NEW JERSEY BOARD OF PUBLIC UTILITIES

MICROGRID REPORT

Disclaimer

This Report was prepared by The New Jersey Board of Public Utilities Staff and does not necessarily represent the views of the New Jersey Board of Public Utilities, its Commissioners, or the State of New Jersey. This Report is provided for informational purposes only and does not provide a legal interpretation of any New Jersey Statutes related to microgrid operations.

Table of Contents

Executive Summary

The New Jersey Board of Public Utilities (BPU) Microgrid Report (report) provides information for the Board's consideration for potentially establishing New Jersey's initial microgrid policies.[1] The report also provides staff's evaluation related to the specific comments raised regarding the distribution of electricity from an advanced microgrid or a Town Center distributed energy resource (DER) microgrid to multiple off-site critical customers during an emergency when the distribution grid is down or failed.[2]

The report is an analysis and assessment of the current publicly available microgrid reports and Distributed Automation/Smart Grid reports.[3] The development of this report involved a review and evaluation of the microgrid statutes, regulations, orders, proceedings and filings in other states, as well as interviews and discussions with officials from those state programs. In addition the development of this report included discussions with New Jersey electric distribution companies (EDC), gas distribution companies (GDC), the United States Department of Energy (USDOE) and their federal labs, and microgrid developers/organizations and DER microgrid customers.

The following is a summary of each section of the report:

Section 1. Background: The general impact of major weather events, including a summary of the overall economic impact, a summary of the State's Hazard Mitigation Plan in regard to alternate energy and the state/local government FEMA recovery requests for back-up generators, and the history of electric system outages and the probability of future storm related outages.

Section 2. General Definition and Classification of a Microgrid: The generally accepted definition of microgrids and microgrid classifications, the types of distributed energy resource (DER) technologies that can operate within a microgrid, their general benefits including resiliency and the cost ranges of DER microgrid technologies.

Section 3. BPU Definitions related to Microgrids: New Jersey's relevant Public Utility Statutes are provided and the statute's relationship to the general microgrid definitions and classifications and other regulations, codes and policies that relate to advanced microgrids.

Section 4. Microgrid Energy Manager: The energy management functions within the distribution and transmission grid system and the advanced microgrid.

---

[1] See Section 2 for a general classification of microgrids based on customers. A multiple customer DER microgrid is also referred to as a level 3 or advanced microgrid. This Report further refers to advanced microgrids that provide DER systems to multiple critical customers at a local level as a "Town Center" DER microgrid. A TCDER microgrid is a type of advanced microgrid. See the NJIT Report in Section 6.5.

[2] The microgrid directive in this Report was initiated in response to a comment summited on the draft Energy Resiliency Bank Wastewater and Water Facilities Program Guide and Financial Product, dated August 27, 2014 as set forth in the Board's September 27, 2014 Order Docket No. 0014060626.

[3] These documents are listed in the reference section of the report.

Section 5. Microgrid Activities in Other States: The current and projected DER cost trends that are impacting microgrid development, the current status of microgrid development in some key states, and including a list of national and international microgrid projects.

Section 6. New Jersey's Current DER and Microgrid Capacity: The current microgrid development in New Jersey and a summary of the New Jersey Town Center microgrid market potential analysis.

Section 7. EDC Smart Grid and Distribution Automation Plans: Defines and describes Distribution Automation and Smart Grid systems. This section summarizes national and New Jersey distribution automation and smart grids pilots and programs as well as the general cost and benefits of smart grids, and the status of distribution automation and smart grid development in New Jersey and other states.

Section 8. BPU Microgrid Stakeholder Meetings / Policy Issues: Summarizes the discussions from the individual BPU microgrid meetings between the NJBPU, the microgrid developers, electric and gas distribution companies, Rate Counsel, and microgrid market sector customer associations. This section addresses staff's response to a comment set forth in the Board's September 27, 2014 Order – The New Jersey Energy Resilience Bank (NJERB) – Initial Program Guide and Budget Extension Docket No 0014060626, and The New Jersey Energy Resilience Bank – Water and Wastewater Treatment Facilities Financial Products Docket No 0014091018 ERB. This comment was submitted based on the draft NJERB Program Guide and Wastewater and Water Treatment Facilities Financial Products presented at BPU/EDA August 27, 2014.[4]

Section 9. Next Steps: Staff's recommendations to the Board based on the analysis of the available data and reports related to the comment and response. This section of the report is

[4] **Comment 116 Submitted by Concord Engineering:** To enable multi user applications the BPU should adopt rules that define the provision of emergency power as being exempt from utility franchise restrictions and allowing a direct wire connection from an onsite generator to nearby critical facilities. This would need to include appropriate safeguards similar to emergency generator transfer trip devices to prevent back feeding power onto utility lines which would be a safety hazard. **Response:** The issues raised by this comment are beyond the scope of the ERB Guide and Product; further, the rules recommended by the commenter may be outside the authority granted to the Board. Staff will recommend that the Board direct staff to initiate a stakeholder process on issues related to the provision of emergency power, including power to critical facilities, and report back to the Board on whether statutory and/or regulatory changes are necessary and, if so, with recommended statutory and/or regulatory provisions.

staff's recommendations related to developing advanced or Town Center DER (TCDER) microgrid policies. This section was developed based on an evaluation of the current microgrid data and information and on discussions with stakeholders at four advanced microgrid meetings.

An objective of the report is to provide data and technical analysis to the Board and provide Staff's response for emergency operations (black sky conditions) in response to Superstorm Sandy and other major grid outages. In addition, the report also provides a general technical analysis for operating a microgrid with multiple customers under normal conditions (blue sky conditions) for 24/7 operations. This includes an analysis of the benefits and costs for operating a microgrid with multiple customers under blue sky conditions for 24/7 operations.[5] The report also lists, reviews and analyzes the regulatory, technical and financial barriers that would need to be addressed to develop a statewide policy for a DER microgrid for multiple customers. This is called an advanced microgrid or TCDER microgrid.

The report examines the following key questions:

- Can the advanced microgrid operate in a manner that provides more resiliency for the state or local government and critical facilities than the current central generator, transmission and distribution grid system?
- Can the advanced microgrid operate in a manner that provides additional reliability to the current local distribution grid system?
- Can the advanced microgrid operate more efficiently than the current central generator, transmission and distribution grid system, saving the microgrid customers, owners and/or operators energy costs?
- Can the advanced microgrid operate in a more environmentally effective manner lowering air emissions, water usage, wastewater discharges, waste generation and land use impacts than the current central generator, transmission and distribution grid system?
- Can the advanced microgrid provide benefits to the distribution grid overall?
- What benefits does the distribution grid supply to the advanced microgrid?
- What are the costs that the advanced microgrid imposes on the distribution grid?
- What are the costs that the distribution grid imposes on the advanced microgrid?

Based on an evaluation of the reference documents cited in this report, a review of microgrid projects in New Jersey and other states, in general a TCDER microgrid, can provide enhanced energy resiliency for critical customers at the local level as well as enhanced reliability and efficiency for usage of the distribution system grid. The TCDER microgrid can accomplish this with enhanced energy efficiency, clean energy generation including both renewables and natural gas combined heat and power, lower air emissions and other environmental impacts, as well as

[5] In a Cost Benefit Analysis (CBA) the benefits are converted to a monetary value to enable a comparison to the costs.

overall energy cost savings to the multiple critical customers. If designed properly, including optimizing the location, a TCDER microgrid can potentially benefit the distribution system.

A specific finding of the benefits for a specific TCDER microgrid will depend on a case- by-case foundation based on the specific design and operations of the TCDER microgrid. It will also depend on how the obstacles that could limit the TCDER microgrids effectiveness and efficiency are addressed. A case specific assessment must be confirmed through a detailed cost benefit analysis and an optimization of each specific TCDER microgrid within the local distribution system. As performed in other state microgrid programs, this would be accomplished through a detailed feasibility study of the specific TCDER microgrid.

It is also worth noting that the experience and knowledge of developing, implementing and operating advanced microgrids within the local distribution system is greatly expanding every day in States across the nation. The report is just a snapshot of that progress to evolve and modernize the grid. A key component to the development of advanced microgrid is the development and implementation of Smart Grid or Distribution Automation. This needs to include the development and implementation of communication systems through distribution energy management systems for these new technologies.

States, along with the federal government, are experimenting with an array of DER technologies and utility business models within a changing and modernized grid. It is clear that the systems and equipment within the current distribution grid that have been developed over the last 100 years have served States and the country well. However, the metric for measuring adequate performance of the distribution system is changing to include not just reliability but resilience, flexibility and sustainability in terms of environmental attributes.

New Jersey utilities, reacting in some degree to Superstorm Sandy and other events as directed by the Board, are moving in the direction of modernizing the local distribution grid. Accordingly, utilities need a firm policy directive to complete that movement. This report can serve in part as the technical background for that policy directive for grid modernization and advanced microgrids as a component of the distribution grid.

1. **Background**

Superstorm Sandy's Impact to New Jersey's Electric Distribution System[6]

As time goes by, the impacts of Superstorm Sandy and other weather-related outages starts to recede like the storm surge waters, but it is important to remember the overall impacts caused by these storms. The following is a summary of those impacts.

At approximately 8:00 p.m. on October 29, 2012, Superstorm Sandy made landfall in New Jersey just north of Atlantic City.[7] Seventy- one percent (71%) of New Jersey's electric distribution system was impacted, resulting in 2.8 million residential and commercial electric customers, approximately 5 million people, losing power. Over three hundred twenty-five thousand (365,000) housing units were impacted, resulting in damages. This is approximately ten percent (10%) of all of the New Jersey housing units, and ten times greater than the new housing construction permits issued on average each year. Nineteen thousand (19,000) small businesses were impacted by Superstorm Sandy with damages totaling over $8.3 billion to their businesses.[8]

(Image 1.a)

[6] Data Presented to the Board by the BPU Division of Security and Reliability after Sandy.
7.
[8] *Economic Impact of Hurricane Sandy Potential Economic Activity Lost and Gained in New Jersey and New York*, U.S. Department of Commerce (September 2013).

In addition to the electric power outages, gas lines to the barrier islands were damaged. Because of the potential for explosions and fires from natural gas leaks, the gas lines to the barrier islands were shutdown. Without pressure in the gas lines, the lines flooded. A portion of the gas distribution to the barrier islands had to be replaced. However, natural gas distribution systems throughout the State were largely unaffected by Superstorm Sandy.

