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January 30, 2017

VIA FERC ELECTRONIC FILING SYSTEM

Federal Energy Regulatory Commission
Attn: eFiling Department
888 First Street, NE Washington, DC 20426

Dear Sir or Madame:

On behalf of the Microgrid Resources Coalition, enclosed please find comments in response to FERC's Notice of Proposed Rulemaking on Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators filed November 17, 2016 in FERC Docket Nos. RM-16-23-000 and AD 16-20-000, submitted pursuant to Rules 214 and 211 of the Rules of Practice and Procedure of the Federal Energy Regulatory Commission.

Thank you for your attention to this matter.

Very truly yours,

C. Baird Brown

CB

Established 1849

Microgrid Resources Coalition
Comment on Notice of Proposed Rulemaking

Docket Nos. RM-16-23-000; AD 16-20-000

Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators

Introduction

Pursuant to Rules 214 and 211 of the Rules of Practice and Procedure of the Federal Energy Regulatory Commission ("FERC" or "Commission")[1], the Microgrid Resources Coalition ("MRC") hereby moves to intervene and submits its comments in connection with the Commission's Notice of Proposed Rulemaking, Docket No. RM-16-23-000, Electronic Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators, dated November 17, 2016 ("NOPR"). The MRC is a consortium of leading microgrid owners, operators, developers, suppliers, and investors formed to advance microgrids through advocacy for laws, regulations and tariffs that support their access to markets, compensate them for their services, and provide a level playing field for their deployment and operations.[2] In pursuing this objective, the MRC does not favor particular technologies deployed in microgrids or ownership structures for the assets that form a microgrid.

The MRC defines a microgrid as "a local electric system or combined electric and thermal system that: (1) includes retail load and the ability to provide energy and energy management

[1] 18 C.F.R. § 385.211, 214.
[2] The MRC is actively engaged in advancing the understanding and implementation of microgrids across the county. MRC members hold significant energy assets connected to the electric grids, provide energy generation and supply services, and are exploring microgrid construction and ownership in different locations throughout the country. The MRC is affiliated with The International District Energy Association and other MRC members include: Anbaric Transmission, ICETEC Energy Services, Concord Engineering Group Inc., the Massachusetts Institute of Technology, NRG Energy, Inc., Princeton University, Thermo Systems, the University of Texas at Austin, and the University of Missouri.

services needed to meet a significant proportion of the included load on a non-emergency basis; (2) is capable of operating either in parallel or in isolation from the electrical grid; and (3) when operating in parallel, can provide some combination of energy, capacity, ancillary or related services to the grid." A microgrid can be as simple as a cogeneration facility behind a single meter with an isolation breaker, but sophisticated microgrids often serve larger facilities or campuses and will increasingly serve multiple customers. The included loads have diverse needs and are served by diverse generating and storage resources. The same advanced control functionality that permits them to manage complex host operational requirements behind the meter also allows them to provide increasingly sophisticated services to the larger grid. The grid has only begun to take effective advantage of the capabilities of microgrids.

In this NOPR, the Commission proposes reforms to its rules and regulations to remove barriers to the participation of electronic storage resources and distributed energy resource ("DER") aggregations in the organized wholesale electric markets.[3] The MRC shares the Commission's concerns that the varying participation models among RTO/ISOs limit market opportunities for new resources and technologies, and is encouraged by the principles that the Commission articulates. We strongly support the Commission's efforts to address these emerging issues.

The MRC is concerned, however, that the Commission has not yet come to grips with the promise and complexity of aggregations. The MRC believes:

- Microgrids are highly flexible integrated aggregations that are capable of providing a wide variety of services to the grid at both the wholesale and distribution levels.

[3] Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators, 81 Fed. Reg. 86522 (proposed Nov. 30, 2016)(to be codified at 18 CFR 35) ("NOPR").

