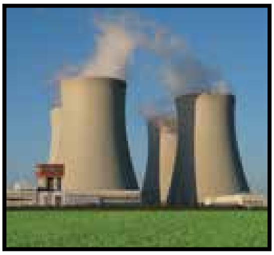
Electricity: Seeking Progress Amid Uncertainty



The Aspen Institute

Energy and Environment Program

2012 Energy Policy Forum

Ernest J. Moniz, Chair
Gernot Wagner, Rapporteur

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Foreword

An invited group of energy leaders and policy experts discussed "Electricity: Seeking Progress Amid Uncertainty" at the Aspen Institute's 33rd annual Energy Policy Forum, held in Aspen July 3-7, 2012.

As in previous years, the format relied heavily on dialogue to explore commercial and public policy issues at the intersection of energy, the economy, and the environment. Short introductory presentations launched each half-day session, and a spirited, off-the-record discussion followed. The diverse participants brought a variety of perspectives and areas of expertise to the table.

The dialogue was chaired by Ernest J. Moniz, Cecil and Ida Green Professor of Physics and Engineering Systems at the Massachusetts Institute of Technology and Director of the MIT Energy Initiative. His years of experience in teaching, research, and public policy made him a valuable advisor in developing the agenda and allowed him to focus the discussion on key issues. He chaired the meeting with skill and good humor. The highly qualified group of speakers provided a wealth of information and a variety of perspectives, and the diverse expertise of a particularly well qualified group of participants contributed substantially to the richness of the dialogue.

The Institute acknowledges and thanks the following Forum sponsors for their financial support. Most have been participants and supporters for many years. Without their generosity and commitment to our work, the Forum could not have taken place.

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On behalf of the Institute and the Forum participants, I also thank Gernot Wagner, who served as rapporteur. While no summary can capture the full richness of the discussion, his lively text identifies the important threads of the dialogue. Timothy Olson managed the administrative arrangements for the Forum with his usual efficiency and dedication, and Avonique DeVignes assisted in preparing the written materials. Their hard work was responsible for a smoothly run meeting, and I am grateful for their conscientious and cheerful support.

This report is issued under the auspices of the Aspen Institute, and the chairs, speakers, participants, and sponsors are not responsible for its contents. It is an attempt to represent ideas and information presented during the Forum, but all views expressed were not unanimous and participants were not asked to agree to the wording.

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Electricity: Seeking Progress Amid Uncertainty

Gernot Wagner
Rapporteur

Full Speed Ahead

Energy is big business: 300 million customers in the United States. Billions globally. Two of the three largest industries on the planet are oil and electricity. Water isn't far behind. (Section III will look at the specific interconnection between energy and water.)

This report summarizes the proceedings at the 2012 Aspen Institute Energy Policy Forum. The discussions were frank, at times spirited, always cordial, and exclusively under the Institute's no-quotation rule.

Frank discussion and the Aspen Institute's setting often turn preconceived notions upside down. Financiers look to patient capital. Industry captains see a green future. Environmentalists argue for going it slow. And regulators seek out the middle ground.

Read the subsequent five session summaries as what they are: Visions of the world how it could or should be, perhaps even as it will be, not merely as it is. In an industry that needs to plan ahead three, four, or five decades, the word "is" does not suffice.

Still, all vision needs to be grounded in reality. That is an especially difficult undertaking if—as many believe—"this time is different."

The U.S. electricity sector has been through upheaval before. The 1970s were a bonanza for new coal generation. The 1980s saw the largest number of nuclear plants come online. The 1990s added barely any generation capacity. The 2000s were dominated by natural gas. Two years into the new decade, things are already changing faster than most anticipated.

Households turn into generators. Utilities become consumers. Cars become storage devices at a rate not seen since the dawn of hydropower turned valleys into batteries. Federal regulators look to states for guidance—not out of respect for federalism but out of the need to experiment and move ahead in light of Washington gridlock.

That may be the one constant: U.S. energy policy is not to have a uniform policy. Often a curse, sometimes this may also be a blessing in disguise. More on that in Section I on Regulatory Issues.

Section II dives into Energy Efficiency and the importance of taking negawatts to heart. Amory Lovins coined the term in 1989. This time it is utility executives extolling some of its virtues, as well as the many pitfalls.

Water comes to the fore in Section III, focused on the intersection between two of the world's most precious resources. The interdependencies are striking. Twelve percent of U.S. energy is used for direct water services. But including indirect water services—primarily the energy used to boil water at power plants—the number is closer to half. And including consumptive and non-consumptive uses, half of U.S. water is used for electricity.

Section IV takes a closer look at Fossil Fuels. Renewable and efficiency gains notwithstanding, fossil energy dominates the power sector. If not coal, natural gas will command the lion's share of generation for years to come.

Financing New Development is at the heart of converting the U.S. grid and is the topic of Section V. Who spends money how and why, and who stands to gain?

