Rethinking Policy to Deliver a Clean Energy Future

America's electricity system is in the early days of a radical makeover that will drastically reduce greenhouse gas emissions, increase system flexibility, incorporate new technologies, and shake up existing utility business models. Depending on each region's history and preference, well-designed markets or performance-based regulation can be used to accomplish power system goals of low costs, high reliability, and environmental performance.

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I. Introduction

The electricity system in America, and in many other nations, is in the early days of a radical makeover that will drastically reduce greenhouse gas emissions, increase system flexibility, incorporate new technologies, and shake up existing utility business models. This transformation is already underway: it is not speculation. Managed well, this transition will give America a great boost, building a cleaner, more affordable, and more reliable grid, as well as an industry ready to profit from deploying its technologies around the globe. Managed badly, we will spend too much time, money, and pollution on obsolete power plants, leave our country increasingly exposed to system failure, and let our energy technology businesses slip to back of the pack.

The stakes are high: every single part of our economy

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requires reliable, affordable electricity. And the world requires a climate that does not drown our cities, dry up our farms, decimate our planet's biological diversity, or leave us vulnerable to mega-storms.

Three factors are driving change in America's power sector. *First*, a large number of new technologies are becoming commercially viable. Power generation technologies like solar (prices down 80 percent in the last five years) and wind (down 30 percent in the same period) are gaining market share.[1] Last year, the U.S. added more wind than any other kind of generating capacity.[2] Smart engineers are rethinking the grid, to transform it from a static delivery system for electrons into an intelligent web that can optimize across many variables. New solid state equipment can deliver more functionality to grid operators and replace huge, expensive, vulnerable, and hard-to-monitor transformers and switching systems. And fracking[3] has transformed the economics of natural gas in America, making natural gas-fired generation an attractive option, though history has proven the value of a diverse set of power supply and demand-side resources to minimize price volatility.

Second, the advent of competition has challenged the protected and privileged status of America's utilities—catalyzing massive change in the energy industry. For a century, vertically integrated monopolies built power plants, strung transmission and distribution lines, billed customers, and were rewarded with a predictable return on investment. That regulatory compact was upended in the last two decades as various parts of the nation's grid were opened to competitive markets, many electric utilities were restructured into multi-state holding companies, and regulators increasingly turned to ''performance-based regulation,'' wherein utilities or competitive service providers earn a profit when they, for example, keep costs low, deliver efficiency, and keep the lights on. It turns out, however, that building a competitive market is devilishly difficult for a commodity that cannot easily be stored, flows to the nearest load regardless of contract intent, runs along monopoly distribution wires, is a prerequisite for all economic activity, and requires real-time coordination across hundreds of power plants and thousands of substations. Still, well-structured wholesale electricity markets and performance-based regulation have proven effective at reducing costs and bringing important innovation to the fore.

There is no more business as usual: These trends will change the power system and utility businesses at their core.

Third, national security, public health, economics, and climate change point to the need for clean energy. Society cannot continue to bear the public health and environmental costs caused by unmitigated carbon pollution—and public opinion increasingly demands clean, homegrown electricity for America. As a result (despite federal inaction), a majority of states have adopted policies to encourage greater investment in renewables, energy efficiency, demand–response, and grid modernization.

What does this all mean? What opportunities and threats does this conjunction of forces portend? This article argues that there is no more business as usual: These trends will change the power system and utility businesses at their core. Profound opportunity is embedded in that change. Several studies have demonstrated that it is possible to power America's grid using a very high share of renewables in the next 40 years, at very modest cost, and without relying on any technological breakthrough.[4,5] That kind of transformation means cleaner air, better jobs, a more flexible power system, and hope for future generations. It is a very big deal.

These changes require a breakthrough in policy and in business models. We must

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re-think power system incentives and regulation, the relationship of American citizens and their government with the power system. An America powered by 80 percent low-cost, reliable renewables is within our technological reach, but we are not on a path to achieve it quickly or efficiently. To succeed, we need to face head-on the task of modernizing our institutions and lining up the right incentives in the power sector.

Power system planners are well accustomed to figuring out where, when, and how to build large, centralized power plants and their transmission lines. They have mostly considered electricity demand to be an uncontrollable variable, to be met by central power plants, which are built based on demand projections, and dispatched to follow load. Today, though, demand-side resources like energy efficiency and demand–response allow system operators and consumers alike to reduce, shape, and shift demand—in effect making it dispatchable. At the same time, renewable energy introduces variability in power supply. Utility systems will have more control on the demand side and less on the supply side—which is manageable if, and only if, there are physical systems in place to optimize the whole, and the regulatory structures to reward those who perform well at this optimization.[6] Utilities and their regulators must re-think system planning, investment, markets, and operation to optimize across both demand and supply resources to keep the system in balance. When they do this, they will unleash innovation, drive down prices, and increase the resilience of the grid.

The world of electricity regulation is extremely complicated—and it is not likely to get simpler, at least in the near term. In order to capture the benefits of new technology—in cost savings, more reliability, and better environmental performance—utility regulators will have to rethink their approach, and will need legislative permission to do so. This article, building on seven studies organized and reviewed by more than 200 of the top experts in the country, is a guide to that rethinking. It is written for state public utility commissioners, power company executives, investors, federal regulators, legislators, grid and market operators, and their staffs, considering the demands of their jobs—to supply reliable, clean, and affordable power.

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II. A Clean Energy System that Works

America has an opportunity to lead the world in a vast power system transformation. As costs of renewable energy technologies decline, experience across the world is demonstrating that it is easier to integrate much higher shares of renewables, more rapidly, than previously thought.[7]

Still, none of this happens automatically. Just as today's electric system was built on clear incentives for utilities, tomorrow's system needs direction, and that will come from the way electricity systems operate, power markets are structured, utilities are managed and regulated, and new market entrants are supported. Technology, competition, and increasing awareness of the dangers of climate change are likely to drive change in the power sector regardless of efforts to preserve the status quo. But without the policy and regulatory drive to facilitate this transition, there is likely to be significant collateral damage and economic hardship.

A clear policy signal is required to drive efficiency and then switch to ever-greater proportions of clean power. Most economists argue that a price on carbon is the most efficient way to do this, and a few states and countries have adopted that approach, though most have done so in conjunction with broader efficiency standards and clean energy policy. Others have employed more targeted tactics: 29 states now require utilities to produce a share of their electricity from renewable sources, under renewable electricity standards.[8] Many states have increased their targets as renewable energy technology costs continue to drop.[9] Other options include feed-in tariffs, production incentives (e.g., production tax credits), or a strong emissions standard for power plants. Design may vary, but the most critical point is to have an adequate, clear, stable, and long-term policy signal that is economically and politically sustainable.

