2015 Energy Policy Forum

Leaning into the Energy System of the Future



Sue Tierney & Clint Vince, Co-Chairs

Dave Grossman, Rapporteur

The Aspen Institute Energy & Environment Program

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A Report from the 2015 Energy Policy Forum

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FOREWORD

For 39 consecutive years, the Energy Policy Forum has convened a diverse group of energy experts from business, policy, academia, and non-profit organizations to discuss a range of current and emerging energy policy questions. This year, the topics covered during the Forum seemed ripped straight from the headlines – the battle over rooftop solar; challenges surrounding coal and nuclear power; a fight against efforts to address climate change. Yet unlike the casual news stories offered to consumers, the robust exchange of ideas and experiences offered during the Forum provided balanced insight about the public policy and business choices facing the domestic electricity industry.

Sue Tierney, Managing Principal of The Analysis Group and former Assistant Secretary of Energy for Policy, and Clint Vince, the chair of Dentons' Energy sector, co-chaired the Forum. Their deep and varied experience with the industry was extremely helpful in developing the Forum agenda. Together their moderating skill, understanding and experience with the issues, and unflappable good nature enabled them to manage the wide-ranging discussions during the Forum. Highly qualified and informative speakers provided a wealth of information and a variety of viewpoints, and the diverse expertise of the participants contributed greatly to the richness of the dialogue.

The Aspen Institute acknowledges and thanks the following sponsors for their financial support of the Forum. The majority have been participants and supporters for many years. Without their generosity and belief in the value of our work, the Forum could not have taken place.

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Dave Grossman again wrote the Forum report. He skillfully extracted major themes from the excellent presentations and wide-ranging discussions.

The logistics of the Forum were handled by Avonique DeVignes. Timothy Olson provided important input on the development of the agenda and speaker management. I am grateful for their continued dedication and support, which are critical to the continued success of this Forum.

The chairs, speakers, participants, and sponsors are not responsible for the contents of this report. It is an attempt to represent ideas and information presented during the Forum, but not all views could be included, the views expressed were not unanimous, and participants were not asked to agree to the wording of the report.

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LEANING INTO THE ENERGY SYSTEM OF THE FUTURE

Dave Grossman
Rapporteur

EXECUTIVE SUMMARY

Global energy markets are changing. Oil prices have experienced an historic collapse due to the U.S. shale supply boom, increased Middle Eastern production, and a range of other global factors. Natural gas prices have faced a somewhat similar situation, in part because of linkages to the oil market and booming supplies from U.S. shale. China's economic slowdown and reorientation, along with its efforts to address air pollution and reform state-owned enterprises, will continue to have fundamental impacts on global markets for oil, gas, coal, nuclear, and renewables.

Five key macro trends will affect the future mix of energy across the globe: abundant, low-cost gas; renewables becoming mainstream; the growth of emerging markets driving distributed power; the emergence of brilliant machines and data analytics; and empowered end customers. Innovation is occurring everywhere across the value chain. In the United States, the electricity industry is transforming, with utilities and others retiring coal plants, bringing in gas, investing in renewables, and working to create a grid that can integrate the new technologies. The outlook for U.S. electricity demand is mostly flat, which means investments in new generation are ultimately about displacement, though some fuels have synergies too. For nuclear power to play a role in the United States, the focus may have to be on finding a way to support and extend the lives of existing plants, as new plants are expensive and lack adequate policy support. Existing nuclear capacity is shutting down for technical and economic reasons, though, and the political support for nuclear power is not strong. Many other countries have no such issues, building new nuclear plants with the support of their governments.

With less coal and nuclear in the future U.S. mix, gas is likely to replace a good portion of that baseload power. The heavy reliance on natural gas is raising concerns about a lack of fuel diversity, though it is unclear how valid those concerns are; portfolios need to be diverse, but the mix can certainly change over time. It is conceivable that the future fuel mix of the United States may be like California's, where state policies led to a mix that has seen growth in natural gas, growth in renewables, growth in distributed energy resources, shrinking nuclear, shrinking hydro, and vanishing coal.

The Clean Power Plan (CPP) from the U.S. Environmental Protection Agency (EPA) has the potential to shape domestic energy markets and influence international action. The plan will face certain litigation about a range of issues, as well as Congressional opposition. While a few governors have filed lawsuits against the rule and have declared that they will not submit a compliance plan to the EPA, most states have started planning how to comply with the rule rather than having a federal plan imposed upon them. States are trying to figure out how to implement the CPP in a way that is consistent with economic dispatch and that does not create lost or stranded assets. The industry too is generally preparing for the CPP to come into force, though the industry is already decarbonizing due to low natural gas prices, market forces, and customer demand. While action on climate change is primarily about domestic policy and politics, international efforts can influence policymaking. The CPP, which represents a large part of the international climate commitments made by the United States, is enhancing the country's credibility and encouraging other countries to make commitments.

In addition to environmental regulations, technologies and customers are increasingly driving the energy world, as has occurred in other industries where customer-focused innovations spurred rapid transformations and eroded the incumbent business model. At the same time, some product innovators are starting to partner with forward-thinking utilities to provide products and services for utility customers. These customers, who are increasingly environmentally concerned, vocal, and tech-savvy, have a range of energy usage patterns; understanding which people tend to use energy at which times can help utilities provide more targeted programs and services. Utilities are generally well-positioned to provide services and to act as trusted energy advisors for customers, assuming regulators create space to allow them to do so.

All of these forces and trends – changing environmental regulations, aging infrastructure, flat demand, flat or declining commodity prices, declining costs of clean (and especially distributed) generation, the proliferation of IT and smarter devices, and changing customer expectations – will help drive the electricity system of the future. That system may well involve a move from a centralized to decentralized model, with increased resilience and use of distributed energy resources (DER). With rooftop solar breaking into the price point it has, the costs of energy storage coming down, and a range of other DER technologies (e.g., microgrids, demand response) on the rise, DER has likely passed the tipping point needed to spur a real industry transformation.

The primary role of regulators in facilitating the energy system of the future should be to remove barriers to entry, allow the new set of consumer-driven technologies to have beneficial impacts, give customers choices, and make tough decisions about the roles of various players – especially the distribution utility – going forward. Regulators may need to define the basic, core service to protect as well as the more flexible service offerings that can occur in a competitive environment. Technology is progressing so rapidly that policymakers may not be able to respond quickly enough, but getting the roles and platforms established can level the playing field and allow the new "barbarians at the gate" to come in and compete. Regulators must continue to be vigilant, though, to ensure that low-income customers are not left behind or burdened.

Some utilities are trying to create spaces to be more nimble around the new disrupting technologies. Some are already pursuing efforts to provide greater services to their customers centered on these technologies and to experiment with new models to capture the rooftop solar opportunity. The role that many seem to envision for utilities in a future electricity system is that of aggregator and network manager (assuming regulators enable utilities to get paid for that role). The big changes in fuel mix, technologies, and the grid will also require utilities to bring in or develop different disciplines and skill sets, including data analytics and cyber-security management.

Major takeaways from the 2015 Aspen Institute Energy Policy Forum included the following:

- *The extraordinary supply boom in the U.S. from the shale revolution and the decision of OPEC not to cut production combined with flattening consumption in BRIC countries have had profound global implications for energy prices, electricity trends and emissions.*

- *The energy system of the future will see greater convergence between different parts of the market – between energy policy and environmental policy, energy networks and other systems, electricity and gas, and state-regulated distributed resources and central station wholesale and interstate resources.*

- *U.S. electricity demand is mostly flat, which means investments in new generation are ultimately about displacement and cannibalization, driven in part by environmental and renewable energy targets and policies.*

- *Technology and the focus on the user experience are increasingly eroding the incumbent utility business model, raising the question of how fast the core will shrink and whether the model can react with sufficient agility.*

- *The US is in danger of losing its position of leadership and influence in nuclear energy and has a strategic choice to make: either design new policy tools or cede the market to China and Russia.*

GLOBAL ENERGY MARKET TRENDS

Global energy markets are changing as the world enters a new age of abundant oil and gas supplies, low prices, and dynamic geopolitics.

Global Oil & Gas Pricing

The price of oil has experienced an historic collapse, starting in late 2014 and going throughout 2015. A key driver of the price collapse has been the extraordinary supply boom in the United States from the shale revolution; the boom initially replaced other supply disruptions but eventually flooded the market. In addition, OPEC in late 2014 chose not to cut production, and Libyan oil also started coming back to the market. After a brief period of stabilization, prices started to slide yet again, this time driven by concerns about the Chinese stock market, the financial situation in Greece, the Iran deal, Iraqi exports, increased Saudi supplies, and historically high levels of global and domestic inventories.

Notwithstanding the glut in the market, the Saudis have increased production since the OPEC meeting in November 2014. The Saudis have signaled this change in approach for many years, indicating that they were not willing to repeat the experience of the 1980s, when they cut production and lost revenue and market share. It was only recently, though, that the world really recognized and believed that the Saudis were no longer acting towards oil markets in the same way they had. The Saudi view is that they can weather this downturn, wait until the price rebounds, and maintain market share in the interim. This suggests there will be a lot of supply coming out of the Middle East for a while to come. Saudi production at a high level also means it has less spare capacity, raising questions about the ability of the world to respond to more supply disruptions.

