WHITEPAPER

Integrated Resource Planning Models Need Stronger Resiliency Analysis

Authors: Maria Scheller; Ananth Chikkatur

Introduction

As reports of unusual cold fronts, wildfires, and floods continue to make news around the country, local and regional electric utilities are again compelled to consider the resilience of electric power grids in the face of weather-related disruptions. In an era defined by climate change and other natural and engineered disruptions, power sector planning needs to not only consider the best resource options, but also ensure that the electric power grid has the capacity to survive and recover quickly in times of crisis. Unfortunately, traditional approaches to Integrated Resource Planning (IRP) fail to adequately consider aspects of resiliency against climate-related and other hazards in the identification of least-cost options for both supply- and demand-side planning. This gap in traditional IRP activities increases utilities' risk exposure, particularly in view of the increasing scale and frequency of weather-related disruptions. To counter this challenge, utilities need to adopt a more comprehensive integrated resource and resiliency planning (IRRP) approach to better plan short and long-term investments, maintain service delivery during high demand, and preserve supply-side fuel capacity. Infrastructure, electrical generation and transmission facilities can and should be planned in a coordinated, efficient and cost effective manner that considers not only the expected needs for electric service, but also the impacts from climate change.

Building Better Resilience Assessments into Integrated Resource Plans

Energy companies normally conduct IRP efforts to evaluate a wide range of alternatives in providing adequate and reliable electric service (including distributed generation resources, renewable energy resources, development of new generation capacity, etc.) and to plot their long-term (typically 10-20 years) delivery of reliable electric service to its customers at least-cost. IRP typically includes identification of resource needs, a preferred portfolio of supply-side and demand-side resources, and a short-term (2-5 year) implementation plan that may include a series of system or technical investments. More detailed IRP efforts also identify substantial risks and uncertainties inherent in the electric utility business, including generation, transmission, and distribution risks. These risk analyses tend to concentrate on the long-run economic and operational performance of alternative resource portfolios (e.g., availability of alternate generation sources, integration of alternatives with existing energy assets, supply reliability, regulatory considerations) as part of the selection of the most cost-effective resource mix.

Resilience assessments, including impacts of climate change, environmental regulations, and other hazards (terrorism, earthquakes, etc.) are conducted for generation sources as well as for transmission and distribution (T&D) systems; however, IRP efforts tend to conduct these assessments in separate parallel tracks without any integration between the two assessments. For example, IRP resiliency analyses have tended in recent years to focus on the availability and reliability issues arising from the transition from less efficient/more environmentally damaging resources (e.g., coal and oil fuel sources) to a more diverse mix of fuel resources with lesser environmental impacts such as natural gas, solar, and hydroelectric. However, they do not usually consider how the reliance on natural gas or demand resources could result in potential instabilities and risk exposure as a result of changing weather patterns due to climate change, increasing share of gas-based generation in the market area surrounding the utility, the sources of natural gas supply, gas contracting challenges, etc. Similarly, while most IRPs consider the ability of a utility to rapidly restore service after a serious rain storm or snowfall damages distribution lines to customers' homes—this is a standard component of any transmission and distribution resilience analysis—they do not usually consider how the grid may react to changing

temperature and precipitation extremes in the future due to climate change. Further, resiliency in the face of a coordinated emergency management is another key consideration. Hence, there is an increasing need to conduct a more comprehensive and rigorous resilience analysis that overlaps the generation and transmission/distribution tracks in order to address the significant risks introduced by global climate change.

IRP Efforts Need Stronger Climate Resilience Analysis in Long Term Generation and T&D System Risks

As recognized in an August 2013 report from the Executive Office of the President[1], extreme weather due to ongoing climate change is the leading cause of power outages in the United States. Over the period of 2003 -2012, severe weather caused 679 widespread power outages around the country and cost the American economy an average of $18 - $33 billion. Most of the current climate change projections show that the incidence and intensity of severe weather (e.g., larger and more powerful storm systems, more dramatic temperature fluctuations, and prolonged periods of drought in different areas of the United States) will increase over the next several years. As severe weather risks increase, so do the risks of significant power outages and selection of inappropriate resources in the long term.

Learning the Lessons from the 2014 Polar Vortex

The "Polar Vortex" event in early January 2014 created a challenging resource management problem for electric providers throughout the Northeast and Midwest, the area's most profoundly impacted by the deep cold. A significant percentage of generation capacity is fueled by natural gas; when temperatures plummeted throughout the Northeast, more of the region's natural gas feed was allocated for heating purposes. This strained the ability of natural gas distributors to allocate sufficient quantities to cover increased power generation demand, and caused a spike in the price some firms paid for critical natural gas fuel. While ultimately most firms avoided a disruption of generation capability, ICF analysts estimated that some came very close to brownout at the peak of the winter storm season.