Each of these approaches has advantages and limitations, but the best have been remarkably effective at increasing the share of renewable energy, delivering efficiency, and driving down costs. The series of articles brought to you in this special issue of *The Electricity Journal* addresses the next generation of policies that can build on the industry's successful growth; policies with the potential to deliver an efficient grid powered by a much higher share of renewable energy.

Regardless of which of these tools a region chooses to use as an overarching signal, supporting policies must be ''investment-grade'' to make the transition readily affordable, but this factor is often neglected. A policy is investment-grade when it reduces uncertainty, thereby shifting risk to parties that can best manage it, offering return commensurate with that risk, and driving private investment. The power sector demands large capital investments, but they will not be made unless the potential for return exceeds the risk. Important criteria for an investment grade policy include:

- Policy certainty that can support investment choices that may have long payback periods;
- Long-term certainty about price, or access to markets;

Conversations about the best way to keep costs low, keep the lights on, and deliver a cleaner power system are often plagued by arguments over whether utilities or markets are king.

- Contract sanctity with credit-worthy utilities (when the utility is the buyer);
- Appropriate reduction of other non-price barriers,[10] such as permitting;
- Access to the grid; and
- Reduced time between application and approval (or denial).

The authors of *Removing Investment Barriers and Managing Risk*—another article in this issue—lay out ways that policy can remove financing barriers, enable investors to make the most of new assets they deploy, and lower the risk of renewable energy investments. Because the power sector is so capital-intensive, reducing risk—and thereby reducing capital costs—is key to keeping consumer costs low.

III. Maximizing America's Resources: A Framework for Regulators and Utilities

America's power system is remarkably diverse. It employs a system of high-voltage wires more than 200,000 miles long—enough to wrap around the Earth eight times.[11] Some parts of the country rely almost entirely on coal-fired electricity, while others already receive a quarter of their electricity from renewables—and the rest of the nation lies somewhere in between.[12] Power generation and demand must be balanced in every instant, all across the grid, to keep America's businesses functioning and homes bright.

Sitting on top of this incredibly complex physical system is an equally complex system of governance. Conversations about the best way to keep costs low, keep the lights on, and deliver a cleaner power system are often plagued by arguments over whether utilities or markets are king, as well as whether legislators or regulators are driving system evolution. There is no ''right'' answer to these questions: America's power system is heterogeneous, and will remain so. Change will happen on a regional basis, and innovative

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partnerships must be forged between previously siloed decision-makers. The path to a clean, reliable, and affordable energy future must therefore be adaptable to a whole range of regulatory and market structures.

Indeed, no matter what choices each region makes about how to organize power system management, there are five basic roles that must be filled:

1. *Generation*: Energy must be converted into electricity and fed into the power system. This can be done by utilities or independent power producers—and increasingly, by businesses and homeowners.

2. *Transmission*: Electricity must be transported from generators to areas where it can be used. This is done by utilities, federal agencies, or independent transmission builders and operators.

3. *Distribution*: Once electricity is delivered via the transmission system, or once it is produced close to where it can be used, it must be conditioned and filtered into the homes and businesses that need it at the end of the line. This can be done by utilities or independent distribution system builders and operators.[13]

4. *Demand-side management and customer service*: Many smart options exist for reducing the amount of electricity that each home or business needs to function, and customer service is about delivering the best energy services—not the most electrons—for the least cost. Demand-side management can include treating energy efficiency as a resource, higher efficiency appliances or motors, or smart controls that ensure electricity is used when it is most needed. Demand-side programs can be administered by utilities or government agencies, but are usually executed by independent service providers.

5. *System optimization*: Supply- and demand-side resources must be evaluated on equal footing to maximize their value, create a portfolio of options to manage risk, and keep the system in balance—both for real-time system operation and longer-term system planning. Advances in intelligent grid technology will underpin this critical task. Properly designed wholesale markets, independent system operators, regional transmission operators, or utilities can fill this role.[14]

Customer service is about delivering the best energy services—not the most electrons—for the least cost.

Each region has decided to fill these roles somewhat differently. And the increasing role of consumers in controlling their energy supply and demand will have profound impacts on how these roles evolve—*Policy Implications of Decentralization*, another article in this issue, explores the evolving role of distributed energy resources in the power system, as well as the policies that can support them. More than half of all electricity consumed in the United States is sold by vertically integrated utilities. This means that the utility handles at least the first three of these roles, and sometimes the role of demand-side management and system optimization as well. These monopolies are regulated by state and federal governments to ensure they keep prices reasonable for their customers while meeting certain social objectives.[15]

"Restructured" electricity markets lay at the other end of the spectrum. Many flavors of restructuring exist because there are many power system "products" or "services" that can be provided through competitive markets. In some regions, customers are allowed to choose their power supplier, or independent companies run the transmission system, or independent system operators use wholesale markets to call on independent service providers and extract maximum value from available resources while keeping the power system in balance. Ancillary services such as voltage support, black-start capability, and system balancing can be provided by regulated entities or independent parties competitively bidding for the work. A particular region may choose to restructure the whole system (e.g., the Electric Reliability Council of Texas), or may just restructure one or two of the roles above, leaving the other roles as regulated monopolies.

In markets that lie somewhere between these two ends of the spectrum, a utility might act as a ''smart integrator.'' In this potential scenario, the utility would take advantage of its unique skills and experience as a large-scale social actor, using markets to select the least-cost, most-valuable resources, and looking across the whole system to integrate those resources effectively. The smart integrator might operate the power grid and its information and control systems, but would not own or sell the power delivered by the grid or by long-term suppliers.[16] This concept relies on new businesses and service providers gaining access to power markets, and suggests a strong imperative to reduce barriers for new market entrants while maintaining service standards. Done well, this will drive innovation and bring down costs.

Figure 1 lists each of the five roles that must be filled in the power sector, and displays the spectrum of ownership models described here. As the figure illustrates, transmission and distribution are physical monopolies—there is only one set of wires, so even if the system operator runs a contest to determine who should build or operate the lines, and even if they are jointly owned, they will ultimately be operated by just one entity. The other roles in the system can all be handled by competitive markets or by regulated monopolies.

As long as all of these roles are filled, it is up to each state or region to determine where along this range it lands between vertically integrated utilities and fully restructured markets. Most regions are a hybrid, and the model is likely to fall somewhere between the three illustrated above. But regardless of the choices made, regulators must ensure that the markets and utility oversight are properly designed, or else costs will rise, while reliability and public health suffer.

