

MIND THE GAP

WHAT SCENARIO ANALYSIS SAYS ABOUT THE FUTURE OF THE U.S. POWER INDUSTRY

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THE U.S. ELECTRIC-POWER MARKET is inching closer to a major shortfall in generating capacity. This is troublesome in itself but what is causing perhaps even more concern for both the industry and the country's broader economy is the magnitude of uncertainty related to alternative ways to address the supply gap. This uncertainty may translate into taking too few or insufficiently concrete steps, and thus it has serious implications for the reliability of the nation's power grid.

Although the U.S. economy was recently hit by a recession, the demand for electric power continues to grow. And the story is also complicated on the supply side: how will recent and future changes in technology and emissions regulations impact the competitive mix in electric-power generation sources?

A number of new and existing variables are clouding the future of the U.S. electric-power industry primarily by exacerbating the uncertainty about policy and the prices power companies will require to justify

making big investments in new generation capacity. The advent of new technology and drilling methods has made the U.S. the world's leading producer of natural gas, allowing gas to approach coal's share of the country's power-generation fuel mix. The U.S. Environmental Protection Agency, the states, and the courts continue to battle fiercely over rules for curbing power plant emissions of carbon dioxide, mercury, and other pollutants. The nuclear industry has been in a state of anxiety since Japan's Fukushima nuclear accident in March 2011. And the renewable-energy business is feeling insecure as a result of waning federal-government support and crumbling power prices due to falling natural-gas prices.

The cumulative effect of increasing uncertainty has been industry paralysis. There has been limited movement in coal-fired and gas-fired plant investment even though the Cross-State Air Pollution Rule (CSAPR) was struck down in 2012. It has been especially hard to add capacity in deregulated states whose economics do not

justify the cost of new plant construction. For example, in only one of the past five years has the price of power reached a level that could support building new combustion turbines (CTs, or “peakers”) and combined-cycle gas turbines (CCGTs) in Texas. (See Exhibit 1.) Even in states whose capacity markets cover a portion of generators’ fixed costs and thus arguably provide some encouragement for new construction, the economics are not attractive.

Power industry officials and regulators are thus at a distinct advantage when it comes to planning for future energy demand. In particular, there are four major questions about the future of the U.S. electric-power market:

- Will the U.S. have sufficient power to meet future demand?
- What will the mix of power generation technologies—coal, nuclear, natural gas, and renewables—look like?
- How much investment will be needed to build the required additional supply?

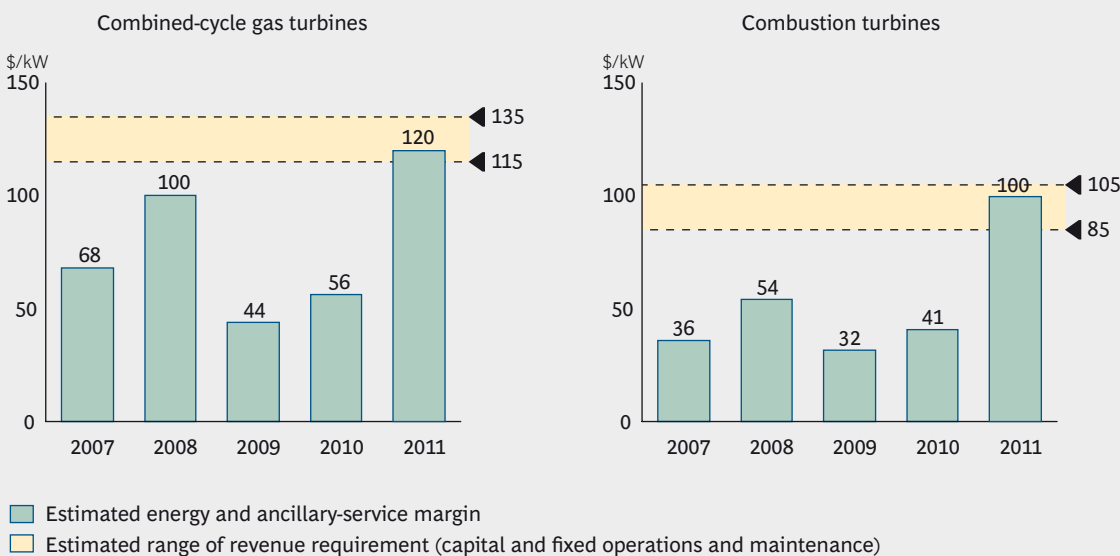
- What will the impact on emissions and consumer rates be?