The absence of the sharp decline in U.S. oil output that some expected is due to a range of factors, including robust access to capital, productivity and technology improvements, and compression of the cost curve in the supply chain.

Since the Saudis are not cutting production, a narrative that has emerged is that the United States may be the new swing supplier in the global market. Shale production can indeed swing more rapidly (i.e., come online and offline faster) than conventional production, but so far, despite the large drop in oil rig counts, U.S. supply has not been swinging; instead, it has basically flattened out or increased. The absence of the sharp decline in U.S. output that some expected is due to a range of factors, including robust access to capital, productivity and technology improvements, and compression of the cost curve in the supply chain. In addition, there is a backlog of drilled and uncompleted wells that can come online when the price rebounds.

The price drop has been a boon for consumers facing low gasoline prices, a boost to GDP growth, and a spur to efforts to implement fuel subsidy reforms in various countries. It has, however, had negative effects on fuel exporters: the Saudis have had to draw on their reserves, the Venezuelan and Nigerian economies are in trouble, the Russian economy is hurting, and OPEC's export revenues have dropped. (While the United States is more energy independent as a nation now than it has been, the list of nations that have been hurt suggests that energy independence and greater security are not necessarily the same thing.) The price drop has also had negative effects on producers, who have significantly cut back on capital expenditures and delayed, deferred, or canceled high-cost projects. More than $100 billion of high-cost projects have been delayed or deferred so far, though several fiscal reforms in Russia, the United Kingdom, and elsewhere have blunted the impact a little.

Natural gas has faced a somewhat similar situation, in part because of linkages to the oil market and in part due to booming supplies from U.S. shale. Gas prices have dropped globally, as have capital expenditures and rig counts – yet U.S. shale gas production continues to rise. There is a lot of U.S. gas available at the $3-$4 range for many years to come.

Globally, liquefied natural gas (LNG) prices have basically converged in Europe and Asia. The outlook for U.S. LNG exports is still very strong, partly because of the tolling fee nature of contracts in place in the United States for gas. A great deal of demand for LNG is expected to come into the market through 2020, and U.S. export capacity could be up to 9 bcf/d by then.

As noted, access to capital has been a big driver of U.S. supply; assuming shale has continued access to relatively cheap capital, oil and gas prices are expected to remain low for a while.

Influence of China and the BRICs

Energy developments in the BRIC countries (Brazil, Russia, India, China) have shaped energy markets and policy in the United States and around the world. The past decade has been a BRIC super-cycle, driven mostly by China, with extended periods of higher-than-average economic growth and high prices. China's booming energy demand helped contribute to a period of high prices in oil markets for the past decade and had even bigger impacts on coal markets and power generation. From 2002 to 2012, China was responsible for more than half of growth in global energy demand, electric generation, coal generation, and nuclear generation, as well as more than a third of renewables generation growth. China and the rest of the BRICs were largely absent from gas generation growth, though, which boomed mostly in North America and the Middle East.

Global energy markets will continue to be fundamentally shaped by some big domestic trends in China. The main one is that China is currently at a decisive moment in its economic development, as income levels have risen and economic growth rates are slowing. The question for China is whether it takes the 'bunny slope' path down through the middle income trap, gradually decelerating from 10% to 7% to 5% growth, or whether it takes the 'black diamond' route down, as Latin American countries did after failing to institute dramatic reforms. China could grow at 1% in 2020 or at 6% in 2020; both are viable pathways.

Which path it takes is largely about the ability of the Chinese government to reorient the positioning of the government from owner to regulator of the means of production; that is a fundamental shift, especially for a planned economy. That kind of broad economic adjustment will require reallocating capital away from the state-owned enterprise (SOE) structure, which has had preferential access to financing, and toward the private sector. SOEs provide one-third of the return on capital as private companies, but they also currently borrow at one-third the rate; leveling out access to capital has the potential for the same investment to drive far greater growth. Such realignment would take capital from heavy industry sectors of the economy (e.g., infrastructure investment) and reallocate it to high value-add manufacturing and the service sector, which means new Chinese growth could be far less energy intensive. The Chinese stock market collapse and the way the government managed it, however, are a bad sign for President Xi Jinping's ability to get economic reforms done.

Another key trend in China is the 'airpocolypse'. The country's air pollution challenges have become quite mature as a policy issue, and certain factions of the Chinese government are now using public outrage around air pollution as a means to leverage changes in energy policy.

President Xi Jinping has also consolidated power, purging opponents and corruption from the party and from the SOE structure. The corruption purge extended to the heads of the major oil and gas companies and is now moving towards the electric power space. A formal power sector reform agenda will be rolled out in 2015, which for the first time will start liberalizing generation prices and giving customers the ability to negotiate directly with generators. Reform will be hard, though, as the state grid is a very powerful SOE.

Global energy markets will continue to be fundamentally shaped by some big domestic trends in China.

These big trends in China's economy and energy sector suggest that the BRIC super-cycle is in its latter half, with no demand coming from China on commodities and with power demand down to low single digit growth. As investment in the industrial sectors slows down, Chinese power demand plummets; total power demand grew at only about 1.3% during the first half of 2015. Within that demand, coal is increasingly getting squeezed in terms of share of new capacity additions, with growing additions of hydro, other renewables, and nuclear instead; if power sector reform successfully changes electricity pricing, coal will likely drop further. China's slowdown has markedly reduced oil demand, too, contributing to the global price collapse. On the other hand, China's large-scale manufacturing of solar photovoltaics helped drive down global PV costs, leading to a boom in solar generation in the United States. China is not just making it, but is also installing it; in 2014, China added more wind and solar than the United States and Europe combined. China has committed to get 20% of its total primary energy from non-fossil sources by 2030, which means about 800-1000 GW of new nuclear or renewables installed between now and then; at those scales, China will further transform global pricing for those energy sources.

China's slowdown has had ripple effects on the rest of the BRIC countries. With commodities prices so low, there will be zero (or worse) growth out of Russia, and Brazil's economy will similarly suffer. There will be some growth in energy demand in ASEAN (Bruni, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam) and India, though there are challenges and uncertainties in both. With China looking to shore up near-term growth without adding to capital misallocation problems, it is increasingly looking to create demand for Chinese goods around the world; there are numerous funds focused solely on seeding infrastructure projects elsewhere (e.g., ASEAN) that will draw out low-cost Chinese goods, including supercritical coal-fired power equipment.

THE FUTURE OF THE ELECTRICITY MIX

Longer-term predictions about the electricity sector have generally fared very poorly, thrown off by major technological or market changes. Most in the industry did not predict the shale boom, the decline of coal, the magnitude of renewables, flat electricity demand, or cyber intrusion. There should thus be no reason to fear challenging the conventional wisdom about what the electricity mix will look like in the future, especially given the tremendous uncertainty around policies in the United States (e.g., EPA regulations on mercury and carbon) and in other countries (e.g., Japanese nuclear policy, Chinese subsidy reform).

Global Electricity Trends

Countries around the world are looking for reliable, accessible, affordable, sustainable power, but the mix by country varies depending on priorities and policies. In the United States, solar, wind, and gas represent the vast majority of new build. China is the number one country in the world in terms of solar, wind, gas, and coal, but coal build is expected to go down significantly as the country starts caring about a range of attributes besides just affordability. In Indonesia, a quarter of the population does not have power, so accessibility is the main criterion there; with thousands of islands, accessibility tends to mean diesel generators, which are very portable. Affordability is also a big issue in Indonesia, which currently means a fair amount of coal build too.

More broadly, there are five key macro trends that will affect the future mix of energy across the globe. First, this is the age of gas. Over the next decade, it is very likely that more gas will be installed than any other technology, driven by cost and availability (depending where one is in the world). More efficient gas turbines are also driving down the economics of gas, which will spur further growth.

Second, renewables have become mainstream. In 2014, 30% of all installs around the world were renewable energy. Renewables have grown tenfold in a decade, due largely to scale, technology, and cost improvements. Today's wind turbine has twice the capacity factor of a turbine from 10 years ago, while solar costs have come down 75% and wind costs 50% in the last five years. The rapidly declining solar PV prices have brought down the prices of competing technologies as well, such as geothermal and solar thermal. Renewables are now and will continue to be major technologies.

The future of power is likely to be a mix of everything – centralized and decentralized, traditional technology and disruptive technology, and in developing and developed markets.

Third, the growth of emerging markets is driving distributed power, with 85% of new energy demand coming from emerging markets. In developed countries, the markets are more about replacement, but the raw demand globally is from emerging markets. Emerging markets have different customer criteria, with distributed assets and the need to be able to provide emergency power being critical.

Fourth, machines are getting to be brilliant, with industrial data analytics finally starting to show real value for customers. Upgrading a gas turbine brings a certain value to customers, but adding in data analytics and software to maximize the output of the turbine can double the value from the same upgrade. Similarly, digital wind farms can mimic their real-world twins and use real-time data readings to optimize and adjust the wind farm, adding 20% to the farm's output.

Fifth, end customers are increasingly empowered. They have more choice, whether storage systems, solar panels, or electric vehicles (EVs). They can generate power on-site, use less power (e.g., with LEDs), and shift power (e.g., with batteries). This will continue to be a very large market.