- Aggregations need their own participation model. They have more uses than expanding access for small resources,[4] and their characteristics are often more complex than the demand response model or the proposed storage model.
- Microgrids typically manage included resources to meet multiple customer goals including optimizing across electric and thermal loads, providing resiliency and power quality, and environmental performance. Managing for these multiple goals is not permissible or possible for grid operators.
- Customers will invest in generation and storage resources to meet their own needs and will be able to provide services to the grid at competitive prices because they are not relying on the grid for the full return on their investment.
- Aggregations should be able to participate in all markets that they can physically and reliably address. They need to face clear price signals so they can allocate resources between their own uses and serving the needs of the grid.
- Aggregations should be permitted, as other grid resources are, to specify portions of resources or particular sub-aggregations to participate in particular markets. The measure of eligibility to participate is the ability to put a resource, as defined, under effective dispatch control by the grid operator dispatch control and to provide metering, controls and real-time record keeping to permit clear tracking of the designated resource.
- Rules to prevent double counting of services are necessary but must be carefully crafted to prevent them from causing unnecessary barriers to participation by unconventional resources.
- Aggregations that include behind-the-meter resources may include customers that are both purchasers and sellers of power. They may have complex pathways to purchase and store

[4] MRC member University of Texas at Austin has over 100 MW of generation capability.

power and use or redeliver power. The Commission's proposals relating to storage acting as both a buyer and seller do not yet address the issues raised by such aggregations.

- Microgrids are the local building blocks of the grid of the future. The path to energy resiliency and security lies through creation of an interlocking web of local controlled aggregations that integrate with and support one another and the larger grid in flexible configurations.

Microgrids are Highly Integrated and Flexible Aggregations

A typical microgrid is an aggregation of multiple DERs serving included load in a compact area.[5] Microgrids may include electric storage resources, distributed generation, thermal storage and electric vehicles as the Commission notes,[6] but may also include a wide array of other resources and capabilities such as the ability to transfer heating or cooling load from electric to thermal energy sources and back, the ability to use buildings themselves as thermal storage, and the ability to alter the time of use for many different types of loads. These capabilities are typically managed by sophisticated controls that permit the microgrid operator substantial ability to control its aggregate load profile in detail, across a variety of factors relevant to the grid operator. In addition, microgrids have the unique capability to serve their customers, but also assist the grid operator by becoming an island in an emergency. They can then resume parallel operation in concert with the grid operator helping to stabilize the restart of the system and the restoration of power.[7]

Through the same flexibility that provides benefits to their hosts, microgrids are uniquely suited to create efficiencies for the grid. They can make it economically feasible to place

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[5] They may include multiple metered loads and be served by more than one substation but are almost always connected to a single transmission node.
[6] NOPR at 86525.
[7] MRC member Princeton did this in the aftermath of superstorm Sandy.

generating capacity in congested areas of the grid and, from a planning perspective, can reduce contingencies that threaten grid stability.[8] Using electric and thermal storage capabilities, a microgrid can provide local management of variable renewable generation, particularly on-site solar. Through fine tuning its own generation and load, a microgrid can shape its system profile to not only provide traditional demand response or ancillary services, but a wide variety of load and generation modification services to the grid pursuant to long term contracts with the distribution company or an aggregator, or in response to real-time dispatch or market signals. Contracted services can be unique, customizable solutions to localized planning and operational challenges. Microgrids employing multiple energy management technologies can simultaneously provide multiple services using multiple dynamic objective functions. These distribution support system services can be designed to meet the particular needs of the distribution system in emergencies or in daily operation.

Aggregations Need Their Own Participation Model

The MRC believes that the proposed participation model for storage resources may be helpful for microgrids and other DER aggregations, and we appreciate the Commission's proposal that aggregators be allowed to register DER aggregations under the participation model in the RTO/ISO tariff that best accommodates the physical and operational characteristics of the distributed energy resource aggregation.[9] We are concerned, however, that just as participation in wholesale markets by storage resources may be inhibited by lack of a participation model suitable to their capabilities, so too, aggregations, and in particular microgrids, do not fit neatly into existing participation models or the new model required by the NOPR. As one example, the current

[8] Please see the paper by Ted Borer, *Microgrids Add Reliability to the Macro-grid,* attached as Exhibit A to this filing.
[9] NOPR at 86523.

