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MARKET BARRIERS AND EMERGING OPPORTUNITIES FOR DISTRIBUTED ENERGY RESOURCE NETWORKS

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ABSTRACT

In the near future distributed energy resource networks will enhance power reliability and create greater economic value than single site distributed energy projects. These networks offer the advantages of decentralized infrastructure and automated managerial processes that optimize energy production near the point of consumption. Barriers to DER networks consist of traditional market impediments as well as challenges for early adopters specific to networking distributed energy resources. This paper examines the motivations of early market adopters and predicts likely outcomes if certain conditions are met.

KEY WORDS

Distributed Energy, Market Barriers, Distributed Generation, Networks, Distributed Energy Resource Networks

Introduction

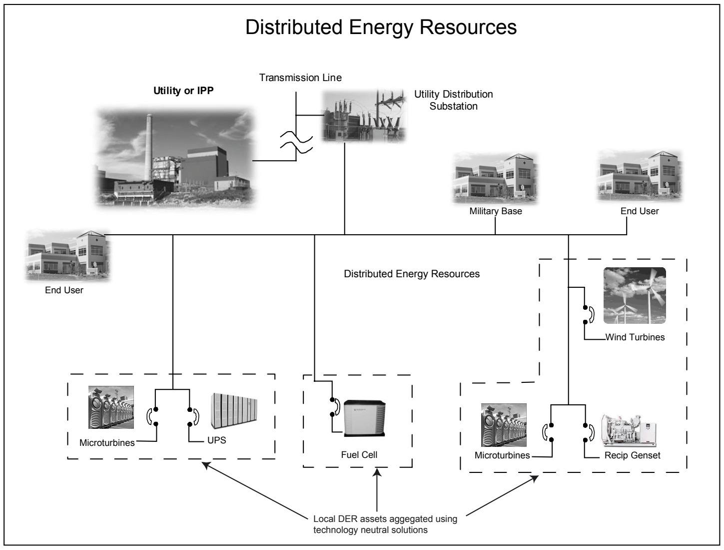
In the next few years, large and robust networks that aggregate distributed energy resources (DER) such as generators, flywheels, microturbines, fuel cells and uninterruptible power supplies will gain marketplace acceptance. By design, DER assets are often sited on the fringes of a utility distribution network. While they are close to the point of energy consumption, DER assets are not necessarily in close proximity to each other or to those who wish to manage them. While onsite management of a single generator in a remote location is difficult, manual coordination of hundreds of generators or other DER assets located at multiple sites is practically impossible. The value of networks integrating DER assets extends beyond simple communications and controls. Integrating DER assets into an enterprise level energy management system improves the energy managers' ability to optimize the production of energy for economic and reliability purposes.

The early adopters of networks aggregate DER assets primarily for power reliability purposes. While the underlying economics will remain important, financial considerations will be secondary for the early buyers. The first installations of robust DER networks are likely to be government agencies – specifically the Department of Defense – and organizations such as utilities engaged in power delivery.

Ironically, the initial purchasers of DER networks will likely not be private sector organizations – the intended primary beneficiaries of utility deregulation. Rather, these early will be the Department of Defense and energy delivery firms since these segments possess the vision, have the motivation and the resources to transcend the multiple marketplace barriers. These two market segments have mission critical demands for energy reliability – demands so high that they are difficult to calculate in economic terms. Thus, the underlying justification for DER networks will be based on power reliability. However, these organizations are not blind to economics and will actively explore avenues to recover their investments in DER networks.

Market Barriers

Despite numerous commercially available technologies, to date there have been few large installations of DER networks. The barriers to implementation are traditional marketplace forces that when combined often make DER projects more expensive and time consuming than many buyers can afford. As an example, technically it is quite feasible to interconnect Caterpillar and Kohler generators with each other and the utility grid and to automate dispatching sequences based on market signals and operating costs. However issues such as utility interconnection, permitting, and emissions must be addressed prior to the commissioning of a project of this scope. Unfortunately, straightforward projects are difficult to accomplish due more to marketplace hurdles rather than technical feasibility.



The various marketplace barriers can be divided into two basic, high-level categories: those that exist throughout the traditional distributed energy marketplace, and those unique to networking DER assets.

Traditional Barriers to DER

Traditional barriers to implementation of DER assets include the lack of coherent and widely adopted standards for emissions, permitting, and utility interconnection. In addition, throughout the energy marketplace opaque price signals make economic values difficult to quantify. And, most DER technologies (other than diesel and reciprocating engines) are early in their commercial lifecycle and require relatively high apital investments in unproven machinery. Because of these factors, the DER marketplace has not matured to the point where there are successful business models to emulate.