Innovation is occurring everywhere across the value chain. On generation, there has been innovation with gas, renewables, and distributed energy resources. Behind the meter, there are energy management systems, energy efficiency, electric vehicles, and new lighting and appliance standards. Batteries can work across the entire chain with different applications, whether sitting next to turbines or in substations. Innovation is also happening in the hydrocarbon sector, which virtually ensures a lower hydrocarbon price environment for years to come. The future of power is thus likely to be a mix of everything – centralized and decentralized, traditional technology and disruptive technology, and in developing and developed markets.

U.S. Electricity Trends

The electricity industry in the United States is transforming, and it has been for years. With lower prices, gas has taken more of coal's market share in U.S. power generation; in April 2015, the share of gas in U.S. power generation exceeded that of coal for the first time in U.S. history. Utilities and others are retiring coal plants, bringing in gas, investing billions in renewables, and working to create a grid that can integrate the new technologies. There is some consensus on the broad parameters of the transformation – low-carbon, highly satisfied customers (encompassing reliability, choice, and cost), and universal access – but when it gets into specifics and practical implications, the conversation becomes much more chaotic. People's views diverge on whether coal has any role in a transformation to a clean energy economy, the role of gas, the role of carbon capture and sequestration (CCS) for coal and for gas, the role of nuclear, whether renewables should be distributed or large-scale, the role of energy efficiency, whether wires should be in the air or underground, the role of microgrids, and so on.

There is currently a great deal of investment in U.S. power generation, particularly gas turbines and renewables, complementing the deflationary price trends of those technologies. The outlook for U.S. electricity demand is mostly flat, though, which means investments in new generation are ultimately about displacement and cannibalization, driven in part by environmental and renewable energy targets and policies. For example, the subsidies for rooftop solar are so large that they are driving a disproportionate amount of solar growth towards rooftops and away from utility-scale, even though utility-scale solar is more efficient operationally and is half the cost of rooftop solar in wholesale markets (though rooftop solar may have other beneficial attributes, such as customer empowerment and – someday – improved resilience).

The outlook for U.S. electricity demand is mostly flat, which means investments in new generation are ultimately about displacement and cannibalization, driven in part by environmental and renewable energy targets and policies.

When the full cost of electricity (e.g., capex, op ex, fuel), externalities (i.e., environmental impacts from generation and construction), and geographic variability (i.e., varying costs in each county) are considered – but not subsidies, decommissioning costs, waste disposal costs, or transmission and distribution costs – the cheapest option for new power plants in the United States if gas is around \$5 tends to be natural gas combined cycle (NGCC), wind, and nuclear. Nuclear is the cheapest in those few places where there is a bad wind resource and no cheap gas, while wind wins mostly in the Midwest and gas wins everywhere else. Lower natural gas prices such as there are now (around \$3) lead to more natural gas at the expense of wind, whereas higher natural gas prices (around \$7) would see natural gas lose market share to wind and a bit to nuclear. Coal is only the cheapest option if environmental externalities are not considered at all (and natural gas does better then too), whereas a high carbon price would lead nuclear and wind to dominate. Natural gas may not do as well if environmental externalities further upstream (i.e., methane leakage) are included. Utility-scale solar only starts to dominate if solar capex really comes down to $1 per watt, which is available in the value chain and may soon come to market; when the Investment Tax Credit comes off for solar, margins will likely shrink, and price will move closer to cost.

The trends and prospects for various fuels have been clearly reflected in the market. The market cap of the four biggest U.S. coal companies fell from $4 billion to $800 million in eight years. At the same time, the four largest solar companies in the United States (who are mostly installers) now have a market cap of $25 billion.

A shift away from coal could cause suffering for rural coal mining, though rural renewables and shale might benefit. Having a vibrant rural America is important, and what might end up happening is a shift in rural economies. With the closing of coal plants, people and towns that spent their lives building an economy and community around these facilities can be devastated. If these sites can be remediated and repurposed, such as for new datacenters or renewable energy production, it can aid communities that are hungry for investment, jobs, training, and a transition to the new economy. One cannot underestimate the impact of redevelopment projects in communities like this, and businesses and policymakers must give serious and creative thought to ways to successfully reinvest in communities during the transition to a low-carbon economy.

In some ways, the electricity mix can be thought of as being about not just forms of generation but also efforts to reduce demand. Energy efficiency and demand response are important tools for many utilities, as they are generally the lowest-cost resource (and the lowest-cost way of achieving emission reductions). Utilities starting such programs can often get off to a fast start, seizing low-hanging fruit such as replacing light bulbs. In later years, though, as they get further into the programs, savings rates can decline, sometimes more than expected. Also, if utilities are long on generation, energy efficiency may not be the best thing to pursue, as it can take revenue from the assets, whereas demand response helps to shave the peak but does not reduce the run hours of baseload units. Utilities can balance energy efficiency and demand response based on what customers want and what their generation mix looks like. In addition, there are incredible opportunities for technology to provide energy savings, such as in voltage optimization, but utilities have to figure out how to get paid for it.

Maximizing Synergies

Renewable energy and natural gas are often pitted against each other, and it is true that they compete. Under economic dispatch, for example, renewables coming onto the grid sometimes push natural gas off the bid stack. On the other hand, cheap natural gas makes it harder to develop renewable energy projects.

The relationship between renewable energy and natural gas is complicated and nuanced though. While they compete, they are also allies, solving each other's problems. The price stability of renewable energy mitigates the price volatility of natural gas, while the reliability of natural gas solves the variability problem of renewables. The two are also related, given the non-trivial potential to make renewable natural gas via methanation. There is lots of energy embedded in agricultural waste; the total technical potential of renewable natural gas in the United States is 10 quads or more.

In addition, renewables and natural gas can solve some of the tensions between carbon dioxide and water in the power sector. Some low-carbon power options are very water intensive (e.g., nuclear, coal with CCS, biomass), but there is a sweet spot of low-carbon and low-water power, which primarily consists of NGCC, wind, and solar. Water itself is actually another area of potential synergy, as the water sector is becoming increasingly intertwined with the energy sector. The issues in water, however, make the issues in the energy world look easy. The regulatory model for water is extremely fragmented, and regulatory tweaking has not even started yet, much less a full overhaul. Water utilities currently are not incented to make infrastructure investments, with weak return on equity. It is conceivable that electric utilities could enter the water sector, deploy capital there, run water meters off of the same digital network, aim to reduce losses in the system, and work to improve the regulatory obstacles.

Utilities need to understand how all the energy technologies and innovations work – and how they work together.

These are just some of the many synergies in the energy world. Utilities need to understand how all the energy technologies and innovations work – and how they work together. The electricity network is interconnected, and in an integrated power system, changes in generation and the grid have ripple effects. Greater adoption of intermittent distributed energy resources, for instance, will impact the circuits those resources are on and will, over time, define the rest of the generation portfolio that needs to surround them (e.g., ramping or storage capability).

Nuclear Power

In an uncertain world moving away from the traditional utility, the ability to take big risks starts to disappear, which may mean that a nuclear renaissance in the United States is even more unlikely than it already was. Utility companies with deep pockets may be able to build a new plant or two, but most companies building a new nuclear plant would be betting the entire company on it. (This is one of the effects of relying on utility investment for a good part of the energy transformation, raising the question of whether at least some technological development should be funded in some other way.) Without some kind of policy support, companies have no assurance that they can take the seven or eight year journey to build a new nuclear plant and actually make it to the other side.

If nuclear power is to play a role in the United States – whether in meeting greenhouse gas reduction goals or in providing reliable, dispatchable power – the focus may have to be on finding a way to support and extend the lives of existing plants. The current U.S. nuclear fleet, consisting of 99 reactors at 62 sites, provides about 800 million MWh, about 20% of total power generation and almost two-thirds of zero-carbon power generation in the country. Nuclear capacity is already declining, with a number of units shut down for technical and economic (not political) reasons; in some of these plants, it was simply impossible to get revenues to exceed costs under any scenario. Public policies and low natural gas prices suggest that energy markets will not be changing in ways favorable to nuclear in the foreseeable future, making it unclear how long investors will keep investing in these resources to keep them running. Thousands of megawatts are coming offline, and there are serious risks for the remaining fleet. Single-unit merchant plants may be most at risk, but even the best, most efficient dual-unit plants are challenged.

If nuclear power is to play a role in the United States – whether in meeting greenhouse gas reduction goals or in providing reliable, dispatchable power – the focus may have to be on finding a way to support and extend the lives of existing plants.

A significant portion of the U.S. nuclear portfolio cannot meet operating costs today. If a solution is not devised that appropriately compensates those plants, they will be lost. Even a carbon price, which focuses on only one of many attributes of nuclear assets, may not be enough to keep the plants viable. Some proposals on energy price formation – such as reflecting true costs in prices and getting fair value for the resource type and attributes being provided – could help existing units survive; current models of price formation, particularly in the Northeast, are causing early shutdown of existing generators. Long-term high-level policy objectives may also need to be prioritized, including reliability (e.g., how to value fuel diversity), economic sustainability (e.g., low costs for customers, sufficient revenues to sustain investment), and environmental sustainability (e.g., carbon and other pollutants).