participation model for demand response in most markets is based on the shutting down of an industrial process or the activation of a seldom used generator. In the former case there is a clearly measurable baseline and in the latter a clearly defined, non-apportioned backup generation resource. In a microgrid using multiple conventional and unconventional resources to manage multiple more and less flexible loads, optimized by sophisticated controls, neither metric may be a good fit. With suitable metering, controls and records the whole or portions of a microgrid can provide specific wholesale services to the grid, but RTOs have been reluctant to recognize these capabilities. As a result, microgrid participation in demand response markets is frequently restricted.[10]

In its Order in the California Independent System Operator Corporation's Distributed Energy Resource Provider Initiative,[11] the Commission permitted participation in aggregations of separately metered resources independent of the various attributes of the other loads and resources behind the meter. The critical feature of this arrangement is the ability to define the limits of participation so that the aggregator, and hence the system operator, can dispatch the aggregation within those limits. For a microgrid operator, it should be enough to present a defined and measurable group of resources that are dispatchable within defined limits.[12] An aggregation may be able to absorb power (have a charging rate) and deliver power (have a discharge rate) but that likely will not fully describe its capabilities. The Commission should affirm the ability of aggregators across all markets to define the capabilities of their resources.

Tariffs Should Allow Advanced DER to Self-Optimize

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[10] MRC members have experienced this difficulty in PJM in particular.

[11] California Independent System Operator Corporation's Distributed Energy Resource Provider Initiative, 155 FERC ¶ 61,229 (June 2, 2016).

[12] Like any other resource, such an aggregation would be subject to penalties if it does not meet dispatch instructions.

The NOPR's discussion of storage devices recognizes that a storage device with co-located load would "be interested" in managing its state of charge.[13] Microgrids, by definition, have co-located loads, and they are more than interested in managing their resources in response to the needs of their included load. That is their primary reason for being.

Microgrid operators manage their resources to meet multiple customer goals. These include not only reasonably priced energy, but resiliency, power quality and environmental performance standards. As discussed above, they often operate to optimize across both electric and thermal load, and they use the capability to substitute gas and electricity (or other energy sources) and different forms of storage to arbitrage their purchases in energy markets. In addition, several MRC members are major research universities where loss of power can destroy years' worth of research: power continuity is critical. And these universities, like many others have either signed either the American College & University President's Climate Commitment or Climate Leadership Commitments[14] or adopted their own stringent carbon reduction goals. Managing this combination of activities and outcomes would not be permissible or possible for distribution companies or grid operators, who must operate to optimize the electric grid for all customers.

To the extent that an aggregation or any storage resource wants to manage its own readiness under the storage participation model or any other model, it should have that option. If the grid operator wants to be able to manage the state of charge or readiness, it should pay for the privilege. This is analogous to the problem encountered in ISO New England of managing the discharge of pumped storage resources. If the operator wishes to "posture" the resource for emergencies then it

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[13] NOPR at 86534.

[14] *American College & University President's Climate Commitment* and *Climate Leadership Commitments*, available at http://secondnature.org/climate-guidance/the-commitments/#Climate_Commitment.

pays for the privilege.[15] If the resource owner wants to bid to provide reserves, for example, it must be able to manage its state of charge so it is able to perform when called. By defining the product, much as PJM has done with enhanced capacity products, the RTO/ISO can obtain the control or readiness it requires. In the absence of compensation, and of agreement and selection to participate in particular markets, the owner should manage the resource.[16]

The microgrid is most efficient when it is able to internally optimize itself against a transparent tariff through price signals rather than being optimized by an outside operator. The microgrid is best optimized when access to markets for wholesale services is uninhibited. The MRC recognizes that the burden of metering to ensure availability and dispatch-ability would fall on the microgrid and notes that this is well within the capabilities of microgrid controls. The MRC believes that as distribution companies become distributed services platform providers,[17] and are compensated for managing the platform, that telemetering should be a part of the function of the platform.[18]

Customer Investment in DERs Benefits All Consumers

Microgrids, as discussed above, typically manage included resources to meet multiple customer goals. Distributed generation and storage resources empower customers to make choices

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[15] *ISO New England Inc., Market Rule 1 Revisions Regarding the Provision of Regulation by Non-Generating Resources*; Docket No. ER08-54-006 (August 5, 2008); *ISO New England Inc. and New England Power Pool, DARD Pump Parameter Changes*; Docket No. ER16-954-000 (February 17, 2016).