Scenario analysis clarifies the issues implied by these questions, allowing for better strategic choices. Two steps are necessary. First, we must establish a baseline to define what we know. Next, from this baseline, we overlay alternative scenarios about the way the power sector may evolve, each scenario driven by different regulatory and technology-related variables.

Baseline: What We Know About the Impending U.S. Power-Supply Gap

Driven primarily by economic and population growth, U.S. power demand is expected to grow by around 1 percent per year over the near term. This is comparable to the 0.9 percent growth in 2010, when the economy was just coming out of the recession, and is consistent with the U.S. Energy Information Administration’s demand projection of 1.4 percent per year. Annual growth of 1 percent takes into account demand side management (for

EXHIBIT 1 | ERCOT’s Energy Margin Covered the Revenue Requirements for New Gas Plants Only Once in the Past Five Years



Sources: Potomac Economics annual reports on ERCOT; BCG analysis.

Note: ERCOT = Electric Reliability Council of Texas; kW = kilowatt; range of levelized costs is the result of using level-nominal versus level-real methods to calculate annual cash flow; *nominal* has equal flow while *real* is low in earlier years and high in later years; 2008 high net revenues were due to a much higher reserve price paid to generators.

¹Energy margins are from Potomac Economics annual reports and were revised by deducting startup and ramp-up costs and negative-margin hours.

example, energy efficiency and demand response), which shaves off 0.4 percent of demand growth per year, reducing total demand by 5 percent by 2020.

What this says is that even before taking into account U.S. power-supply dynamics, we can expect that by 2020 the country will need an additional 9 percent, or 90 gigawatts, of capacity, and certain regions will likely be more affected than others. This amount is significant and is the more certain part of the U.S. power-economics story. For simplicity, this analysis assumes reserve margin requirements similar to today's going forward.

It is even more challenging to think about how U.S. power-generation capacity will be affected by the pipeline of new power plants in the planning stages, as well as those plants that will be retired. Both sets of decisions are likely to be influenced by future emissions regulations, renewable portfolio standards, and changes in power plant technology (for example, the emergence of new low-cost power generation). All three of these factors are held constant in the baseline.

Estimates indicate that new capacity totaling roughly 46 gigawatts is likely to be built from the capacity currently planned or scheduled for construction. At the same time, about 89 gigawatts of capacity will likely be retired. Of this amount, about 50 percent was already scheduled for retirement, while about 25 percent is expected to be retired owing to advanced age and another 25 percent owing to failure to meet increasingly stringent emissions regulations. CSAPR was thrown out, but stricter mercury and air toxicity rules are scheduled to take effect in 2015.

Currently, about 37 percent of electricity is generated at coal-fired plants, while 31 percent is fueled by natural gas, 20 percent by nuclear power, 7 percent by hydropower, and the rest by other renewable-energy sources including wind and solar.

This baseline analysis indicates—assuming no change in emissions regulations that

are “on the books” today or in generation technology—that there will likely be a shortage of approximately 50 gigawatts of generation capacity by 2020. This represents about 5 percent of the country's total existing capacity. Unless new power-plant capacity is built between now and 2020, the nation's power grid will likely experience major reliability consequences such as rolling blackouts.

How Can We Fill the Gap?

To manage the tremendous uncertainty associated with the key power-market fundamentals—especially emissions regulations and technology—it is helpful to create several scenarios driven by distinctly different variables. The three scenarios we describe below highlight alternative paths the industry could take, given fundamentally different assumptions about these variables. For the sake of simplification, for every scenario, economic growth is held constant at the baseline rate. In each case, the cost and ease of building new transmission and distribution capacity are held constant. In the renewables-intensive scenarios, which will require more investment to connect generation to what are often distant load centers, we assume this capacity will be forthcoming.

Muddling Through. In this business-as-usual scenario, the industry stays generally on its current path. It is, therefore, characterized by political gridlock, continuing uncertainty about emissions and carbon policy, and disjointed federal and state regulations. Without a clear and stable regulatory framework, investment is discouraged because there is less ability to make credible plans for new generation. The slowdown in adding new generation capacity creates significant reliability issues, and power shortages emerge.

In response to an urgent need to add capacity quickly, the 50-gigawatt gap is filled primarily with CTs, which, although they can be built rapidly, produce electricity at a higher cost relative to base-load capacity.