Supporting existing plants will only go so far, however. Nuclear plants are currently licensed for a life of 60 years, and if they do not get an extension to 80, all nuclear plants in the United States will be retired by around 2040. The Nuclear Regulatory Commission (NRC) will likely look at proposals to extend existing facilities' lives sometime this decade and in the early 2020s. There are some questions about how old nuclear plants can get – how long their lives and licenses can be extended – and still retain safety. Not every plant can run for 80 years without problem, and there may be some clunkers out there that should not be extended, but that can be determined on a plant by plant basis. The NRC's regulatory scrutiny is very comprehensive, and every plant will have a thorough review to determine whether relicensing is a viable option. There is already annual investment in these plants of about $50-100 million for constant upgrading of equipment.

Beyond extensions, another possibility for nuclear in the United States may be small modular reactors (SMRs). There are examples of small reactors working. SMRs have been in place for a long time and have worked very well in the Navy, and the New Horizons probe that passed Pluto is powered by a small nuclear reactor. Future SMR customers could include remote oil and gas operations or island communities.

Politics must be considered when evaluating the future of nuclear power in the United States. The fact is that most of the clean energy advocacy community does not support nuclear power, seeing it as competition for and much more expensive than renewables and efficiency. There is also a strong and influential contingent of Northeast politicians vehemently opposed to nuclear. It is surprising that the industry has not been more active in talking to key environmental and clean energy advocacy groups to think about creating a coalition to argue for national policies that promote rapid deployment of all forms of zero-emitting technologies. There may be a moment now for broader-based support for protecting the existing nuclear fleet, as those who preferred gas as a bridge fuel are realizing that they may be locking themselves into a gas future in a way that blocks renewables development.

The status of nuclear power in the United States is not echoed in the rest of the world. The amount of nuclear power plants operating, being built, and being planned pre- and post-Fukushima are about the same. There is big building occurring in China and India, as well as in Korea, Turkey, Vietnam, the Czech Republic, Hungary, the UK, and France. In most countries, nuclear plants are being built with the help of the state (or Russia). In addition to building nuclear power plants around the world, the Russians are trying to build their fuel capacity and corner the market on fuel. The United States is clearly losing its position of leadership and influence in nuclear energy. The country has a strategic choice to make: either design new policy tools to remain in the nuclear game, or atrophy out the remaining declining workforce and expertise and cede the market to China and Russia.

Fuel Diversity

It seems very likely that there will be less coal and nuclear in the future U.S. mix. Those two fuels combined account for over half of current generation, raising the question of how to replace that amount of baseload power. It can take a long time for utilities to plan replacement capacity. In a dynamic environment where everything is changing, it is easy for utilities to decide to do pilots for new technologies (which cost millions), but it is much harder for them to take new technologies to scale (which costs billions), given concerns about obsolescence, stranded investments, investor returns, impacts on systems and reliability, and future technologies that might be even better. As practical implementers of technology, utilities have to balance the sense of urgency and excitement with prudence around decision-making.

For a utility looking to build new baseload power, gas is currently the only really viable choice, but if gas takes up all of the anticipated baseload slack, that is a lot of reliance on natural gas, raising concerns about price risk and volatility. There is also a concern that people are rushing to gas and might be missing other options. There are therefore questions about what methods are available for valuing and quantifying the value of diversity and incorporating it into market decisions.

It is unclear how valid the concerns about diversity are. While portfolios need to be diverse, the mix can certainly change over time. Around 2008, the mix was about 50% coal, 20% nuclear, 10% natural gas, and 10% hydro and other renewables. The United States appears to be moving toward the same numbers but with different fuels – about 50% natural gas, 20% nuclear, 20% hydro and other renewables, and 10% coal – yet now concerns are being raised about fuel diversity. Even with rising gas, the energy mix is still quite balanced. Of course, in places that are heavily dependent on coal, adding natural gas is what makes the fuel supply more diverse.

California as a Model

It is conceivable that the future fuel mix of the United States may be like California's. Switching from coal to natural gas is already a done deal in California; every rise comes with a fall, and the rise of natural gas in California came with the fall of coal. Coal was made virtually illegal in California in 2006, with the state Emissions Performance Standard basically requiring emissions standards equivalent to state-of-the-art NGCC and essentially eliminating any new investment in coal plants. The state cap-and-trade program, which started in 2013, furthered the demise of coal, as did low natural gas prices.

Renewables have also been on the rise in California. The original state Renewable Portfolio Standard was enacted in 2002 as 20% by 2017, which was then raised in 2006 to 20% by 2010, raised in 2011 to 33% by 2020, and then raised again by the Governor's plan to achieve 50% by 2030.

Increasingly, the California Public Utilities Commission is going beyond renewables and gas in the mix, requiring utilities to consider "preferred" resources to fill system needs and provide traditional reliability services. These include energy efficiency, demand response, renewables, and distributed resources, as well as energy storage (including wholesale and customer-connected storage). California is also moving to a decided focus on localized, distributed energy resources (DER), which are basically the same as "preferred" resources with the addition of EVs. With the rise of DER, traditional investment in the grid is falling, with a focus instead on a robust, two-way grid with the ability to plug-and-play and with lots of distribution and substation automation. It took 100 years to build a dumb grid, and it will take a while to build a smart one that is hardened, strengthened, and equipped to enable more DER.

As a result of California's policies, the state's fuel mix has seen growth in natural gas, growth in renewables, growth in DER, shrinking nuclear, shrinking hydro, and vanishing coal. Thousands of MW are still being added every year. California utilities are making massive investments in technology; these are more than just experiments. In California, utilities define a five-year procurement plan up front, and as long as they stay within that, expenditures are per se reasonable. The pre-approval of all long-term contracts means they are determined to be prudent up front, so there is no second-guessing in a look back. This works because California relies on competitive markets, so utilities can demonstrate that they are buying the best things the market can provide them.

TACKLING CARBON

No consideration of the current and future U.S. electricity mix can ignore climate change as a vital driver. Carbon is such a different thing to regulate than other air pollutants; it is more pervasive and cannot just be scrubbed out. Policies to address climate change, particularly the EPA's Clean Power Plan (CPP) setting carbon dioxide limits on existing fossil-fueled power plants, have the potential to reshape domestic energy markets and influence international action.

Clean Power Plan

The EPA's Clean Power Plan, issued under section 111(d) of the Clean Air Act,[1] faces a future full of litigation. All arguments crafted about the CPP are ultimately about framing a narrative that can influence Justice Anthony Kennedy, as he will clearly be the swing vote if and when the CPP reaches the Supreme Court.

Opponents of the rule will file to have it stayed, though the arguments for a stay may be undermined by the long timelines under the rule. It may be hard to make the case that huge expenditures will have to be made during the pendency of litigation.

The issue of the EPA regulating 'beyond the fence line' will also be challenged. The 'beyond the fence line' approach, however, is

1 Finalized in August 2015, shortly after the 2015 Energy Policy Forum concluded.

not particularly novel, especially in the context of the power sector. Typical power plants do not operate like monasteries, but rather are inherently connected to and dependent on other resources in the system, so it is not illogical for the EPA to set a standard that allows those resources to participate in the compliance determination. The EPA will have to demonstrate that compliance instruments will exist in a functioning market at reasonable costs and in adequate quantities to allow affected facilities to comply – which is basically what the agency had to do with sulfur dioxide in the 1970s. A systems approach makes sense for the electric power sector; if an agency in the future tries to apply the approach to another sector in a manner that produces unreasonable results, the courts have ample power to strike that down.

Another issue that will inevitably be litigated is whether the EPA can regulate carbon dioxide from power plants under section 111 of the Clean Air Act at all, since power plants are already regulated for other pollutants (e.g., mercury) under section 112. In the 1990 amendments to the Act two versions of section 111(d) were signed into law; the Senate version clearly allows the agency to regulate in this circumstance (as it talks about pollutants not yet regulated elsewhere), whereas the House version is more awkwardly drafted and may be ambiguous (as it talks about sources not yet regulated elsewhere). Under *Chevron* deference, one could argue that the agency's interpretation should apply, though it is possible that this may be less a question of ambiguity and more one of pure statutory interpretation.[2] Even if *Chevron* deference is not applied, which is the path the Supreme Court has taken on a couple of recent cases (particularly where there are big economic and societally systemic impacts), the EPA's interpretation of 111(d) implements the Clean Air Act's statutory purpose; section 111(d) was designed to fill gaps to ensure that harmful pollution not regulated other under standards gets regulated. Some wonder whether the EPA will ask for a vacatur of the mercury rule, which was issued under 112 and

2 Chevron U.S.A., Inc. v. Natural Resources Defense Council, Inc., 467 U.S. 837 (1984) - a landmark Supreme Court case that set forth the legal test for determining whether to grant deference to a government agency's interpretation of a statute it administers.

returned to the D.C. Circuit by the Supreme Court; the agency has already gotten 80-90% of the benefit of the mercury rule, and vacating it would eliminate the 111 versus 112 issue because the source category would no longer be regulated under 112. The EPA could then come back to mercury after the CPP is litigated, jump through the hoop the Supreme Court set out about considering costs up front, and regulate mercury and air toxics more strictly the next time. Others, however, think that extremely unlikely.

Another subject of litigation could be the section 111(b) rule for new power plants, for which the issue of whether carbon capture and sequestration has been "adequately demonstrated" will be brought to the fore. If the 111(b) rule falls, the 111(d) rule falls with it (as the Clean Air Act requires new sources to be regulated before existing sources).