Energy delivery firms and governmental agencies are uniquely positioned to address many of the traditional DER barriers. Collectively these organizations are responsible for many of the market impediments. Energy delivery companies enjoy a high degree of control over interconnection requirements and rate design. As highly regulated organizations, they have ongoing relationships with government agencies and are well equipped to address emission and permitting issues. Government agencies such as energy policy boards and the Department of Defense have superior access to regulators for permitting and emissions issues than private sector parties. This is becoming particularly evident as senior political leaders recognize the need for recognized the need for reliable energy. Additionally, governmental bodies are in a better position to receive favorable treatment from energy delivery firms, as energy delivery firms are dependant on regulators for their commercial success.

New Market Challenges for DER Aggregation

Barriers to DER aggregation, specific to networking technologies, pose new challenges for early adopters requiring unique resources. There are two sets of hurdles. First, buyers are faced with a fragmented vendor base with the majority of vendors offering partial or incomplete networking solutions. Moreover, many vendors are startups with little commercial experience to prove their technologies. Thus the buyer may require technical advisors to perform research and recommend the appropriate combination of vendors and technologies. Second, once DER assets are aggregated, commercial applications requiring power export or bi-directional power flows remain difficult to execute due to limitations in the utility delivery system and inefficient market structures.

Barrier: Fragmented Vendor Base

Buyers of DER networks have a multiple set of vendors to select from, yet are often challenged to find a vendor with a complete product offering since aggregating distributed energy resources requires the following elements:

1) An interface synchronizing DER assets with the energy delivery network and/or the utility grid.

2) An interface synchronizing DER assets with each other in various combinations of generation and power storage technologies to support various modes of interoperation.

3) A communications interface integrating and interoperating multiple DER assets with multiple DER sites.[1]

To illustrate the value of each of these elements, consider the following three points:

First, without a synchronous connection to an energy delivery network, the DER unit operates in isolation serving a dedicated load. By design, a non-synchronous installation can only create value if there is demand from a dedicated load. If a dedicated load source is idle, then the DER asset also remains idle and unable to take advantage of external events. Devices to synchronize DER assets with the utility grid are widely available from OEM and traditional electrical apparatus suppliers.

[1] In addition to an interface with multiple DER assets and multiple locations, certain buyers may require advanced network functions such as integrated communications with utility SCADA systems, power trading systems, ISOs and specialized networks such as load aggregators, demand response programs and enterprise energy management software platforms.

However, this vendor base rarely provides the additional networking components.

Second, synchronization is vital to aggregate DER components sharing the same site. Without the ability to load share, DER assets cannot be dispatched in optimal sequences. Operators of DER networks will seek the ability to prioritize dispatch sequences based on a variety of factors including operational costs, fuel availability or emissions output. Few OEMs of DER assets provide interfaces to synchronize their technology with those of competitive products. As an example, both Caterpillar and Cummins are leading manufacturers of similar generator technologies. Despite nearly identical technological platforms, synchronous operations between two generators of the same vintage require an interface solution often provided by a third party. Fuel cells, microturbines, flywheels and other DER technologies require similar bridging technologies for synchronous operations.

Third, technologies for the remote management of multiple DER installations must provide the necessary communications channels to each node on the network. While there are a multitude of vendors with communications solutions, many of these technologies are based on proprietary or closed communications protocols and fail to interface with competitive products. Often they are simple networking devices (hardware based solutions) that can determine if a DER is on or off but fail to provide safe and dynamic system control. Additionally, the majority of networking devices do not integrate fuel price, energy tariff data, and other external market data as triggers to bring DER networks online. Remote management technologies represent yet another set of vendors providing the integration of DER assets with SCADA systems, customer meters and enterprise level management platforms.

Government agencies, particularly those with deep research and development resources, are best poised to address the challenges of a fragmented supply base. The Department of Defense was one of the earliest adopters of fuel cells and has experimented with a variety of onsite energy technologies in a diverse number of locations for many years. With an existing depth of resources, the Department of Defense is in the best position to work with a fragmented supply base to create a robust and technology neutral network to aggregate and manage distributed energy resources.

Utilities, like many privately held firms, lack the government's depth in technology research resources. Without the resources to integrate multiple products from a fragmented vendor base, utility customers may select vendors with a single but potentially incomplete networking solution. These incomplete solutions are often based on proprietary generation or communication technologies that limits the scope of a DER network.