[16] NYS Dept. of Public Service, *Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision: Order Adopting a Ratemaking and Utility Revenue Model Policy Framework*, May 19, 2016, p. 49.

[17] NYS Dept. of Public Service, *Reforming the Energy Vision: Staff Report and Proposal*, April 4, 2014, p. 9.

[18] There is considerable current controversy about high penetration rates of DER on the distribution system. This mostly concerns high levels of rooftop solar. All DER are not created equal. For example, the typical rooftop solar PV installation does not communicate to the grid in real time and is unable to modulate production in response to signals from the grid or its owner. At the other end of the spectrum, advanced DER such as microgrids are typically smart and responsive – able to communicate with the grid operator and respond with finely tuned output. Our suggestions are focused on sophisticated, responsive aggregations.

that efficiently suit their energy needs. Customer goals include obtaining high-quality, reliable, low-cost electricity, but also obtaining heating, cooling, hot water, chilled water and steam for specialized processes. They have choices of energy sources, including gas, electricity, geothermal, solar, biofuels and biomass, and through thermal and electric storage and equipment optionality (such as steam vs. electric chillers or ice or chilled water storage using low cost night time power and reducing demand for peak afternoon power) can optimize among those sources. Customer decisions about usage of other utilities, such as water and sewer services, are often integrated in the decisions about energy use. Those uses may soon expand to include wide use of electric or plug-in hybrid vehicles. Customers also frequently have non-monetary goals, such as decreasing their carbon footprint. Customers generally are the only ones that can effectively make integrated choices between energy sources, between modes of operation, and between monetary and non-monetary goals for their energy usage.

Because customers have incentives to invest in energy solutions to meet their own needs, they are often in a position to provide services to the grid at prices that need not reflect their full cost of capital to provide the service.[19] All grid customers can benefit from microgrid cost-competitiveness. Customers deploying DER need to face clear price signals for the services they provide to the grid to allow them to make efficient decisions. Because microgrids have the ability to provide reliable, low-cost services, they can make an extremely valuable contribution to wholesale markets and customer results.

Aggregations Should Have Access to All Markets

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[19] It follows that efforts to measure the cost or macrogrid cost of particular microgrid services may difficult or self-defeating.

In order to ensure that the full benefits of Microgrids are realized, and in order to permit Microgrids to fully contribute to the competitiveness of RTO/ISO markets, progress must be made on removing regulatory barriers to entry. In addition to allowing aggregators to define their resource qualitatively and quantitatively for bidding purposes, artificial restrictions on market entry must be eliminated. The Commission and commenters identified many particular barriers to non-traditional resource participation.[20] MRC members have experienced many of these difficulties.[21] The MRC has identified numerous additional barriers to non-traditional resource participation aside from tariff frameworks and restrictive definitions of resources that limit microgrids' ability to obtain compensation in the market. The MRC notes that the recent CAISO tariff revisions regarding the aggregation of distributed resources allowed resources to participate in the market that would not otherwise fall within the size or resource definitions for DER resources and were restricted to providing demand response rather than participating fully in the wholesale market.[22] Once the tariff changes allowed for the participation of aggregated distributed resource, those resources were able to participate in the wholesale markets. The MRC supports the proposed rules as a way for the Commission to enable new technology resources to participate in wholesale markets and provide value to the wholesale grid.