While the litigation strategies will be plentiful and the courts will end up being the final word in the absence of Congressional action, most people seem to agree that the judiciary is absolutely the worst location to be developing U.S. energy and environmental policy.

The CPP faces other challenges besides litigation. Congress will enact riders and might pursue a Congressional Review Act resolution as well, but those will assuredly get vetoed, as the Obama Administration views the climate regulations as a central part of the President's legacy. After the 2016 presidential elections, things are less certain. If a Democrat wins, the CPP will clearly continue. If a Republican wins, the CPP's prospects are not as good, but it is not a certainty that it will get pulled back; there will be many discussions in the lead-up to the election attempting to highlight the economic, health, and other benefits that the CPP could deliver while positioning the country for a low-carbon future.

There are probably better, cheaper, more efficient ways to decarbonize the power sector than the CPP – in theory. An explicit, transparent price on carbon would be one approach, especially if the revenues are used wisely, but there is no way a national carbon tax will happen during the Obama Administration (which might be good for the idea to eventually get Republican votes or even be a Republican proposal, perhaps as part of comprehensive tax reform). Still, there is more willingness to consider and be informed about carbon pricing in many places in the United States than there is on Capitol Hill.

States

The CPP will be implemented by the states. While a few governors have filed lawsuits against the rule and have declared that they will not submit a compliance plan to the EPA, most states have started planning how to comply with the rule rather than having a federal plan imposed upon them. Even many states that are particularly averse to mandates and federal oversight are having internal discussions about possible compliance options if the CPP is upheld. In many states, air and energy regulators have been talking to each other and working together to understand the CPP and figure out their compliance options under the rule. There have also been meetings and conferences on the CPP by the National Association of Regulatory Utility Commissioners (NARUC) and the Federal Energy Regulatory Commission (FERC), as well as educational outreach by non-profit groups and robust state collaborative efforts in various regions of the country. It is possible that in doing the planning, some states may discover that their CPP targets can be rather easily met, as the CPP is following the direction that the industry and many states are already moving.

Even many states that are particularly averse to mandates and federal oversight are having internal discussions about possible compliance options if the Clean Power Plan is upheld.

Some stakeholders have concerns about how to implement the CPP in a way that is consistent with economic dispatch. Utility assets are operated as a fleet across multiple states. States that respect economic dispatch may want to pursue a mass-based multi-state approach, as it makes sense to follow the boundaries of the electricity system. A straightforward way states can meet targets without interfering with dispatch decisions would be to apply emission limits to affected electric generation units and to use credits to cover the delta between actual emissions and those limits. Every hour or ton over the limit is a cost to factor into dispatch decisions. Such an approach would not require states to agree on a uniform plan – just to have policies that recognize credits from other states and set rules on things like double counting. This could be part of a 'common elements' approach that facilitates interstate trading.

States may also struggle with devising compliance plans under the CPP that avoid creating lost or stranded assets. States may need to consider the effects on assets of picking a rate-based approach versus a mass-based approach; for example, states pursuing rate-based models could lose an existing nuclear reactor and still be in compliance, whereas that would not happen under a mass-based approach, which is something for states that want to keep their existing nuclear fleet to consider. There is also a risk that investments approved by regulators for expensive scrubbing or other technologies on bigger, newer fossil-fueled facilities (largely in response to other EPA rules) may become stranded due to the CPP.

In designing compliance plans under the CPP, states should be mindful that the CPP's emission reduction goals (and commitments made by other countries) are insufficient to meet global climate targets as laid out by the Intergovernmental Panel on Climate Change. The need for even greater reductions at some point might counsel for the adoption of compliance strategies that are scalable and can be ramped up. Natural gas, for instance, hits a stopping point with regard to climate unless carbon capture and sequestration becomes viable. States may want to adopt strategies that minimize the need to undo or dismantle anything to move further.

Industry

The actual compliance obligations under the CPP will fall largely on utilities and other owners of fossil-fueled electric generating units. While some feel the CPP represents federal overreach, the industry has to be risk averse and so must be prepared for the CPP to come into force (at least in some form). The industry is already in the process of decarbonizing, even in coal-heavy states, partly due to low natural gas prices, as well as customer desires for cleaner resources, lower bills, and innovative technologies. Utilities are slashing their coal use, vastly increasing their use of natural gas, increasing energy efficiency efforts, approving biomass facilities, and investing in utility-scale renewables. Customers are also excited about distributed generation, battery storage, and demand response options that did not used to exist in the utility world. Some utility Integrated Resource Plans (IRPs) now include proxy carbon prices.

Utilities are trying to be practical about solutions that ensure a diverse portfolio and that do not rely too heavily on gas. Some utilities may meet the CPP targets by retiring coal units years ahead of schedule and continuing to redirect capital to gas, renewables, and comprehensive energy efficiency and demand response programs. It should be noted, though, that depreciating an asset over less time costs more, and in the co-op world, where everything is debt-financed, retiring an asset early means not paying a lender. The CPP, with its long timeframes, will likely be an opportunity for the industry to engage collaboratively with policymakers to develop policies that address the practical implications of the transformation to achieve the 2030 goals, including investment concerns.

International

Within the international landscape, a great deal of attention has been focused on the 21st Conference of the Parties (COP 21), to be held in Paris in late 2015. Most of what matters in terms of specific reductions coming out of a Paris agreement has already been determined (or will be before Paris) in the form of countries'

Intended Nationally Determined Contributions (INDCs). Countries are essentially pre-negotiating their commitments. Unlike the COP in Copenhagen in 2009, which was seeking to negotiate top-down targets, there is no expectation that countries will negotiate over numbers in Paris. Paris itself will focus instead on such matters as the rules for transparency, verification, reporting, and financing. The Paris agreement may also be structured in a way to allow country commitments to be updated in the future without renegotiating the entire accord.

While action on climate change is primarily about domestic policy and politics, international efforts can exert influence on the margins and can influence policymaking.

While action on climate change is primarily about domestic policy and politics, international efforts can exert influence on the margins and can influence policymaking. The Clean Power Plan represents a fairly large part of the international greenhouse gas reduction commitments made by the United States in its INDC, and those commitments are an essential backdrop to the Obama Administration's support for a strong CPP. Similarly, in some developing countries, it is possible that climate commitments leading up to COP 21 (or the next round of commitments) could swing the needle away from new coal and towards gas and renewables.

In the United States, the headlines coming out of Paris will probably matter more than the substance of the agreement, as those headlines can influence domestic politics. If Paris is seen as a success, it will indicate that China and India are taking action too; if it is seen as a failure, it will reinforce the perception of some policymakers that the United States would be taking unilateral action. Policymakers, advocates, and opponents will not be making claims about climate policy based on a careful, nuanced reading of the Paris agreement, but rather on preconceived ideologies and the public perception of how Paris went.

COP 21 is providing impetus to national actions and collaborations among countries, and those national, bilateral, and regional efforts matter more than COP 21 itself. The international perception that the United States is serious on climate change, driven in part by the CPP, is enhancing the country's credibility and is having international influence. Other countries now want to be seen as acting with the United States on climate issues. There is good anecdotal evidence that Mexico, in coming forward with its INDC, really valued the prospect of the President of the United States saying Mexico was doing a good job on climate change. In addition, the Xi-Obama climate commitments agreement in November 2014 will help ensure that China takes strong action on climate change; there is a lot in the U.S.-China bilateral relationship that the two sides do not agree on, but energy and increasingly climate change are positive areas where they can collaborate to solve shared challenges.

TECHNOLOGY AND CUSTOMERS AT THE CENTER OF EVERYTHING

Companies in the technology space are increasingly trying to get into the game of providing comfort and other things customers desire, and these companies could be either competitors or partners for utilities. Utilities, in turn, are at the early stages of redefining their relationship with consumers, and some are beginning to behave as if they actually need to win their customers.

Technologists Challenging Incumbents

At various times over the past couple of decades, there have been customer-focused product designs and innovations – such as iPods and other Apple devices – that have broken through and spurred massive, rapid transformations in sectors. The lessons from these transformations could be applicable to disruptors in the energy business today.

Many of these innovations were entirely focused at the outset on customer experience. Every detail – from the way a cord connected with the product to the sights, sensations, and smells of opening the box – was designed with the customer experience in mind. The focus on customers, though, does not necessarily mean giving them what they say they want. Customers do not know what will shift their behavior; they would not have been able to explain in advance what all the uses and values of iPads would be, for instance. Innovators have to meet customers on the journey to where they are going, not necessarily where they are now.

Because of the customer focus, these innovations and product concepts broke through despite massive skepticism and market adversities. Critics at the time compared the technologies against old business models, but no disruptive technology can succeed when compared against the norm of prevailing business structures. The iPod, for example, succeeded not just because it was a beautiful device, but because it was married to the iTunes platform, and for the first time, people could buy 99 cent individual tracks instead of committing to a $15 CD. These products changed the value and services provided to consumers and created new business models. Those in the energy business should look for technology solutions and business models that put the customer experience first.

Innovators have to meet customers on the journey to where they are going, not necessarily where they are now.

These innovations also generally involved tremendous speed to market, moving from the concept stage to market deliverables in the space of about 12 months. As these products continued post-launch, the innovation cycles grew tighter and shorter, with software innovations occurring on one-month cadences. This is a completely different cadence than in the energy world, which looks years and decades out, and it is something the electricity sector will have to grapple with as disruptive technologies continue to advance. The energy and technology worlds are tectonic plates that are moving at different speeds but that have a direct relationship with each other in terms of market transformation and customer behavior.