Tidal surge, flooding and wind damage caused power outages and a shutdown of the State's petroleum bulk storage terminals along the Arthur Kill, as well as two major refineries and several petroleum pipelines. Over seventy percent (70%) of gas stations in northern New Jersey were off line a week after Superstorm Sandy. The limited gas stations that had power still had a sparse delivery of fuel because of the shutdown of the refineries and pipelines. Governor Chris Christie evoked his emergency powers regarding the rationing and delivery of petroleum products to customers. This included gasoline as well as diesel for operating back up or standby generators.

Many critical facilities, including wastewater treatment plants, water treatment plants, hospitals, nursing homes, care centers, communication centers and county evacuation centers were either operating on standby generators or were completely shut down. Some multi-family apartment buildings had no power to operate their elevators or other utilities. Hospitals, nursing homes, long-term care facilities, domestic violence shelters, foster homes, mental health facilities, multi-family public housing and other critical social service providers throughout the state were forced to contemplate evacuation in light of prolonged power outages. Police stations, fire stations, 9-1-1 call centers, and other emergency operations were also severely hindered in their efforts to provide emergency services.

(Image 1.b)

Ninety-four wastewater treatment plants across all twenty-one counties flooded and lost power. Failed pumps allowed saltwater intrusion into the systems destroying electrical equipment. It is estimated that between 3 and 5 billion gallons of untreated wastewater was discharged into New Jersey's waterways. Two hundred and sixty-seven (267) of the six hundred and four (604) water systems across the State were without power, and thirty-seven (37) of those systems issued boil water advisories following the storm.[9] One month after Superstorm Sandy made landfall, seven drinking water systems were still subject to boil water advisories.[10] Low-lying facilities in flood hazard areas could not operate pumping stations without power, causing direct and significant long-term damage to facilities.

(Image 1.c)

Local Requests for Backup Generators after Superstorm Sandy

The first recovery activities and funds deployed after a statewide emergency like Superstorm Sandy are through the Federal Emergency Management Agency (FEMA) under the Hazard Mitigation Grant program (HMGP). This aid is based upon requests submitted in a Letter of Intent (LOI) from state and local government agencies and not-for-profit (NFP) companies to assist in recovering quickly from the damage. Long-term recovery funds come from the U.S.

[9] NJDCA Sandy Response Action Plans and amendments http://www.renewjerseystronger.org/wp-content/uploads/2014/11/Action-Plan-Amendment-1-NonSubstantial-Clarifications.pdf and http://www.renewjerseystronger.org/wp-content/uploads/2014/11/NJ-Action-Plan-Substantial-Amendment-7-R-FINAL-formatted-5-23_CLEAN-ve-.pdf.

[10] NJDCA Sandy Response Action Plans and amendments http://www.renewjerseystronger.org/wp-content/uploads/2014/11/Action-Plan-Amendment-1-NonSubstantial-Clarifications.pdf and http://www.renewjerseystronger.org/wp-content/uploads/2014/11/NJ-Action-Plan-Substantial-Amendment-7-R-FINAL-formatted-5-23_CLEAN-ve-.pdf.

Department of Housing and Urban Development (HUD) in the Community Development Block Grant – Disaster Relief (CDBG-DR) program.

After Superstorm Sandy there were almost 1,000 individual LOI requests for multiple back-up or emergency generators. The New Jersey Sandy HMGP budget was $100 million and the LOI requests for back-up generators totaled over $469 million. It was estimated by BPU and DEP staff that the LOI for emergency back-up generator requests collectively totaled over 800 MW. The LOI for emergency back-up generator requests were for powering critical facilities or to support operations of critical functions at the local level including: emergency traffic lights; emergency street lights; pump stations; emergency shelters; wastewater and water facilities; police, fire and emergency response facilities; and administration buildings that provided emergency shelter.

In October of 2013, the State announced the award of the $25 million HMGP Energy Allocation Initiative to support back-up power and alternative energy solutions for local governments to enhance energy resilience (move footnote 12 here). Because of overwhelming demand for this program and the availability of additional HMGP funding, the State provided an additional $13 million in HMGP funds under the Lifeline / Life Safety Program to fund additional local energy projects at critical facilities. Collectively these programs were able to provide funding awards to 337 local governments in all twenty-one (21) counties. Despite the availability of the HMGP funds, only eight percent (8%) of the LOI backup generator requests could be funded.

Based upon the overwhelming HMGP requests, there is a clear need for local government agencies to improve and enhance their energy resiliency at local critical facilities.[11] This was not the first time the state and/or federal government supported the funding of backup generators for local critical facilities and functions. Unless a better program was developed after the next emergency, the state and/or federal government might be back supporting the procurement of more backup generators.

Because of the magnitude of the HMGP requests a portion of the State's Hazard Mitigation Plan developed by the New Jersey Office of Emergency Management (OEM) was updated in 2014 to address this issue. A new goal was developed in the statewide plan to require the enhancement of energy resiliency of critical facilities through alternate energy sources. Further, the OEM sought to encourage the development and implementation of alternate energy sources for resiliency at the local level within the local emergency mitigation plans.

Major Storms Impacting NJ's Electric Distribution System

Over the last several years New Jersey and the Northeast/Mid-Atlantic States have been impacted by several major storms including:

[11] New Jersey statutes do not define energy resiliency. See N.J.S.A. 48:2-1 et seq. For this report, energy resiliency is the addition or inclusion of islanding equipment and black start capabilities as part of an on-site distributed energy resource system.

1. East Coast Derecho July 2011
2. Hurricane Irene August 2011
3. October snow storm October 30, 2011
4. Super Storm Sandy October 29, 2012
5. Northeaster November 7, 2012
6. East Coast Derecho June 2013
7. New Jersey wind storms June and July 2015

While not causing statewide power outages, the Northeast polar vortex that caused the deep cold weather of the winter of 2014 and the Northeast snow storms and blizzards of the winter 2015 should also be included in any analysis of the impacts of extreme weather on the centralized power systems. These extreme weather conditions resulted in a demand on the electric power generators at the time that stretched the central power generation and transmission system to the ultimate limits. The impacts of these extreme weather events have resulted in significant changes in the Regional Transmission Organizations operations.

During these past significant extreme weather events, electric restoration efforts took 4 to 7 days to reach full restoration. Hurricane Irene required seven to eight (7-8) days before approximately one million customer outages were restored. The October 2011 snowstorm took seven (7) days before approximately one million customer outages were restored. In the case of Superstorm Sandy, despite having the largest utility workforce ever mobilized in New Jersey, full restoration of the 2.8 million customers outages took fourteen (14) days.

These storms and others, resulting in varying degrees of power outages across New Jersey and the Mid-Atlantic/Northeastern States, pointed to the immediate need to harden the energy infrastructure to be more resilient to future storms. Because of the impacts of these storms, New Jersey state government, and the State's utilities, has taken steps to harden the distribution system infrastructure.

Following Superstorm Sandy, the BPU commissioned a study by Rutgers' Center for Energy, Economics and Environmental Policy ("CEEEP") regarding energy vulnerabilities and resiliency needs.[12] Utilizing New Jersey storm electric outage data from the National Oceanic and Atmospheric Administration ("NOAA") in addition to New Jersey electric distribution companies' annual reports, the CEEEP study documented the number of total electric outages by outage events and types. As noted in the total storm outage table below, New Jersey experienced 143 events that caused a sustained power outage between 1985 and 2013.[13]. These events

[12] Rutgers Center for Energy, Economics and Environmental - Policy Overview of New Jersey Power Outages: Risks to the New Jersey Grid, March 6, 2014

[13] As used in the Rutgers' Outage Report a sustained outage is an outage greater than 5 minutes IEEE Guide for Electric Power Distribution Reliability Indices No 13666. N.J.A.C. 14:5-1.2 defines a major event as an interruption of the electric service resulting from conditions beyond the control of the EDC which affect at least 10% of the customers in the operating area.

include tropical storms, hurricanes, wind storms and rainstorms, ice storms, tornadoes, and winter storms/nor'easters.

Total Storm Outage Report

Outage Event	# of Total Events	# of Cumulative Affected Customers	% of reported events	Mean size of customer outages
Wind/Rain	96	4,430,900	67.1	46,155
Winter Weather/Nor'easters	22	2,018,200	15.4	91,736
Ice Storm	5	95,500	3.5	19,100
Tornado	2	121,000	1.4	60,500
Lightning	9	175,800	6.3	19,533
Hurricane/Tropical Storm	9	5,768,500	6.3	640,944
Totals	**143**	**12,609,900**		

Database storm event totals and proportion of storm types/mean outages; from CEEEP Storm Events Database. Image 1.d)

As noted in the major outage chart below, of the 143 sustained outages, 27 qualified as major outages. A major outage in the CEEEP Report is defined as an outage that impacts more than 100,000 electric customers for a period that extends beyond one day. The customers impacted in outage reports refer to the number of meters of the EDC. The actual number of people and businesses impacted by an outage is greater than the number of meters impacted by approximately two and a half times. [14]

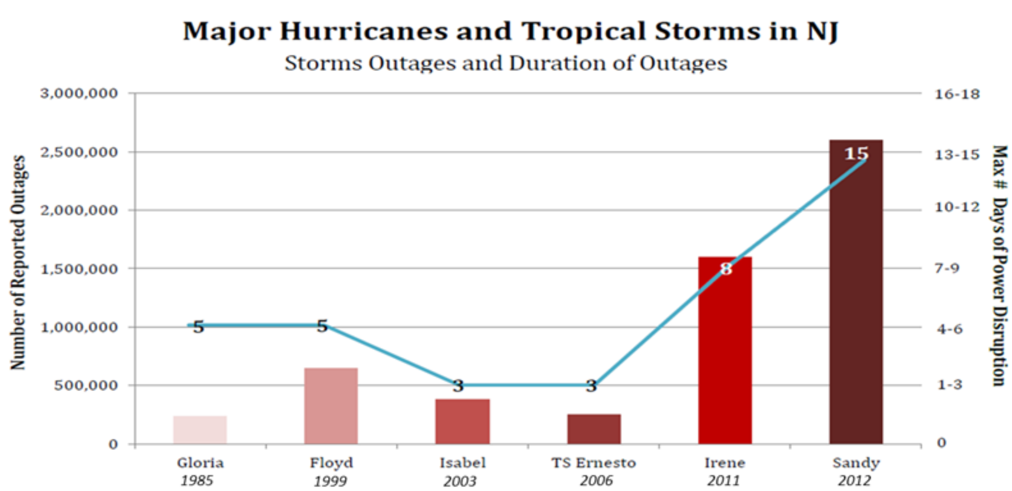
[14] This is estimated based on the average number of people in a New Jersey Household. http://www.census.gov/quickfacts/table/HSD310214/00

Major Storm Outage Reports

	# of Major Storms	# of Cumulative Affected Customers	% of Major events	Mean size of customer outages
Wind/Rain	13	2,623,000	48.2	201,769
Winter Weather/Nor'easters	8	1,636,000	29.6	204,500
Hurricane/Tropical Storm	6	5,718,500	22.2	953,083
Totals	**27**	**9,977,500**		

"Major" storms and their outages (by totals, proportion, and mean outages); from CEEEP Storm Events Database. Image 1.e)

This equates to 1.3 hurricanes or tropical storms per year. In addition, the CEEEP report data suggests that one major hurricane or tropical storm capable of causing a major outage occurs once every five years. Hurricanes/tropical storms are the lower frequency events but account for the largest average number of customers without power. As noted in the chart below this average significantly increased after Hurricane Irene and Superstorm Sandy[15]



(Image 1.f)

15 . A copy of their report is available at http://ceeep.rutgers.edu/wp-content/uploads/2014/07/NJ-Power-Outages-Report-to-BPU-Final-Version.pdf.