This report does not lay claim to being complete—neither of the rich discussions in Aspen, nor of the wider electricity landscape. It does try to focus on several issues that matter. All five sessions—and their corresponding sections in this report—try to lay out the big questions and zoom in to the details that keep government officials, utility executives, financiers, and environmentalists up at night.

First up is the regulatory landscape. What does make this time different from previous years and decades?

Regulatory Issues

Let's start with four facts:

One, electricity sales are flat. Part of the reason is a sluggish economy, but that doesn't explain all. Much of it is a push toward increased energy efficiency—in other words, not using electricity in the first place.

Two, capital investments are up. The power sector has seen a dearth of investments for quite a while, which is now being reversed, while electricity rates are still at some of their lowest levels ever.

Three, utilities are increasingly removed from their customers. The technical term is "disintermediation." In practice, consumers are getting more control and more choice.

Four, distributed generation decreases utility sales further and turns many households into producers. By one measure, rooftop solar alone has a 200-300 gigawatt peak potential (compared to about 1,000 gigawatt of total generation capacity in the United States to date). Given the huge absolute costs and the enormous challenges involved, others of course dispute that figure as wildly optimistic. This has the potential to be disruptive to the utility sector—in the best and worst sense of the word.

In other words, Amory Lovins's and Roger Sant's writings from the 1970s and 1980s may have rightfully been called visionary, just that it has taken regulators and others a while to catch up with their thinking. There is no doubt that production, distribution, and consumption will be dramatically different at the end of the century than they are now.

The timeframe, of course, is long enough to always be able to say that it's all going to change. But as obvious as that seems, it must be the starting point of any utility and regulatory conversation. And as these four facts are showing, change is happening fast—at least by the historic rate of change of the utility sector.

The way to get there is contentious, non-linear, and expensive. Society demands more and more investment in what society would like to use less and less of.

The two institutions in the middle of all of this will be utilities themselves, and the regulators trying to ensure a smooth transition. Smooth, of course, is particularly difficult given the reality of large, lumpy capital investments.

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The task for lawmakers and regulators is almost impossible. The Power Plant and Industrial Fuel Use Act of 1978 prohibited the building of new natural gas units for reasons of fuel diversity and stable supplies. That decision may well have been based on solid analysis available at the time. In hindsight, it was counterproductive. (The Act itself was repealed in 1987.)

Today's focus on natural gas, of course, could seem as myopic a decade or two hence, as the Fuel Use Act seems today.

That said, most agree that the four facts mentioned upfront are hard ones with which to quibble. Add to them issues like grid stability, especially in light of cyber security, electro-magnetic phase disturbances, and general fickleness of computer-driven systems—"imagine an electric grid as stable as your computer's operating system"—and it's clear that regulators aren't dealt a winning hand.

More to the point, it's not only a world of known or at least knowable risks. Instead, we have often unknown and unknowable ones.

There is one requirement for regulators: enable consumers, utilities, and investors to create business models that are flexible enough to cope with eventualities of all sorts.

The task for utilities is to constantly ask themselves what business they are in. Don't fall in love with your product. Look for competition in all the unexpected places. Provide new value to customers, where "value" doesn't need to mean selling more kilowatt-hours. A utility's product ought to be providing energy in the largest sense possible—providing solutions, not just kilowatt-hours.

One clear mandate for regulators is to enable more flexible bidding in wholesale markets. They need to evolve to be more like capacity markets. Some markets allow rooftop solar producers to sell their electricity back into the grid. Others don't.

Similarly, regulation ought to enable—not simply tolerate—new "two-way communication" technologies (one of the features of the smart grid). Less volume of delivered energy, coupled with higher costs for distribution, make many of these technologies even more attractive for entire new segments of the population. Most people's current interaction with utilities is decidedly "left to right." The only thing "right to left" is when the customer is paying the bill. Two-way communication technology could stabilize the grid, make it more cost-effective as well as flexible. Regulators need to keep pace.

Perhaps more to the point, today's business models are simply not sustainable. Regulators ought to be at the forefront of creating a viable financial model for deploying distributed generation technologies, increasing the availability of data on cost-effective energy, and providing effective wholesale market oversight on the federal level to provide consumers confidence in the overall market.

Conversely, a devolution of authority to the level of multi-state, interconnected Regional Transmission Operators would reduce costs to consumers as well as utilities. The question is one around full system integration—the role RTOs play today plus the management of the distribution grid.

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Another important regulatory question is around the integration of renewable energy. For one, everyone agrees that the most important driver for renewable deployment—primarily, of course, to address the global warming externality—is to put a price on carbon (either via a direct price or an explicit, declining cap). Little else would be as effective an instrument, and, in fact, some utilities are calculating that we will have a price on carbon within a decade, at least under the most plausible scenarios.

Short of that, regulators can focus on a variety of helpful actions—from enabling large-scale renewables integration to establishing systems with full locational marginal pricing. A sustained, stable integration of 20 percent wind generation, for example, raises real questions around costs. Whether or not it happens is largely a question of regulatory judgment.