IV. The Goals, and Ways to Accomplish Them

Regardless of how a region's markets are organized, power system planners must optimize for high *reliability*, reasonable *cost*, and strong *environmental performance*. The first two of these objectives have been explicit for as long as the

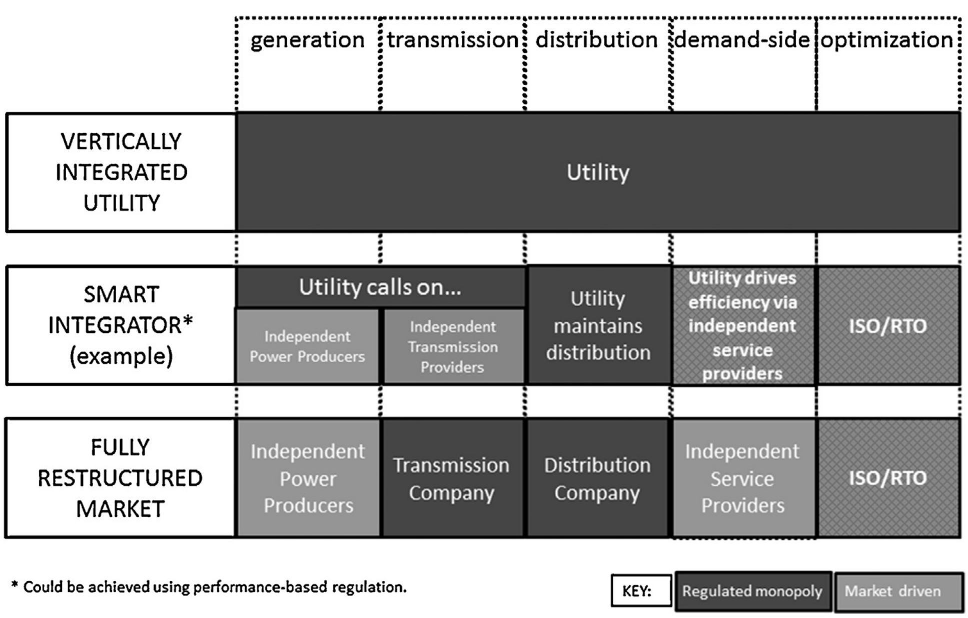

Figure 1: A Wide Spectrum of Market Structures Operate in America Today

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power grid has existed. The third—environmental performance—has gained considerable traction as an equally important objective.[17] Sometimes there can be tension between these three objectives, but emphasis is usually set by policies put in place by the electorate and the legislature with public interest in mind. Striking the right balance between these three objectives is essential to ensure the power system continues to meet America's needs. To keep costs low, power system planners, regulators, and market designers must think about how to minimize *bills* (not rates) for customers, as well as how to minimize price volatility. They must also make sure that rates are designed to send the right signals to customers about what kind of energy to use, when to use it, and how much of it to use. This means that fixed costs cannot be passed through as large fixed charges to consumers. At the same time, maintaining reliability means keeping power system infrastructure up to date (see sidebar), and minimizing the frequency, duration, and scale of outages. And finally, environmental performance can be measured via conventional pollutants, greenhouse gas emissions, water use, effluent management, and optimal siting for new infrastructure. Figure 2 provides examples of both regulatory and market solutions to each of these challenges—though it is important to note that all market solutions also require regulatory oversight.

There are many ways to design markets or regulation badly—and the worst of these can be disastrous. But the right mix of smart regulation and well-designed markets can each be very effective. Five general principles for good power policy design can help increase effectiveness *no matter how a region's markets are structured*:

1. *Long-term signals* are necessary to give utilities and other investors the confidence they need to get the right resources built and online by the time they are needed. Regulations must be transparent, and must articulate the market failure they address.

2. *Innovation and efficiency* should be properly incentivized.

3. All resources—*both generation and demand-side*—should be properly valued for

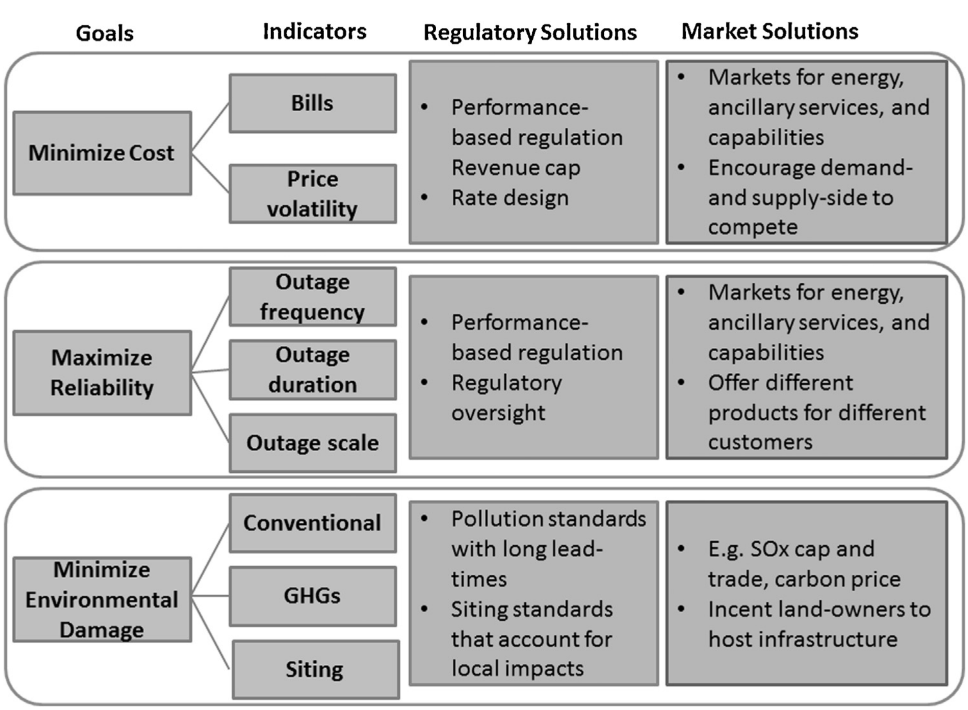

Figure 2: Regulation or Markets (or a Combination) Can Be Used to Optimize Cost, Reliability, and Environmental Performance

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their useful attributes. Supply and demand resources should be compared *on an equal footing* to determine the right mix of resources for the system. Two other articles in this issue, *Policy Implications of Decentralization* and *Supporting Generation on Both Sides of the Meter*, give clear policy recommendations for how to do this, including how to analyze trade-offs between centralized and distributed resources (emphatically including efficiency) as well as ''integrated distribution planning.''

