other hand, other Forum participants noted that governments have tended to become most active in the energy policy arena in response to public outcry and during periods of perceived crisis. In such instances, they maintain, government actions (e.g., the imposition of energy price caps) have sometimes prolonged the crises.

## ***Session II: California Electricity – Lessons Learned***

Many California energy watchers felt confident that the lights would never be allowed to go out, since such an event would probably spell the end for restructuring. Now, since the unthinkable has happened, debates about the causes of the crisis and about the merits of electricity restructuring have arisen as expected.

The California crisis was brewing long before either the rolling blackouts of the past year or the implementation of electricity restructuring in 1998. Major flaws were embedded in the state's electricity restructuring plan even prior to implementation. Among these was the requirement that California investor-owned utilities divest themselves of most generating assets and buy bulk power on the spot market. This feature of the restructuring program gave potential market power to new owners of generating assets, and those owners, according to some analysts, have exercised that power forcefully over the past year. Another important flaw was the restructuring program's combination of deregulated wholesale prices and regulated retail prices. While this feature escaped public notice as long as supplies were adequate, it effectively forced California utilities toward bankruptcy when the market tightened.

In discussing key flaws in the design and execution of California's electricity restructuring program, Forum participants sought lessons for the future and for other states now in the process of restructuring. In addition, participants addressed a series of larger

questions related to energy industry restructuring, including the question of standard offer service and, more broadly, the logic and necessity of electricity restructuring.

### The Foundations of the California Energy Crisis

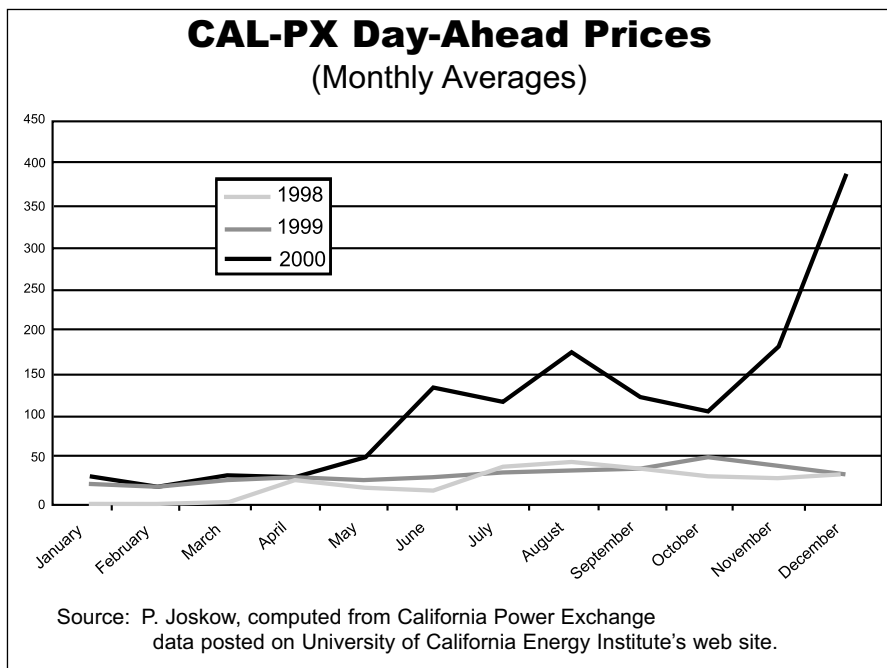
According to many observers, fundamental flaws in the design of California's restructured electricity industry became evident as early as 1998 when the new system's implementation began. Problems with the management of congestion on the transmission system and other arcane issues prompted Federal regulators to call for a major redesign of the market at the end of 1999, but the process was overtaken by events. For all intents and purposes, the warning signals went unheeded by most government officials and consumers, and the technical insider analysis of details was replaced by the political process of managing a crisis.

While 2000 began as previous years, with low prices, the crisis flared in May, when day-ahead wholesale prices shot up unexpectedly by an order of magnitude. In response, the Federal Energy Regulatory Commission (FERC) acted in May and June to offer price relief by implementing its "price mitigation" scheme, effectively imposing wholesale price ceilings. A FERC investigation in the autumn of 2000 recommended removal of retail price caps. Despite these actions, wholesale prices rose dramatically throughout 2000. For example, in January, wholesale power cost \$31.8/MWh on average; by December, wholesale prices had risen to \$385/MWh.

In March 2000, the Public Utility Commission predicted \$28/MWh throughout the year. What they missed, however, was the fact that changes in market fundamentals were about to make their impacts felt. At least four factors, discussed below, merit mention in this regard.

1. *Supply and demand factors.* In late 1999 and early 2000, demand grew by 4% per month—much faster than over the years prior, as a glance at historical data shows. Even at this level of demand growth, however, there would not have been a power shortage in California had power generators operated at their historic production levels. While normally about

Figure 4



7,000 MW of generating capacity are taken offline for maintenance during the summer, more than 16,000 MW were down during the summer of 2000. Some observers have alleged that many plants were removed from service for strategic reasons, since the low elasticity of demand in California gave market power to electricity producers. The reliance on spot markets for power purchases may have provided opportunities for producers to game the system to manipulate prices. Drought in the U.S. Northwest, which reduced hydroelectric generating capacity, also contributed to California's problems.

2. *Rising gas prices and tight gas supply.* Gas prices rose nationwide, especially after May 2000. In December 2000, California gas prices rose to more than \$50/MMBtu, well above the national average. Imports of gas (especially from Western Canada) to California declined, due to rising

demand in other parts of the country. As a result, California lost the equivalent of 3-5 GW of gas-fired capacity in the latter half of 2000.

3. *Rising Air Emissions Permit Prices.* Prices of NOx emissions credits in the Southern California Air Quality Monitoring District rose quickly from \$3/lb to over \$40/lb between January and July, imposing significant new costs on power producers.
4. *Regulatory Failure.* As the power crisis came to a boil in California, both state and federal regulators were slow to respond and, in the opinion of some industry participants, responded ineffectively once catalyzed to action. Among its lessons, the California crisis has demonstrated that FERC may lack some of the human and technical resources it needs to oversee energy markets in a fast-moving era of restructuring. Although there were strong differences of opinion among participants at the Forum regarding the appropriate role of state and federal government in the energy industries, most participants agreed that government action in California was too little and too late to mitigate the crisis.