The HMGP LOI for the Energy Allocation Initiative and Lifeline/Life Safety programs demonstrated a need to address energy resiliency at the local level, especially for critical facilities and operations. The CEEEP Weather Outage Report highlights that the timeframe of the next major storm and the number of people it will impact is at best uncertain. Based on the data we do not know how much time we have to design, develop and implement the enhanced resiliency of local energy systems. The above data suggests that it will happen again. The State should be prepared before it happens again.

The uncertainty of the occurrence of the next major event decreases the usefulness of back-up generators to address enhanced resiliency. Back-up generators are an asset that, while important, will be potentially unused for long periods of time waiting for the next major outage. This may negatively impact the availability of back-up generators during an emergency. The past outage experiences and future potential outages call for the State to develop a better solution.

Back-up and emergency generators provide a necessary service and, in many circumstances, are the only options. In some case a better long term solution may be a system that can operate continually, 24 hours a day, seven days a week (24/7). A system that can operate under normal conditions, "blue sky", or during emergency conditions, "black sky". A system that can operate both in sync with or islanded from the distribution system during an emergency that was caused by a major power outage. A system that can link together several critical facilities at the local level that are in close proximity. This is a simple description of an advanced microgrid or a TCDER microgrid.

Likewise, a DER microgrid or an advanced microgrid or a TCDER microgrid may not be the better solution in all situations. Determining this would be done on a case by case basis. The key to that evaluation of the best solution is a detailed feasibility study. The feasibility study would include the overall cost effectiveness of the system design and operations as well as the optimization of the system. An advanced microgrid or a TCDER microgrid can be designed to operate solely during an emergency when the distribution grid is down. However, that would require an investment of a significant amount of infrastructure to be used potentially only once every 5 years.[16] The design and operations of a microgrid must be cost effective which points to operating the microgrid 24/7 under blue sky conditions as well as for emergencies under black sky conditions.

As noted in Appendix E , New Jersey has 50 operating microgrids. Many of these operating microgrids have been funded through the BPU's Clean Energy Program.[17] Some of these microgrids operated during the recent extreme weather emergencies when the grid was down. Based on this operating experience, as well as operational experience in other state microgrid

[16] . Based on Rutgers CEEEP Outage Report at http://ceeep.rutgers.edu/wp-content/uploads/2014/07/NJ-Power-Outages-Report-to-BPU-Final-Version.pdf.

[17] See http://www.njcleanenergy.com/commercial-industrial/programs/combined-heat-power/combined-heat-power.

programs, demonstrates that microgrids can provide value to a customer, particularly critical customers, during emergencies and in 24/7 operations under blue sky conditions.[18]

In addition, to providing customer's their value of avoiding lost power in an emergency, a microgrid can provide potential energy and cost savings to these customers through more energy efficient operations. A microgrid can provide enhanced reliability to the grid as well as a more efficient usage of the grid. It can provide lower overall environmental impacts at the same time as providing resiliency for critical facilities at the local government level. These issues are the basis for the policy recommendation in the Energy Master Plan Update related to microgrids.

[18] See http://www1.eere.energy.gov/manufacturing/distributedenergy/pdfs/chp_critical_facilities.pdf.

2. General Definition of Microgrid and Distributed Energy Resources

Microgrid Definition and Classification

The United State Department of Energy (USDOE) Microgrid Exchange Group in 2012 developed a generally accepted definition of a microgrid as

> *A microgrid is a group of interconnected loads and distributed energy resources (DER) within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.*

The above definition for microgrids covers a broad array of systems, technologies, customer types and interconnection types. Currently, there is no definitive or universally accepted classification system for the different types of microgrid configurations. A microgrid can be categorized in several different manners. Below is one classification of microgrids based on interconnection to the grid.

1. <u>Level 1 or single customer microgrid.</u> This is a single DER system such as a photovoltaic solar (PV) system, combined heat and power (CHP) or fuel cell (FC) system that is serving one customer through a single meter. This microgrid class is connected to and can island from the distribution grid.

   Examples of this classification of microgrids in New Jersey are a single owner PV system with either a backup generator or an off-grid inverter that can isolate from the grid, or a CHP that serves just a single building load such as a hospital, office building, restaurant, school or multifamily public housing building. (See list in Section 6.1).

2. <u>Level 2 or single customer / campus setting; also referred to as the partial feeder microgrid.</u> This classification includes either a single or multiple DER systems connecting multiple buildings, but controlled by one meter at the point of common coupling. This microgrid class is connected to and can island from the distribution grid.

   Examples of this classification of microgrids in New Jersey includes several DER systems that serve a campus setting such as a college or university, healthcare/hospital campus, pharmaceutical complex or military base. (See list in Appendix E).

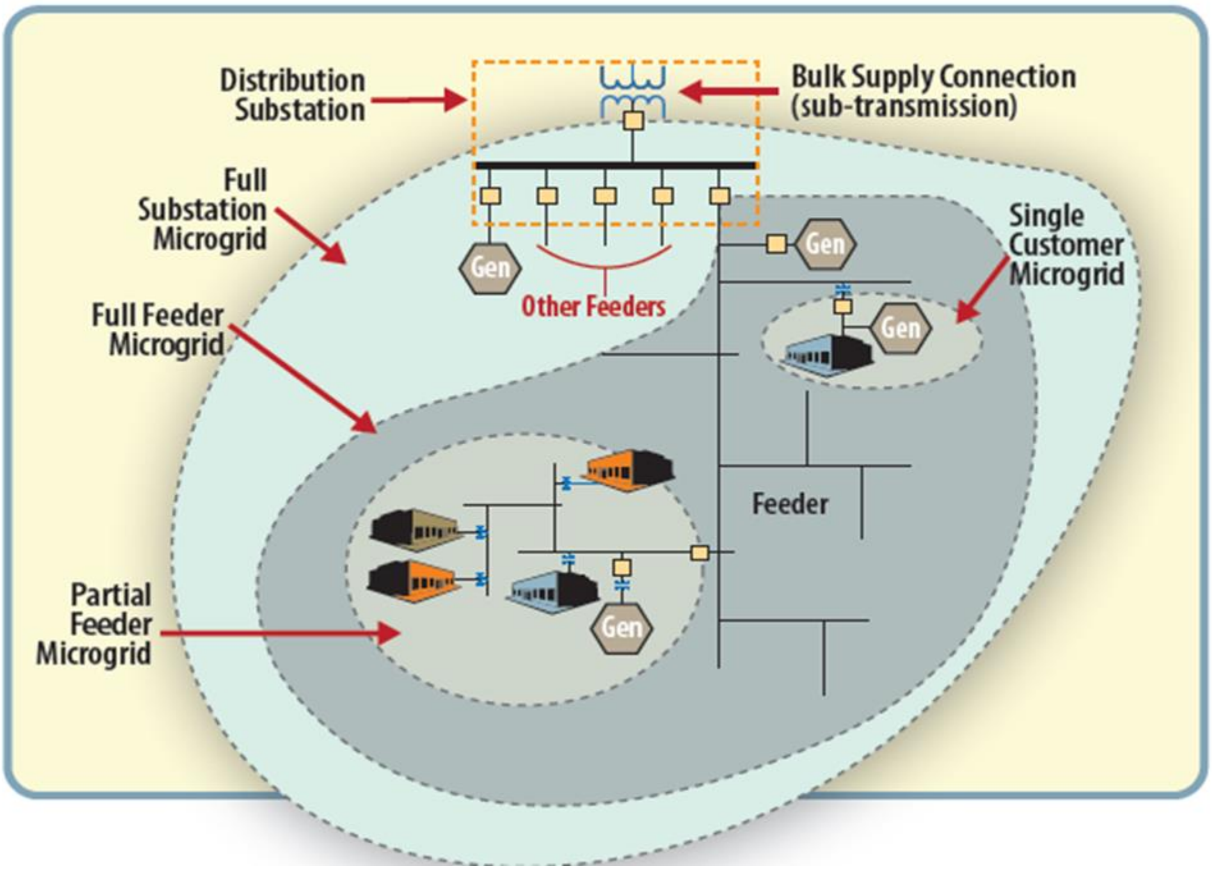
3. <u>Level 3 or multiple customers / advanced microgrid; also referred to as the full feeder microgrid.</u> This is a single or multiple DER system that serves several different buildings/customers that are not on the same meter or on the same site as the DER. An advanced microgrid has one point of common coupling (PCC). The individual buildings/customers may be independently connected to the larger distribution grid and through the microgrid PCC. New Jersey has two inter-district thermal energy facilities, but currently there are no advanced microgrids operating in New Jersey. However, the NJ Transit Grid project being developed by NJ Transit and the Hoboken Microgrid

project are examples advanced microgrids. The TCDER Microgrid Potential Report, produced for the Board by the New Jersey Institute of Technology (NJIT), identified 24 potential Town Center microgrids in 17 municipalities in the 9 FEMA designated Superstorm Sandy impacted counties.