4. *New ancillary services* must be valued (and old ones modified) as the grid modernizes. These non-energy grid services are essential to keeping the system balanced in real-time as well as over the long-term. Many experts are beginning to call these new ancillary services ''capabilities,'' which include both real-time and forward services.

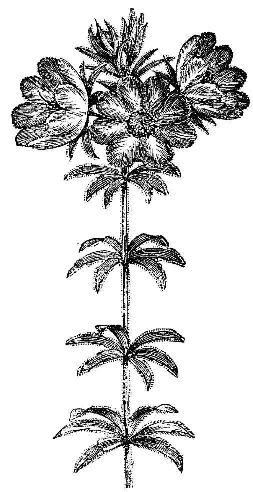
5. *Coordination among agencies*—and constructive communication with utilities—is critical.[18]

These general principles can be used as preliminary screens to identify the most effective proposals for new markets or regulatory policies. The supporting articles in this issue provide many more specific recommendations, but each meets these criteria.

The following two sections lay out best practices for optimizing cost, reliability, and environmental performance using these five principles within both competitive markets and regulated utilities.

A. Best practices: competitive markets

Competition has moved—at varying paces in different parts of the country—into electricity generation, transmission, and demand. Most of the country has introduced competitive generation, and independent power producers own and



operate three-quarters of all renewable energy generation.[19] Federal Energy Regulatory Commission (FERC) now sets rules for these wholesale markets across the nation. Some areas have also introduced competitive transmission, wherein independent transmission companies may compete to build and operate transmission lines, taking bids and negotiating contracts to move electricity (subject to FERC oversight). Some parts of the country have adopted retail choice, where residential and small business customers can choose their own power supplier. As a rule, a system optimizer—such as an independent system operator (ISO) or a regional transmission organization (RTO)—is also needed whenever operations are handled by more than one entity. As long as all five roles in the power sector are filled and the barriers to entry into the market are minimized, competitive markets have the potential to lower prices, drive innovation, and deliver the energy services that customers need. But it is tricky to design markets that cover all the near- and long-term system needs, so regulators need to act with care and sophistication.

An important step in maximizing the efficiency of competitive markets is consolidating balancing areas—creating more system flexibility and options by enlarging the area over which supply and demand have to be balanced. Consolidating balancing areas helps system operators take advantage of a wider range of resources, which reduces aggregate variability in both generation and demand, decrease the need for costly backup generation or reserves, and decrease price volatility.[20] When balancing areas cannot be fully consolidated, a second-best approach is to open an organized exchange for grid services between control areas—often called an ''energy imbalance market''—coupled with authority for dynamic transfers between regions.[21,22]

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An article in this issue, *Planning for and Investing in Wires*, provides clear policy recommendations for getting new transmission lines built to enable balancing area consolidation or energy imbalance markets. Siting of new transmission will remain a challenge, but best practices for streamlining the process are laid out in one of this month's articles, *Finding a Home for Renewable Energy and Transmission*.

Each energy market has its own products and services. Within a balancing area, well-designed competitive markets clear on many different timescales for each of these different products and services. To make the most of renewable and demand-side energy resources, markets for energy and short-term ancillary services should clear as often as every 5 min (or less), so as to take advantage of short term fluctuations in demand and variable supply. Examples of these ancillary services include power quality, voltage management and frequency regulation. At the same time, hour-ahead markets usually ensure that electricity supply and demand are on track to be balanced, and that ample ancillary services (like load following and ramping capabilities) will be available to keep the grid reliable. Markets for access to adequate power generation capacity and ancillary services may also clear a day ahead of when they are needed. In parallel to day-by-day markets, markets may also clear on a year-by-year basis for access to electricity, capacity, and—in some places—ancillary services. Taken together, it is a huge task to have all these markets built and functioning well, but luckily smart information technology and communications infrastructure can help by automating many of the transactions. All of these shorter-term markets are shown in the shaded ellipses in Figure 3.

Even as these complex shorter-term markets operate, system optimizers and grid planners must think about the future. Maintaining the right resources to keep the grid in balance requires long-term certainty for investors and utilities, either through well-functioning markets or long-term contracts, giving them the confidence they need to undertake the multi-year process of gaining reliable access to controllable demand, building new supply and transmission resources, or upgrading older ones. Markets for delivery of products or services several years in the future are called ''forward markets.''

Some grid regions, such as PJM (the largest wholesale electricity market in the world, located in the eastern part of the country), have established forward

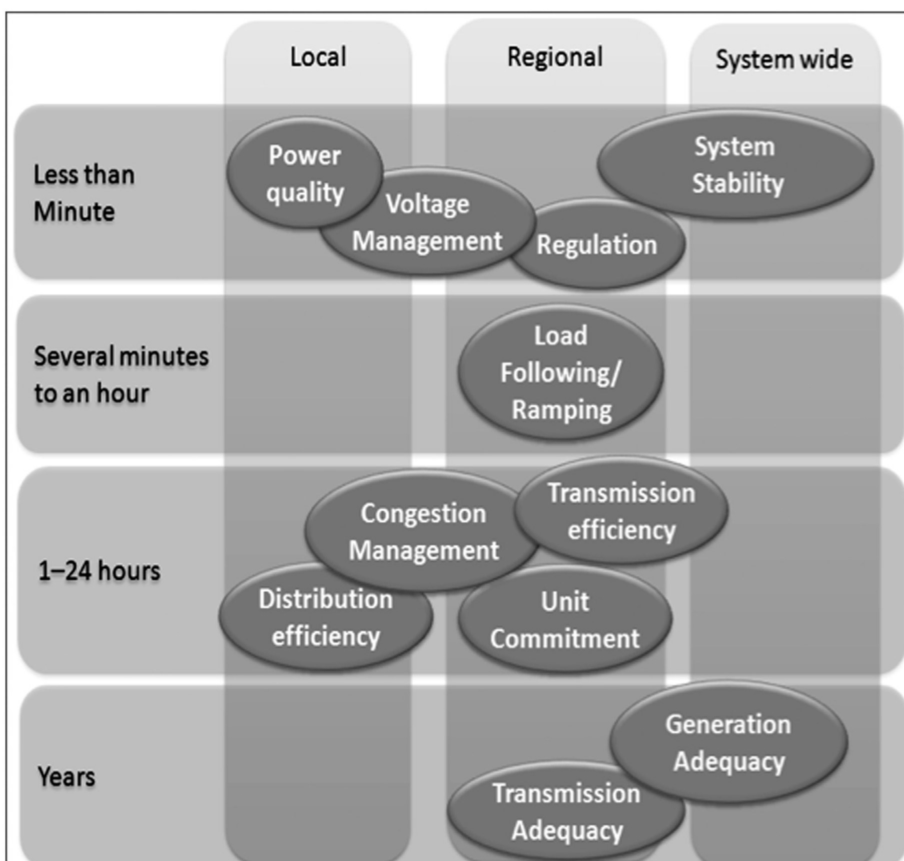

Figure 3: Electric Power Markets Clear on Many Different Timescales[36]