### Technology and the Future of Electric Power

The California crisis underscores several of the potential hazards of electricity restructuring. As the previous section discussed, the incentives for investment in technological innovation and for the deployment of new technologies have changed significantly with the liberalization of the industry. Competition may discourage investments in long-term R&D and shorten the capital investment horizons of electricity industry participants. At the same time, the importance of these investments is growing since they will play a determining role in the shape of the industry and the nation's infrastructure over the next half century—an era in which major social, economic and environmental changes could place unprecedented challenges on the system.

The large-scale infrastructure systems that exist now and that will be augmented or built in coming years will be expected to support major economic and demographic transformations that are now on the near horizon. With this in mind, it is important to recognize that electricity is likely to be the end use energy source of choice for the foreseeable future. In order to meet this daunting challenge with minimum environmental impact, minimum infrastructure expansion, and lowest cost, it will be important to have a clear vision of the optimal system architecture. Some important steps to the electric power architecture of the future are:

- Eliminating the meter as it currently exists and replacing it with a two-way, real-time gateway combining gas, electricity, and telecommunications services. Using technology to give consumers more information and more choice in their consumption decisions will make them more responsive customers and make the system as a whole more resilient.
- Deploying electronic controls and switches throughout the system, from generator to end user, and broadening their use.
- Moving to a continental—rather than a national—grid system and viewing such a prospect as more opportunity than threat.
- Increasing the opportunities for the deployment of distributed generating technologies such as microturbines and fuel cells that can be located close to the point of power consumption. Some analysts envision networks of such smaller-scale technologies as the most promising pathway to an electricity future that is reliable, affordable, and environmentally sustainable.
- Revisiting the physical properties of electricity in thinking about infrastructure design for the future. Electricity will never be able to act as a commodity as long as the system remains as it is now. Recognize also that, if regulators and traditional energy companies do not move to bring about change, the industry will move around the lagging leaders.

## Managing California's Electricity Portfolio

As one Forum participant noted, in the past electric utilities operated under a regulatory compact that imposed on them an obligation to serve the general public in exchange for a fair rate of return on their investment. The belief that providing electricity was a "natural monopoly" merited this bargain between government regulators and industry. The regulatory compact endured from the late 1930s to the early 1990s. In the restructured environment, however, power producers' obligations and abilities to manage their portfolios with the interests of all consumer groups in mind are more controversial questions. As the California crisis has shown, the system failed in this regard, as portfolio management at the wholesale level alone has proven insufficient to keep the lights on for smaller consumers. While energy service companies did enter the market and provide risk management services to large users, these services never were available to smaller consumers.

While several well known factors conspired to bring the portfolio management issue to a head in California recently, it is important to examine some common assumptions surrounding the crisis and its causes as well. For example, analysts often cite the state's spiraling demand as an underlying cause of the crisis. In fact, between 1990 and 1999, electricity growth in California averaged 1% annually. The year 2000 was an exception, where demand growth approaching 4% resulted from a combination of factors, including exceptionally hot weather and a very strong state economy.

Another oft-heard assertion regarding the onset of the energy crisis in California is that onerous siting and permitting processes make it impossible to build new power plants in the state. Some participants claimed this is an exaggeration, however, and that the environmental community, for example, has supported the development of new combined cycle gas and renewable energy generation facilities and played a key role in moving proposals for new plants through the siting process. According to some analysts market uncertainties rather than siting and permitting complications delayed additions to generating capacity in recent years. Some com-

panies that had had new facilities approved chose to hold off on construction because of the market's volatility and questions about how restructuring would unfold. Other participants noted, however, that siting and permitting in California have for decades been a factor in that failure to add generating capacity within the state.

Nonetheless, California's electric power system has indeed been greatly stressed, despite planned capacity additions and peak demand reductions in 2001 (for example, June 2001 peak demand was 28% lower than June 2000). California's governor promised to suspend, if necessary, regulations on air emissions should they present a threat to power reliability, highlighting the extraordinary measures adopted to relieve pressure on the system. That said, many industry observers do not anticipate such a need arising. The recent reductions in pressure on the California grid are, for that matter, the result of a combination of factors including weather, higher prices, new energy efficiency standards, higher levels of public awareness amid rolling blackouts, an economic downturn, and an effective public information campaign to reduce energy demand.

Despite the short-term success of these and other measures in reducing electricity demand, the economy will revive, and this is not a viable strategy for grid management in the longer term. California and the western states face an ongoing crisis, which might be characterized as a catastrophic failure in portfolio management. The assumption, prior to restructuring, was that retail level portfolio management could be left to the market, although evidence now suggests that this may only be achieved by a more carefully thought out restructuring plan. Thus, it has yet to be determined who will create, manage, and ensure the existence of an electric power resource portfolio for smaller customers. Restoring incentives for a strong portfolio management function that includes both supply and demand side management activities will be an essential part of successful electric utility restructuring.

Moreover, in California, most people accepted the assumption that retail restructuring would come to bear quickly, since the state was considered the best available test bed for deregulation. In retro-

spect, since futures markets also offered no signals of trouble ahead, it is possible that the forward markets may have been looking too far forward. Yet another important and related question concerns the role that hedging should be allowed to play in a liberalized retail electricity market. While hedging does not necessarily produce the lowest price, it does mitigate price shocks and can serve as a very important tool.

The challenge of effective wholesale portfolio management—regardless of whose that task may be—will be complicated by several factors. For example, portfolio managers must factor in the environmental provisions in California’s state implementation plan that will force several plant retirements in coming years. Also, as noted earlier in the case of petroleum exploration and production, one participant expressed a concern that scarcity of craft labor (including boilermakers and other skilled technicians) may place limitations on the system. Finally, considering that the most popular gas generating technologies (combined cycle turbines) are manufactured by only three vendors, supply bottlenecks could arise in the future should the popularity of gas continue to grow.