While some call renewables "intermittent" and long for the day when full intermittency costs are passed through to consumers, others insist that the correct term is "variable." This variability, they insist, can largely be forecast and planned for. In other words, they say, it is not so much a matter of having renewables pay extra for their inherent variability, it is a question of having each generation source pay the full cost of possible variability and true intermittencies—e.g., unanticipated outages of baseload plants—to create a level playing field. The resolution to this debate is precisely the kind of judgment call regulators ought to make.

Many smart grid capabilities only require relatively innocuous but important regulatory support mechanisms. The biggest of them—hardly a small task—is fully dynamic pricing.

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The biggest regulatory question, in the end, is who would or should pay for all of it. Newer technology may enable cost savings down the line, but it requires upfront investment.

The traditional task for regulators has always been to ensure the cheapest possible, stable grid, while creating proper incentives for investors. (Clean, of course, is another factor, although that task more often than not has fallen on Congress and the Environmental Protection Agency rather than electricity regulators.) On that measure, regulators have succeeded wildly over the years, with electricity prices continually falling to new, inflation-adjusted lows (or at least they haven't stood in the way of innovation and making economies of scale play out). That leaves little room for additional investment.

But the smart grid offers an entirely new value proposition to consumers, other than ever cheaper costs. It offers stability, at least once the startup kinks have been ironed out. In the long run, the biggest value of the smart grid may be in keeping the grid up in the first place—which itself may be something for which consumers might be willing to pay extra. Grid stability is all the more complicated by the fact that increasingly the grid needs to integrate many more individual responses and technologies. Two-way communication and distributed generation, for example, could be part of the solution but also impose more demands on the grid. In short, we need more and smarter transmission.

A conundrum for utilities, of course, is that if they act out of their own volition, electricity rates will necessarily go up, prompting households to want distributed generation like solar panels even more.

This is where the regulator needs to step in, and perhaps—with legislative approval—needs to broaden its longstanding focus on costs and stability to include other value propositions as well.

Energy Efficiency

Energy efficiency is often described as the "fifth fuel"—fifth in the chart, number one in everyone's heart, as the joke goes.

By some accounts, energy efficiency is the cheapest, quickest, cleanest resource for meeting demand and addressing climate change. It is—sadly—still relatively untapped, its technologies can often be taken off the shelf, it can garner bi-partisan support—no one wants to be seen on the side of energy *in*efficiency—and its pursuit enhances global competitiveness. What's not to like?

Energy efficiency also faces enormous challenges. The market and hard business case is often insufficient at best and counterproductive at worst. Many argue that consumers and businesses do not spend money on energy efficiency, even if it pays for itself many times over—creating an "efficiency gap." It's the age-old metaphor of why people don't pick up twenty dollar bills from the ground. Explanations abound. Some point to the fact that there aren't twenty dollar bills in the first place. There are nickels and dimes that may indeed be plentiful but difficult to pick up without further inducement.

First and foremost, taking advantage of energy efficiency requires so-called "soft infrastructure": information and awareness campaigns, public policy aimed at nudging behavior in the right direction that may be in everyone's self-interest.

Another all-too-real barrier is the initial capital requirement for many projects. Investments done today may pay for themselves in practically no time, resulting in large overall payoff—"printing money" after a short initial period. Still, having to spend significant money upfront is often prohibitive. The missing price signal for carbon and other socialized pollution costs doesn't help.

Despite the fact that energy efficiency should be—and often is—a bipartisan cause, actual implementation can run against long-standing policy preferences. Some of the proven public policy measures to advance energy efficiency are antithetical to conservative values, including direct economic incentives and sometimes also standards and mandates. Ironically, some of these standards and more direct measures may well go over better in a world where direct price incentives are too political to tackle. Still, some measures do run into political problems.

Lastly, there is indeed a very real obstacle, which comes in two parts: measurement and valuation. Energy efficiency gains are often hard to measure relative to unobserved and unobservable baselines. Moreover, utilities face the problem of valuing "negawatts." Utilities that have traditionally been focused on selling more kilowatt hours to ever more customers as their main way of increasing revenues and profits will find their entire business model turned upside down. Regulators should play an important role in this regard, and they do. Although the political and very practical difficulties of pursuing energy efficiency are laid bare by the fact that California, Massachusetts, and New York alone account for half of all investments in energy efficiency nationwide.

In the end, of course, we also need to be clear that efficiency by itself is not the goal. Reducing costs, saving resources, and decreasing emissions—while ensuring reliability—is. Efficiency may be part of the answer, but it is not the only one.

Theoretical discussions of energy efficiency are one thing. Practice is quite another. California's experience has often been hailed as the most important success story, decoupling energy use from increases in gross domestic product per capita in the 1970s, bucking national trends. A more careful examination of the California story shows that perhaps a fifth of this success can truly be attributed to California's policies alone.

Energy efficiency policies and other measures have turned Austin, Texas into an energy efficiency laboratory *par excellence*. Austin Energy has removed at least one 500 megawatt coal plant from its long-term plans because of energy efficiency savings.