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markets for capacity alongside their energy markets. This introduces an explicit value for the ability to call on resources whenever they are needed, and ensures a revenue stream for capacity that may rarely run, but is critical to system reliability. Demand response is delivering more and more capacity in PJM's forward market—almost 15 GW of *new* demand–response cleared the market in 2012 for delivery in 2015/2016,[23] which suggests that demand-side resources could have great potential to deliver low-cost solutions to capacity requirements in other parts of the country. Any new market should take care to ensure that demand-side resources—at least including efficiency, demand–response, and distributed generation—can participate and bid on equal footing with supply-side resources. Demand-side resources will be an important part of the flexible grid of the future—giving system operators the freedom to call on whichever resource can deliver clean, reliable power at the lowest cost.[24]

Another article in this issue, *Aligning Power Markets to Deliver Value*, suggests that forward—i.e., future—markets should also be opened for a handful of existing ancillary services, such as the capability to ramp energy production up or down quickly. The article also suggests that new kinds of ancillary services should be added, such as a service that hedges the price differences between one scheduling interval and another. As generation becomes more variable and demand more controllable, the flexibility characteristics of power generation resources will become more valuable.[25] Market designers must develop tools to better forecast net demand, and shed light on the future value of grid flexibility. Valuing the new capabilities that we anticipate needing can make sure the right resources are online when grid operators need them to fill resource adequacy requirements or to minimize costs and keep the grid reliable.

Table 1 shows the market solutions to meet each of the five principles for good power policy design outlined above. Even if a region relies heavily on competitive markets, there is still a substantial role for regulators setting policy direction and providing market oversight to minimize gaming.

B. Best practices: performance-based regulation

To usher in a modern system, regulators must reconsider the very premise upon which utilities have traditionally received compensation. A focus on rate-of-return regulation may no longer make sense for America's power system—partly because of the spread of competitive markets, partly because it is unlikely to adequately compensate utilities if they are building less new infrastructure (as growth in electricity demand slows), and partly because policymakers are increasingly focused on *performance*, rather than capital investment.[26] The power sector

Table 1: Markets Can Address All of the Principles for Good Power Policy Design.

Principle	Market Solution
Long-term signals	Work to make short-term markets for energy and services healthy enough to provide long-term signals[37]; open forward markets for energy and services.
Value supply- and demand-side resources	Ensure new markets encourage bids from all resources.
New ancillary services	Open markets for new ancillary services and capabilities, carefully defined to assure an even playing field for new services, and to reward innovation and performance.
Innovation and efficiency	Minimize barrier to entry for new resources and service providers.
Coordination among agencies	Consolidate balancing areas, organize frequent meetings, between PUCs/ISOs/RTOs, and utilities.

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increasingly demands a service business, rather than a commodity business. As noted in another article in this series, *Utility and Regulatory Models for the Modern Era*, rate-of-return regulation suggests a focus on answering ''did we pay the correct amount for what we got?'' But performance-based regulation shifts more of the focus to: ''did we get what we wanted?'' A full departure from rate-of-return regulation is unlikely, but alternatives are worth serious consideration alongside conversations about rate design.

Performance-based regulation rewards the utility based on its achievement of specific performance measurements. ''Incentive regulation'' is a form of performance-based regulation that provides a means for the utility to earn a higher return over a multi-year period if it is able to reduce expenses associated with providing service.[27] Both of these forms of regulation encourage utilities to achieve desired goals by granting them some more freedom to become more innovative and efficient, and can encourage new market entrants when they enable utilities to call on third-party service providers. These forms of regulation also protect energy consumers by ensuring they receive adequate services by exacting penalties on utility shareholders when performance standards are not met. Many states across the nation—as well as some other countries—already employ some form of performance-based regulation. Figure 4 shows a graphical representation of how it works.

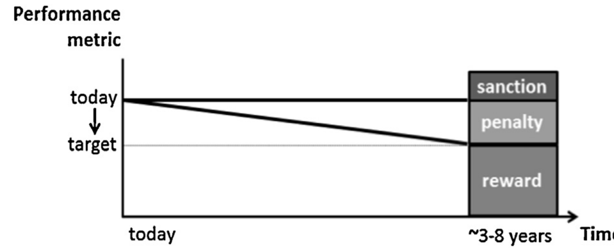

Figure 4: An Illustration of Performance-based Regulation
PUCs set rates or allowed revenues and clear performance standards—such as a CO_2/kWh standard, a power balancing standard, or a total cost per customer standard—for several years in the future, and then give utilities the freedom to innovate in the intervening years. At the end of the compliance period, performance is measured. Utilities receive a reward for meeting or exceeding the standard, a penalty for falling short, or—if the utility completely misses the mark—its monopoly status could come into question

Performance-based and incentive regulations have the potential to achieve the goal of minimizing cost, maximizing reliability, and maximizing environmental performance more efficiently than historical rate-of-return regulation. To succeed, however, regulatory independence is of great importance—ties between the regulator and regulated entity complicate this regulatory structure and can cost customers. Still, the lines of communication between regulators and utilities must be open and clear in order to find solutions that enable both utilities and customers to thrive amid the changing energy environment.[28] Examples of performance-based and incentive regulation include: revenue-per-customer structures, efficiency and demand-side management incentives, portfolio incentives, service quality indices, and others.[29] Well-designed performance-based regulation can accomplish all five of the principles for good power policy design—it can provide long-term signals, value supply- and demand-side resources, integrate new ancillary services, and drive innovation and efficiency. Coordination among agencies—such as between air quality and economic regulators—requires special care and attention in a performance-based system. But if the regime is well-designed, utilities will prosper when they innovate to meet performance standards, energy users will prosper by having energy services met at reasonable cost, and citizens will prosper from less pollution.