### The Ghosts of Regulation Past, Present, and Future

Virtually all Forum participants agreed that the redesign of the regulatory regime in California was badly flawed. Inaction by political leaders when the flaws initially became obvious exacerbated the problem. While deregulation in principle is not necessarily a bad thing, it is worth mentioning that California’s restructuring of the electric power industry was by no means a process of complete deregulation. Note, for instance, that the state public utility commission still has more than 1,000 employees.

That said, in the light of recent events, some Forum participants are now questioning the necessity of energy industry restructuring and asking in hindsight if, in fact, the old system was really all that bad. After all, during the era of strong government regulation (from the late 1930s to the early 1990s) the United States developed the

largest, most reliable, and most affordable electricity system in the world. These reflections resonate with many California energy consumers who are particularly angered by their exclusion from the design phase of the restructuring process.

Some observers argue that, while it is important to identify the flaws in the current system as a first step toward further redesign, it may be even more critical to use the vantage point of the current crisis to begin thinking about some deeper questions. For example, to what degree should an entity that is as central to the nation's quality of life and economic well being as the electricity system be subjected to the forces of the free market? As one participant asked, has California and have other states effectively taken a dive off the high board and only assumed the existence of a pool of water below?

While some Forum participants felt that California's electricity restructuring was a badly executed effort to fix a system that was not broken, others were unwilling to concede that restructuring was not necessary. A primary concern of theirs was the fact that the old system, which indeed kept the lights on and prices relatively low, provided less incentive for technological and product innovation than a more competitive system would do. They contended that realities such as the lack of real-time pricing, the lack of a distributed generation network, and the fact that some companies are still building coal plants are all indicative of persistent regulatory distortion. True deregulation—rather than California's flawed restructuring—would correct these and other shortcomings of the current situation.

That said, government still has an important role to play in deregulated energy markets in the opinion of many participants. For example, since regional power pools are still largely unable to communicate with one another, federal rule makers will have a critical role to play in reconciling the regional systems with one another to allow interregional power trading. Moreover, regulatory actions will also help to ensure a well-functioning demand-side of the electricity equation and the viability of demand-side measures such as real-time metering, "negawatt" markets, and other conservation incentives. Demand-side management tools such as these deserve priori-

ty since they can be deployed very quickly and inexpensively and do not overshoot in the way that capacity additions often do.

Other participants argued that a key causal element in California's problem was the fact that the state chose an exceptionally difficult deregulatory path, given the resources and experience level of the state's regulators. Their operating experience simply was mismatched with their expectations and optimism regarding electricity restructuring. This being the case, some suggested that a careful and dispassionate national review of the crisis—similar to the review of the 1979 Three Mile Island nuclear accident—would be a worthwhile undertaking from which the entire country could gain valuable insights.

If there is anything positive to be said about California's energy crisis, it is that high prices have furthered the causes of energy efficiency and conservation. Industry analysts expect, for example, more than 4 GW of new demand reduction efforts in the latter half of 2001 alone. Thus, price signals to end users have proven to be effective load management tools. This, in addition to 4 GW of new generating capacity, will offer welcome relief to the state's power system.

Nonetheless, California's regulators may be, in effect, falling into a "farm subsidy" trap through their efforts to compensate consumers for not using electricity. For instance, consumers who use 20% less electricity this year than last receive a 20% credit on their electricity bill. While demand reduction incentives such as this are more attractive to consumers than the more punitive tool of simple price signals, they further contribute to the poor financial condition of the regulated utilities.

Compared with other states, California's per capita electricity usage was historically very low, and wholesale prices were generally below the national average. So, in the light of the current situation, it is clear that the legislature's mandates and the PUC's implementation of restructuring exacerbated the problem. As noted before, the regulators insisted, for example, that the utilities had to divest themselves of generating capacity to avoid giving the utilities opportuni-

ties to gain market power. Ironically, through forced divestiture, the commission created a situation in which generators and marketers may have been able to exercise great market power, since utilities had to purchase all their electricity from a state power exchange at a single-price auction, and without the benefit of long-term contracts or hedging. At the same time, wholesale prices were deregulated and decoupled from retail prices, which remained capped. This retail rate freeze resulted in a combined \$14 billion undercollection in 2000 for Southern California Edison (SCE) and Pacific Gas and Electric.

Not surprisingly, several problems emerged in the new regulatory environment. First was a crisis of supply, since, as demand grew, no new capacity had been coming on line. Power generators faced substantial uncertainty under the new system and were understandably reluctant to bring on new capacity.

Second, there was a price crisis that was felt statewide. While utilities there were paying 3 cents/kWh for energy a little over a year ago, in early 2001 prices rose temporarily more than one hundred-fold. Prices have stayed stubbornly high, even during periods of low demand. On average, SCE has paid an average of 30 cents/kWh and recovered 6 cents/kWh. In total, the utility has paid about \$5.5 billion more than it has recovered from customers. As one participant noted, over the past year, California utilities have ceased operating as power providers and now function more as banks financing their customers' electricity purchases. Since the crisis began, California utilities have financed approximately \$20 billion in electricity purchases before their access to credit was finally blocked. It was only then that the state government stepped in to make power purchases on the utilities' behalf and keep the lights on. The state government is discussing a solution with California utilities—one in bankruptcy and the other close to it—that would return them to solvency while transferring transmission assets to government control. Yet, approval of the agreement by the legislature or bankruptcy judge will be required and has been slow in coming.

Ultimately, the electric power system must be reliable to function well. Inadequate infrastructure will have a major impact on reliability, and under current circumstances utilities simply cannot finance infrastructure investments needed to ensure future system stability. In many key respects the responsibility for resolving the current crises and smoothing the way for future infrastructure investment lies with the state PUC. In the absence of a swift resolution of this issue, longer-term economic impacts of inadequate infrastructure will make themselves felt statewide.