These savings did not materialize all by themselves. They were the result of concerted policy efforts. Every newly built residential home in Austin, for example, must soon be net-zero energy compatible.

Austin's experience also harbors some important lessons.

Building codes don't save energy. Correct implementation of building codes can save energy. That's a key distinction, and one that's often completely overlooked. Compliance and enforcement matter.

Jevon's paradox—the insider term for a "rebound effect"—is real. Weatherization itself brings enormous benefits, but it also encourages households to use some of the savings to increase their energy consumption. That's simply because poor households can afford to turn on air conditioning for the first time. The overall effect is far from a 100% "bounceback" but it is likely around 10%, and perhaps as much as 30%, of overall savings. That's important to consider in policy design questions.

Austin also made another discovery, sometimes painfully so: There is value in being second. First-movers face the largest technological hurdles. Those going second can often learn from that experience and achieve significantly better results, more cheaply.

Perhaps the most important national policy lesson from the experience of one particular locale is that there are limits to how much advanced technology, clean generation, and energy efficiency technology we can deploy immediately. Plug-in hybrids, for example, would be most valuable where the electric grid itself is relatively clean—Washington State, say—as opposed to where electricity generation is carbon intensive—say, Ohio. It's unclear who will make such decisions. But we do need to realize that energy efficiency can be a prime tool that needs to be targeted correctly. That does not exclude Ohio, of course, from encouraging energy efficiency, but limited federal resources ought to be deployed with the overall balance in mind.

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Often the most important question with energy efficiency is whether people truly care. There are 2.6 billion electric and water meters worldwide. Fewer than 10% have automatic measurements and many fewer could be considered "smart." That largely leaves the burden on consumers to use their meters in the most effective way possible, or to upgrade altogether.

Realistically, it will take policy nudges and mandates to move toward a world where smart meters become the norm and energy efficiency reaches its potential. Few will jump on the bandwagon without the right policies. These policies need to be aimed at guiding the right technology, not necessarily the most advanced technology.

Some technologies will rely on the direct participation of consumers. Some will bypass consumer behavior altogether. The power sector simply isn't at a stage yet where its products are anywhere nearly as desirable as the typical Apple product where consumer adoption comes more naturally.

That also brings up the attribution question. If incentives are offered, is it consumers who should be compensated for their efforts, or is credit due to policy makers or utilities? In the end, it will be both, and it may not matter. But the credit question goes to the heart of who will need to step up to the plate and make the necessary changes. There, side benefits can play an important role.

In many ways, it is clear that adoption of new technologies depends on multiple factors. For some consumers, energy independence, security, and the feeling of no longer being dependent on the grid may be as important as direct monetary benefits. If anything, these consumers may even be willing to pay extra for additional services. For most, of course, the right monetary incentives will still trump other objectives. If such incentives do not achieve the benefits society needs, regulatory measures may be required.

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Despite all new technologies, gimmicks, and policy drivers enabling and scaling up energy efficiency efforts, the old adage holds: consumers want hot showers and cold beer. Few are going to compromise reliable, cheap electrons for fulfilling energy efficiency ideals, despite other non-utility-provided side benefits not available with traditional technologies.

We also cannot simply focus on new construction but also need to focus on retrofitting existing building stock. Lastly, we also need to realize that energy efficiency itself can only go so far. We can always squeeze out additional energy productivity from existing sources, but at some point we do, in fact, need additional generation—both to replace existing stock and to add additional capacity. Energy efficiency is one of the main fuels and has a lot of potential, but it is not the only one.

Energy and Water

Energy and water have much in common. Some think of both as a birthright.

For water, some even argue that it should be free or very close to it. Many others, however, would argue that water, like energy, is often underpriced. That leads to significant overuse and inefficiencies—perhaps not unlike energy with its enormous efficiency potential.

Energy and water are related in another way as well. Considering direct water services and steam use alone, 12 percent of U.S. energy is used for water. Taking into account indirect uses, including energy spent to boil water at power plants, closer to half of U.S. energy is consumed for water services in one way or another. And according to the U.S. Geological Survey, half of U.S. water used is for electricity, primarily in the form of non-consumptive withdrawals for cooling thermal power plants. "Withdrawals" is a key word; though thermal power plants withdraw a tremendous amount of water, only a small percentage is evaporated, or "consumed" in the traditional sense of the word. The rest is simply returned back to the source, though usually a few degrees warmer than it was before. That thermal pollution can create environmental problems and has been regulated for decades.

Extensive water use also creates potential challenges for the energy sector. Droughts and heat waves pose risks for electricity generation as plants might need to cut output due to water shortages or thermal pollution limits. Such events have occurred or come close to occurring in places like France, the southeastern U.S. and Illinois. At the opposite end, two Texas coal plants had to shut down because of an unexpected winter freeze, causing statewide rolling blackouts in February of this year.