The United States power grid regularly faces a number of weather-related threats, from Hurricane Sandy in 2012 and the deep cold of the 2013/14 winter season, the wildfires in California and the flash floods in Arizona. In the California drought/wildfire example, the power grid faces multiple and comingled threats. On the supply side, the persistent drought has caused reductions in hydroelectric power generation, and the closure of the San Onofre Nuclear Generating Station also limited the overall power supply in Southern California. Wildfires threaten transmission and distribution lines, but the overall demand is also increasing due to the high temperatures in the region. While efforts are underway to mitigate these risks and prevent widespread outages, such as purchases of additional electrical supply and increased use of solar power, the resilience of California's utilities is being truly tested. Unfortunately, California's utilities are not alone in confronting these increasingly severe weather-related threats. To name only a few recent examples, the increased glacial melt in British Columbia stressed the capabilities of the region's dams, large ice storms caused power outages throughout the Southeast U.S., and the harsh "Polar Vortex" events during January 2014 challenged the abilities of electric power suppliers from the Midwest to the Northeast to access sufficient natural gas and other fuel supplies, which were also experiencing their own transmission and demand issues.

1. "Economic Benefits of Increasing Electric Grid Resilience to Weather Outages," Executive Office of the President, August 2013 (http://energy.gov/sites/prod/files/2013/08/f2/Grid%20Resiliency%20Report_FINAL.pdf)

However, it is not just the natural forces that can affect power systems. Acts of terrorism, flooding, fallen trees, improper maintenance, insufficient spare parts, and other hazards can greatly increase risks of power system failures. In the face of these increased risks, energy companies will be compelled to reconsider how they evaluate both long and short term risks to their infrastructure and incorporate more comprehensive resilience assessments into their traditional long term IRP analyses, as well as their short term emergency planning.

IRP analyses often fail to give adequate consideration to the impacts of climate-related shocks on generation, as well as transmission and distribution systems. Instead, they are often just focused on least-cost selection of generation and fuel resources, with a static perspective on their performance. Given the spread of distributed energy resources and the changes in the fuel diversity and technology deployments of generation market operators, however, it becomes critical to understand and appropriately model the resilience implications of distributed generation systems. As energy firms retire older fuel sources (e.g., closing or reducing coal-burning generators for regulatory or environmental reasons, retiring nuclear generation facilities) and replace them with more diverse distributed generation options such as natural gas-fueled generators and renewables (which themselves have unique resiliency challenges), the potential risk of severe weather-related shocks can increase and must be modelled appropriately in IRP analyses.

Many of the same pressures that drive the deployment of distributed electricity generation (e.g., consumption and grid performance demands in congested areas, environmental/regulatory influencers on applied technology and fuel selection, increased development of cogeneration facilities, differential costs per kWh by fuel type) will also drive increased consideration of generation resilience issues as a risk management priority and competitive differentiator.

Therefore, the IRP framework needs to take into account aspects of resiliency against climate and other hazards. An Integrated Resource and Resiliency Plan would incorporate deeper simulations including transmission planning than traditional planning approaches to establish appropriate considerations of risks in developing new system investments. While utility commissions and state regulations may not yet require such deeper analysis, such prudent planning will better position utilities in addressing uncertainties while increasing resilience and reliability.

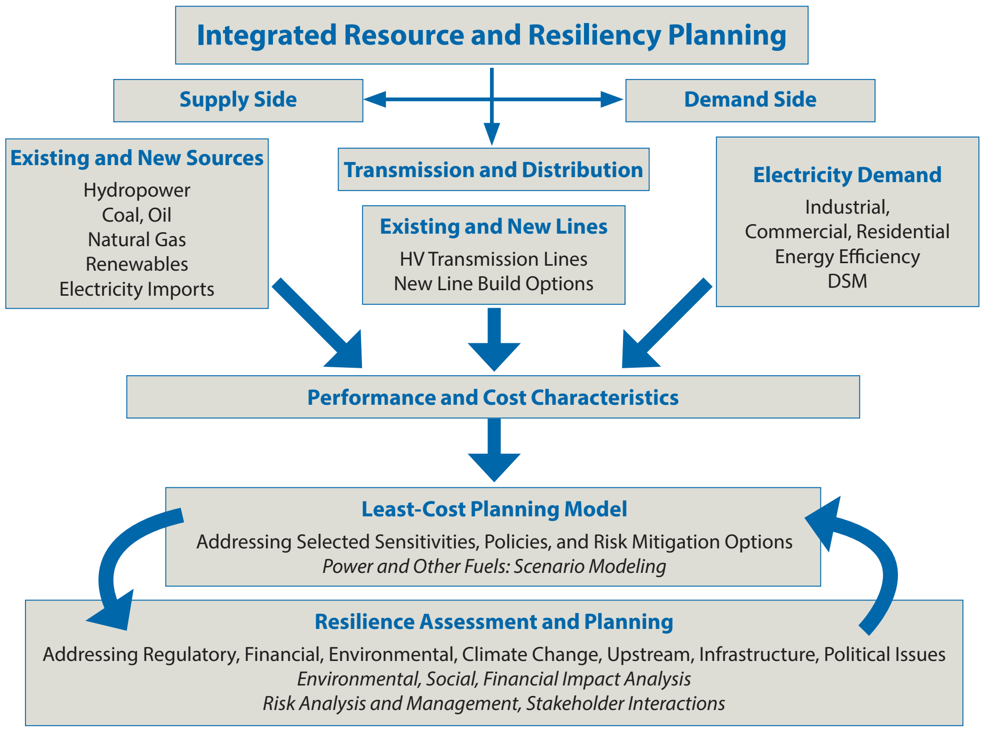
Building a Strong Integrated Resource and Resiliency Plan (IRRP)