## ***Session III: Restructuring—The Road Ahead***

The third session of the Forum considered the progress of electricity restructuring in the U.S. since the early 1990s and the challenges that lay ahead. Some participants noted the important role that new federal energy legislation and regulation could play in smoothing the path for the continuation of the restructuring process. Others emphasized the importance of industry leadership in advising regulators and legislators as they shape the landscape for the future of electric power, and in envisioning a future that takes advantage of a broad range of technological possibilities in building new infrastructure. The session also explored two models for innovation in electric power market structures: the U.S. mid-Atlantic PJM power pool and the United Kingdom's New Electricity Trading Arrangement (NETA).

### Where Do We Go From Here?

With the passage of the 1992 Energy Policy Act, many analysts expected that the restructuring of the energy industries would be a fait accompli by the end of the 1990s. No one anticipated, for example, that the processes of setting up independent system operators (ISOs) and regional transmission operators (RTOs) would be as arduous and protracted as they have turned out to be.

Also, over the past decade, the wholesale electricity market has become more balkanized than it was prior to restructuring. In some states utilities have divested their generation assets, and in others they have not. In the former states there has been a shift in regulatory responsibility from the state to the federal level, and the provider of last resort issue is a pressing one because distribution companies must obtain supply for remaining customers (that is, most customers) from the wholesale marketplace. In these states with largely merchant generation, most new capacity additions are gas-fired combined cycle plants. In the latter group of states there are equally serious, yet different, concerns, such as price responsiveness of demand (or consumers' inability to see real-time prices and respond to them), and possible new investments in and use of coal plants. In some sense, the two coasts fit the pattern of the former, while large sections of the middle and south of the country fit the latter. This fragmentation of the industry has been facilitated by both federal policies and the persistent lack of federal restructuring legislation to supplement the 1992 Energy Policy Act. The growing incompatibility of regional electrical grids in the U.S. is a serious problem that federal legislation ought to reconcile but has not.

But despite the chronic problems associated with restructuring and deregulation, it is important to place the current situation in the broader context of the electric power industry's long and impressive history. For example, a recent study published by the U.S. National Academy of Engineering listed the electric power system as the greatest invention of the 20th century, for its unique profound contribution to quality of life improvement in the U.S. and around the world. Furthermore, the next 11 inventions on the NAE list were also tied directly to electricity.

Consider also that enormous improvements in electric power production and use have occurred even since the late 1970s, when the door to deregulation was initially cracked open via the Public Utilities Regulatory Policy Act (PURPA). While regulated monopolies worked well for a long time in the U.S., following fuel shocks of the 1970s and the passage of PURPA, people began to see that prices could fall and technological innovation could occur more rapidly under a new

regime. Moreover, once challengers to the regulated monopolies were permitted to enter the industry, there were huge gains in the industry's average heat rates, and large gains in end use energy efficiency. These developments simply would not have happened had the old system been left undisturbed.

Thus, even though many people are justifiably upset with the current state of the industry and the incumbent high gas and electricity prices, taking a generally longer view may help to mitigate those sentiments. The process of restructuring is moving, sometimes slowly, but surely forward. The grid is being used with increasing efficiency, as is evidenced by the quantum growth in inter-regional electricity transactions. Today there are more than 2 million inter-regional transactions annually—a level several orders of magnitude higher than a decade ago. The country also has a more diverse and environmentally sound fuel mix today than even just ten years ago, since the fuel of choice for new base load generation is shifting from coal to gas.

Serious problems persist, of course. For example, some analysts argue that there has been a profound lack of industry leadership in the articulation of a vision for the future of electricity. Some Forum participants believe that, in the absence of strong industry leadership, regulators and policymakers cannot be expected to play a definitive role in this regard. As one participant noted, recent events in Kentucky offer a cautionary example here. The state government recently imposed a moratorium on the construction of new gas plants, since all new capacity on order in Kentucky was gas-fired, while the state favored, for political reasons, the construction of coal plants. Thus, the state intervened in the market to favor coal, despite the clear environmental benefits of, and public preference for, gas. Those firms threatened by the prospect of change will obviously act to resist it. Visionary leadership from the industry will be necessary to overcome the inertia of the old system. It is important to add that this inertia is not maintained by the industry alone. Consumers also will have to be better informed to facilitate change in the system. Even ten years after telecommunications deregulation in the U.S., AT&T still retained nearly 50% of the residential market.

Many analysts believe that the industry as a whole has often blocked open access to the grid to new entrants, stalled the creation of ISOs and RTOs, and slowed comprehensive energy restructuring legislation. Yet if it continues to stonewall on these fronts, it will only undermine its own positions. Failure to lead will ultimately result in the industry's being dragged along in a process of change that it will have had little influence in shaping. As one Forum participant noted, when change is inevitable, it is better to be a thermostat—a shaper of the new environment—than a thermometer. Whether the industry embraces the notion or not, change is inevitable and going back to the old ways is not an option.

### Infrastructure and System Innovation

Electricity infrastructure presents many pressing challenges as well. The country's generating plants are aging and many—especially older coal plants and nuclear plants—will need to be replaced soon. While the industry has learned how to extend the life of existing facilities, their replacement is difficult in the absence of the old regulatory compact, particularly if fuel diversity is to be maintained. Transmission infrastructure also may place serious limits on the growth of the electric power industry. The transmission grid is already groaning under the strain of its age and the ever-increasing demands upon it, yet the prospects for expanding the grid by opening up major new transmission corridors appear dim, given the strength of resistance that communities and environmental groups have assembled.

Distributed generation, powered by newer technologies such as fuel cells and microturbines, may enable the creation of energy webs and local electric power networks that could improve overall system efficiency and reliability, and reduce price volatility. Yet the dominant thinking in the industry still favors the old model of large, centralized plants, long lines, and one-way transmission. While the technologies for distributed networks may be ready for deployment, current opinion and policy incentives still favor the traditional model. As one participant observed, the U.S. is now faced with the

challenge of drafting a long-term plan while embroiled in a short-term crisis.