The above general microgrid definition and classifications do not address the issue of the regulatory status of microgrids as public utilities. BPU statutes and regulations relating to microgrids are discussed in general in Section 3.

New Jersey's Clean Energy Program (NJCEP) CHP/Fuel Cell tables in Appendix E lists 50 New Jersey CHP or biomass facilities funded through the NJCEP that have the ability to island from the grid and operate as a Level 1 or 2 microgrids.

Below is a schematic that documents the three levels of microgrids including their PCC.



(Image 2.a)

Distributed Energy Resources (DER) within a Microgrid

DER are the technologies that power a microgrid. A DER is defined by DOE as consisting of a range of smaller scale and modular generation and storage devices designed to provide electricity and sometimes also thermal energy, in locations close to or on-site to the customer or end user of the energy. While there are different types of DER technologies, there is no standardized classification system as to what technologies are defined as DER.

A DER system can use fossil fuel or renewable energy as the prime mover of an electric generator. Some examples of DER technologies include CHP, solar PV, wind, small scale hydro, biopower/waste to energy, storage both thermal and electric, standalone generators, fuel cells, and combinations of these DER technologies.[19] Prior to the recent advancement of energy storage, these systems were defined or classified as distributed generation (DG), but now with advancements in storage can included in the broader classification of DER. New Jersey statutes do not define DER and have a limited definition for DG as it applies in the Standby Charge Review Law.[20]

The BPU, through New Jersey's Clean Energy Program (CEP), has incentivized the development of CHP and FC that are powered by either fossil fuel or renewable fuels. In addition, the BPU supports the financing of CHP and FC at local government facilities through the Energy Savings Improvement Program (ESIP). The New Jersey Economic Development Authority (EDA) provides financing support for some DER projects that provide energy resiliency at critical facilities through the New Jersey Energy Resilience Bank (ERB). The focus of the ERB is on increasing energy efficiency and resiliency. Currently, the ERB is focused on the three major types of DER technologies of CHP, fuel cells and battery storage.[21] The ERB and the CEP do not support standalone diesel or natural gas generators.

Currently the CEP and other state DER incentives are based on capacity rather than the energy produced. The monitoring of a DER facility's energy output, hours and days of operations and efficiencies would provide more meaningful performance metrics. An example of such a program with a monitoring requirement is the New York State Energy Research and Development Authority's (NYSERDA) DER Integrated Data Management program. Through this program, NYSERDA tracks remotely the hourly performance of all their incentivized DER facilities.[22]

[19] There are several technologies that could generate electricity and thermal energy in a CHP system and they include engines, turbines, microturbines and fuel cells.
[20] See N.J.S.A. 48:2-21.37
[21] The ERB is an energy resiliency financing program managed by the EDA with federal CDBG funds. The BPU provides technical assistance to the ERB.
[22] See http://chp.nyserda.ny.gov/home/index.cfm.

Combined Heat and Power and District Thermal Energy Facilities

Combined Heat and Power

A CHP system in a microgrid produces both thermal and electrical energy. The use of both thermal and electrical energy on-site classifies CHP as energy efficient. The heat and cooling is produced by recovering the waste heat from a generator that produces electricity. Also, CHP systems can include absorption chillers and back pressure turbines to increase their efficiencies. Reciprocating engines, gas turbines, microturbines and fuel cells are a few types of CHP equipment that can be used that produce both electricity and thermal energy.

Under most conditions a CHP facility has increased energy efficiencies as compared to existing separate heating, cooling, hot water and electricity provided from the local distribution grid. Typical efficiencies for CHP units are measured by the lower heating value (LHV) which are between 60 to 80 percent; CEP requires a minimum efficiency of 65% LHV.[23]

The increased energy efficiencies of CHP means energy cost savings, and less overall emissions and discharges to the environment from the CHP facility's as compared to separate components. As a result, a natural gas fired CHP system of three MW or less requires only a general permit from NJDEP because of the relatively low emissions.

Typical capacity factors for CHP can be in the 85% range. However, CHP systems may usually operate at lower capacity factors in the 50% range depending on site-specific conditions including system fuel costs, routine operations and maintenance (O&M) and the economics of the cost for electricity from the grid.[24] CHP systems may operate full time when electricity prices are high and less when electricity prices are low. Likewise operations will vary with the price of natural gas. These economic factors impact a CHP system's capacity factor.

Currently, average CHP installation costs vary in the $2,000 to $4,000 per kilowatt range.[25] CHP systems in New Jersey have higher average costs compared to the DOE and EPA national databases on CHP costs. Biogas fueled CHP systems may have significantly increased installation costs due to additional expenses related to fuel storage and fuel clean-up.

While centralized power plants on the grid will become more efficient as they are upgraded and older inefficient units are replaced with newer more efficient combined cycle units, the overall

---

[23] This LHV efficiency is under review by the new NJCEP Program Administrator

[24] BPU Clean Energy Program incentives are currently available based on capacity (kW) not performance or energy (kWh). However the final incentive payment of 10% of the CHP/FC incentive in based on meeting a specific performance.

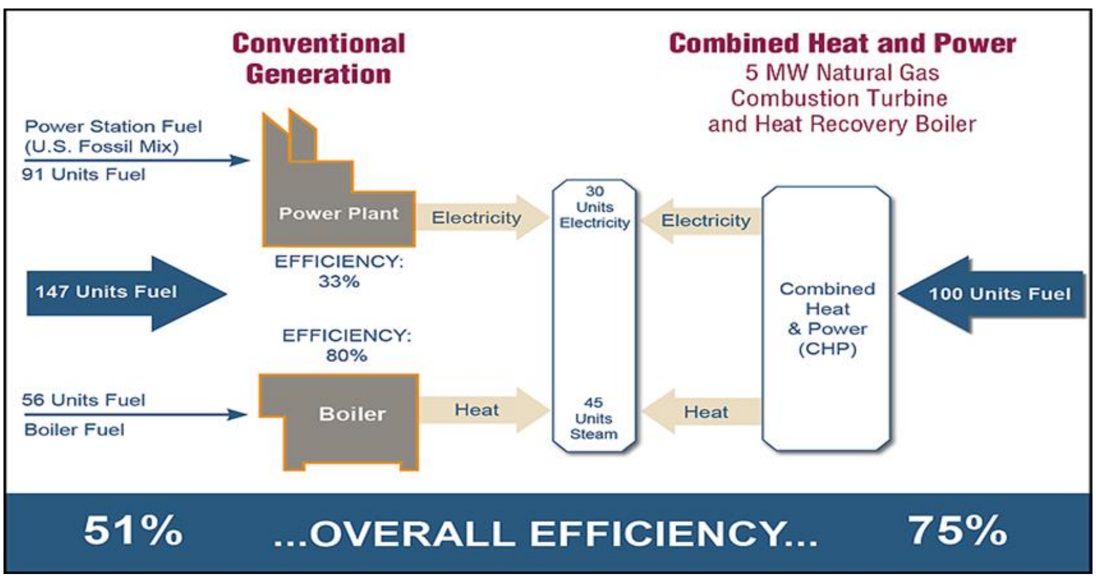
[25] http://www.energy.gov/eere/amo/chp-deployment and http://www.njcleanenergy.com/files/file/Committee%20Meeting%20Postings/CHP%20Working%20Group%20-%20CBA%20&%20Quantifying%20Uncertainities%20-%20Dec%202013%20v_3.pdf

efficiency of the CHP system will always be greater than the central electric generation because of line losses over the distribution and transmission system.

Transmission and distribution line losses average in the five (5%) to eight percent (8%) range.[26] A number of factors, such as the size of lines and equipment, distance to load and load variation during peak contribute to total line losses. Line losses can be reduced by increasing the load factor by reducing peak or averaging out the load. CHP systems and other DER technologies can assist in optimizing the grid and reducing losses.

In addition, the energy resilience value of a CHP system with islanding capacities will actually increase over time the more the unit is called on to operate under these emergency conditions.

CHP systems and other DER technologies, can improve the efficiency and reliability of the transmission and distribution system, especially during peak usage, if they are operational during these periods. Otherwise, the reverse can occur whereby they become an additional load during peak. Based on specific design and operation, a DER facility can have a zero footprint on the grid during peak periods. A CHP system as well as other DER systems can function to provide energy, capacity and other ancillary services to the larger grid, which can potentially provide additional revenues to the DER system.



http://www.epa.gov/chp/chp-benefits *(Image 2.b)*

[26] EIA" Frequently Asked Questions"

District Thermal Energy Facilities

While not consistent with the above DOE definition of a DER or DG technology, a district heating and cooling facility or a district thermal energy facility could operate as a microgrid. A district heating and cooling facility is a system for distributing heat as steam or hot water; and cooling as chilled water generated in a centralized location for a customer's thermal energy requirements such as space heating, hot water and air conditioning. A district heating and cooling facility without electricity generation for use on-site would not currently be defined as a microgrid.

As noted in Appendix E, New Jersey has over 200 hundred CHP facilities but less than 70 are defined as DER. There are two district thermal energy facilities in New Jersey. One is the Trenton District Energy Facility that serves downtown Trenton State facilities. The other is the Mid-Town Thermal Facility in Atlantic City that serves a number of hotels and casinos. New Jersey district thermal energy facilities currently do not provide electricity to their customers and will typically sell the electricity they generate into the wholesale energy markets. In the case of New Jersey facilities, this is through the Pennsylvania-New Jersey-Maryland Interconnection (PJM).