Aggregators Must Have Flexibility to Define Their Bid Resources

As new technologies enter the system, it follows that operators and aggregators of DERs need to be able to define the capacity of their resources. The Commission makes a nod in this

[20] NOPR at 86531.
[21] We find it particularly disappointing in light of the Commission's compilation and our experience that the PJM market monitor claims there are no barriers that limit participation by electric storage resources. In any event, we believe that the barriers to microgrid participation are more numerous than those facing storage resources as such.
[22] And those including cogeneration using fossil fuels are prohibited entirely from the demand response markets notwithstanding their superior efficiency. California Independent System Operator Corporation's Distributed Energy Resource Provider Initiative, 155 FERC ¶ 61,229 (June 2, 2016).

direction when it suggests permitting batteries to de-rate their capacity in order to meet durational requirements of a wholesale market product.[23] The MRC supports this suggestion, but would go further. Traditional generation resources are allowed the flexibility to divide themselves into multiple ownership or management shares which may be controlled and bid by different parties, and, except to the extent required by the terms of a capacity market, are generally free to bid or not bid different portions of a resource in different markets. We strongly suggest that resource aggregations such as microgrids be permitted to do the same.[24] In one example in which an MRC member was involved, a non-profit institution in New England installed a new, behind-the-meter cogeneration resource and concluded that the most effective positioning in the wholesale market was in part as a baseload passive unit and in part as a dispatchable demand response resource. ISO New England initially denied this registration, thus eliminating a competitive resource from the market.[25]

In the experience of MRC members, these kinds of decisions often rest on manuals or discretionary interpretations of rules for which it is difficult to obtain effective review.[26] A microgrid operator must choose between retaining flexibility in the use of its own resources for its own internal optimization, or committing them whole or in part to the system operator. There is an opportunity cost to foregoing operational flexibility by bidding into the wholesale markets that the microgrid operator hopes to recoup in those markets. System operators cannot appreciate the nature and extent of these trade-offs, and should not be empowered to substitute their own

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[23] NOPR at 86531.
[24] Rules in PJM have permitted MRC members to bid an incremental MW of generation capacity into the regulation market, but other rules have prevented them from also participating in the spinning reserve market.
[25] This decision was reversed months later, after an opportunity to participate in the annual capacity auction was missed.
[26] In some instances the decisions are expressly articulated as implementing a "minus G" policy notwithstanding the clear language of Order 745 and the Supreme Court's decision in *EPSA v. FERC. Federal Energy Regulatory Commission v. Electric Power Supply Association* (*EPSA)* 136 S. Ct. 760 (2016) ("FERC v. EPSA").

judgment to cut off participation in the markets.[27] RTO/ISO local decisions have the potential to undermine resource flexibility unless the Commission articulates a strong policy preference for resources not only to be permitted to aggregate but also to disaggregate and apportion resources in the structuring of bids.

The Commission Should Exercise Caution in Articulating Rules To Prevent Double Counting.

The NOPR articulates that resources should not be able to participate in wholesale markets while at the same time receiving the benefit of net metering or demand response programs.[28] The MRC supports the principle of avoiding double compensation for the same service but recommends caution in applying what the Commission states as a flat prohibition. A preliminary concern follows directly from the previous discussion. A microgrid operator or other aggregator should be permitted to use different resources within its aggregation or different portions of the same resource to participate in different programs. So long as metering, controls and recordkeeping are in place to prevent double counting, the microgrid operator is the best judge of how to optimize its allocation of resources between its own load and participation in various available programs.[29] A microgrid operator should be required to register and meter resources under its control for each relevant market and meet the physical requirements for the market.

The important principle is that a single resource should not be paid twice for the same net energy output; e.g. energy exports from a net-metered solar array. But, the same generator could be bid into several markets in segments. It is also important to keep energy products separate from other products. A reserve resource gets paid for power when called to deliver as a reserve resource.

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[27] NOPR at 86531.
[28] Id. at 86543.
[29] Id. at 86534.

The payment it receives for standing by to provide reserves is separate from the payment for energy when called. A demand response resource can also provide regulation by modulating output around its dispatched demand response profile. The MRC is concerned that RTOs will use policies slated as flat prohibitions to exclude broad categories of advanced but unconventional resources. We ask the Commission to clearly articulate that these rules be crafted narrowly and not act as arbitrary limitations on participation in wholesale markets.