The use of water in power plants is primarily related to improving the efficiency of the steam cycle that is used to generate electricity. In addition, the production, transportation and preparation of fuels are also important in the larger picture. Nuclear energy is particularly water intensive. Traditional coal plants are more water-intensive than natural gas plants, which in turn are more water-intensive than renewables such as solar PV and wind. The power cycle technology used can affect the amount of water used (that is, steam cycles use more water than combined cycles, which use more water than simple cycles). And, alternative water supplies such as recycled or "gray" water could potentially mitigate some of the risks of scarcity. Although the production of shale gas can indeed be water intensive, shale gas uses less water than some types of coal when preparation and combustion are included. There is also often a tradeoff between water use and emissions. In contrast to wet cooling, dry cooling can decrease withdrawals at the cost of increased emissions. All of these conclusions, however, are very technology and location dependent.

Trends imply these strains will only be exacerbated in the future. Population growth increases total demand. Economic growth increases per capita demand. Policy shifts, like incentives for ethanol, often further contribute to increasing the water intensity of energy. Others can increase the energy intensity of water. Stricter water and wastewater treatment standards, deep aquifer production, desalination, long-haul pipelines and inter-basin transfers all are moving us toward more energy intensive water production.

Water itself is abundant but often in the wrong place, form, or time. That makes proper management crucial.

Perhaps one of the biggest hurdles in all of this is poor data. In the past, the Energy Information Administration collected comprehensive water data every five years. But it has not done so in fifteen years.

Real-time, household-level metering could be even more difficult. If we think electricity meters are dumb, water meters are even dumber. Leaks often remain undetected, sometimes for years. Predicting leaks is nearly impossible without new technologies. None of this is revolutionary. Israel—largely by necessity—is on the forefront of deploying drip-irrigation as well as advanced water meters to perform predictive maintenance on its water system.

As a result of these and other measures, Israel, with a population of a bit over 7 million uses 2 billion cubic meters of water per year. Arizona, with a population of a bit under 7 million uses 8 billion cubic meters per year.

Similarly, excess water runoff creates costly problems in California and elsewhere. All of that, of course, points to inefficient water use in the first place.

Other solutions to excessive water use abound. Advanced cooling technologies at power plants are already being deployed. For transportation, low-water biofuel feedstocks already exist and may prove to be more efficient than currently preferred feedstocks. The solutions package may also include water re-use and distributed water harvesting as well as less energy-intensive water treatment through integrated system design.

Many of these solutions, of course, need to be driven by pricing mechanisms or more direct policy interventions. It starts with collecting more accurate and up-to-date information and should lead to a more integrated approach to policymaking, a heavier focus on water-related research and development as well as the establishment of a federal policy role for water use. The EPA is in charge of water quality, but no single federal agency now has jurisdiction over the amount of water used.

Some particular federal statutes do effectively work as limits on water use, but they are still ostensibly about quality. EPA's cooling water intake rule is one example. This particular rule also highlights the importance of smart policy design. Benefits and costs matter, or at least they should when it comes to setting policy objectives. Currently, several options are on the table, and a full range of benefit-cost analyses ought to inform the final outcome.

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Not all policy steps and overall improvements will be easily received. With new water meters, water bills may well go up as water is metered correctly for the first time in decades.

Similarly, many with long-established water rights will resist any policy changes that would increase the price of water, even if such a step could create true win-win situations. Water may be extremely valuable to a particular sector of the economy, like the energy industry. That could create situations where it would be worthwhile for energy companies to invest in advanced drip-irrigation equipment for farmers, which would free up valuable water resources to use elsewhere.

The same goes for pipe and system maintenance in general. Up to forty percent of water doesn't get to the end user. That may not worry users who effectively hold free rights to a certain amount of water, but it creates opportunities for those who place large values on water and don't currently hold such rights.

Other perhaps more mundane but no less important obstacles exist as well. The eastern U.S. uses gallons as a unit of measurement. The western U.S. uses acre-feet. More importantly, there are no mutually agreed upon definitions of withdrawal, or consumption.

Much as with energy, the question often is what will finally prompt a re-thinking that could lead to smarter water policy. In Australia, it was a severe drought that prompted it to revamp its water market over the last decade. The U.S. has already experienced several regional droughts that have put severe strains on existing water systems. The big hope is that it will not take an even more severe drought to truly get political forces re-aligned and get things moving.

One possible answer could be projects akin to a recent attempt at solving California's water challenge. A self-sustained integrated energy-water system that treats and desalinates water to support high-value agriculture may well serve as a template for others. Significantly, it is not the actual power but rather waste heat that is used to drive the desalination process. That also implies the project operates independently of electricity costs. The primary driver instead is the price of water.

Fossil Fuels

Fleets are aging. Rules are changing. The economy is fragile. Add to that some of the technology changes on the consumer side that make load forecasting more challenging than ever, and it's easy to see that things are difficult for fossil fuel interests.

The most significant change of them all, however, has come within fossil fuels: a switch from coal to gas as the utilities' fossil fuel of choice for new capacity. Low natural gas prices are also frequently leading utilities to dispatch gas before coal. Gas beats coal when looking at fixed investment costs and, at today's gas prices, when only looking at variable fuel costs as well.