Twenty-six States have either grant, rebates, loans or portfolio standard incentives for CHP[27]. In the Mid-Atlantic States Maryland, Delaware, Pennsylvania and New Jersey provide rebates or grants for CHP. Delaware, DC, West Virginia and Maryland provide net metering for CHP. Delaware and Pennsylvania include as part of their Alternate Energy or Energy Efficiency Portfolio Standard.[28]

Fuel Cells

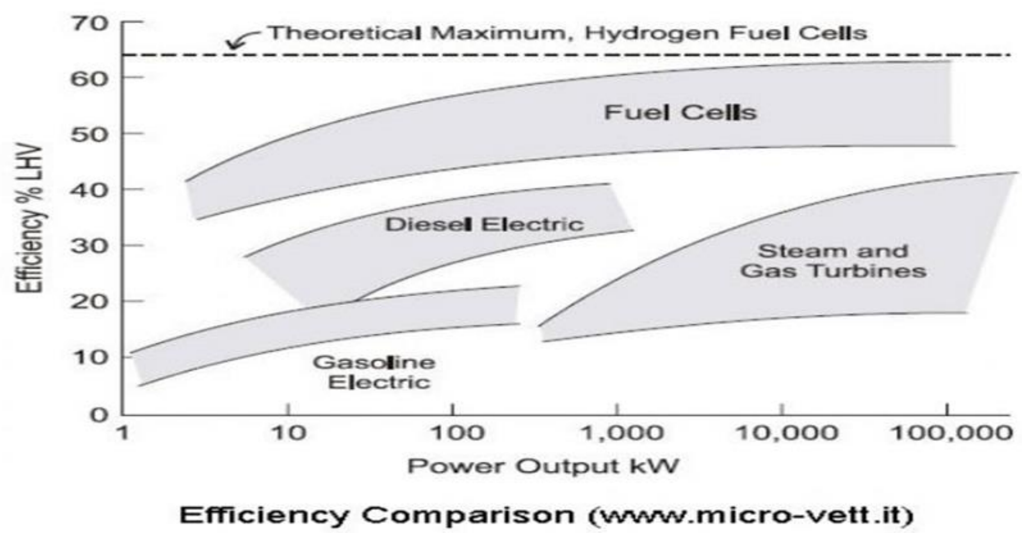
Fuel cells also can serve as another DER microgrid technology. A fuel cell produces electricity electrochemically by combining oxygen (O_2) and hydrogen (H_2) to form water (H_2O). The reaction to generate electricity from the formation of water is an exothermic reaction and produces heat. Depending on the type of fuel cell this heat can be significant and would be classified as CHP. The hydrogen can be supplied from fossil fuels like coal or natural gas, renewable fuels like biogases, or compounds that have numerous hydrogen atoms such as urea or borax. There are several types of fuel cells including polymer electrolyte membrane (PEM), phosphoric acid, solid oxide and molten carbonate.

As noted in Chart # below, most fuel cells generating electricity without capturing thermal energy are more efficient in the generation of power than other conventional generation systems. This efficiency is increased when you take into account the line losses from a centralized power plant as opposed to using the DER fuel cell energy on-site. The NJCEP and ERB set this at a

[27] http://en.openei.org/wiki/List_of_CHP/Cogeneration_Incentives
[28] https://www.epa.gov/chp/dchpp-chp-policies-and-incentives-database National Association of State Energy Officials – Mid-Atlantic States - https://www.naseo.org/

lower heating value (LHV) of 50% or greater.[29] While fuel cells generate electricity efficiently the classification of fuel cells as energy efficiency is not as clear as classifying them as DE. The fuel cell operations have to result in less energy used in the on-site facility. This has to include an evaluation of the fuel to generate the electricity not just the reduction in electricity usage in the facility.

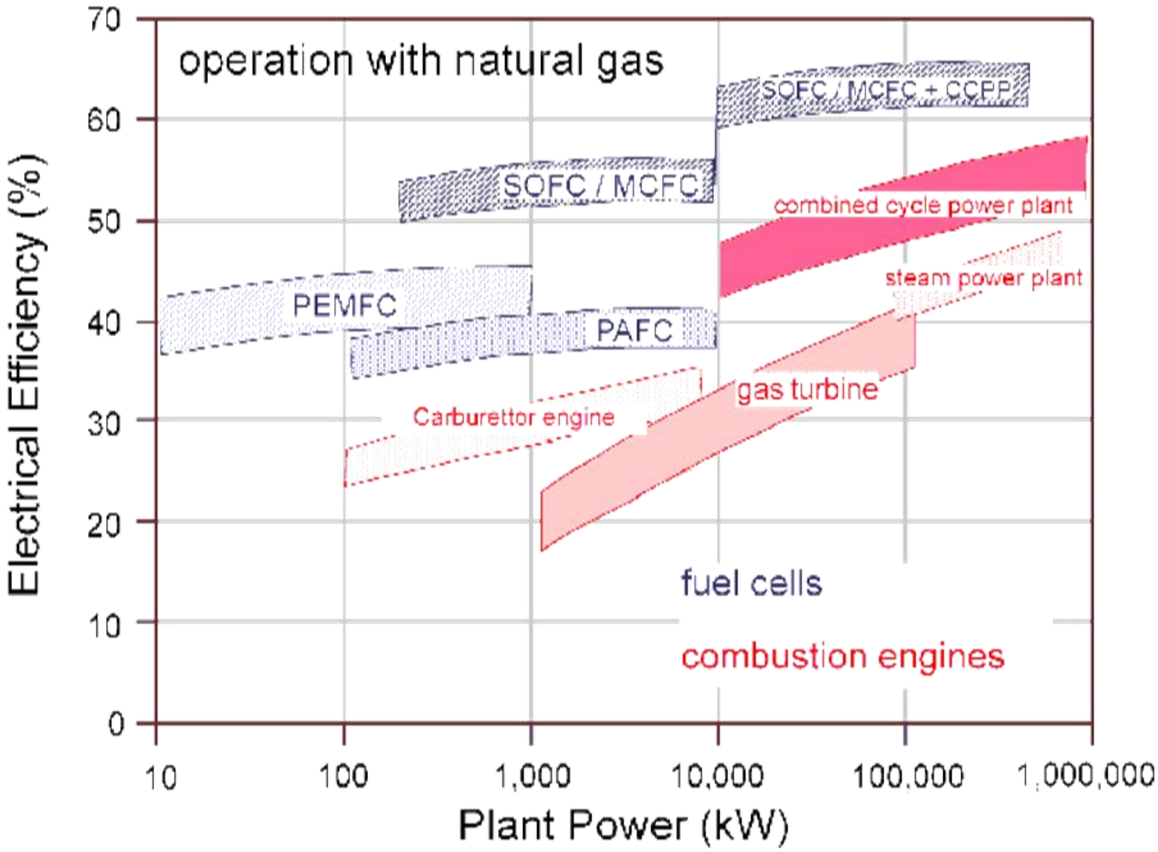
The fuel cell is one of the "cleanest" DER systems to generate electricity using a fossil fuel. It has negligible level of nitrogen oxide (NO_x - ozone) emissions because of the lower operating temperature versus combustion of fossil fuels. The fuel cell has essentially zero sulfur dioxide (SO_2 – acid rain) and mercury (Hg -toxics) emissions because of the fuel it uses. In addition, as a result of its operations, the fuel cell generates no waste or wastewater discharge except for water. The fuel cell, if using methane or natural gas, will have approximately the same CO_2 emission profile as a natural gas generator or turbine. But because of its efficiency over the central electric generation with distribution and transmission line losses, the fuel cell will have lower overall CO_2 emissions compared to the combustion of methane or natural gas in a central power plant at the customer's point of use.[30]



(Image 2.c)

http://www.ags-energy.com/html/efficiency-g3.html

[29] This LHV efficiency is under review by the new NJCEP Program Administrator
[30] http://www.cesa.org/assets/Uploads/Resources-pre-8-16/CESA-fuelcelltechnology-may2010.pdf



(Image 2.d)

The major advantage of the fuel cell is its capacity factor. Because the fuel cell has essentially no moving parts to generate electricity, its capacity factor is extremely high. The fuel cell generates electricity by moving gases through a membrane. A fuel cell capacity factor can be 95% or higher.[31] Having essentially no moving parts except for the flow of gases, the fuel cell operates very quietly. Therefore, a fuel cell can be utilized in locations where other conventional electric generators would violate the noise code. The typical cost for a fuel cell is in the range of $5,000 to $7,000 per kilowatt installed.[32]

Batteries/Storage

Electricity, unlike thermal energy, cannot currently be efficiently stored. Therefore, it must be used as generated. Typical storage systems are either large hydro pump storage or compressed air systems which are both costly and have significant environmental impacts.

Because electricity is not stored for use during times of peak demand, regional transmission operators (RTO) like PJM require excess generation capacity, called operational or spinning and non-spinning reserves to be available to plan for peak usage and emergencies. . To account for

[31] http://www.nrel.gov/hydrogen/proj_fc_systems_analysis.html
[32] http://www.nrel.gov/hydrogen/proj_fc_systems_analysis.html

peak electricity demand this electricity reserves typically represent about 15% of the average electric demand. These peaks occur within the central electric generation system in the transmission and distribution lines during extreme hot or cold weather. The potential for storage of electricity is beginning to with the advent of smaller, higher density battery storage systems at lower costs.

Storage batteries systems are not distributed generation. They do not generate energy, but are distributed energy resources when paired with a generator. The generator may be solar PV, wind, CHP or a backup emergency generator. The benefit is the battery storage extends the supply side of the electric generation system. With solar PV, batteries can store the excess electricity generated from the solar PV system during the peak period when the sun is shining, and extend the time the solar electrons are available without relying on the distribution system to 'store' electricity.[33]

When the solar PV is no longer generating electricity at its peak, batteries can supply the solar electrons to more closely match the distribution grid's peak. This stored solar PV electricity can benefit the larger grid by reducing the need for large central power plant reserves. Battery storage can also extend the fuel supply for the backup generator allowing the generator to run longer on the same fuel volume.

In addition to extending the electrical availability of generators, battery storage can assist in managing the quality of power on the grid. Battery storage can quickly respond to grid fluctuations to manage flicker, voltage sags and surges. A battery storage system, as part of a DER system, can function to provide stored energy, capacity and other ancillary services to the larger grid, which can potentially provide additional revenues to the DER system.[34] Some CHP system can also provide these same services.[35]

The current drawback of battery storage systems is the relatively high cost. The capacity costs are within the $1,000 to $3,000 per kilowatt range. This installed cost is in the same range as CHP. However, the issue with batteries in not the installed capacity costs but the cost per kilowatt-hour. This energy cost can range from $200 to $700 per kilowatt-hour. More appropriately, batteries are rated in amp-hours, i.e. the amount of current that can flow from a battery in one hour at a given voltage. Amp-hour ratings are a way that different batteries types can be compared to the same standard.[36]

There are a number of factors that impact the cost and benefit effectiveness of battery storage in a DER system. These include the battery chemistry, operating conditions such as temperature, capacity, response time, discharge duration, depth of the charge, charging rate and round trip efficiencies.   A system designed and operated to maintain one hour of energy will cost less than one required to supply 8 hours of energy.   Key cost factors for battery system designed within a DER system is the cycle time for the battery and the lifetime of the batteries. A battery storage

[33] http://www.nrel.gov/docs/fy16osti/64764.pdf

[34] http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6025112&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D6025112 and http://www.nrel.gov/docs/fy16osti/64987.pdf

[35] http://aceee.org/files/pdf/white-paper/chp-and-electric-utilities.pdf

[36] http://www.sandia.gov/ess/publications/SAND2013-5131.pdf

system could be cost-effective under certain conditions given the potential revenues for stored energy, capacity and other ancillary services in the electric markets.