In the energy world, technology, policy, and markets are generally thought of as the three key legs of the energy stool, but technology is currently ruling the day. Technologists are the new entrants in the energy space, and some of them have the balance sheet capacity to be more patient and to outlast others in the market. They also have different risk appetites, horizons, and capacities to penetrate markets than other actors. The technologists are not well attuned to energy policy but are very market savvy, and so they try to minimize the role of policy in what they do; instead, they lead with energy consumers, thinking of them as a source of demand pull and market creation. Technology and the focus on user experience are increasingly eroding the incumbent business model, raising the question of how fast the core will shrink and whether that model can react with sufficient agility to the new forces being unleashed. Things seen as peripheral are rapidly moving to the center and scaling. The trends are real and inevitable, and the rate of acceleration is increasing. This means entities in the energy world now have to be prepared to act and lead, using their market positions and customer contacts to proactively engineer and devise a new system.

Technologists Partnering with Incumbents

Some product innovators are starting to partner with forward-thinking regulated utilities to give utility customers access to highly discounted products and to offer customers through those products both new energy services (e.g., incentives for participation in demand response programs) and services beyond energy (e.g., home security). Having the gravitas and longevity of utility brands behind a technology platform, as well as heavy discounts, is a very different proposition to get customers into new technologies. Through such partnerships, utilities can diversify their business, build new revenue streams, and engage their customers more regularly and more positively. The average person spends only nine minutes a year thinking about their electricity provider, and those are often negative, but through partnerships with innovators, utilities can interact with customers several times a week (e.g., through a utility's smartphone app) and offer new programs and services every few months. For product innovators, such partnerships can greatly increase the number of households adopting their product, as well as broaden the base of technology adopters to include lower income levels.

Innovative ideas are fragile at the outset and can be squashed by any number of traditional regulatory constraints. To enable partnerships to flourish, regulators should create space instead of plans and rules, allowing innovators to come up with business models that can deliver new revenue streams as well as better customer choice, protection against increases in energy rates, and a host of other objectives. Regulators should also promote open information, where practicable, to foster partnerships and innovation; for instance, data from smart meters made available to customers and whoever else they want to designate can enable innovation to meet customer needs, while sharing of utility operations data could similarly facilitate innovations such as heat maps that could let others see problems and identify solutions. Innovators are out there and are hungry to be partners with all kinds of energy businesses. If the conditions are right, transformations can be delivered.

Customer Desires, Usage, & Segmentation

The needs, desires, and characteristics of utilities' customers are changing. Consumers are far more environmentally concerned and aware, more vocal, and more tech-savvy. Some of them like to be in control, to have choices, and to be more self-reliant, while for others electricity is a low-engagement product (i.e., they only notice when it is not there). Customers increasingly expect personalized service and convenience and have little tolerance for reliability issues.

Utilities are often criticized for thinking of electricity users as a single ratepayer class instead of as customers, but this is not entirely true anymore. Many utilities, regulated and (especially) deregulated, have bought segmentation analyses, but many of these are not being used well. When marketing new products and services though, segmented behavioral data is essential. Demand response programs offer an interesting lens on consumer desires and behavior.

Smart meter data from three continents and dozens of states reveals that residential customers' energy usage comes in five basic shapes: people who use the same amount of electricity throughout the day, evening peakers, late-night peakers, daytime peakers, and people with both morning and evening peaks. Understanding which people tend to use energy at which times can help utilities provide more targeted demand response messages (and, potentially, differentiated rate designs). For instance, targeting people whose use stays pretty constant throughout the day would make little sense for a demand response program, whereas evening peakers could be a rich target. Communicating with targeted customers about an upcoming peak event and following up with communications afterwards about the degree of savings can be highly effective, producing reductions in peak of around 5-7%. Even without a financial incentive, better communications and thank-you follow-ups can get 3-5% reductions in peak.

Customers respond to these kinds of messages for a range of reasons. Some may be motivated by money, others by a sense of contributing to the climate fight. However, those may just be rationalizations. When people are shown how their energy usage compares to their neighbors, or when people make commitments to take action, they actually take action. People have a natural instinct to do what others around them are doing. When it comes to products, people often buy them because they are better in terms of design, experience, and/or reliability; if they happen to save money and energy and be good for the environment, that is a bonus.

Utilities Providing Consumer Services

Utilities generally think in terms of programs – lighting programs, air conditioner programs, thermostat programs, etc. Utilities have historically kept their various teams and programs siloed, have offered customers programs individually instead of as a suite, and have put little to no effort into finding out what customers care about. Utilities have to get outside the paradigm of programs and move from a focus on energy usage to a focus on energy uses. Utilities must start thinking about offering more holistic suites of services to customers or risk falling behind. There are a variety of products and services customers might need that a utility or other provider could offer as an integrated demand-side portfolio. Consumers with different load shapes represent different value propositions.

The revenue model will vary market to market, but there are clear precedents in co-ops, deregulated markets, and other industries for selling a diversified set of services to customers. In the telecom sector, for instance, service ideas developed in the 1980s are still cash cows for companies, such as call waiting and voicemail. Utilities could offer services such as setting thermostats not for temperature levels but for a set bill amount, which can help customers with bills and provide utilities with a high margin opportunity. Some utilities are testing mobile apps that provide real-time usage information to customers with smart meters, drilling down to the appliance level. Already, there are partnerships among utilities, solar companies, energy management companies, and others to offer holistic solutions. Over time, as homes become more like little microgrids that combine generation, storage, use, and automation, utilities will be well-positioned to offer the service of managing that.

Utilities must start thinking about offering more holistic suites of services to customers or risk falling behind.

Utilities are also well-positioned to serve as trusted energy advisors for their customers, educating customers about technologies, costs, installers, and the like. Utilities have 100+ year relationships with customers, and liked or disliked, one should not underestimate the trust they have of their customers. Some utilities are already pursuing massive education campaigns for customers (often with unregulated affiliates that can do the actual installations). That education in itself could be a source of revenue for utilities, providing customer acquisition services for third-party providers. Given the trust, if utilities could sell services behind the meter, they would easily make money from that.

For utilities to get there, regulatory space needs to be created to enable utilities to do customization for customers, which is a challenge; most regulators are still thinking about traditional markets, not markets for services, technology products, or other kinds of markets. In addition, some regulators view utilities not as trusted advisors but rather as combatants. Some requests for recovery of costs to hire special energy advisors to pursue these kinds of customer service opportunities have been disallowed because of a view that it is unacceptable for regulated monopoly utilities to make money selling services to customers.

There will be paths through the current regulatory malaise. Utilities have unparalleled reach to consumers, and if utilities build stronger relationships with their customers, those customers could demand that utilities be allowed to compete to provide services. In addition, revisions are needed in ratemaking to include time-of-use rates and to find a way to reward utilities for taking action to integrate demand-side resources; that may involve getting away from ratemaking and coming up with another way to price services (e.g., fixed prices for services). More thought is also needed on how these services and rates could be applied to customer classes besides residential.

THE ENERGY SYSTEM OF THE FUTURE

The only thing certain about the energy system of the future is that it will be in the future. Utilities need to make practical investment decisions to navigate from the grid as it is today to whatever the future looks like, but predictions of the future, as noted, tend to be off-base. There are, however, some drivers, obstacles, and opportunities that seem relatively clear.

Visions of the Electricity Future

While the precise contours and characteristics of the electricity future are unknown, the trends and forces to which the system will need to respond (and is already responding) are not. Those include changing environmental regulations, aging infrastructure, flat demand, changing demand peaks, flat or declining commodity prices, declining costs of clean (and especially distributed) generation, the proliferation of IT and smarter devices, and changing customer expectations. The goals for the future energy system include that it be clean, lean (i.e., reduced energy intensity), reliable, safe, resilient, customizable for customers, affordable, fair, and flexible. Getting to a new energy future will involve grappling with questions such as who has to pay for the changes, who gets to make money off the changes, how to ensure continued investment in the system, and how to preserve universal service.

There is a continuum from the status quo to the future. Incremental changes will achieve only so much progress, though there are some in the sector that feel that the structures that exist today are, in many ways, sufficient and that incremental changes will be all that are needed to achieve affordable, reliable, clean power. For many, however, there is a big wall on that continuum located between the progress that can be achieved with incremental changes and the ultimate end goal. Some may not even know what the end of the continuum looks like; they do not know what is on the other side of the wall, which makes it really hard to get there. Their vision of the future, though, clearly involves paradigm shifts and a wide range of strategic, operational, technological, commercial, environmental, and regulatory changes that are transforming the traditional utility model for energy provision.

A Resilient, Distributed Energy Ecosystem

One vision of the electricity future involves a move from a centralized to decentralized (but not disconnected) model, with increased resilience and with distributed energy resources pushing the center of gravity downstream. Ever since passage of the Public Utility Regulatory Policies Act (PURPA) in 1978, there have been assertions that we are on the brink of not needing central station generation because of new technologies, but people kept pushing out when the future starts. With rooftop solar breaking into the price point it has and with the rise of a range of other DER technologies (e.g., microgrids, demand response), it is possible that the tipping point that has been talked about for so long is actually here. Anyone can now click and buy a Nest thermostat or a solar home generation system, eroding the utility base.

