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WHITE PAPER

How and Where Distributed Energy Resources Will Reduce the Need for Transmission

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Executive Summary

The rapid growth of distributed energy resources (DER), a non-transmission alternative, is raising concerns over the viability and necessity of new transmission lines. ICF International's review and analysis of case studies concludes that targeted DER programs will reduce the need for transmission and distribution (T&D) investments in certain areas. Carefully tailored programs can match DER generation with central station resources in a way that reduces new transmission requirements. When DER growth is unorganized (most is today), it does not provide adequate reliability benefits given the changing generation landscape. In light of a significantly changing generation profile due to projected coal unit retirements, additional renewables, and high levels of gas generation, new transmission lines provide an adequate level of flexibility to the system to transfer power from generation to load centers. Aging infrastructure in several regions across the country combined with potential system contingencies also necessitate new transmission lines to be built. Finally, commissions and utilities need to consider regional issues related to electric system contingencies while evaluating transmission needs in the face of growing DER.

Benefits of Transmission

Since the beginning of time, utilities, commissions, and investors have applied the same formula to evaluate the need for new transmission. Transmission lines have long-standing defined benefits. Some of the key benefits offered by transmission lines include providing system redundancy during periods of contingencies (loss of large generation or transmission facilities), enabling development of economic generation options, and increasing optionality on the power supply side.

Recent extreme weather events have caused significant damage to the electrical infrastructure across the United States and have resulted in outages for a large number of customers. These events underline the benefit of a resilient transmission and distribution system. Although DER could provide for certain benefit categories like improved system resiliency, certain factors should be considered such as the flexibility of accommodating new resources where traditional transmission scores better in comparison (see Exhibit 1below).

DER Benefits to System Reliability

DER can provide reliability benefits to the system in the form of deferred T&D upgrades if targeted in specific localities. The class of DER that includes

Exhibit 1—Comparison of Transmission and Non-Transmission Alternatives

Need for new transmission

- Flexibility to accomodate new resources
- Electric and fuel systems contingencies and interdependencies
- Lack of performance history of DER
- Lack of correlation of DER output with system peak
- Reactive power and inertia requirements

Deferral of transmission

- Reduction in T&D losses
- Helpfulness of targeted programs
- Economic benefits of avoided costs of generation
- Reduced water needs and air pollution
- Deferral of distribution system investments

energy efficiency (EE), demand response, solar photovoltaics (PV), and combined heat and power (CHP) applications has the effect of reducing peak demand by providing appropriate incentives to customers to lower energy consumption during stressed grid conditions. In markets like PJM[1], demand resources already contribute about 7.5 percent of the anticipated peak demand in a year. Large transmission projects planned in this region, like the Mid-Atlantic Power Pathway, have been deferred due to weak growth in peak demand partly because of an increase in DER.

The distributed nature of these resources also provides a higher degree of security of supply because minimal common mode contingencies (like loss of fuel for conventional generation) occur.

DER is likely to become much more pervasive. Falling capital costs of certain categories of DER such as solar PV and policy initiatives for CHP, EE, Electric Vehicles (EV) and other applications are causing an unprecedented shift in terms of the balance between the nation's central and distributed generation resources. The list of corporate entities is growing as large firms like Walmart and Costco increasingly embrace the idea of DER to satisfy their energy needs rather electricity purchased from utilities. Because of the reliability of electric supply when sourced locally, coupled with price stability, some of these large commercial customers look at DER options to satisfy their energy needs.

New England Case Studies Illustrate Broad Variations in Viability of Non-Transmission Alternatives (NTAs) Over Transmission Options

Northeast Utilities and National Grid New England East West Solution (NEEWS) Lines Are Needed Even with NTAs

The need for the Greater Springfield Reliability Project (GSRP) was largely driven by double-circuit transmission tower contingencies in the local area of Springfield, MA. These old tower configurations were built several decades ago, and certain types of tower contingencies were creating reliability violations in the system. The proposed transmission solution would replace the towers and provide high-voltage reinforcement in the same corridor. The regulatory commissions in the Southern New England states require an analysis of NTA's while considering the construction of high voltage transmission projects. In the analysis of potential alternatives for this project, the local utility (Northeast Utilities) concluded that DER (mainly energy efficiency and demand response) did not have the capability to offset the need for the proposed transmission project. Detailed analysis indicated that the level of DER projected in the region did not provide an adequate level of reliability required based on the North American Electric Reliability Corporation's transmission planning standards. Subsequently, the project secured all the approvals and now is under construction.