A key to battery storage within a solar PV system is the use of an off-grid inverter. All of the currently installed and operating solar PV systems cannot operate when the distribution grid is down. The grid-tied inverter, which is the typical inverter in all the NJ solar PV systems, is designed to shut down the solar PV system when there is no power on the distribution system. Just like a CHP or fuel cell system, the solar PV and battery storage system needs a transfer switch and an inverter that can be isolated and islanded from the grid when there is a power outage. Given the advancement of these new technologies within DER systems, building codes and interconnection issues are still in the developmental stage.

Another storage technology within a DER system or microgrid is thermal energy storage. This DER stores thermal energy generated during different times of the day or year to be used to supply or supplement heating and cooling in a building. This includes peak day heating/cooling or seasonal supplemental heating/cooling. Examples of thermal storage include chilled or hot water tanks, ice storage tanks, and ground or air sourced heat.

DER Benefits to the Microgrid and the Distribution Grid

In general, because of the DER's higher system efficiencies and lower line losses, the DER systems can be defined as EE equipment. This is a straight forward determination for CHP, but requires a case by case specific analysis for other DER technologies without thermal energy usage or storage.

It is this increased efficiency that results in the DER systems reduced energy usage and the facility's overall energy costs savings. In addition, because of the DER system's increased efficiencies, there are lower emissions, less waste generated, lower water usage, and less wastewater discharge from DER system when compared to the same energy profile usage from a centralized power plant system and the overall HVAC system when considering thermal usage. These avoided environmental impacts, as well as the increased site efficiencies are the benefits against which the cost of the DER systems needs to be evaluated. These benefits are monetized to be able to compare on the same metric.

This monetization of the environmental benefits are more directly available in vertically integrated States as opposed to a competitive State like New Jersey that separated generation and transmission in a competitive market and distribution on the regulated side. DER's lower environmental impacts benefit the central generators not the distribution grid. To monetize this benefit in competitive States there needs to be a way to transfer this benefit in lower emissions to the in-State generators. This is in part addressed through the Renewable Energy Portfolio Standard for Class I renewables.

As noted above, the overall system efficiencies of the centralized power plants will be upgraded over time with the closure of older inefficient units. The value of these benefits for some DER technologies may decrease over time. On the other hand as some DER technologies increase in efficiency, this benefit will increase over time. However, the overall efficiency of the DER system will always be greater than the central electric generation because of line losses over the distribution and transmission system.

As documented in EPRI's *The Integrated Grid*, DER can benefit the distribution grid because of these increased efficiencies. DER can assist in managing the quality of power on the grid including enhanced voltage controls and balancing real and reactive power. DER systems can provide energy, capacity and other ancillary services to the larger grid, which can potentially provide additional revenues to the DER system. A key aspect noted by EPRI is that DER can help to optimize the operations of the distribution grid by being fully integrated with distribution grid operations.[37] EPRI promoted this through an *Integrated Grid Benefits-Cost Framework*.

The higher system efficiencies and lower environmental impacts are in part the basis of the benefits for the cost/benefit analysis (CBA) model the BPU developed with Rutgers CEEEP.[38] The Rutgers' DER CBA model evaluates the installation and operating costs of the DER system (costs) against the efficiencies; energy costs savings, avoided transmission and distribution losses and avoided environmental costs (benefits) of the DER system. The CBA is an essential tool to evaluate the effectiveness of any DER. But it is not the only tool or method to determine whether a DER system is efficient or effective. For an advanced DER or TCDER microgrid the effectiveness of the system needs to be accomplished within the context of a detailed feasibility study of which the CBA is one component of that feasibility study.

Each advanced DER or Town Center microgrid project, should be required to undergo a project specific CBA as a part of the overall evaluation. The ratio of benefits to costs should be greater than one to be considered cost effective which would be part of the determination as an energy efficient project. This CBA must include all the costs and benefits of the DER microgrid. The Rutgers DER CBA model evaluates those cost and benefits on an annual basis as a first cut evaluation. If needed, a more detailed hour by hour CBA should be performed.

Another part of the cost analysis is to install a DER system is the cost comparison to a diesel backup generator (BUG). A standby or backup generator will cost approximately $600 per kW installed. This is evaluated against the cost for DER which can range between two thousand dollars ($2,000) and four thousand dollars ($4,000) per kW, including the additional resiliency cost of islanding.

This cost differential between a BUG and a DER must be evaluated in terms of the benefits of energy savings and the value of longer term energy resilience of DER over BUG. The two technologies have very different and complex technical abilities which require a detailed technical analysis. In addition to the difference in cost and benefits, BUG and DER have very different regulatory and permit requirements. This overall analysis should be part of any

[37] http://www.eenews.net/assets/2014/02/10/document_cw_02.pdf

[38] http://ceeep.rutgers.edu/combined-heat-and-power-cost-benefit-analysis-materials/. The Rutgers DER CBA model calculates the costs and benefits on an annual basis only.

feasibility analysis performed by the customers and communities of a potential microgrid in weighing the economic, technical and regulatory/permitting decisions and the overall costs and benefits.

Resilient DER to the Microgrid and the Distribution Grid

A new cost for DER systems is the cost of adding islanding and black start capabilities to improve energy resiliency. The efficiencies and energy savings of the DER are the same regardless of whether the system is designed as a microgrid to be able to island and black start or not. Designing energy resiliency into the DER does not change its overall efficiencies, and in certain circumstances, does not alter its designation as EE equipment. But it could add cost, and depending on the facility and system, this resiliency cost could be significant. On the other side of the equation, this increase resiliency from the DER adds value to the system that need to be included as a benefit.

The majority of the DER systems that are currently installed and operating in New Jersey, including solar, CHP, fuel cells and other renewables, did not operate during or after Superstorm Sandy when the distribution grid was down. (Appendix E) Most small DER systems such as solar are installed with an inverter to allow them to be interconnected to the distribution system. The inverter converts the direct current (DC) produced by the DER system into an alternating current (AC) that can be used by the customer onsite.

Most small DER systems are installed with grid-tied inverters. Standard grid-tied inverters are designed to sense the outage of the grid and shut down the DER as a safety precaution. This is in addition to an external disconnect switch on the customer's side of the meter which is required by electric code. To enable an inverter based DER system to be a microgrid requires the installation of additional equipment to operate in island mode. These microgrid controls become an integrated part of the DER system.

To enable a DER system to operate independent and isolated from the distribution system as a microgrid, adds cost to the overall DER project. The additional cost has a wide range. If properly designed into a new facility, this cost could be a relatively small incremental portion of the overall DER system total cost. If designed and installed as a retrofit to an existing facility the costs can be greater in the 10% to 30% range. For retrofitting energy resiliency into an existing facility, the DER equipment must be upgraded to island mode and a significant portion of the existing electrical and interconnection systems must also be redesigned. With Sandy and other large regional storms, governmental entities are beginning to evaluate the overall costs and potential savings to operating during and after a storm when the grid goes down. The benefits of this operation must be added into the overall cost benefit analysis.

Currently almost 80 (80%) of the new applicants for NJCEP CHP/FC program rebates may operate in island mode disconnected from the electric distribution system during an emergency as a microgrid.[39] These applicants included the overall cost of islanding into the total project cost on which the rebate cost is calculated. CHP/FC rebates are currently calculated as a percentage of the total project cost up to a total cost cap.

New Jersey already has several CHP facilities that can operate in island mode. There are currently 50 natural gas or renewably fueled (biomass) CHP facilities incentivized through the NJCEP that can operate as a microgrid. This does not include the renewable CHP facilities or the CHP facilities that were installed prior to the NJCEP. These 50 facilities included the overall cost of islanding into the total project cost on which the rebate cost was calculated.

Twelve of the 50 microgrid facilities are defined as “level 2” or “campus-wide microgrids.” These facilities have increased costs because the thermal energy pipes and electric wires are underground. However, such undergrounding is what enhanced the resiliency of the campus wide microgrid facilities, and allowed them to operate after Sandy when the distribution grid was down due to downed wires and poles. The additional cost and benefits of undergrounding the advanced microgrid’s pipes and wires should be compared to the cost and benefits of undergrounding the existing electric distribution and transmission system wires. Generally, utilities across the country have reported that the cost of undergrounding the entire distribution system is not cost effective and that the benefits do not exceed the costs. The additional undergrounding cost for the electric wire in an advanced microgrid would be cost effective since it would be a relatively small part of the overall project costs.

The Rutgers’ DER CBA model is being expanded to include the cost of adding islanding and black start components within the DER system. In addition to these costs, the Rutgers’ CEEEP DER CBA model is being upgraded to include the avoided costs (benefits) of the value of lost load to the customer and society as the result of a power outage. The CBA must include the costs and benefits of the DER microgrid noted in Section 2.3 and must also include the new costs and benefits of resiliency.

The typical method for evaluating the resiliency benefits of a DER system is through a determination of the value of lost loads or the value of electric service. This is the estimated value that an electric customers would be willing to pay to avoid a disruption in their electricity service.[40] The Lawrence Berkeley National Lab (LBNL) developed a model called the Interruption Cost Estimate (ICE) Calculator that provides the value of lost load calculations for use in assessing the value to customers from improving reliability. LBNL uses their model to estimate the value of service reliability for various electric utility customers under different duration of lost load. This is basically the methodology used in the Rutgers DER CBA model to assess the benefit of resiliency in a DER system and microgrid.

[39] All of these are for CHP facilities. Currently no NJCEP fuel cells projects have reported as having islanding capabilities.