Gas as the Fuel of Choice. This scenario sees the industry making a clear shift to efficient (base load) gas-fired power plants such as CCGTs in response to the boom in unconventional-gas production and the enactment of moderate CO₂ regulations. Sustained low gas prices provide encouragement for new gas-generation technologies (for example, H-frame gas turbines). In addition, more coherent regulation—in the form of capacity markets, CO₂ taxes, or clarity related to coal shutdowns—allows for new-capacity support that will accelerate retirement of the nation’s coal fleet. This will cause the power supply gap to increase to 71 gigawatts before being filled primarily by CCGTs.

Renewables Breakthrough. This scenario supports slightly more fuel independence as stricter emissions regulations are implemented. In addition, there is commercialization of technology innovations that reduce the cost of solar photovoltaic systems, bringing the technology closer to grid parity, as well as favorable incentives that encourage investment. Consequently, adding renewable-energy technologies—such as solar and wind—to the grid

becomes more economical. Fossil-fueled-generation capacity, on the other hand, becomes less attractive owing to the new regulations. As the most fossil-fuel-unfriendly scenario, it would result in even faster coal-fleet retirement than the scenario that has gas as the fuel of choice.

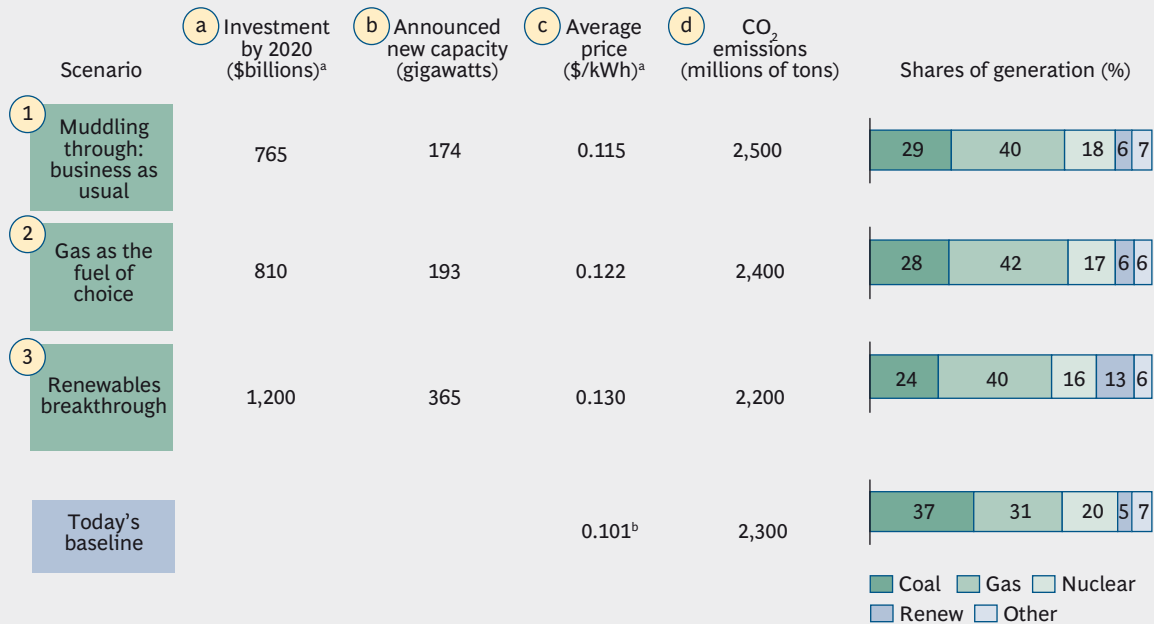
But growing from a smaller base makes it difficult for renewables to fill the gap left by coal-fired capacity. Hence, this scenario sees the power supply shortfall jump to 96 gigawatts before being filled primarily with renewables and CCGTs.

Results: How the Future May Play Out

In all scenarios, coal-fired capacity shrinks, and gas-fired capacity grows. The jump in gas’s share of capacity in all three futures is significant: from 31 percent to more than 40 percent. (See Exhibit 2.)

Coal’s large share of today’s total capacity makes its accelerated retreat challenging, especially in the cleaner-energy scenarios in which coal’s retirement significantly outpaces the building of new capacity.

EXHIBIT 2 | Gas-Fired Generation Increases in Each Scenario



Sources: U.S. Energy Information Administration, *Electric Power Monthly*, December 2011; BCG analysis.