The concept of performance-based regulation is simple and the theory is clear. But structuring it right is tricky—and can produce perverse effects. In theory, legislators and regulators can set goals for reliability, cost, pollution, greenhouse gas emissions, utility innovation and profitability, and whichever other goals are important to them, and

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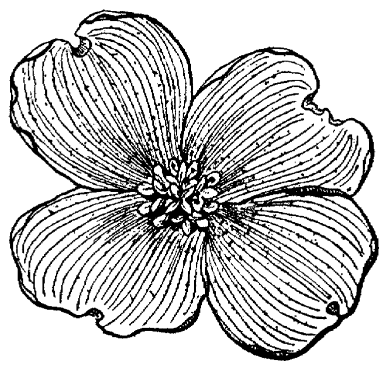
utilities (or transmission companies, distribution companies, etc.) will be highly motivated to meet them. In practice, these performance goals can incite gaming, such as data falsification.[30] Careful monitoring and adjustment of performance metrics, measurements, and outcomes can minimize gaming.

Luckily, there is a good deal of experience from which to draw lessons. Regulators across America have been experimenting with performance-based regulation in the energy sector for almost as long as the sector has existed. Experience with performance-based regulation in the telecommunications sector provides a helpful set of lessons as well. A survey of 25 experts in performance-based regulation from across the country provided several insights about their experience in both telecommunications and energy regulation.[31]

Oregon's Alternative Form of Regulation is an example of a successful case of performance-based regulation with revenue decoupling from the early 2000s. Oregon implemented a well-designed revenue cap for PacifiCorp's distribution service, decoupled profits from electricity sales, measured the utility's service quality, and included a safety valve in the form of upper and lower bounds on profit potential – with an obligation to share profit with consumers if it exceeded a certain amount. The result was that PacifiCorp improved service quality and reduced costs by 15 percent, with a commitment to further reduce costs.[32]

''Revenue decoupling'' is an example of performance-based regulation, wherein a utility's financial health is separated from the volume of electricity or gas that they sell. Decoupling accelerates energy efficiency,



distributed generation, and demand response. Decoupling also aligns utility incentives with those of consumers who are generating or controlling their own power. Decoupling can be achieved in several ways, including a revenue-per-customer structure with or without additional incentives. Some form of revenue decoupling has been adopted in 15 states—from New York to Ohio to Oregon, and it is pending in six more. Decoupling has been very successful at removing utility incentives to sell more electricity, giving them the revenue certainty they need to become drivers of energy efficiency and enablers of distributed generation. Because traditional rate-of-return regulation provides a fixed return on capital that a utility would have invested in new power plants and other infrastructure in the absence of energy efficiency, some states have adopted an incentive structure to provide a similar financial reward for achieving real efficiency in the system.

But decoupling plus incentives can produce unintended effects via the process for performance measurement and evaluation. First, regulators, utilities, and other stakeholders must work together to establish well-defined outcomes that everyone understands. Next, a clear methodology must be created to determine what would happen in the absence of utility programs—the ''counterfactual.'' Without this, it is impossible to determine whether or not a utility performed to its standard, and whether or not it should receive a financial reward. California's decoupling program—now about 30 years old—has undoubtedly contributed to the state's per capita energy consumption now being roughly half the national average,[33] but California's Public Utilities Commission continues to wrangle with program design to maximize performance. These lessons from regulatory experience with revenue decoupling (e.g., the need for a clear, quantitative counterfactual) shed light on how to design successful performance-based regulation for renewable energy generation.

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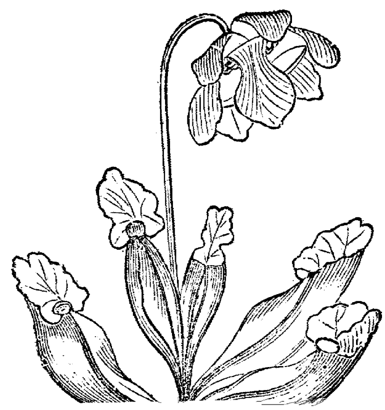
Across the Atlantic, the UK is also experimenting with a new broad-scale program of performance-based regulation in which the utilities have eight years of certainty in revenues to perform in six categories of outputs (e.g., customer satisfaction, reliability, environmental impact). At the end of those eight years, utility performance will be measured and they will receive an incentive for meeting the goals or a penalty if they do not.[34] It will be important to watch the UK's progress to glean lessons for performance-based regulation as the program unfolds. Another article in this month's series, *Utility and Regulatory Models for the Modern Era*, provides more information about the UK's program, as well as some other examples of performance-based regulation.

Principles for good performance-based regulation include[35]:

1. Tie program objectives to regulatory goals and clearly define metrics for performance. This sounds simple, but it is difficult, critically important, and sometimes rushed.
2. Use the mechanism to simplify the regulatory process, improve public understanding, and prepare for increased competition.
3. Ensure the performance-based program gives credible certainty over a long enough time period to give utilities and investors the confidence they need to launch new initiatives, invest, build, and interconnect.
4. To the extent possible, performance-based mechanisms should cover all of a utility's costs that are not returned by competitive markets—piecemeal programs lead to gaps, perverse incentives, and gaming. Simply adding performance-based regulation to existing regulation—without carefully adjusting the terms and conditions of each—will add complexity and undermine both.



5. Performance-based mechanisms should not discourage energy efficiency, demand response, or distributed generation by promoting growth in the volume of electricity sold.
6. Performance-based mechanisms should shift an appropriate amount of performance risk to the utility, in exchange for longer-term certainty (more policy certainty, less exposure to volatile fuel prices, and clarity about their role and degrees of freedom) or incentive compensation. Another option may be to allow utilities to recover fixed research and development costs via rates. These options can promote innovation.
7. Progressive revenue sharing should be included in any program, but structured so that there is enough potential for utility profit to drive innovation.
8. Measurement and evaluation is the most vulnerable part of the system – gaming this process can cost customers greatly. Regulators should be granted appropriate authority and make the right tools available for oversight, adjustments, and enforcement.
9. Establish data access and methodology at the start of the program. Prescribe which data sets will be needed, as well as the public process for gathering and reviewing them. In addition, establish a clear methodology for the counterfactual ahead of time.
10. Consider the use of collars (price floors and ceilings) to prevent unintended consequences.

The upshot is that there are many lessons to draw from in the world of performance-based regulation. These 10 principles broadly summarize the field, but a reference list for this article provides a rich set of material for further inquiry.