Purchase and Sale of Energy by Microgrids

The NOPR's discussion of batteries generally assumes that a battery purchases electricity from the grid and resells it.[30] There is no discussion of the regulatory posture when behind the meter resources charge the battery[31] other than a third-party comment that it will generally be at retail rates.[32] The MRC believes that LMP rates are the more economically efficient result, but agrees that retail rates are legally appropriate.[33] In retail choice jurisdictions large customers can typically arrange to pay LMP (plus a markup) for the commodity power portion of their utility bill. A retail supplier could also agree to pass through to the customer the economic consequences of a demand bid by the supplier on the customer's behalf.

FERC has requested comments on whether the proposed requirements should include existing RTO/ISO requirements conditioning eligibility to provide ancillary services on having any energy schedule.[34] Microgrids and other behind-the-meter resources do not usually have an

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[30] Batteries installed in connection with solar arrays are eligible for federal investment tax credits in proportion to the percentage of their charging power that comes from the solar array. Accordingly, operators will want to manage this aspect carefully.
[31] Id. at 86525.
[32] Id. at 86538.
[33] The Court in *FERC v. EPSA* held that the Federal Power Act grants FERC jurisdiction over rules and practices that directly affect the wholesale rate while approving FERC's use of LMP as the wholesale standard for demand response. See, *FERC v. EPSA*.
[34] NOPR at 86531-86532.

energy schedule for the reasons discussed above, but are operating in parallel and ready to serve. The energy schedule requirement is an unnecessary impediment to competition. Again, regardless of schedule, if a microgrid bids, but does not respond to the dispatch signal it faces penalties.

Microgrids are the Building Blocks of the Grid of the Future

The Commission's actions in this docket are critical, not just for the functioning of the current grid and the current markets, but for the future of the grid. United States grid assets are old compared to those in other industrialized countries and our rate and duration of outages exceeds those in such countries.[35] The grid was built before the advent of modern control technologies and at a time when superior economies of centralized generation prevailed. It is not adequately designed to withstand determined cyber-attacks or physical attacks.

Technology now permits a new kind of grid that takes advantage of the reduced costs of DER, while also rendering the grid more stable and less vulnerable. A grid composed at the local level of a web of microgrids managed through semiautonomous distribution system controls can deploy and conduct an orchestra of DER in a manner broadly analogous to packet switching on the internet. Individual microgrids, or groups of microgrids, can become islands or net exporters to avoid cascading failure or to support neighboring areas. They can have the benefits of interdependence but avoid the risks, making the grid as a whole more stable and secure.

To build this system microgrids and other sophisticated aggregations must be able to compete on a level playing field with other resources. They need a non-discriminatory

[35] Off the Grid News, Study: US Power Grid Has More Blackouts Than Entire Developed World, available at <http://www.offthegridnews.com/grid-threats/study-us-power-grid-has-more-blackouts-than-entire-developed-world/>

participation model that addresses their widely adaptable characteristics, and offers true open access to markets. The MRC hopes that the Commission can use this NOPR to move forward on these issues.

Conclusion

The MRC thanks the Commission for considering these comments in response to the NOPR. We hope the brief discussion of issues and initial feedback presented in these comments help to highlight some of the Commission's options to allow full non-discriminatory market participation by aggregations and to foster microgrid development. Overall, the MRC wishes to stress that advanced distributed resources such as microgrids encounter strong barriers to entry and limited compensation opportunities for providing services to the grid. We encourage an approach in which all services (including all net exports to the grid) are valued and compensated appropriately based on their performance. This is the only approach that is consistent with non-discriminatory opportunities for all capable and competitive resources to provide grid services and the empowerment of customers.

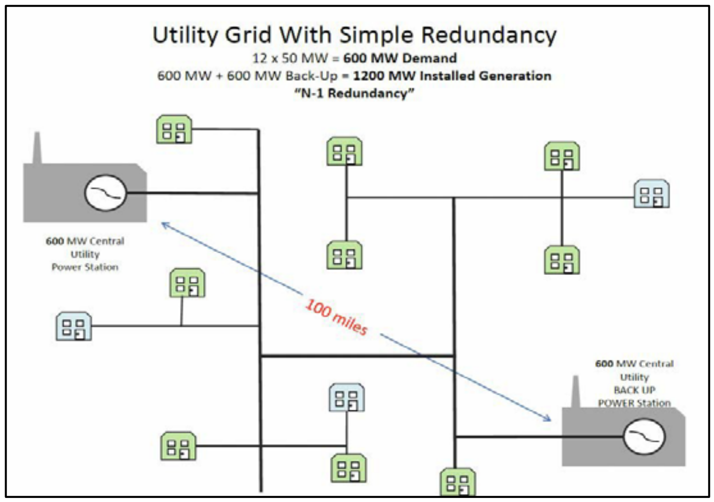
Appendix A: Microgrids Add Reliability to The Macro-grid