On a more positive note, models of change in the electricity industry can be found both in the U.S. and abroad. For example, the mid-Atlantic's PJM (Pennsylvania-Jersey-Maryland) power pool is an example of a successful effort to establish a regional electricity pool in the U.S. Siting and permitting in the PJM region has been streamlined and is working well, and the regional ISO has been granted tariff authority, allowing it to respond quickly to changes in market conditions. Also, in New Jersey, the question of the supplier of last resort has been satisfactorily resolved, as the standard offer is now determined by open competitive bid. While this method became untenable recently as wholesale prices rose, New Jersey utilities responded by combining their electric loads and putting them out to bid as a unit to give maximum flexibility to companies that might want to serve different customer classes within the state.

These features of PJM, all of which have required compromise on the part of industry, regulators, and legislators in the region, nonetheless appear to have yielded substantial gains for all participants and for the public goods—reliability of service and price stability—delivered by the system. In many respects, this regional architecture is serving as a model for other parts of the country; for instance, the New England states recently adopted a regional model that is based on that of PJM.

In some ways, the New Electricity Trading Arrangement (NETA), which was instituted in the United Kingdom in January 2001 to replace England and Wales' power pool, can offer some lessons for the U.S. electric power industry as it looks to shape its future. NETA was designed to correct several problems with the old electricity pool, including its lack of demand-side participation, complex bidding and price setting arrangements, and slow pace of reform. NETA, by contrast, signals a move toward the trading of electricity like other commodities (such as oil or metals). Whereas it was compulsory for all electricity to be bought and sold through the pool under the old arrangement, NETA allows generators to self-dispatch

and employs forward markets, a balancing mechanism, and an imbalance settlement process to ensure stability and check price volatility.

Some Forum participants pointed out that the UK's single power grid with few interconnects and its National Grid Company form the centerpiece of the NETA. Thus, they noted that NETA is a model of only limited applicability in the U.S., given its fragmented transmission infrastructure. Nonetheless, NETA may serve as a useful model on a regional scale in the U.S., and it provides an example of successful cooperation among regulators and industry to find innovative solutions to energy problems.

## ***Session IV: Oil Markets—Problems and Prospects***

Many energy industry analysts have sought explanations for the unexpected rises in gas and oil prices since late 1998. Session IV of the Aspen Energy Policy Forum addressed several factors that underlay the sharp price increases in oil markets specifically. As the discussion below explains, a combination of international and domestic factors worked to drive up prices. An important international development was renewed solidarity among members of the Organization of Petroleum Exporting Countries (OPEC) and its allies, which succeeded in coordinating oil production cuts beginning in 1999. From a more theoretical perspective, one observer explained that a common misunderstanding of the relationship between inventories of petroleum products and prices has helped to amplify price volatility in world oil markets. On the domestic front, regulations such as the 1990 Clean Air Act Amendments (CAAA) have also contributed to rising oil prices by spurring demand for reformulated gasolines, custom designed to meet the environmental requirements of specific geographic areas around the country. These and other key issues in world oil are discussed below.

### The Resurrection of OPEC

Reliance on oil entails perennial political and economic risks. U.S. public and policy makers' perceptions of those risks seem to have shifted and diminished recently, however, perhaps due to the

more pressing crises involving electricity in the western U.S. and volatile natural gas prices. Despite the relatively low level of attention given to oil at the moment, it would be unwise to conclude that fundamental changes in the nature of the oil market have altered the outlook for world oil or diminished the potential for future volatility in oil markets. Major developments in world oil over the past four years offer some useful insights in this regard.

Starting in late 1997 as the Asian economic crisis intensified, OPEC increased its production with disastrous results. Prices fell to around \$10/barrel (bbl)—their lowest level in the cartel's history. By mid-1998, however, producers were able to rally and agreed to large production cuts that took effect in early 1999. Consequently, the world market price of oil tripled over the next two years. With cooperation from Mexico, OPEC proved its ability to discipline itself and rise from the ashes to dominate oil markets once again. The cartel's members have since shown remarkable solidarity and have succeeded in sustaining \$25/bbl crude prices.

While OPEC has rallied, reactions in consuming countries have been varied. In the U.K. and elsewhere in Europe, for example, large groups of protestors blocked roads and access routes to oil refineries and demanded government relief from the soaring gasoline prices that followed OPEC production cuts. In the U.S., the federal government has on one occasion drawn down the Strategic Petroleum Reserve by means of swaps as heating oil stocks in New England dwindled and prices soared in 1999. The Bush Administration's policy response has included 1970s-style calls for energy self-sufficiency and redoubled efforts to increase domestic oil and gas production. Yet, as we look to the future, oil is likely to remain the world's dominant fuel source for at least twenty years, and most of that oil will come from the Middle East regardless of the West's best efforts.

As the Aspen Forum was meeting, OPEC also met and again decided to maintain its current level of production in order to keep oil prices at their current level of around \$25/bbl. Yet this price is becoming more difficult to sustain because of the softening of the world economy over the past year. In response to dwindling world

demand, OPEC has already cut its output twice this year (by a total of 2.5 million barrels per day) in anticipation of further slowing of the world economy. This situation raises some important questions for policy-makers in the West. First is the question of causality. Is the softening of the world economy driving down oil production, or are reduced OPEC output and high oil prices braking what might otherwise be a robust economy? Second, why have governments in consuming countries been so reluctant to speak up for themselves and state what they believe would be the "correct" price for oil on the world market? OPEC has been assertive in this regard, but silence has been the response from the West.

### U.S. Policy and the World Oil Outlook

U.S. energy policy may provide at least a partial explanation for the West's ineffective response to recent OPEC actions. Effective energy policy must consist of both a clear goal and a means of achieving the goal. In the opinion of some participants, the Clinton Administration never articulated an energy policy, and the new Bush Administration's recently issued energy policy includes neither of these core elements. By this analysis, in the absence of these elements, the Bush energy policy centers on a plea for more: more nuclear plants, more oil and gas drilling, more pipelines and wires, more renewables, more conservation, more subsidies for producers and researchers.