Vermont's "Geo-Targeted" Energy Efficiency Program Has a Strong Potential to Result in Viable NTA Options

In contrast, in the same New England region, ISO-New England (ISO-NE) performed an analysis related to the need for transmission upgrades in the New Hampshire-Vermont areas. ISO-NE identified specific locations in the grid where potential addition of DER could provide a level of reliability comparable to that of proposed transmission projects. In this case, if targeted and planned development of DER occurred at specific locations, the possibility existed for deferring new transmission projects. Historically, Vermont has implemented "geo-targeted" energy efficiency programs to target specific regions for peak demand reductions (see Exhibit 2 on next page).

Maine Example: NTA Defers Transmission Need

Targeted and planned deployment of DER sources could offer reliability benefits that could offset or defer the need for T&D investments. Consider the example of Maine. In April 2012,

[1] PJM Interconnection operates the world's largest wholesale electricity market as the regional transmission organization for the area that encompasses all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia.

the Maine Public Utilities Commission approved a pilot NTA program to defer investment in new transmission lines in the Boothbay region.[2]

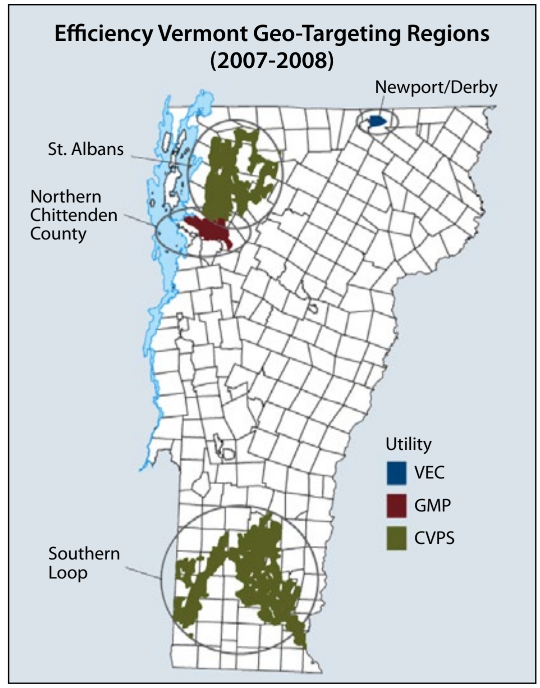
This region of Central Maine Power's (CMP) electric grid primarily is served by a single transmission line. The growth of electric load during the summer season in this region would have necessitated transmission system upgrades to meet electric demand during peak hours. CMP identified approximately $18 million to upgrade a 34.5 kV transmission line from Newcastle to Boothbay Harbor (Line#23) for load serving needs. The commission-approved pilot NTA project comprises the development of 2 MW of DER (2 MW of net load reduction), primarily distributed generation, energy conservation, and demand response that would offset the $18 million transmission need in the Boothbay region.[3]

Targeted NTA programs such as those in New Hampshire and Vermont leading to DER development would defer transmission investments. However, much of the DER program development that happens across the country is not targeted and occurs as a function of customer propensity to invest in technologies. Demographics, income levels, and incentives in the form of state or federal subsidies largely drive development trends of DER. In order to be considered as a strong competitor for T&D investments, these resources need to be analyzed, planned, and developed in a manner similar to traditional T&D systems planning performed in utilities.