The installed cost of solar has plummeted, for residential and commercial PV and for utility-scale. Residential and commercial PV will drop below $3/watt and $2/watt respectively by 2020, which is staggering, and U.S. solar capacity will rise to a conservative estimate of 65,000 MW by then. In Texas, there is already a merchant solar plant selling into ERCOT, and price points in Austin have gone from

$160/MWh in 2008 to $40/MWh in June 2015 and could go down to $20/MWh by 2020. That is the reality of solar right now.

Storage will have similar price reduction curves, especially lithium-ion and flow batteries. Lithium-ion will go from around $550/kWh in 2014 to below $200 in 2020, and the installed base of storage by 2024 will be above 6,000 MW (60% central, 40% distributed). Storage is not yet financially viable, but it will be soon. Storage could be a game changer, with $6 billion or more in investments by 2020.

Tipping points have arrived, and wherever entities are within the energy system, they have to make critical choices.

DER has likely passed the tipping point needed to spur a real industry transformation. In 2018 (and perhaps 2017), distributed generation new build will be larger than centralized generation new build. Regulatory discussions in California and New York are breaking new ground in creating markets for the industry, while policies in the Northeast in response to weather-related outages are having a strong impact on the acceleration of DER (e.g., microgrids). There are more intelligent devices in homes, and home automation may become common in the not-too-distant future. The speed of change will only accelerate.

The entire set of DER pieces is available, and what is not economical now will become economical in a few years. No single technology is a solution; there is a need to think about a broader suite of technologies. Companies – and really all industrials with a high load, as well as many residential customers – are looking for the right set of on-site power solutions, including solar and battery storage, as well as load reduction efforts such as using LEDs, all integrated into a holistic solution. The potential is enormous, and regulations, rates, and business models will have to evolve.

The physical grid will have to be modernized and refurbished to be more resilient and to integrate DER. This effort will include both basic refurbishment (e.g., cable replacement) and things like sensors, smart meters, smart substations, and distribution automation. A DER ecosystem model will have two-way energy flows, plug-and-play capability for intelligent devices, and autonomic computing capabilities to enable the grid to self-heal and self-correct. The need for resilience also suggests greater use of microgrids, as well as exploration of ways to connect them together to enable dispatch across microgrids. Similarly, deploying storage for multiple customers could help them ride through outages. Utility-scale solar will also be an important part of the broader portfolio, as will community solar.

Tipping points have arrived, and wherever entities are within the energy system, they have to make critical choices. The change is occurring at a rate and scale that no one controls, but entities want to be on the winning side of the transformation. Those in the energy world have to be prepared to be surprised, to be amazed, and to act, lead, and adapt or else be left behind.

Reinventing Regulation

The current regulatory model for utilities was designed to electrify America, with big central station generation providing service in an undifferentiated way to every customer. A new model must be developed that will incorporate new DER technologies and will work for customers, investors, and other stakeholders.

The energy system of the future will see greater convergence between different parts of the market – between energy policy and environmental policy, energy networks and other networks (e.g., communications, water), electricity and gas, and state-regulated distributed resources and central station wholesale and interstate resources (which are increasingly substitutable for each other but regulated in different ways). With all that convergence, the electricity system of the future will be challenged by an extremely disaggregated suite of players that regulate pieces of the system, including regulators at the state and federal levels, agencies, public power utilities, independent system operators (ISOs), and regional transmission organizations (RTOs). The system could not possibly be any more complicated. There is a choreographed dance among those with authority, but the pieces are increasingly in friction and tension with each other.

There is a growing tension, for instance, between trends pulling energy technology and decision-making to a state level and trends pulling things up more regionally, nationally, and globally. Aggregating the range of technologies on the customer side (e.g., rooftop solar, demand side resources, batteries) can perform some of the same capabilities of central station generation, and these technologies are mostly regulated at the state level. On the other hand, electricity planning and thinking is increasingly regional. The need for a strong transmission grid to support the integration of location-constrained renewables, such as utility-scale wind and solar, is a regional regulatory concern, and as more of the fossil fleet retires, more transmission will be needed to balance the system in a different way. The Clean Power Plan may also spur more regional carbon markets, though issues such as climate change also bring the scale up to the national and global levels.

Geeky regulatory doctrines will have a lot to say about how the technologies that will underlie the future electricity system are enabled and paid for. The Supreme Court will be looking at whether federal regulators of wholesale markets have jurisdiction over the aggregation of things on the customer side of the meter; if they do not, it will change the way distributed solar, storage, and other DER technologies are regulated. National energy regulators will also have to decide how community solar and other burgeoning areas get paid (e.g., whether they are distribution or wholesale). State regulators (and, in some places, legislators) will continue struggling to find the right rate designs, incentives, and policies to support rooftop solar market growth while sustainably supporting the grid, and behind-the-meter batteries will raise their own suite of rate design issues.

The primary role of regulators in facilitating the energy system of the future should be to remove barriers to entry. There is more competition on the generation side and the demand side, and the regulatory model has to adjust to acknowledge the competition. Regulation is primarily needed where there is a monopoly, and that area is shrinking (and shrinking quickly on the generation side). Regulators have to be agile to the new set of consumer-driven technologies and allow them to have beneficial societal impacts without getting in the way. Getting out of the way, however, does not mean that regulators should abstain from acting. Policymakers and regulators have to facilitate the transition, give customers choices, and make tough decisions about the roles of various players – especially the distribution utility – going forward. Regulators have to allow investment to be certain, safe, and encouraged, allow entities involved to earn a living, and allow more entry into the market.

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Getting the roles and platforms established can level the playing field and allow the new "barbarians at the gate" to come in and compete. Emerging technologies argue that they are blocked out of the market, that monopoly utilities should not be allowed to create barriers to entry, and that those utilities also should not be allowed to compete (because of brands, low-cost capital, captured customers, etc.). Utilities, on the other hand, argue that their revenues are declining and they have to expand their services, not contract them; they are seeking some flexibility to address changes in a way that still provides a sufficient return to attract the capital needed to make investments. There may be a point at which emerging technologies have advanced so far that they no longer need to worry about the upper hand that utilities often have, but until that point has been reached, regulators may need to do more to define the basic, core service to protect as well as the more flexible service offerings that can occur in a competitive environment. In other words, regulators may need to tease out the differences between utilities, parent corporations, and affiliates, ensure the utilities themselves can attract the needed low-cost capital to support the broader shared system that has to stay stable, and open everything else up to competition (including potentially allowing affiliates to compete).

Pending a new paradigm, utilities acting as facilitators, gateways, and implementers of new technologies need a way to recover costs, and putting new assets into the rate base will likely be the practical reality. In establishing the playing field for the electricity future, though, regulators should be very cautious about putting a lot of new costs on the backs of ratepayers going forward. Consideration must be given to whether relying on utility investment for the energy transformation means the risks of developing expensive new technologies are being shifted to those least able to afford them. Regulations and policies have to ensure equity and fairness in the distribution of costs and benefits going forward, particularly as debates in regulatory proceedings begin to shift from shareholders versus consumers to one group of consumers versus another. Many solutions could come to market that leave low-income populations behind, and that is an area in which regulators must continue to be vigilant. Some states have already discarded the century-old concept of treating all customers the same and have created rate designs to assist low-income customers. There has also been a lot of creativity from co-ops to help low-income customers, including prepaid metering, on-bill financing, and potential community solar tariffs.

Regulators are in a tough spot, though, having to deal with consumer demands, rapid technological innovation, antiquated laws, and tremendous changes in environmental policy and fuel prices. Many could use additional education or training, as some are not even regulating right under utility 1.0, much less under 2.0 or beyond. Regulators are also generally inadequately resourced; even as the issues are getting more complex, many states are cutting budgets.

Technology is progressing so rapidly that policymakers may not be able to respond quickly enough; speed is an issue for regulators. Federal and state regulators have important roles in furthering research, helping to establish the rules of the road, and cultivating markets, but everything else is evolving at far too fast a rate for them to keep up. Given the rapid pace of technological change, consideration should be given to shortening the planning cycle horizon to allow newer technologies to be factored into planning (though a challenge with a shortened planning horizon is that the investment recovery period has generally lined up with a longer-term window). Similarly, because the regulatory process moves so slowly, consideration should be given to flipping the order of things; instead of taking months and months to think about whether a utility should deploy a new technology or provide a new service, a utility could be allowed to form a limited hypothesis about what to expect, go out and do it, and then come in for the long proceeding, during which everyone can weigh in based on the actual data from the initiative instead of speculation. In addition, rate design is not evolving as fast as the cost structures for renewables and storage are coming down; rate design may need to be more dynamic to allow for reducing subsidies in tandem with costs.

New York and California are in the midst of proceedings that will define the roles and responsibilities of regulated utilities. Hawaii and Massachusetts are exploring these questions as well, and good discussions are occurring in different parts of the United States. Emerging models include the utility as the distribution system operator (DSO), third parties as the DSO, and utilities as value-added service providers (e.g., home energy services, rooftop solar, EV charging stations). For the most part, though, energy regulators are not driving the market. Environmental regulators and policymakers, on the other hand, are, at least in some regards. Technologies that are cool and make people's lives easier may or may not be compatible with goals such as reducing environmental externalities, transitioning to a low-carbon economy, and addressing intergenerational equity, and policy has a pivotal role in furthering those aims.