V. Top Policy Recommendations

Based on the set of set of seven other articles in this issue and discussions with more than 200 experts in electricity policy, the following represents the set of top recommendations from this series and the organizations that are called upon to implement them:

1. Move away from rate-of-return regulation; use performance-based regulation that gives utilities the freedom to innovate or call on others for specific services. Separate the financial health of the utility from the volume of electricity it sells. (State legislatures and PUCs)

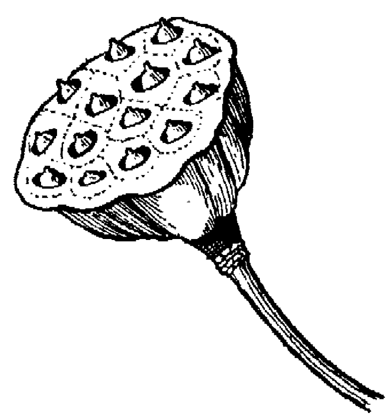
2. Create investor certainty and low-cost financing for renewable energy by steadily expanding Renewable Electricity Standards to provide a long-term market signal. (State legislatures and PUCs)

3. Support distributed generation by acknowledging customers' right to generate their own energy, by charging them a fair price for grid services, and by paying them a fair price for the grid benefits they create. Set a clear methodology for allocating all costs and benefits. (PUCs, utilities, ISOs/RTOs)

4. Ensure that all markets (e.g., energy, ancillary services, capacity) and market-makers (e.g., utilities) include both demand- and supply-side options. All options—central and distributed generation, transmission, efficiency, and demand response—should compete with one another to provide electricity services. (ISOs/RTOs, PUCs, utilities)

5. Employ electricity markets to align incentives with the desired outcomes, such as rewarding greater operational flexibility. Open long-term markets for new services such as fast-start or fast-ramping. (ISOs/RTOs, utilities, PUCs)

6. Before investing in technical fixes to the grid, first make operational changes that reduce system costs, enable more renewables, and maintain reliability. For example, coordinate between balancing areas, dispatch on shorter



intervals, and use dynamic line rating to make the most of existing transmission lines. (ISOs/RTOs, utilities, PUCs)

7. Mitigate investor risk by adopting stable, long-term policies and regulations. Financial policies should be predictable, scalable, affordable to public budgets, and efficient for investors. (Congress, state legislatures, PUCs)

8. Reduce siting conflicts by using explicit, pre-set criteria; ensuring access to the grid; respecting landowner rights; engaging stakeholders early; coordinating among regulatory bodies; and providing contract clarity. (Federal land managers, state legislatures, PUCs)

VI. Conclusion

The U.S. power system is at an inflection point. New technologies offer great promise to increase reliability, reduce fuel costs, minimize capital investment, and reduce environmental damage. Capturing these benefits requires a new approach to utility regulation and business models—no matter if the power system is driven by a vertically integrated monopoly, by a competitive market, or by a hybrid of the two.

Legislators and governors, state public utilities commissions (PUCs), Federal Energy Regulatory Commission (FERC), ISOs, utilities, investors and other decision-makers will need to move deliberately and thoughtfully to create new standards, markets, and business models. If they delay, consumers will incur steep, long-term costs, as the investments flowing from today's structure are unlikely to meet tomorrow's needs—and much less take advantage of tomorrow's opportunities. And getting this right the first time is an imperative; it is much more expensive—if not impossible—to go back later and change the course of evolution in the asset-intensive power sector.

This article argues for clear goals, backed by business decisions and regulations designed to maximize innovation and performance while minimizing costs. We recognize that translating these goals into

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specific business models and regulations is a big job, and this work will have to be customized for each organization and each region of the country. We are heartened by conversations with experts from all realms—PUC commissioners and staff, investors, academic experts, system operators, utility executives, and NGOs—who see this challenge and are working hard on new systems.

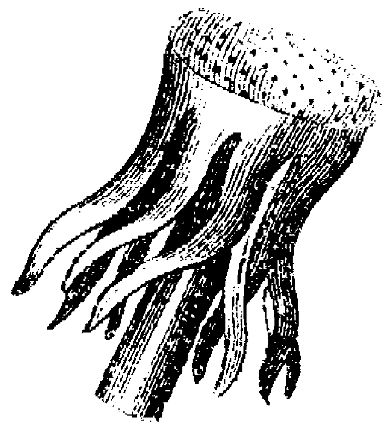
Our strongest recommendation, then, is for policymakers—governors, legislators, and public utilities commissioners—to face this challenge directly, openly, and forthwith. PUCs can open proceedings on how to build the electric system of the 21st century. Ensure that these conversations include experts in new technology, in systems optimization, and on the demand side as well as the supply side. Challenge participants to find solutions that meet all three public goals: minimize costs, increase reliability, and reduce environmental damage. Insist that they demonstrate how new proposals bring in innovation. Stress-test recommendations for flaws. Launch and accelerate pilot programs, test markets, and more. We can succeed. Now is the time to get going.■

Endnotes:

1. Michael Liebreich (2013), *Global Trends in Clean Energy Investment*, Bloomberg New Energy Finance. Accessed May 13, 2013. <http://about.bnef.com/presentations/global-trends-in-clean-energy-investment-3/>

2. American Wind Energy Association (2013), Wind Energy Top Source for New Generation in 2012, Press Release, at <http://www.awea.org/newsroom/pressreleases/officialyearendnumbersreleased.cfm>

3. Hydraulic fracturing, or ''fracking,'' is a technique for accessing natural gas and/or oil by drilling a well and then using pressurized fluid to fracture porous



rock and initiate the flow of gas or oil.

4. National Renewable Energy Laboratory (2012), *Renewable Electricity Futures Study*, at <http://www.nrel.gov/analysis/re_futures/>; Bob Fagan, Max Chang, Patrick Knight, Melissa Schultz, Tyler Comings, Ezra Hausman and Rachel Wilson (2012), *The Potential Rate Effects of Wind Energy and Transmission in the Midwest ISO Region*, Synapse Energy Economics, at <http://cleanenergytransmission.org/wp-content/uploads/2012/05/Full-Report-The-Potential-Rate-Effects-of-Wind-Energy-and-Transmission-in-the-Midwest-ISO-Region.pdf>. Also Bob Fagan, Patrick Lucknow, David White and Rachel Wilson (2013), *The Net Benefits of Increased Wind Power in PJM*, Synapse Energy Economics, Forthcoming; and Amory Lovins, et al. (2011), Reinventing Fire (Rocky Mountain Institute and Chelsea Green Publishing), Eric Martinot (2013), *Renewables Global Futures Report 2013*, REN21. NREL's analysis suggests that an 80 percent renewable electricity system in 2050 is robust to constraints on transmission, energy storage, and flexibility.