[40] https://emp.lbl.gov/sites/all/files/REPORT%20lbnl-2132e.pdf, and https://emp.lbl.gov/sites/all/files/value-of-service-reliability-final.pdf.pdf

The LBNL updated study estimated costs to customers for an interruption of service of 16 hours durations as follows:

1. Residential customer average usage 13,351 kWh per year - $32.40 per 16 hour duration
2. Small C&I customer average usage 18,214 kWh per year - $9,055 per 16 hour duration
3. Med. and Lg.C&I customer average usage 7,140,501 kWh per year - $165,482 per 16 hour duration

3. New Jersey Statutes Applicable to Microgrids

Title 48 in the New Jersey statue does not specifically define a microgrid or DER. Key provisions in the amendments of the Electric Discount and Energy Competition Act (EDECA) N.J.S.A. 48:3-51 et seq., relate to microgrids. These provisions are contained in Appendix A. There is a limited definition of DG in EDECA related to the Standby Charge Review Law and the net metering regulations at N.J.A.C. 14:8-4.1.

The key provisions in EDECA as they relate to microgrids are summarized as follows:

N.J.S.A. 48:3-51 - Definitions

Off-site end use thermal energy services customer

"Off-site end use thermal energy services customer" means an end use customer that purchases thermal energy services from an on-site generation facility, combined heat and power facility, or co-generation facility, and that is located on property that is separated from the property on which the on-site generation facility, combined heat and power facility, or co-generation facility is located by more than one easement, public thoroughfare, or transportation or utility-owned right-of-way.

On-site generation facility

"On-site generation facility" means a generation facility, including, but not limited to, a generation facility that produces Class I or Class II renewable energy, and equipment and services appurtenant to electric sales by such facility to the end use customer located on the property or on property contiguous to the property on which the end user is located. An on-site generation facility shall not be considered a public utility. The property of the end use customer and the property on which the on-site generation facility is located shall be considered contiguous if they are geographically located next to each other, but may be otherwise separated by an easement, public thoroughfare, transportation or utility-owned right-of-way, or if the end use customer is purchasing thermal energy services produced by the on-site generation facility, for use for heating or cooling, or both, regardless of whether the customer is located on property that is separated from the property on which the on-site generation facility is located by more than one easement, public thoroughfare, or transportation or utility-owned right-of-way.

Class I Renewable Energy

"Class I renewable energy" means as electric energy produced from solar technologies, photovoltaic technologies, wind energy, fuel cells, geothermal technologies, wave or tidal action, small scale hydropower facilities with a capacity of three megawatts or less and put into service after July 27, 2012, and methane gas from landfills or a biomass facility, provided that the biomass is cultivated and harvested in a sustainable manner.

Class II Renewable Energy

"Class II renewable energy" means electric energy produced at a hydropower facility with a capacity of greater than three megawatts or a resource recovery facility, provided that such facility is located where retail competition is permitted and provided further that the Commissioner of Environmental Protection has determined that such facility meets the highest environmental standards and minimizes any impacts to the environment and local communities.

N.J.S.A. 48:3-77.1

Utilization of locally franchised public utility electric distribution infrastructure

In order to avoid duplication of existing public utility electric distribution infrastructure, and to maximize economic efficiency and electrical safety, delivery of electric power from an on-site generation facility to an off-site end use thermal energy services customer as defined in section 3 of P.L.1999, c.23 (N.J.S.A. 48:3-51), shall utilize the existing locally franchised public utility electric distribution infrastructure. The New Jersey electric public utility having franchise rights to provide electric delivery services within the municipality shall provide electric delivery services at the standard prevailing tariff rate that is normally applicable to the individual off-site end use thermal energy services customer.

N.J.S.A. 48:2-21.37

Distributed Generation (DG)

"Distributed Generation" means energy generated from a district energy system or a combined heat and power as that term is defined in section 3 of P.L.1999, c. 23 (C.48:3-51), the simultaneous production in one facility of electric power and other forms of useful energy such as heating or process steam, and energy generated from other forms of clean energy efficient generation systems.

New Jersey Examples of the On-Site Statute Provisions

Currently, there are thirty-eight (38) level 1 microgrids and twelve (12) level 2 microgrids operating in New Jersey. There are no advanced microgrids or level 3 microgrids that provide electricity to multiple customers across multiple ROW. The Trenton District Energy Company facility and the Atlantic City Mid-Town Thermal Energy facility are defined as on-site generators that provide thermal energy to multiple commercial customers and cross multiple rights of ways (ROW). The customers of these on-site generators are defined as off-site end use thermal energy service customers. These districts thermal energy on-site facilities are not classified as advanced microgrids, because the USDOE definition of an advanced microgrid, noted in Section 2, focuses on electrical boundaries and electric loads interconnected with DER. The BPU, as set forth in N.J.S.A. 48:3-51 does not regulate an onsite thermal facility that has multiple off-site end use thermal energy service commercial and industrial customers that cross multiple ROW as a public utility.

Several advanced microgrid projects are in the process of being developed, including the New Jersey Transit Grid and Hoboken Microgrid. These projects are working in partnership with BPU and other agencies to evaluate how these provisions will be implemented within an advanced microgrid.

As currently set forth in N.J.S.A. 48:3-51 and 48:3-77.1, a district thermal energy facility that expands to supply electric service, or an advanced microgrid, can only serve the on-site electric end-use customer that is geographically contiguous and only cross one ROW. To connect multiple electric commercial customers that cross multiple ROW, the expanded district thermal energy facility, or advanced microgrid, must use the existing electric distribution system. Several level 2 campus wide microgrids, which were developed prior to the amendments in N.J.S.A 48:3-77.1, cross multiple public ROWs that transect their campus.

Issues with the Existing On-Site Statutes Related to Enhanced Reliability and Resiliency of Advanced Microgrids

As noted above in Section 1, it was the above ground existing distribution grid that failed after Sandy and other major storms. They fail because wind, trees or flooding take down above ground power lines and utilities poles. The majority of the electric distribution and transmission grid system is above ground. One response to this failure is to strengthen the utility poles and implement vegetation management which is on-going in the State.

An option to address this failure is to underground all utility services but that option is not cost effective and presents other operation difficulties. Undergrounding of the distribution system is a potential solution to grid outages which is raised in every state after every statewide emergency. Undergrounding electric system wires is extremely costly. Recent reports by Florida, North Carolina, Oklahoma, Virginia and Maryland did not find undergrounding wires was not cost efficient, and did not recommend it as an option to respond to recent system-wide grid power outages caused by severe weather. A recent Edison Electric Institute study found the cost for overhead lines was between $136,000 to $197,000 per mile, and the cost for undergrounding wires was at a range of $409,000 to $559,000 per mile without the same level of benefits.[41]

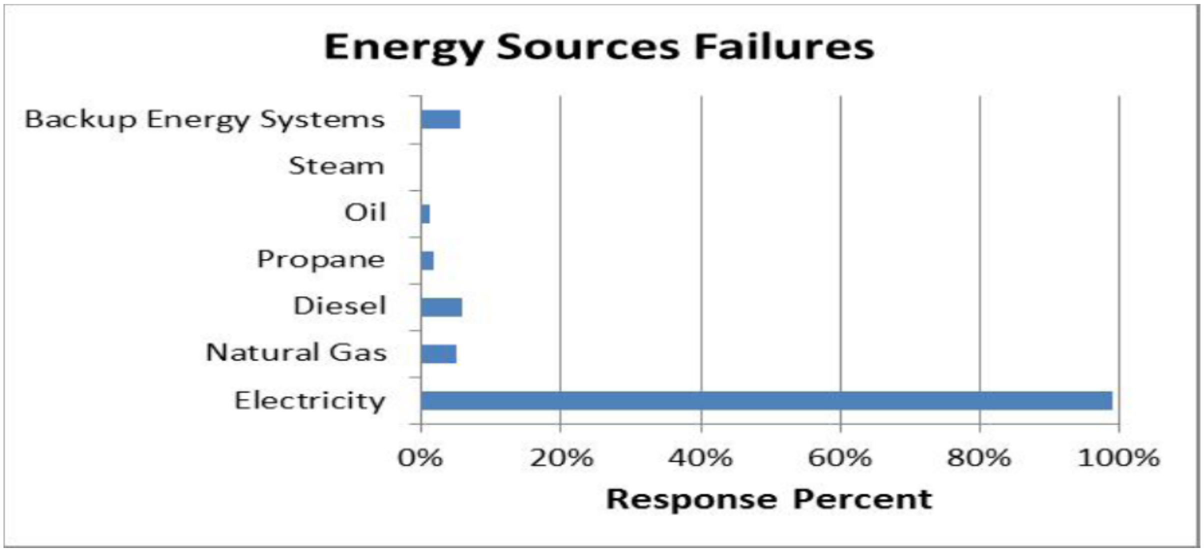
While EDCs may underground some critical customers, the transmission and distribution infrastructure would remain exposed to extreme weather. An option that could address this issue is to connect critical customers in an advanced microgrid to provide emergency power in an effective manner with utilities underground connecting multiple critical customers. However, N.J.S.A. 48:3-77.1 requires multiple electric commercial customers that cross multiple ROW that want to be served by an on-site generated must connect to the existing electric distribution system because of economic efficiency.

The provisions in N.J.S.A. 48:3-77.1 do not address the need for improvement and advancement of resiliency and reliability given that the majority of the distribution grid system is above ground.

Some of the current level 2 or campus-wide microgrids are able to provide emergency services to their buildings during the grid outage. The eight New Jersey Campus microgrids found undergrounding to be cost effective in their CHP projects due to underground construction of the thermal pipes. Adding in the electric wire does not substantively increase this cost. It was the below ground pipes and wires of the level 2 or campus-wide microgrids that allowed for isolation from the distribution grid and the continuation of both thermal energy and electricity to their on-site buildings.

Below is a summary of a survey performed by the USDOE National Renewable Energy Lab (NREL) for the State as part of the HMGP Energy Allocation Initiative and Lifeline funding grants. The HMGP Energy Allocation Initiative and Lifeline grants were available to local and state governments to assist in the procurement of alternate energy systems or emergency back-up/standby generators. There were over 500 grantees that responded to the survey.
One of the questions NREL asked was which energy sources failed after Superstorm Sandy. The below survey data documents that the underground natural gas distribution system had less outages and failures than diesel.

[41] http://www.eei.org/issuesandpolicy/electricreliability/undergrounding/documents/undergroundreport.pdf



(Image 3.a) **From NREL Survey - Alternative Energy Generation Opportunities in Critical Infrastructure *New Jersey*** E. Hotchkiss, I. Metzger, J. Salasovich, P. Schwabe

Other Codes and Regulations Related to Microgrids

There are several other requirements, regulations, standards and codes related to the development of advanced microgrids and several key requirements are listed below.