Gas has achieved rough parity with coal as a source of power production, but the change is even more dramatic among newly built plants. A handful of new coal plants are coming online, but there are virtually none in planning. Coal faces a stark cost disadvantage, not even including any mention of the eventual need for carbon capture and storage where coal once again loses out to natural gas.

Similarly, natural gas beats nuclear generation in terms of levelized costs of new capacity. There are currently two new nuclear plants being built in regulated markets, none in deregulated markets. It's simply not economic to build.

But even natural gas faces some hurdles. Most notably a recent overbuild of new plants in certain markets ensures that lots of gas is entering the system, but few investors in gas production are necessarily betting on gas prices staying low.

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The biggest question on everyone's mind is where natural gas markets will go. Natural gas as a whole faces some uncertainty, but markets are primarily driven by a massive resource potential. Prices have declined beyond points imaginable only five years ago. The Marcellus Shale in particular remains the largest driver of short-term growth in gas markets.

Gas price development is anyone's guess. Looming coal retirements will increase natural gas demand over the coming few years. Similarly, natural gas export terminals projected to come on line in the latter half of this decade will increase demand and may also push up prices.

That's particularly true since cheap natural gas at the moment is primarily a North American story. Prices in most of Asia are often five times what they are in the United States. A more active export market will equilibrate prices somewhat, although not nearly all the way. Few predict dramatic price increases for U.S. natural gas, barring any unforeseen events like almost comprehensive bans on fracking.

Anyone trying to guess where gas markets will go needs to look into several factors. On the supply side, these include: How many producers can survive at current low gas prices, and how many additional low-cost plays will producers commercialize? How will wells perform away from "sweet spots" currently in play? Is there more improvement in store, or slower progress—especially also vis-à-vis improving well performance? Can service capacity respond to market growth? Are there any new big players entering the field?

On the demand side, questions are mainly around manufacturing and transportation demand and U.S. exports: How much Asian premium demand exists? Will additional export terminals be permitted if domestic prices rise significantly? What market is there for industrial applications of natural gas? How much of an appetite do fleet operators have for using natural gas for trucking?

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Any fossil fuel discussion would be remiss if it did not also focus on environmental consequences. A comprehensive U.S. cap-and-trade policy for carbon dioxide emissions would have provided certainty for industry investment. That is gone for the foreseeable future.

Instead, we are faced with a hodgepodge of regulation that no one likes, few think is the most effective way of solving the problem, and almost everyone believes ought to be replaced by something better.

Natural gas is a prime case study. It does better than coal when it comes to global warming pollution, but only if it is done correctly—by determining the amount of methane leakage and ensuring it is under control—and only if natural gas does not strangle renewables in the crib.

No one knows precisely how much methane is released during natural gas production. Methane emissions are much more damaging to the climate than carbon dioxide in both the short and long term. Leakage, though, is a fixable problem. It's a step that benefits industry itself, but it will not be completely fixed on its own. It will require regulation and civil society attention.

Unlike reducing carbon dioxide emissions, reducing methane leakage is not about fundamentally transforming how we do business. It is ostensibly about plugging leaks and avoiding gas escaping from production to use. That is a significant difference, and one that may make all the difference when it comes to addressing the problem. An important first step will be collecting accurate information on the quantity of leakage and other emissions.

Significantly, from a global warming perspective, most natural gas is still used for heat and industrial uses, not directly for power generation where it could displace coal. This point is often ignored when the importance of methane leakage from shale gas production is minimized because gas can back out coal in power plants.

Carbon capture and storage also plays a significant role in this discussion. The difficulties are huge, and little will happen on carbon capture without a price on carbon. So much is clear. What's not so clear is what role carbon capture will play while we are still debating a nationwide price on carbon.

Enhanced oil recovery may well play a role here, adding additional value to capturing carbon in some regions. It can complement but not replace a true price on carbon. It can also help develop capacity along the supply chain. Lastly, it can help shape the regulatory environment (including liability issues), which by itself may be a significant boost.

What enhanced oil recovery cannot do is avoid the need for a subsidy for capturing carbon from power plants or for a significant price on carbon dioxide emissions. It simply is not economical otherwise. That is particularly true for natural gas, where carbon is less concentrated and, hence, more expensive to capture per ton of carbon, although the capture cost per kilowatt-hour is lower for gas. Most importantly, enhanced oil recovery cannot replace global warming as the primary driver for developing carbon capture and storage technologies.

The natural gas discussion is often presented as one of "buying time," while policies are being put in place to spark a true switch from carbon-intensive fossil fuels to more renewable alternatives. Buying time, of course, is only helpful if we do indeed use the time to work on carbon policy. At the same time, we need to jumpstart innovation—another area where government has an important role to play.