Ted Borer, PE

4/16/15

Microgrids reflect the local community priorities

Microgrid operators often choose not to own enough behind-the-meter power generation to meet peak electric demands. Most don't find it cost-effective to generate all their own power at all times. But they own enough generating capability to meet *mission-critical* demands and they can decide in advance which power uses are deferrable in an emergency. They have re-claimed the ability to decide what lamps get lit in a crisis. One can imagine that in a regional emergency, municipal services such as police, fire, hospital, water, sewer, railroads, and sources of a community's food and fuel should get highest priority. Similarly, when health and safety are at risk, some electric demands could be deferred such as: a sports arena, furniture store, clothing factory, theater, skating rink, or a shoe repair. If power is only supplied and controlled from distant locations outside a community, these choices are not always available.



How could a power grid be arranged to improve reliability without excess cost?

In simple terms we want to reduce the scale of failures and diversify risk while operating at high efficiency. Let us look at a ***highly simplified*** example.

Figure _1_ shows a regional power grid with 600 megawatts peak demand, represented as twelve 50 MW loads. There is one main 600 megawatt generator to meet the demand and one 600 megawatt generator available as back-up for any time the main generator is unavailable. The two utility plants are located far from each other to minimize the risk of common-mode failure. Each green building represents one or more critical loads. Dark lines represent the high-voltage transmission system. Lighter lines represent a medium voltage distribution system. Each blue building represents one or more deferrable loads. With 100% back-up, the system has "N-1" redundant generation. But there is no cost-effective means to use the waste heat since the generating stations are far from the thermal users. This represents much of today's grid.

Figure _2_ shows two different vulnerable points where the loss of a transmission node or substation could interrupt power to several critical and non-critical loads, even when both generators are available. This was the most common type of failure during Hurricane Sandy.

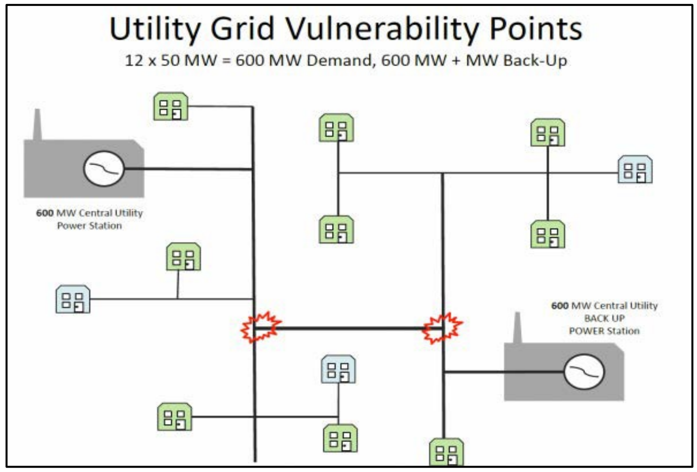


Figure _3_ shows a hybrid grid made of central utility plants with distributed microgrids. By localizing some power generation, the transmission and distribution inefficiencies are reduced. There is the possibility of improved reliability and efficiency without building additional high voltage distribution systems. The opportunity for CHP exists, while non- critical loads can still be fed by larger, relatively efficient generators. Either one of the two central utility plants can fail, but all loads get service. Both of the 200 MW utility plants or a few of the microgrid plants could fail and all critical loads would still get service. Similarly we have reduced the risk of transmission system failures with more distributed generation. The spinning reserve requirement has dropped from 600 MW to just 200 MW. Note that in this example, 800 MW of distributed power generation is providing a much higher level of reliability and efficiency than 1200 MW of utility-only generators shown in Figure _1_.