5. While this article focuses on renewables, energy efficiency will be a massively important complement to deliver a clean and healthy power system. For an excellent set of efficiency policy recommendations, see Nicole Steele (2013), *Energy 2030 Research Reports*, Alliance to Save Energy, at <http://www.ase.org/resources/ee-commission-report-summaries>

6. Further innovation is needed to develop cost-effective and ubiquitous energy storage as another option for managing this transformation.

7. REN (2013), Renovaveis Abastecem cerca de 70% do Consume Nacional de Eletricidade no 1 Trimestre, Press Release, at <http://www.ren.pt/media/comunicados/detalhe/renovaveis_abastecem_cerca_de_70__do_consumo_nacional_de_eletricidade_no_1__trimestre/>

8. In addition, 24 states have established energy efficiency goals and policies to support them. See <http://aceee.org/topics/eers>

9. Governors' Wind Energy Association (2013), *Renewable Electricity Standards: State Success Stories*, at <http://www.governorswindenergycoalition.org/wp-content/uploads/2013/03/RES-White-Paper-March-2013.pdf>

10. Primary non-price barriers include (1) a problem of the commons, wherein the benefits are too dispersed, spanning over a number of jurisdictions; (2) externalities associated with system security and blackouts, (3) perception of risk associated with new technologies, and (4) complexity of permitting or interconnection requirements imposed by multiple agencies.

11. ''Transmission,'' Edison Electric Institute (2013), at <http://www.eei.org/ourissues/ElectricityTransmission/Pages/default.aspx>

12. Based on state-by-state data from the U.S. Energy Information Administration.

13. Independent distribution system operators are rare in the United States, but are much more common in Europe.

14. Cost-effective storage technologies could fundamentally change the nature of this role, but this article does not assume their near-term and large-scale deployment.

15. Utilities can also be ''monopsonies,'' which are single customers for a product or service in a market.

16. This concept was first described in Peter Fox-Penner (2010), SmartPower (Washington, DC: Island Press).

17. Environmental performance can mean emphasizing cleaner resources, as well as using intelligent criteria for siting of new generation and transmission. Intelligent siting can reduce regulatory delays, costs, and timelines for integrating new renewable energy sources. For more detail on intelligent siting, see Hladik and Zichella, Oct '13.

18. Ronald Binz, et al. (2012). *Practicing Risk-Aware Electricity Regulation: What Every State Regulator Needs to Know*, Ceres, at <http://www.ceres.org/resources/reports/practicing-risk-aware-electricity-regulation>

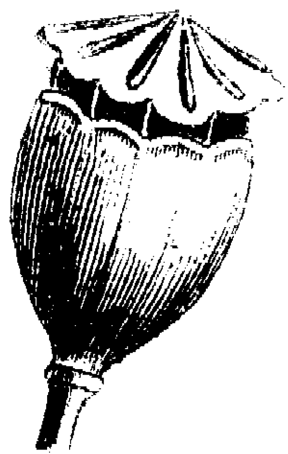
19. Table 1.3. Net Generation by Energy Source: Independent Power Producers, 2003-May 2013, U.S. Energy Information Administration (2013), at <http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_1_3>

20. M. Milligan, B. Kirby and S. Beuning (2010), *Combining Balancing Areas' Variability: Impacts on Wind Integration in the Western Interconnection*, National Renewable Energy Laboratory conference paper for WindPower 2010, at <http://www.nrel.gov/docs/fy10osti/48249.pdf> and North American Electric Reliability Corporation (2011). *Special Report: Ancillary Service and Balancing Authority Area Solutions to Integrate Variable Generation*, NERC, at <http://www.nerc.com/files/IVGTF2-3.pdf>

21. PacifiCorp and California Independent System Operator (2013), *PacifiCorp-ISO Energy Imbalance Market Benefits*.

22. ''Dynamic transfers'' refer to virtual transfers of control for specific resources over certain times.

23. PJM (2012), *2015/2016 RPM Base Residual Auction Results*, at <http://www.pjm.com/~/media/markets-ops/rpm/rpm-auction-info/20120518-2015-16-base-residual-auction-report.ashx>



24. Many studies have shown that cost savings alone will not drive efficiency; policy can address market failures.

25. Mark Rothleder, *Long Term Resource Adequacy Summit*, California Independent System Operator, Presented Feb. 26, 2013, at <http://www.caiso.com/Documents/Presentation-Mark_Rothleder_CaliforniaISO.pdf>

26. The number of states using broad-based performance-based regulation for utilities and distribution companies has declined since 2000, but through the initial experimental process, many important lessons were learned about how to design smart performance-based regulation. For example, setting a clear and quantitative counter-factual at the beginning of a program makes performance measurement much easier.

27. Definitions from David Sappington and Dennis Weisman (1996), *Designing Incentive Regulation for the Telecommunications Industry*, MIT Press, and Jim Lazar, Regulatory Assistance Project.

28. Binz et al. *supra* note 18.

29. Price caps or rate caps can also be considered under the rubric of performance-based regulation, but are not recommended as they incent utilities to maximize electricity sales.

30. ''Decision Regarding Performance Based Ratemaking (PBR), Finding Violations of PBR Standards, Ordering Refunds, and Imposing a Fine,'' California Public Utilities Commission (2008), at <http://docs.cpuc.ca.gov/published/FINAL_DECISION/91249-16.htm>

31. This survey was conducted by the authors as part of the research for this article. For more information, contact the authors.

32. Jim Lazar (2000), *Performance Based Regulation and Incentive Regulation*, The Regulatory Assistance Project.

33. California's progressive building efficiency policy, Title 24, has also driven the state's energy efficiency achievements.

34. Ofgem (2010), *RIIO: A New Way to Regulate Energy Networks*, Factsheet 93, at <http://www.ofgem.gov.uk/Media/FactSheets/Documents1/re-wiringbritainfs.pdf>

35. Sources: insights from author interviews with 25 experts in performance-based regulation; William B. Marcus and Dian M. Grueneich (1994), *Performance-Based Ratemaking: Principles and Design Issues*, Prepared for Energy Foundation; and Lazar (2000) *supra* note 32.

36. Figure from ICF International.

37. William Hogan (2005), *On an ''Energy-Only'' Electricity Market Design for Resource Adequacy*, Center for Business and Government, John F. Kennedy School of Government, Harvard University, at <http://www.ferc.gov/EventCalendar/files/20060207132019-hogan_energy_only_092305.pdf>

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