One interesting question is whether the increased importance of natural gas could alter national climate politics. That does not seem to be the case. For one, there is no such thing as a uniform natural gas industry. Many players with very different interests all have their own agendas. Some large players are also heavily invested in oil exploration. Others own both natural gas and coal interests. In the end, the biggest worry right now for many natural gas players is not global warming. It's to stay in business until prices rise.

Financing New Development

Energy is big business. It also requires plenty of capital to maintain and expand its existing infrastructure.

The 40,000-foot view in that regard is rather hopeful: The power sector seems to have no problem raising money. Access to capital markets is good. Demand for utility equity is high. Equally important, the ratio of net debt to capital has been falling continuously over a decade. That improves credit worthiness and contributes to overall financial health.

At the same time, utility expenditures remain high and are expected to stay so for the next few years. We have also seen sustained growth in transmission investment, which once again points to a healthy outlook for how the utility sector is developing overall—even though overall investments are still lagging behind needs.

None of that, however, should mask some potential challenges ahead. New environmental rules as well as the looming nuclear retirements will all but force new investments onto the industry. To replace 25 gigawatts of nuclear capacity by 2030 alone would require additional investment of at least $200 billion.

All that new investment will necessarily increase rates to consumers. The good news is that the absolute cost of electricity has been stable, largely driven by declines in commodity prices that have stabilized the energy cost component of electricity bill in recent years. Cheap natural gas is a deciding factor. That implies some breathing room for utilities in being able to recoup new investment costs. This is particularly true as energy spending as a percent of disposable income has hit all-time lows since the 1980s. Ratepayers may well push back against any increases, but there is clearly some room to maneuver.

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If market conditions demand additional electricity, natural gas is largely the fuel of choice. Wind generation often comes in as a close second, although its future is largely tied to the extension of the Production Tax Credit set to expire by the end of the year. That creates enormous uncertainties for the industry. It also shows that wind, right now, is not yet a viable competitor to natural gas without direct help from policy, both from production tax credits and state-level renewable portfolio standards.

Solar presents a slightly different story. It is still more expensive overall, but has indeed achieved grid parity in certain areas. Annual installations have increased almost exponentially in the past two years, with no sign of letting off. Admittedly, solar is starting from an extremely low base. Even in 2012, total solar installations are about equivalent to three large combined cycle natural gas turbines.

Policies are important drivers for both wind and solar installations. State-level renewable portfolio standards are one of the most important. The same goes for energy efficiency investments on the part of utilities, many of which can only pay for themselves if they are driven by significant policy interventions.

Demand response faces a similar challenge. It takes fundamental rethinking of capacity markets to make investment in demand-side management pay for utilities and third-party providers.

Every form of policy intervention seems to be under attack from somewhere. Spending, taxing and regulating are almost equally under assault. That often leaves loan guarantees as the only choice for policy makers. Sadly, they seem to have a rather checkered past—primarily with respect to geothermal and synthetic fuels but also with nuclear power. They also seem to have a checkered present.

Most consider performance tax credits to be more efficient for deployment and scale-up of new technologies. However, performance tax credits run into their own problems. They cannot be bonded in the sense that no debt investor will factor them into the project economics. Too many uncertainties persist. That makes the situation for new wind generation particularly daunting, where performance tax credits seem to be the only policy option on the table. In the end, loan guarantees and performance tax credits are very different vehicles.

Performance tax credits also harbor a problem of an entirely different caliber. The nature of the subsidy sometimes leads to negative dispatch costs. Consumers can essentially be paid to use electricity. That is neither in the interest of utilities nor is it in the interest of the policy maker, who chose the instrument in the first place largely to address environmental concerns.

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Policy uncertainty around utility financing opens up avenues for more creative solutions. In Massachusetts, one such instrument creates long-term contracts between utilities and renewables suppliers. The utility has to assist in the financing of the renewable project, essentially removing the need for renewables generators to approach investors directly.

The upside for the utility is guaranteed compensation for its investments. It also allows for direct subsidies to renewables.

On the flip side, it suppresses prices and makes it harder for everyone else to participate in the market. The overall effect remains unclear.

Filling some of the void left by a lack of comprehensive carbon and investment policy may well necessitate similarly creative financing tools. That's particularly true as the scale-up of renewable technologies is a matter of building supply chains as well as advancing technologies and reducing costs. Policies enabling and catalyzing that process will likely prove most important. Those policies often go beyond mere carbon pricing and call for more direct government support.

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Nuclear generation faces an entirely different set of challenges. It echoes many of the investment challenges of renewables, just at a larger scale: enormous upfront costs and low fuel costs compared to fossil fuels.

Still, upfront capital investment poses the biggest challenge. It is unclear whether mergers and acquisitions in the utility sector will make much of a difference here. No utility is currently equipped to finance a nuclear plant independently. That situation is unlikely to change. No single company can build a nuclear plant absent a major regulatory bargain. It's not a question of the size of the balance sheet but of regulatory design.

The last nuclear plant built in the U.S. was completed last century. It was supposed to cost $500 million and ended up costing $4 billion. No one will build a new nuclear power plant until we see what happens to the two plants currently in the works.