Note: kWh = kilowatt-hour; percentages may not add up to 100 as a result of rounding.

^aReal terms.

^bReflects 2011 average across all customers.

The analysis indicates that emissions regulations can bring about a tremendous difference in the requirement for new generation capacity—174 to 365 gigawatts—across the scenarios. The abundance of relatively cheap natural gas and the more rapid construction of gas-fired plants suggest that CTs and base-load gas plants (CCGTs) will make up a good part of the difference in new capacity.

This new power generation translates into an equally significant investment commitment of between \$750 billion and \$1.2 trillion by 2020, with approximately half representing transmission and distribution. The renewables breakthrough scenario has the highest price tag. It involves adding more capacity than the other two scenarios because of the greater contraction of the coal-fired fleet and the need for additional transmission and distribution capacity. With lower requirements for additional capacity, muddling through is the least costly scenario.

How does the consumer fare in each of the scenarios? Generally, the scenarios suggest a moderate to large rate impact. To pay for new investment, consumer electric rates will likely increase from today's levels by at least 12 percent and nearly as much as 30 percent. This translates to an increase from today's average rate of about \$0.10 per kilowatt-hour to as much as \$0.12 to \$0.13 per kilowatt-hour. Pursuing the renewables breakthrough scenario would result in the highest rate increase, followed by the gas-intensive scenario. Muddling through would result in the lowest increase in rates.

What would be the impact on CO₂ emissions, whose reduction is one of the key objectives of stricter environmental regulations? If the use of cleaner fuels is made a national priority in the renewables breakthrough scenario and the most coal-fired capacity is retired, CO₂ emissions would likely fall by about 4 percent by 2020 from today's levels. Under the scenario that has gas as the fuel of choice, CO₂ emissions would rise by about 4 percent. And CO₂ emissions in the mud-

dling-through scenario could increase by nearly 9 percent by 2020.

There are several wild cards that could upend the predicted outcomes, but two stand out. An accelerated economic recovery may be one of the most important wild cards, given that the gap is highly sensitive to growth in peak demand. Indeed, the gap could climb to nearly 140 gigawatts if the growth rate were pushed up from 1.4 percent to 1.75 percent per year. Alternatively, the U.S. economy could experience a double-dip recession, depressing electricity consumption and reducing the need for new capacity.

Filling the Gap: Next Steps

Considered together, these very different scenarios point to a few important certainties for the U.S. power industry's future:

- Adding capacity will remain a challenge owing to regulatory uncertainty, lack of clear price signals, and dampened power prices, especially in deregulated markets.
- Gas consumption in power generation will increase dramatically.
- Rates will likely see a moderate to large impact from new investment.
- CO₂ emissions can be expected to rise even with significant coal shutdowns and increased gas generation.

The country's current political and regulatory dynamics suggest that muddling through will be the most likely scenario to play out. This means that there is a high likelihood that the power industry may emerge with an inefficient portfolio of plants (mostly CTs) and may experience serious reliability problems as it moves to fill the gap by 2020.

Several actions need to be taken to address these issues:

- First and most important, regulators must set unambiguous policy that

encourages clear and credible price signals for new generation development. These steps could include establishing long-term capacity markets and providing clarity on coal plant transitions (including potential age-based shutdowns compensated with incentives for new capacity).

- Utilities should evaluate the possibility of swapping old-coal shutdowns for new CCGTs in a way that is consistent with their rate trajectories and should use select efficiency programs to mitigate rate impacts. To determine the best ways to further improve availability and costs, the industry should study how best to transfer experience and efficiencies gained from merchant operations to regulated operations. Finally, utilities will want to make sure that cash flow is carefully managed during this time of regulatory uncertainty, still pushing for clarity from regulators on the overall fuel portfolio.
- Merchant generators have the most uncertain future. They should evaluate long-term power-purchase agreements to build new plants, look for opportunities to lower overhead costs, and even consider entering new lines of business during this challenging period of plant development. Some of these new lines may include providing operations as well as engineering and construction services to third parties, and entering into transmission, LNG, and biofuels development.

WHAT IS CERTAIN is that electricity demand, emissions regulations, and technology will continue to shape the industry's future. Thus, as market participants aim to fill the gap, each should capitalize on opportunities for gaining competitive advantage, simultaneously mitigating the risks that characterize this period of uncertainty.

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1/13