One participant noted that amid the current energy policy debate, a more fundamental policy issue was being neglected. Even if the U.S. government were granted all its wishes with regard to energy policy, it would still not achieve what should be its primary goal—freedom to set its own foreign policy and manage its economy without fear of OPEC inflicting another period of economic harm on the United States. In this observer's estimation, the ongoing California crisis pales in comparison with this "real" energy crisis, stemming from the fact that the oil cartel still wields the power to throw the U.S. economy into recession and, thus, to dictate U.S. foreign policy.

According to this view, an overriding energy and foreign policy goal should be for the U.S. to break the power of the oil cartel. This is not to say, however, that the U.S. should seek energy independence, but rather to introduce greater levels of competition into the "cartelized" world oil markets. An energy policy with this core aim would attempt to extend the reach and influence of market forces, to displace monopolies, and to eliminate subsidies and other government interventions that have proven counter-productive in the past. No amount of domestic oil drilling will achieve this paramount policy goal in a time frame that has any political significance. Note also that the U.S. has failed to mitigate energy price spikes through the use of the Strategic Petroleum Reserve (SPR). Even during the critical period following Iraq's invasion of Kuwait in 1991, the government failed to tap these stocks—not least because of a continuing debate over whether they should be used to limit price increases occurring in anticipation of a shortage. Likewise, the government's efforts to persuade Arab allies to abandon their pricing practices have gone nowhere.

Could the U.S. reduce the influence of OPEC on its foreign policy? One course, obviously, would be to do nothing and wait for the cartel to collapse of its own weight again as it did with excessive price increases in the 1980s. Yet, this would be a dangerous course since OPEC is, as mentioned earlier, newly cohesive after the fright its members suffered during the low-price years of the 1990s. Thus, a wait-and-see policy course would prove expensive to the U.S., since OPEC would continue to manipulate the market within a certain price range.

Alternatively, one oil policy "hawk" suggested U.S. policy should focus on making both sides of the market function more efficiently. On the demand side, this means internalizing externalities to get prices right. On the supply side, a good first step in this direction might be elimination of artificial constraints on the market, for instance by pressuring Mexico to end its curtailment of certain oil shipments to the U.S. and by tying U.S. contributions to the future defense of Kuwait to increased production there.

On the demand side, some participants suggested that the imposition of environmental taxes on energy use—particularly if revenue neutral—could also be an effective component of the energy policy portfolio, despite the reluctance of U.S. policymakers to consider this option. Raising fuel prices domestically could stem the flow of transfer payments to OPEC producers, encourage conservation and efficiency, and create revenue streams for environmental programs.

Most Forum participants agreed that the U.S. should also revisit its sanctions on Iran, Libya, and Iraq. Particularly in the former two cases, which involve unilateral sanctions, the costs and benefits of sanctions regimes need dispassionate reevaluation. Most evidence suggests that such sanctions policies are ineffective, often penalize U.S. industry and consumers, and complicate other aspects of U.S. foreign relations.

Some of the policy actions described here are clearly high stakes propositions for the U.S. and for the world, since the repercussions of U.S. action quickly ripple outward. Most participants felt that many of these actions would be excessively risky or inappropriate, at least under current circumstances. Yet, the suggestion that such policies be considered underscores the fact that the "real" energy crisis rises above the evanescent matters of oil prices and market volatility. According to this view, energy policy must ultimately serve the grand strategy aim of reducing external influences on American foreign policy.

### The Role of Inventories in Determining Energy Prices

While OPEC countries may have a highly important role to play in determining world oil prices, they are by no means the only actors whose behavior influences market conditions. Another key factor that must be considered is the role that government and private inventories play in shaping the oil market.

One analyst noted that it is important to understand the counter-intuitive linkages between inventories and commodity prices. Firms hold private stocks when the markets offer a positive return for

doing so, and positive returns to holding stocks occur when stocks are high. So, the economic incentives associated with holding stocks increase as the stocks themselves increase. Conversely, firms will not hold stocks when there are no incentives to hold them, so incentives decrease as stock levels decline. A market clearing price for future delivery that is higher than today's price—a positive spread—provides the strongest incentive for firms to hold inventories.

There are contending theories explaining the existence of spreads, and these theoretical differences have important implications for energy. The first theory, drawn from finance, posits that cash prices are determined by supply and demand, while forward prices are determined by future production costs and are treated as forecasts of future prices. Inventories do not play a role in this model, which is accepted by the U.S. Federal Reserve Board.

The second theory, known as the "supply-of-storage" model, derives from agricultural economics and suggests, like the previous model, that cash prices are set by supply and demand. However, in this model, the spread between cash and futures prices is linked to inventories, since forward prices are not presumed to be forecasts. The agricultural theory postulates a non-linear linkage between inventories and spreads, because of the possibility of arbitrage. That is, when inventories rise above a certain level, the spread between futures and cash prices reaches a ceiling and stops increasing. However, as inventories fall, the premium offered for cash supplies increases relative to forward prices and there is no ceiling. This theory appears to apply to all energy markets, including electricity.

The supply-of-storage model offers an explanation for the apparent absence of linkage between production costs and prices, since inventory declines can cause spreads to grow very large. This is, in some ways, a cautionary tale since the U.S. is now diversifying its use of petroleum products and increasing its consumption of specialized "boutique" fuels, but is not increasing storage.

Oil exporting countries have studied the supply-of-storage model and are exploiting it to their advantage today. OPEC has recognized

that prices collapsed when inventories rose to high levels in 1998, and the cartel's March 1999 decision to cut production was based on the principle that inventory reductions would cause spreads to widen. This analysis proved correct.

While producing nations have already employed the supply-of-storage model successfully, consuming countries can also use it to their advantage. In this regard, strategic stocks are critical. The release of strategic stocks, when inventories are low and current prices exceed future prices, can dampen price increases. Governments could reduce the price risks associated with exploration by building their reserves when stocks are high, thereby moderating price volatility. This assumes, of course, that oil prices are "mean reverting"—implying that market prices will eventually return to a mean price if left to themselves—and that price volatility is undesirable. Strategic inventories can also moderate the downward pressure on industry inventories resulting from recent oil industry mergers.