Strengthening a utility's overall resilience requires a deep understanding of complex, interlinked electric and fuels systems, evaluating the potential impacts and risks of climate change and other hazards, and balancing the needs and wants of utility customers and regulators. Complying with environmental regulations, particularly those aimed at reducing greenhouse gas emissions, are also having major impacts on resource planning decisions both in the short and the long term.

ICF has developed a model for IRRPs which emphases a stronger feedback loop between resilience assessment and planning efforts and least-cost planning models. As seen in Figure 1, this approach uses the traditional IRP methodologies to develop an interim Least-Cost Planning Model that incorporates the utility's supply, demand, and transmission performance and cost characteristics, but then filters that initial model through a more rigorous resilience assessment and planning process that tests the model through a range of potential threat scenarios. These analyses consider the more likely regulatory, environmental, climate change-related, infrastructure, and political risk scenarios, and are used to generate a "resilience-optimized" least cost model. Utilities can use this optimized least cost model to plan investments, champion infrastructure improvements, and optimize operations that strengthen the reliability of both the supply and demand sides of their operations,

reduce the impacts of weather-related outages, and bolster customer service performance even during peak demand and/or service disruptive events.

Figure 1 - Sample IRRP Framework



The strength of this approach lies in a practical and realistic assessment of resilience threats from multiple sectors across the entirety of the utility's operations, not only the generation and transmission elements, but the customer demand elements that themselves will vary in response to weather-related challenges. A strong IRRP would consider, for example, the ability of a utility to maintain sufficient hydroelectric capability in the face of prolonged droughts and increased population density and demand for water for other purposes, in the case of California.

IRRP Usefulness in Developing Countries

Utilities operating in developing countries can similarly use the IRRP principles and tools to better design their power systems so that they are better prepared to address impacts of climate change, while ensuring that there is sufficient resources to meet their expanding power demand in a resilient and sustainable manner.

Many developing economies are just embarking on strengthening and expanding their electricity infrastructure; several are on the cusp of new infrastructure development that will be the basis for their long term economic development. As such, they are in a perfect position to incorporate climate and other hazard resilience into their long term planning. There are very good opportunities for better integrating icfi.com

About ICF International

ICF International (NASDAQ:ICFI) provides professional services and technology solutions that deliver beneficial impact in areas critical to the world's future. ICF is fluent in the language of change, whether driven by markets, technology, or policy. Since 1969, we have combined a passion for our work with deep industry expertise to tackle our clients' most important challenges. We partner with clients around the globe—advising, executing, innovating—to help them define and achieve success. Our more than 4,500 employees serve government and commercial clients from more than 70 offices worldwide. ICF's website is www.icfi.com.

the full lifecycle (i.e., Generation and T&D) energy resilience into their planning framework, based on comprehensive and in-depth models and simulations--rather than just relying on standard IRP processes.

Scenario analysis that combines exposure of the power system to the climate hazards with standard tools such as ICF's Integrated Planning Model are well suited to assess resilient resource plans that go beyond just least-cost. Such IRRPs can help assess the value and trade-offs of such resiliency planning in terms of economic implication (pure utility cost), and loss of load potential. Sensitivity analyses can also be constructed to include a range of risk factors such as fuel price variation, fuel availability, low hydro conditions, and transmission limitations. The implications of these risk scenarios would be used in a planning framework with stakeholder inputs to determine the least cost and risk solution that would better prepare developing countries for handling climate-related shocks in the future.

Conclusion

IRP process should incorporate resiliency considerations and climate change-related impact scenarios into their analytical frameworks. Climate change-related shocks will continue to be a significant factor in energy operations and risk management efforts for the foreseeable future. While there will always be the potential for a once-in-a-lifetime event to challenge a region's power grid, a strong IRRP approach will enable utilities to plan and build stronger, more reliable, and more resilient short- and long-term investment decisions.

Authors

Maria Scheller is an expert in long-term planning and forward market modeling. She is experienced in assessing long-term market risks and developing strategies around reducing risks and maintaining operational standards. ▪ +1.703.934.3372 ▪ maria.scheller@icfi.com

Dr. Ananth Chikkatur has over 10 years of experience in the energy and environmental sector. He has worked on several power sector, natural gas, and carbon capture and storage (CCS) projects, including projects for private clients, World Bank, the U.S. Environmental Protection Agency (EPA), and the European Commission. ▪ +1.703.218.2593 ▪ ananth.chikkatur@icfi.com