Not All DERs and NTAs Are Equal in Terms of Reliability Value

DER impact on transmission will vary vastly by region. Reliability needs in the transmission system are studied and analyzed using contingency analysis performed on industry standard modeling tools. As part of this exercise,

Exhibit 2—Targeted DER Implementation in Vermont



transmission planners assume the outage of multiple elements in the system and study the line flows and voltages at substations to ensure that they are within acceptable limits. When these values are out of limit, they trigger the need for potential transmission solutions. While doing such an analysis, planners consider varying demand conditions, combinations of contingencies, and other externalities in the system (like imports and exports). Due to the nature of contingencies, peak demand, and other externalities, needs vary significantly by region and local system conditions.

Among the key concerns that complicate the comparison of transmission and DER are the lack of performance history and the variability of these resources across regions. For example, in several markets, regional transmission planning organizations have not yet fully finalized

[2] State of Maine Public Utilities Commission, Order Approving Stipulation, Docket No. 2011-138, April 30, 2012. Retrieved from http://www.gridsolar.com/uploads/boothbay_rfp/puc_order_stipulation/PUC Order Approving Stipulation - 20120430.pdf

[3] GridSolar, LLC. Retrieved from http://www.gridsolar.com/BoothbayProject.html.

appropriate methods to reflect DER in long-term reliability planning studies.

Resources such as rooftop solar PV also exhibit substantial variation in performance across the United States, even between markets with rapid solar PV growth. For example, residential solar PV systems net annual average capacity factors in Southern California and New Jersey are typically 18 percent and 14 percent, respectively. Although the magnitude of annual generation varies by state, the typical daily output profile of a solar PV system escalates over the course of the morning as the sun rises, peaks in the afternoon when the sun is at its highest point, and declines through sunset. System performance varies seasonally and geographically due to differences in climate conditions, which are collectively accounted for in average annual irradiance estimates (available solar radiation over time). Similar issues exist with regards to modeling of CHP units based on technology type and in different regions. For an effective study of DER as an option against transmission, utilities and other stakeholders involved in the process must fully agree upon the underlying set of assumptions and modeling methods.

Conclusion

Distributed energy resources can be considered as NTAs because they provide capacity on the supply side to the electric system during periods of need. Federal policy in the form of Federal Energy Regulatory Commission Order 1000 requires transmission providers and utilities across the country to actively consider DER as potential NTA options. This provision allows DER to have an equal footing to compete against transmission. Can these resources really offset the need for high-voltage transmission? Will a time occur when no new transmission lines are necessary because every structure has a solar panel on its rooftop? The answer depends on the reliability of the distributed resource and its location in the network. Only targeted programs that add resources at specific substations in the grid have the capacity to provide reliability benefits in a manner similar to transmission lines. Other generic programs that lead to overall growth in DER will not have a significant impact on the need for transmission projects.

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About ICF International

Since 1969, ICF International (NASDAQ:ICFI) has been serving government at all levels, major corporations, and multilateral institutions. With more than 60 offices and more than 4,500 employees worldwide, we bring deep domain expertise, problem-solving capabilities, and a results-driven approach to deliver strategic value across the lifecycle of client programs.

At ICF, we partner with clients to conceive and implement solutions and services that protect and improve the quality of life, providing lasting answers to society's most challenging management, technology, and policy issues. As a company and individually, we live this mission, as evidenced by our commitment to sustainability and carbon neutrality, contribution to the global community, and dedication to employee growth.

About the Author

Kiran Kumaraswamy is a Senior Manager in ICF's Energy Advisory Solutions practice. Mr. Kumaraswamy's decade of expertise is in transmission planning studies, transmission asset valuation, due diligence, Locational Marginal Price (LMP) forecasting, merchant transmission investment assessment and power systems modeling. He also specializes in distributed generation modeling, generation interconnection and risk assessment, estimation of transmission congestion, NERC Reliability Standards Compliance and benefits of Regional Transmission Organizations (RTO) in deregulated energy markets. Recently Mr. Kumaraswamy studied the impact of varying levels of distributed energy resources penetration on feeders in the western US and associated reliability impacts on the distribution system. Prior to joining ICF, Mr. Kumaraswamy worked on the dynamics of Distributed Generation (DG) systems where he studied the modeling of fuel cells and micro turbines related to power generation. Mr. Kumaraswamy extensively uses GE-MAPS©, PowerWorld© & GE-PSLF© for modeling applications and analysis.

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