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Managing amidst uncertainty harbors many challenges—both on the utility and investment front. A few areas, though, have become increasingly clear: We are witnessing a relentless push towards renewable energy—largely, of course, with direct help from government but increasingly also on its own.

Yet all that is currently dwarfed by one certainty: Natural gas is winning.

Natural gas attracts the most investment dollars by far. That was clear even before the rise of shale gas. The last decade saw significant natural gas capacity additions. Back then it was largely due to the relatively low cost of new gas plants. Now it is a story driven by low natural gas prices as well, but also by the fact that there are largely no economic alternatives.

Appendices

Agenda

Electricity: Seeking Progress Amid Uncertainty

Tuesday, July 3

6:30 – 9:00 pm	**Opening Reception and Dinner** **Hosted by Duke Energy**

Wednesday, July 4

8:00 – 11:30 am

SESSION I: REGULATORY ISSUES

The financial model of regulated utilities is under stress due to low sales, distributed generation, political pressure over rates, and other factors. Building new generation, large or small, is difficult without a policy guarantee. Environmental uncertainties exacerbate investment uncertainties. Concerns about rates and privacy impede smart grid investment. Speakers from different institutional perspectives will kick off a discussion of these and related questions.

Chair:	**Peter Fox-Penner, Principal** **The Brattle Group**
State Regulator Perspective	**Doug Scott, Chairman** **Illinois Commerce Commission**
Developer Perspective	**Steven Corneli, Senior VP for Sustainability, Strategy and Policy, NRG Energy**

Utility Perspective	**Paul Bonavia** **Chairman and CEO** **UniSource Energy**
Special Guest:	
Evolving Environmental Policy	**Lisa Jackson** **Administrator** **Environmental Protection Agency**

Thursday, July 5

8:30 am—noon

SESSION II: ENERGY EFFICIENCY

What will drive the move toward greater energy efficiency? What are the obstacles, and what progress is being made to overcome them?

Chair:	**Kateri Callahan** **President** **Alliance to Save Energy**
Unpacking the Energy Efficiency Gap	**Richard Newell** **Professor and Director** **Duke University Energy Initiative**
Utilities	**Roger Duncan** **Center for Energy Policy** **University of Texas, and** **Former General Manager** **Austin Energy**
Residential	**Philip Mezey** **President and COO – Energy** **Itron Inc.**
Commercial and Industrial Energy	**Kevin Cooney** **Managing Director** **Navigant Consulting**
Information and Communications Technologies	**Tomm Aldridge** **Director** **Energy and Sustainability Lab** **Intel Labs Europe**

1:30—5:00 pm

SESSION III: ENERGY AND WATER

Generating electricity requires water. Delivering water requires electricity. How do they interact? How do differences in fuels, technologies, and geography affect water use in electricity? What options are available for reducing water use? How can energy and water needs be met simultaneously?

Chair:	**Javade Chaudhri** **Executive VP and General Counsel** **Sempra Energy**
Overview	**Michael Webber** **Associate Professor** **University of Texas – Austin**
EPA Water Intake Rule	**Steve Fleischli** **Senior Attorney, Water Program** **NRDC**
Technology Opportunities	**Mike Howard** **President and CEO** **EPRI**
Case Study: **Areva-Fresno Project**	**Michael W. Rencheck** **President and CEO** **AREVA, Inc.**
6:30 – 9:30 pm	**Reception and Dinner** **Hosted by AEP**

Friday, July 6

8:30 am—noon

SESSION IV: FOSSIL FUELS

Large scale additions to generating capacity in the near term are expected to be met largely by coal or gas. What are the factors affecting utility choices? How do these choices align with national interests?

Chair:	**Mark McCullough** **Executive VP of Generation** **AEP**
Utility Choices between Coal and Gas	**David Campbell** **CEO** **Luminant**
Gas Price & Supply	**Jen Snyder** **Principal Natural Gas Analyst** **Wood Mackenzie**
Reasons for Worry about Gas	**Armond Cohen** **Executive Director** **Clean Air Task Force**
Carbon Capture and Storage	**Howard Herzog** **Senior Research Engineer** **MIT Energy Initiative**

Saturday, July 7

8:00 – 11:30 am

SESSION V: FINANCING NEW DEVELOPMENT

How are current fiscal difficulties affecting the financing of electricity projects? What is the federal policy outlook, and how is it affecting investment? What is the appetite for tax equity? Is the competitive generator model still viable? What other factors are shaping financing?

Chair:	**Ernest J. Moniz** **Director** **MIT Energy Initiative**
Federal Incentives for Renewables and Efficiency	**Truman Semans** **Principal** **Green Order**
Implications of Market Events on the Power Sector	**Dan Eggers** **Managing Director** **Credit-Suisse**
Credit and Infrastructure Finance	**Ellen Lapson** **Founder and Principal** **Lapson Advisory**
Viability of Competitive Generator Model	**Ralph Izzo** **Chairman and CEO** **PSEG**

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