Utility of the Future

The strong legislative and regulatory pushes in places such as California and New York are not happening everywhere. In other states, utilities and their stakeholders are the ones driving policy and action, trying to create spaces to try new things and be more nimble around some of the new disrupting technologies. The seemingly inevitable wave of new technologies means new business paradigms in which utilities can survive, thrive, thrive robustly, or disappear.

Utilities that do not push themselves to higher-level thinking could become the next Kodak, dominant right up until they are not.

As noted earlier, utilities are already pursuing some efforts to provide greater services to their customers centered on new technologies, such as creating platforms and programs to connect third-party devices and services with consumers, acting as a virtual marketplace. Some are also experimenting with new models and incentives to capture the rooftop solar opportunity. An Arizona utility, for instance, is keeping ownership of the rooftop systems, deciding which customers to target to get the best system benefits, and giving customers a monthly lease payment for use of their roofs, which can be particularly beneficial for low-income customers.

In addition, some utilities are exploring ways to take advantage of new technologies and digital networks to support municipalities. Some, for instance, are promoting technologies such as smart street lights, which are LED lights that have a control node connected to a digital network, through which municipalities can dim them to reduce usage, brighten them for an event in the community, or make them flash if there is an emergency in a location. Some utilities are also creating municipal portals that let municipalities pull up a map, understand the causes and status of outages, and prioritize restoration of key facilities with the utilities.

The core role that many seem to envision for utilities in a future electricity system is that of facilitator, aggregator, and network manager (assuming regulatory models can adjust to enable utilities to get paid for that role). Across industries that have grappled with evolving business models and emerging technologies, there are four basic business models: asset builders, service providers, technology creators,

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and network orchestrators. Companies can play multiple roles, but network orchestrators, which create networks of peers who interact and share in the value creation, are the ones leading the way. In the energy world, some utilities are beginning to try to play that role, and for the foreseeable future, at least, it will likely take a regulated monopoly utility to manage and balance a network that can smoothly integrate increasing amounts of renewables, energy efficiency, and DER. Utilities can bring distributed renewables and demand-side programs into the IRP process to determine how much baseload curtailment and peak load curtailment are possible and can analyze the hosting capacity for feeders to assess how much distributed generation they can take on. In addition, utilities may have a particular role in promoting microgrids for public critical infrastructure (e.g., water pumping stations, hospital campuses, emergency response centers).

The big changes in fuel mix, technologies, and the grid will create complexity for utilities trying to make it all work. In addition to impacting utility strategies and business models, they will also have huge impacts on utility operations, organization, and culture. Different disciplines and skill sets will be needed to manage the new technologies and systems. For instance, there will be a lot of monitoring and controlling systems needed, as well as basic needs like more contract negotiators. Data analytics will also be a critical source of value in the electricity sector and will represent another aspect of capacity that utilities will either need to gain or contract for.

Similarly, utilities and most other organizations in the sector lack core expertise in security management, but with the grid moving to a more highly interconnected, dynamic system, it will become that much more important – and more difficult – to protect against cyberattacks. The entire computing industry needs to figure out how to better protect the internet and all the assets on it, as it has become clear recently that it can be broken into easily, but unlike the average "hack" that accesses personal information, the biggest threats to the electricity system are serious attacks on critical infrastructure. Cybersecurity will require more real-time, predictive, analytic, event correlation systems that can monitor for patterns and take immediate evasive action.

APPENDICES

AGENDA

Thursday, July 16

8:30 – Noon **SESSION I: *OVERVIEW*: TRENDS IN ENERGY MARKETS – SHORT TERM DEMANDS AND LONG TERM SIGNALS**

Energy markets have long been a relatively stable world defined by long-term fuel contracts, centralized generation, cost of service charges, the regulatory compact, and long-term capital-intensive infrastructure. This is changing as we enter a new but far less certain world where energy prices – including electricity – are closely tied to market forces; a world where old pricing signals likely do not apply and larger geopolitical factors matter more. How are these challenges affecting the choices that market participants are making today?

Moderator: **Sue Tierney**

Discussant Topics:

New Global Pricing Realities and Effects on Domestic Energy	**Jason Bordoff**, Founding Director, Center on Global Energy Policy, Columbia University
The BRIC Influence	**Trevor Houser**, Partner, The Rhodium Group
Domestic Energy Trends, Challenges and Changing Customer Expectations	**Lynn Good**, President and CEO, Duke Energy
Investment and Market Implications	**Julien Dumoulin-Smith,** Executive Director, U.S. Electric Utilities and IPPs Group, UBS Investment Research

1:30 – 4:30 PM SESSION II – *PATHWAYS TO CHANGE:* CARBON CONUNDRUM

Market signals are important but other equally important drivers of change need to be considered as well. The EPA's proposed carbon pollution rule for existing fossil-fueled power plants – also known as the Clean Power Plan – is one such driver. The final rule will have to account for the numerous crosscurrents in the states, and within the energy industry, affecting existing facilities and future fuel choices. The rule is also the centerpiece of President Obama's climate action plan and seen as crucial to creating the political conditions needed for an ambitious agreement at COP21 in Paris, December 2015. Where does the EPA rule stand? How are regulators in states and across regions complying, or not? What role are decisions by cities and municipalities regarding land use, building practices, and transportation playing? How are generators and suppliers of electricity responding? How will all this affect consumers? What are the international implications?

***Moderator:* Clint Vince**

Clean Power Plan - Update	**David Hawkins**, Director, Climate Programs, NRDC
International Implications	**Michael Levi**, Senior Fellow, Energy and Environment, Council on Foreign Relations
State Regulatory Response	**Jim Gardner**, Vice Chairman, Kentucky Public Service Commission
Utility Response	**Kim Greene**, EVP and COO, Southern Company
Local Government Role	**Cris Eugster**, Group EVP and Chief Generation & Strategy Officer, CPS Energy

Friday, July 17

9:00 – NOON SESSION III – *PATHWAYS TO CHANGE:* THE FUTURE OF THE ELECTRIC MIX

Driven largely by both price and policy, gas-fired generation has dominated the new power generation capacity built since the 1990's and is continuing to gain market share – displacing coal. Is the central role of natural gas in the US power system of the 21st century a near certainty? If so, how can fuel switching from coal-fired generation to gas-fired work with the increasing demand for renewables? Is there evidence of other possible synergies between natural gas and renewables over the near- and long-term? Is there a viable long-term role for nuclear? What infrastructure enhancements are necessary to further encourage de-carbonization?

Moderator: **Clint Vince**

Overview: Maximizing the Synergies	**Michael Webber,** Deputy Director, Energy Institute, UT Austin
The Complimentary Nature of Natural Gas & Renewables	**Matt Guyette,** Chief Strategy & Marketing Officer, GE Power & Water
The Role for Nuclear	**Bill Mohl,** President, Entergy Wholesale Commodities
Infrastructure Challenges	**Stuart Hemphill**, SVP, Power Supply and Operational Services, Southern California Edison

1:30 – 4:30 PM SESSION IV – *PATHWAYS TO CHANGE:* NEW TECHNOLOGIES, MORE INTELLIGENT SYSTEMS AND CYBER RISKS

The energy system of tomorrow will look very different from the system of today. What new technologies are enabling this change? Are consumers and power providers embracing new and "game changing" technologies? Why or why not? Power systems can increasingly engage with power consumers via intelligent electronic devices including sensors, data and communications technologies. What is required for the grid of the future? Can better use of this new technology and data reduce utilities' investment costs, such as through better asset utilization and increased use of demand response and energy efficiency? Is declining demand reducing the need for additional transmission? Are longstanding concerns related to privacy and customer data valid? Are there international markets that serve as compelling test cases for utilities to increase their comfort with adopting new technologies?

Moderator: **Sue Tierney**

The 51st State: Visions for Our Electricity Future	**Julia Hamm,** President and CEO, Solar Electric Power Association

Designing Regulated Business Models of the Future	**Andy Baynes,** Director, Business Development and Energy Efficiency, Nest Labs
Designing a New Utility/ Customer Relationship	**Alex Laskey,** President and Founder, OPower
Accelerating Technology Deployment	**Cheryl Roberto,** Associate Vice President, Clean Energy, EDF
Electricity Industry Cyber-Security Challenges	**Martin Milani,** General Manager, Software and CTO, Nexant, Inc.

Saturday, July 18

8:30 – NOON SESSION V –THE ENERGY SYSYEM OF THE FUTURE

What will the energy system of the future look like? With the challenges of a changing customer base, stagnant over-all electricity use, and declining profits, how will ongoing costs of reliability, transmission, and distribution services continue to be recovered? How will incumbent energy companies manage the changes needed to overcome archaic business models that no longer apply? Are new business models needed to deal with current markets realities?

Moderator: **Roger Ballentine,** President, Green Strategies

The Energy System of the Future	**Andy Karsner,** Executive Chairman, Manifest Energy
Distributed Energy Resources: Lead or Follow	**Jan Vrins,** Leader, Global Energy Practice, Navigant Consulting, Inc.
The Utility of the Future	**Anne Pramaggiore,** President and CEO, ComEd
Reinventing Regulation	**Cheryl LaFleur,** Commissioner, FERC

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