### Domestic Challenges for the U.S. Oil Industry

In addition to the global challenges now confronting the oil industry and oil markets, there are several pressing concerns on the domestic front. In particular, the U.S. downstream industry finds itself in an increasingly tight position due to a combination of factors including dwindling refinery capacity, aging infrastructure, growing environmental regulation, and increasing demands for specialized or "boutique" products.

The U.S. oil industry's domestic operations have historically had high levels of government regulation and oversight in the form of price caps, windfall profit taxes, and anti-trust laws. However, since the 1970s and the concomitant rise in environmental sensitivities and legislation, the Environmental Protection Agency (EPA) has played a dominant regulatory role in the industry. EPA now determines to a large extent the range of products the industry produces, the markets in which those products will be sold, and the prices for them.

The growing body of regulation affecting the downstream oil industry in the U.S. will demand high levels of capital investment to keep the industry in compliance. This presents a challenge to industry managers, since that portion of the industry has always had a relatively low return on investment (approximately 4%). Since oil is expected to account for about 40% of the country's energy consumption through at least 2020, the demands on the oil industry and infrastructure will be enormous and the challenges great.

Considering the growing demands on the downstream industry, many industry observers argue that a serious effort at regulatory streamlining could eliminate ineffective and politically-motivated rules—some participants pointed to federally-mandated reformulation of gasoline using ethanol—while benefiting the environment. This action could redirect investment capital from regulatory compliance to badly needed new infrastructure projects.

The rise of numerous reformulated gasolines—"boutique fuels"—is among the largest challenges that the industry faces today. The use of reformulated gasoline (RFG) designed to reduce harmful emissions from auto fuels was a result of the Clean Air Act Amendments (CAAA) of 1990, which mandated use of RFG in specific Clean Air Act non-attainment areas. From a scientific perspective, the rationale behind reformulated gasoline is a sound one, as the CAAA aims to remove byproducts of auto use known to damage human health, including lead, sulfur, nitrogen, volatile organic compounds, and air toxics.

The proliferation of "boutique fuels," however, has greatly complicated the refining process and increased fuel prices in many parts of the country. Consider, for example, that there are currently 10 mandatory RFG areas, and 11 other areas that have voluntarily adopted boutique fuel requirements. Twelve states have adopted boutique fuel programs to address summer ozone pollution problems and even 15 U.S. cities now have their own gasolines, marketed solely in those places.

The boutique fuel phenomenon has distorted the market and heightened price volatility, since variations in wholesale prices for different reformulated gasolines vary sharply from place to place within the US.

Prices in areas using MTBE as an additive, such as New York City, for example, have been less volatile than others, like Chicago, which has its own custom formula gasoline. Customized fuel requirements effectively give producers market power and makes regions dependent on these fuels more vulnerable to natural or strategic supply interruptions.

Rather than mandating the use of RFG, as the current regulatory approach to air pollution control does, an alternative path to air pollution control was proposed that might achieve superior results and avoid many of the current regime's shortcomings. By focusing, for example, on environmental performance goals rather than technology mandates, and allowing states and localities flexibility in achieving those goals, results can be achieved more cheaply and more efficiently. Even though emissions reduction targets for several air pollutants have been met and exceeded nationally, oxygenates have played a minimal role in this achievement. Industry observers and regulators have pointed out that environmental goals can be met without the levels of oxygenates now required; the mandated use of ethanol as an oxygenate, for that matter, serves a more important function as an agricultural subsidy than as an environmental compliance tool.

Regulatory alternatives would also need to consider the interplay of, and tensions between, state autonomy and federal mandates. Voluntary state actions rather than federal rules, for instance, are now the prime movers of the boutique phenomenon and increasing volatility in gasoline markets. Efforts to understand and mitigate the state-driven boutique fuel trend would be a key component of regulatory change.

Similarly, Forum participants agreed that the issue of geographic coverage must be addressed. In order to reduce issues such as tightening refinery capacity and gasoline market volatility, it would be necessary to conduct a thorough analysis of the environmental benefits of boutique fuels in specific areas versus the broader economic and environmental benefits of single formula fuels with broader geographic applicability.



## *Session V: Breakout Group Summaries*

Several important themes recurred in the course of the presentations and discussions at the 2001 Energy Policy Forum. The fifth and final session of the Forum gave participants an opportunity to explore some of these topics in greater depth in smaller breakout groups. Three themes were selected for discussion in the breakout groups: the future of U.S. energy infrastructure, the value of an expert commission to investigate and draw lessons from the California energy crisis, and the overall benefits and risks of energy liberalization and restructuring.

### The Future of U.S. Energy Infrastructure

Infrastructure features prominently in the ongoing energy challenges facing the U.S., from the ongoing California crisis to the future development of petroleum supply, electricity generation and transmission capacity, domestic pipeline infrastructure, and oil refining industries. Some participants viewed the limitations of the current energy infrastructure and impediments to change (including lack of investment capital, environmental regulations, and community resistance to infrastructure expansion) as a crisis that has developed over many years. This situation, they noted, has come to public attention only recently as a result of the price spikes and reliability disruptions of the past two years.

The breakout session discussion started with the premise that the country's energy systems are now undergoing continuous change and enduring increasing strains, and with the expectation that accelerating change and increasing stress will characterize the foreseeable future. This being the case, the group emphasized the importance of designing regulation and industry structure to facilitate continued change rather than stunt it, as many believe the case to be today.

The group raised a host of important questions concerning the future development of energy infrastructure. First, in what directions are the major energy systems (gas, electricity, and oil) likely to evolve—for example toward a continuation of the centralized system or toward more distributed system alternatives? Second, assuming one had the ability to redesign the country's energy infrastructure today, what would the new systems look like? Considering that the world is imperfect, what barriers stand between the energy infrastructure of today and the ideal infrastructure as envisioned and how might such barriers be eliminated? Finally, there is the important question of roles and responsibilities. To whom does the task of building tomorrow's infrastructure fall? Is this the realm of industry, government, or some combination of the two?