Barrier: Power Export

One of the frequently cited values of aggregating DER installations is the ability to assemble large blocks of marketable energy. Alone, a single DER asset often does not produce enough energy to create a marketable block of wholesale power. However, collectively, many DER assets acting in concert can create marketable trading blocks of energy. For any commodity to fulfill its commercial potential there must be an inexpensive and reliable means of transportation to the marketplace or the commodity value is diminished. While DER assets in aggregate can create large blocks of electricity, unless the demand for that energy is local – on the same substation feeder or microgrid – it may not be feasible to deliver the commodity to a market exchange. [2]

Unlike power from central generation plants, the output from DER units is often difficult to transport for technical, safety and regulatory reasons. Utilities, for the most part, have not constructed their transmission and distribution networks to transport power upstream or "backwards" through sub-stations. Thus for DER assets sited near or on low voltage distribution networks, exporting power beyond the local feeder may not be feasible. Another constraint is that safety considerations limit the exportation of power from customer controlled DER assets onto a utility network. Finally, the Federal Energy Regulatory Commission and many state regulators require licenses for commercial electric utility networks and commercial electric generators. Gaining regulatory approval is typically time consuming and expensive.[3] Thus, quantifying and then capturing commodity energy value produced by DER networks is difficult if there is not a local point of consumption.

Energy delivery firms are responsible for the design, construction and maintenance of transmission and distribution networks. They are the sole organizations that can implement a technological solution that incorporates bi-directional power flows. In essence, energy delivery firms can provide DER owners physical access to the wholesale energy markets. The probability that they do so in the near future remains low. To date, with few exceptions, many energy delivery firms have been hesitant to provide interconnection services linking DER assets to the utility grid. Until DER assets are installed in synchronous operations with the utility grid, there is little reason for energy delivery firms to focus on power export issues.

[2] DER assets can be placed upstream of substations – however, then they are no longer are "distributed" but assume the function of a central plant.
[3] Production and transportation of thermal energy is an unregulated industry and networks of thermal energy exist throughout the US often located in central business districts and in campus environments.

Market Opportunities: The Energy Delivery Sector

Energy delivery firms engaged in owning and/or operating transmission and distribution networks possess a regulated monopoly status. Their primary mission is the reliable delivery of energy on a universal basis. Failure to meet this mission is difficult to quantify but the costs associated with it have long-term political and financial ramifications. As energy delivery firms seek DER assets as part of their reserve margins and demand curtailment programs, economic considerations will take a backseat relative to the mission critical demand for power reliability. Since DER networks are highly reliable and offer fast response times, energy delivery firms challenged to meet peak market demands may become the first adopters of DER technologies. As these DER technologies are spread across the vast utility delivery network, management networks will be installed to integrate DER assets with other utility systems.

In the construction of DER networks, the physical asset can be placed on either side of the customer meter. The location is important in that it defines many business applications. However, as long as the energy delivery firm retains control of the asset – even on the customer side of the meter – the asset can be used to enhance overall power reliability throughout the delivery system. Assuming the DER serves a local load, total system demand is alleviated through onsite generation. Customer owned DER assets could become contributors to what many in the utility industry have referred to as virtual power plants.[4] Virtual power plants are assets owned by a non-utility entity but are utilized to enhance utility operations. As virtual power plants are adopted, utility entities will create networks to manage them.

In addition to improving system reliability, energy delivery firms recognize a strategic opportunity to establish networks of distributed energy resources. At some point in the near future, as onsite generation gains market acceptance with end users, energy delivery firms will be faced with a competitive threat. Consumers of DER technologies are often interested in activities that reduce their consumption of utility supplied electricity. Energy delivery firms could be severely hurt by the widespread adoption of distributed energy resources as they have little market flexibility. They are obligated by regulatory fiat to provide reliable service on a universal basis and are heavily invested in a capital-intensive network of fixed assets that may become underutilized when onsite generation is widely adopted by consumers. Thus, energy delivery firms will be challenged to either compete against a potentially disruptive technology or provide incentives to end users that allow the energy delivery firms to manage the onsite generation assets in mutually beneficial ways. A market-focused energy delivery firm will create DER networks to control consumer owned generation assets so that the assets are used in coordination with the utilities' needs. If they fail to do so, end users of DER assets will compete directly against energy delivery firms.