The session reached a variety of conclusions with regard to these challenges. Above all, participants stressed that changes and developments in energy infrastructure are not keeping pace with the changing and growing energy needs of society. Stemming from this observation were the following concluding points:

- If infrastructure is to change to meet future energy needs efficiently and with smaller environmental impacts, there must be fundamental changes in the way people think about and define infrastructure. Future thinking about electricity infrastructure must also prominently feature the demand side of the equation—appliances, meters, and consumer behavior and incentives. Only when all aspects of the system are included in the analysis can the system become more flexible, stable, and capable of meeting future energy needs. Recent analyses show, for example, that the use of "smart metering" technologies that

give consumers more information and opportunity to participate in the energy market as buyer or seller would allow the existing transmission and distribution infrastructure to serve 40% more demand than it does currently.

- Infrastructure has a primary purpose of serving the interests of the public interest rather than that of that of the energy industries themselves. Thus, infrastructure redesign and expansion efforts ought to represent the interests of citizens and to create a series of energy systems and markets that reduce price volatility and provide the public with affordable and reliable energy services.
- Government has a critical role to play in energy infrastructure as a setter of standards for the new and expanded systems. Because there are many contending political constituencies (e.g., industry, states, etc.) with interests in the path of energy infrastructure development, this will be a very difficult role and accommodation of all interests will be impossible.
- The government will have its own institutional momentum to overcome in changing its regulatory practices and becoming a more constructive player in energy. For example, the standards-based approach to regulation mentioned above would, in itself, represent a significant departure from the dominant command and control regulatory method of today. How such institutional changes might be facilitated and what the "first principles" of a standards-based approach might be are important questions that the Energy Policy Forum might usefully address in the future.

### Understanding California's Crisis: The Value of an Expert Commission Investigation

Electricity restructuring in California clearly went awry in many ways and at many points along the way; partial responsibility for the crisis can—and has—been assigned to every important player in California's energy industries and government overseers. Aspen

Forum participants put forward the notion of having an expert panel, modeled on the Kameny Commission's investigation of the 1978 Three Mile Island accident, undertake a dispassionate study of the California case.

Such a commission would require a high-level political mandate—perhaps from the federal level—to guarantee its credibility in the national policy debate on energy restructuring. At the same time, the commission in its composition and actions would have to be broad-based, balanced, non-partisan and perhaps even somewhat academic in its method and tone.

For the commission's findings to be regarded as credible, its chair would have to be an individual recognized by the industry, government, and the public as having both professional competence, independence, and personal integrity. To ensure a comprehensive analysis, the membership of the commission, as envisioned by the breakout group, would include industry experts from both the U.S. and other countries. Public stakeholder input to the commission's activities and report would also be an essential element.

While the main goal of the commission would be to shed light on the causes of California's energy crisis, its charter would include other goals as well. Some participants suggested that an additional aim of the commission, for instance, might be to clarify and justify the potential value of energy restructuring, if executed thoughtfully, to the public good. To this end, lessons learned from the investigation of the California case could be synthesized and used to facilitate a review of the first principles of design for energy restructuring around the country. A third goal would be to design metrics by which the process of restructuring could be gauged, and which would allow prompt response should early warning indicators suggest the onset of major problems. A final aim of the commission might be to revisit the issue of institutional capacity. Since the response to the California crisis from both state and federal agencies has been largely ineffective in stemming the crisis, the question of institutional design for a liberalized energy market place is of the highest importance.

## Benefits and Risks of Energy Industry Restructuring

While many Forum participants embrace the ongoing processes of liberalization and restructuring, others repeatedly raised questions regarding the observed and potential hazards associated with the introduction of competition and market forces to energy, and wondered about the role of public policy in the new energy environment. Since the process of energy restructuring in the U.S. has not been an unmixed good, the third breakout group aimed to articulate, to the extent possible, a full range of benefits and risks of liberalization for each of the constituencies concerned.

Liberalization offers several potential benefits to energy consumers, including lower average costs of service. Moreover, while lowering energy prices, the introduction of competition can also bring higher levels of service and spur continual product innovation, increasing the range of choices available to consumers.

Liberalization's potential benefits to the economy as a whole include greater overall system efficiency; consider, for example, that the United Kingdom had more than 60% overcapacity in electricity generation prior to restructuring. The competitive market also prompts the industry to be more dynamic and innovative than a monopoly environment, which tends to be more static and slow to change. Finally, since liberalized energy markets are concerned more with delivering value than low price to customers, the overall quality of energy services delivered is likely to be higher in a liberalized environment.

The liberalized market place is not without its inherent risks, however. The benefits of low price and good value of service, for example, do not necessarily find their way to small consumers, and the transition process from regulated to liberalized markets often entails periods of high volatility and higher energy prices. Moreover, since politicians wish to protect citizens from the potential short-term ill-effects of restructuring, there is often a tendency for policymakers to intervene in the liberalization process that distorts the market and hurts consumers in the end.

If the rules of the market are improperly structured, the potential benefits will not be achieved and economic harm may result. Badly designed energy markets can—and have—created the potential for firms to exercise market power, for supply failure, and for confusion caused by overlapping state and federal regulatory jurisdiction.

While many energy companies embrace with enthusiasm the transition from regulated to liberalized markets, there are high stakes involved for industry incumbents. Since many established companies lack the skills needed to operate in the new markets, company failures are common. Likewise, regulatory agencies also often lack the skills demanded by the restructured environments, and fail to do their jobs adequately or in a timely manner.

Having considered the benefits and risks of energy liberalization outlined above, several key issues remain to be addressed. Among the most important issues, according to this group, are the following:

- How can there be guarantees of a provider of last resort, especially for smaller customers, in a liberalized market place? Who will provide this service and how will that provider be guaranteed payment?
- How can the state-federal jurisdiction issue be settled? Who is competent to decide this?
- How can the creation or continuation of entry barriers to the liberalized energy markets be prevented?
- How can energy prices be made more responsive to consumer demand?
- How can "natural monopoly" functions be cleanly detached from competitive components of the energy industries in the restructured environment?

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