Inside the utility sector, energy delivery firms are uniquely positioned to address many of the traditional DER barriers. As previously mentioned, they often control interconnection requirements, have superior access to regulators, and possess strong competencies in the ownership, management and control of energy intensive devices scattered across a large region. These capabilities stand in contrast to other sectors of the utility industry. Energy firms focused primarily on marketing commodity power lack both a compelling rationale and the underlying means to create and manage DER networks. While DER technologies are often cited as a means to reduce energy expenditures, when the bulk of those expenditures are decomposed and analyzed, the majority of the costs are related to energy delivery. The market value of the underlying commodity is generally low. Unless incorporated with high demands from end-users for thermal energy, firms focused on commodity energy will have difficulty justifying the economic merits of DER technologies solely on the basis of market prices in most regions of the US. However, if these firms can combine the commodity value with the delivery value as defined by transmission and distribution organizations, the incentives to build and actively manage DER networks will be increased.

Market Opportunities: The Defense Sector

Governmental agencies comprise another early market for DER networking technologies. Governmental agencies have the means and the motives to create a robust DER network. These organizations have the better access to address environmental, regulatory and interconnection policies than any current commercial stakeholder. The underlying motives to adopt DER network technologies are compelling for political and military leaders. In short, for politicians, energy instability correlates to political instability. For military planners, energy security is becoming synonymous with national security.

Military planners have long sought methods of reducing energy costs. Now, in light of recent events, energy security will become increasingly important. The use of DER technologies may play an essential role in reducing overall energy costs while enhancing power reliability for the military. To date, the Department of Defense has been at the vanguard of installing and testing fuel cells in diverse applications and environments. While the primary motives for testing were to improve power reliability and to reduce total energy costs, the tests

[4] Encorp, the authors' employer, develops and markets software that aggregates and manages DER assets under the name Virtual Power Plant™. For more details, visit the www.encorp.com for product literature and white papers on the Virtual Power Plant™.

themselves are part of a large research and development project that few private sector firms could afford to finance.

Military bases provide ideal settings for networking DER assets. Many defense installations have onsite power systems for emergency backup purposes. These emergency systems are often isolated from the distribution network and remain idle expect for the rare utility outage. As the demand for reliable power increases, these assets can be networked and dispatched for automating testing and maintenance procedures. Via networking, military energy managers can deploy diverse fuel and generation technologies. These diversities create additional layers of security during emergencies.

Fort Bragg, located in North Carolina, has retrofitted its emergency standby generators by interconnecting them with the utility grid and to each other. A total of 3.85 MW of peak load generation capacity has been created from assets previously sitting idle except for emergency purposes. As a result, the Army achieved its goal of enhancing power reliability by creating a manageable network of DER assets and by reducing its overall energy expense through peak shaving capabilities.

Conclusion

Customers considering the installation of a DER network are confronted with a choice between open, technology-neutral networks and closed, proprietary systems. A leading challenge to technology neutral networks is the fragmented vendor base. While the military has deep resources in research and development, most other organizations including utilities do not.

Early adopters in the energy delivery sector may select closed, proprietary DER networks. In the past, the utility industry has concentrated on standardization of assets. The reasons often cited include the simplification of operations and maintenance that leads to greater reliability. With the potential lack of research and development resources to evaluate and then integrate multiple technologies, it is unlikely that energy delivery firms will have any desire to work with a fragmented vendor base to create a technology neutral network. Commitment to proprietary technologies may ultimately delay robust network applications. The DER market is nascent and it is too early to predict which generation technologies and communication platforms will be dominant. In selecting proprietary standards, energy delivery firms are betting that today's DER marketplace will remain static or that current standards can be easily adapted to future technologies.

The military may take a different perspective and find that a technology neutral network provides greater flexibility and redundancies. Energy security can be compromised by the weakest link in the network. Therefore, by diversifying communication and generation technologies overall network stability is increased. An open – or technology neutral – DER network can integrate multiple generation technologies with multiple communications protocols. To further enhance the management of this network, open protocols can be integrated with existing IT systems. Given the need for energy security and its existing research and development resources, it is unlikely that the military will rely on both a single communications platform and a single generation technology.

Going forward, the greatest challenge for technology vendors to address is the creation of dynamic and non-proprietary DER networking standards. The fragmented vendor base will recognize the greater value of technology neutral networks. Low cost and simple interoperability of technologies is a vital step to reach the mainstream marketplace. In the next few years, it can be expected that leading DER networking vendors will work in a coordinated manner to create integrated solutions to aggregate and actively manage distributed energy resources.

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About Encorp:

Founded in 1993, Encorp develops and markets software and hardware technology solutions for the communication, control, and networking of distributed energy. Encorp's product and service offering includes a complete line of power controls, automatic paralleling switches, automatic transfer switches, digital paralleling switchgear, software and technical services. For more information visit www.encorp.com or call 888-295-4141.

References

[1] Geoffrey A. Moore, *Crossing the chasm* (New York, NY: Harper Business, 1991).