Building Energy Construction Codes

An advanced microgrid must meet all building code requirements. The New Jersey Department of Community Affairs – Division of Construction Code Enforcement regulates the fire and life safety aspects of emergency energy systems and will review any plan related to the systems that connect multiple DER technologies to multiple critical customers across multiple ROWs. As the DER systems get smaller and more cost effective, how they are addressed in the state, national and international building energy construction codes, and the classification of facilities with micro-CHP, both commercial and residential, will be important to the development of advanced microgrids.

IEEE 1547 Interconnection and IEEE 2030 Interoperability[42]

The Institute for Electrical and Electronic Engineers (IEEE) has several codes and guides related to microgrids and DER operation to and within the grid. Specifically IEEE 1547 series of standards addresses the interconnection of DER to the distribution grid. IEEE 1547.4 addresses the standard related to islanding of DER microgrids. These standards are in the process of being upgraded and expanded given the recent interest in enhancing the development of microgrids, especially advanced microgrids. It will be important for the Board and staff to stay abreast of these standards and how they should be incorporated into any EDC interconnection guidance, requirements and tariffs.

[42] http://www.nrel.gov/docs/fy15osti/63157.pdf

Another related IEEE standard is the interoperability standards at IEEE 2030 Guide for Smart Guide Interoperability of Energy Technology and Information Technology Operation with the Electric Power Systems and End-Use Applications and Loads. The guide provides standard in understanding and defining smart grid interoperability of the electric power system with end-use applications and loads. Smart grid is a key in expanding and implementing DER advanced microgrids and IEEE 2030 is a key standard to expanding and implementing Smart Grid.

BPU Class I Renewable Energy Net Metering and Interconnection Requirements

As set forth in EDECA, N.J.S.A. 48:3-87(e) provides for the interconnection and net metering of Class I renewable energy sources.

Class I Renewable Energy Net Metering

EDECA allows for net metering of any capacity generating size Class I renewable energy facility for residential, commercial or industrial customers on the customer's side of the meter at the avoided retail rate provided that the generating capacity does not exceed the amount of electricity supplied to the customer over an historical 12-month period. The objective of net metering is to net out a customer's electric bill to zero over an annual period. The objective of net metering is not to intentionally design a system to consistently generate excess electricity from the Class I renewable energy facility. [43] The requirements for Class I renewable energy net metering are set forth at N.J.A.C 14:8-7.

Class I renewable energy generated on the customer's side of the meter

Class I renewable energy generation facility that meet the criteria at N.J.A.C. 14:8-4.1 are deemed to be generated on the customer's side of the meter. In this case the renewable energy generation facility must be within the legal boundaries of a property, as set forth within the official tax map, on which the energy is consumed or that is contiguous to the property on which the energy is consumed.

The property on which the energy is consumed and the property on which the renewable energy generation facility is located shall be considered contiguous if they are geographically located next to each other, but may be otherwise separated by an existing easement, public thoroughfare, or transportation or utility-owned right-of-way and, but for that separation, would share a common boundary. The fact that a public thoroughfare may be encumbered by third-party easements does not alter a determination as to whether two properties would be considered contiguous.

[43] EDECA allows a customer to choose to be credited on a real-time basis or a customer may execute a bilateral agreement for the sale and purchase of the customer's excess generation.

Class I Renewable Energy Aggregated Net Metering

The EDECA provisions in N.J.S.A. 48:3-87(e)(4) provide for net metering aggregation to a single EDC customer that operates a solar electric power generation system installed at one of the customer's facilities or on a property owned by the customer, provided that the customer is a State entity, school district, county, county agency, county authority, municipality, municipal agency or municipal authority. However, aggregated net metering is not available to an on-site generation facility. The requirements for aggregated net metering are set forth at N.J.A.C. 14:8-7.

BPU Class I Renewable Energy Interconnection Requirements

The EDECA provisions in N.J.S.A. 48:3-87(e)(2) provide for the interconnection of customer generators that are eligible for net metering. The interconnection regulations at N.J.A.C. 14:8-5, direct the EDC to provide three review procedures for applications for interconnection of customer-generator facilities as follows:

> Level 1, for customer-generator facilities of 10kW or less, provided a facility meets certification requirements for these systems;
>
> Level 2, for applications to connect customer-generator facilities with a power rating of two MW or less, which meet the certification requirements of this sized system; and
>
> Level 3, for applications to connect customer-generator facilities that do not qualify for either the level 1 or level 2 interconnection review procedures

As set forth at N.J.A.C. 14:8.7 there is no process fee for Level 1 inverter based Class I renewable of 10 kW or less. The processing fee for Level 2 and 3 systems are listed in the regulations and in part depend on the complexity of the system and the requirement evaluations. Each EDC has a specific interconnection tariff and information on each EDC tariff can be found at http://www.njcleanenergy.com/renewable-energy/programs/net-metering-and-interconnection/interconnection-forms on the BPU's Clean Energy website[44].

One of the specific provisions that may impact the amount of variable DER that can be interconnected to the distribution system is the provision related to the 15% peak load screen. Screens are the tests the EDC system engineers review to insure the variable DER system can be safely connected to the distribution system for both the DER customer and the EDC system. The screen limits the capacity of variable DER on a distribution line to 15% of the line's peak load. For a twelve (12) kilovolt (kV) line this is approximately three (3) MW. A twelve (12) kV line is a typical line on all the EDC's distribution systems throughout the State in residential areas.

[44] The Tariff are typically termed Non-Utility Generator (NUG) tariffs

Another key issue is the interconnection and use of more than one type of DER technology on the same site. This is especially the case in combining CHP and solar PV or solar PV and storage because a conflict arises in regard to net metering. EDECA does not provide for net metering for non-renewables and limits net metering to Class I renewables. The system developed by advanced microgrids with multiple DER technologies needs to be able to accurately meter, record and report Class I renewable net metered electricity separately from the other components in the DER microgrid system that are not net metered.

FERC Qualified Facilities (QF) Interconnection

The Public Utility Regulatory Policies Act of 1978 (PURPA) established a new class of generating facilities which would receive special rate and regulatory treatment. Generating facilities in this group are known as qualifying facilities (QFs), and fall into two categories:

1. Qualifying small power production facilities; and
2. Qualifying cogeneration facilities.

A small power production facility is a generating facility of 80 MW or less whose primary energy source is renewable (hydro, wind or solar), biomass, waste, or geothermal resources. A cogeneration facility is a CHP facility that produces electricity and another form of useful thermal energy.in a manner that is more efficient than the separate production of both forms of energy. There is no size limitation for qualifying cogeneration facilities. QFs have the right to sell energy and capacity to a utility. However, the utility is relieved of this requirement if the QF has access to the wholesale market such as in a competitive state like New Jersey[45]

All DER systems that want to sell or provide their excess energy and capacity to the wholesale market must be interconnected per PJM requirements. The PJM interconnection requirements are listed in their Manual 14A Generation and Interconnection Process. System 20 MW or less can follow the small generator interconnection process listed in Chapter 3 of the Manual.[46] The PJM small generator procedures follow the small generator interconnection procedures and agreement promulgated by FERC in FERC Order 792.[47]

PJM, consistent with FERC Order 792, there is an expedited queue process for small generators. However, for a 10 kW inverter based system to access the PJM market as an energy or capacity resource there is a $300 nonrefundable fee to determine if the point of interconnection is FERC jurisdictional and then a $500 nonrefundable fee for the interconnection review. The fee for

[45] Detailed information on QF can be found at http://www.ferc.gov/industries/electric/gen-info/qual-fac.asp

[46] Detail of the PJM Interconnection Process can be found at https://www.pjm.com/~/media/documents/manuals/m14a.ashx

[47] Detail of FERC SGIP and SGIA can be found at http://www.ferc.gov/industries/electric/indus-act/gi/small-gen.asp

larger DER is scaled up from this level. The BPU fee for an EDC review of a 10 kW inverter based Class I renewable system is $0.00.

All the DER list is section 6 have been interconnected and the majority of the DER systems can export power to the distribution grid and some can export energy to the wholesale markets. The EDC tariffs include all FERC classified QF and all Class I renewables. The EDC's provide this same process for the interconnection of a fossil fuel system which is not a QF or a class I renewable and are in the process of expanding this process for interconnecting battery storage systems.

The Interstate Renewable Energy Council (IREC) publishes an annual report that ranks the states in terms of their overall net metering and interconnection statutes, regulations, policies and procedures. Since 2007 through 2015 New Jersey has achieved a ranking of A for interconnection procedures and B for net metering policies.[48]

New Jersey's Clean Energy Program – Statutory Provisions

As set forth in N.J.S.A. 48:3-59 the Clean Energy portion of the societal benefits charge (SBC) can be used to support demand side management programs, energy efficiency and Class I renewable energy.

N.J.S.A. 48:3-51 defines demand side management (DMS) as the management of customer demand for energy service through the implementation of cost-effective energy efficiency technologies, including, but not limited to, installed conservation, load management and energy efficiency measures on and in the residential, commercial, industrial, institutional and governmental premises and facilities in this State.

The BPU through New Jersey's Clean Energy Program (NJCEP) provides incentives to develop renewable energy and DSM energy efficiency DER technologies and projects. DER microgrid technologies promoted through the NJCEP includes but is not limited to solar, wind, sustainable biomass, CHP powered by renewable fuel such as landfill gas or biomass gas, CHP powered by fossil fuel and fuel cells. The CHP and fuel cells powered by fossil fuel must be defined as DSM energy efficiency. One of the criteria to evaluate a DSM EE DER technology or project is a cost effectiveness test that is part of the Rutgers' DER CBA model.

Linkage to the New Jersey Energy Master Plan Update - December 2015

The initial policy directive set by the Board for this Report was to address the comment and the response as noted in the Summary Section above. However, there are additional policy, regulatory, technical, and financial reasons for developing a statewide microgrid policy that can

[48] Detail of State rank for IX/NM can be found at http://freeingthegrid.org/.

operate 24/7 under both blue skies and black sky conditions. These reasons are referenced in the 2015 New Jersey Energy Master Plan (EMP) Update.

The BPU as Chair of the EMP Committee issued the 2011 EMP Update in December 2015. The EMP Update notes that the production and distribution of clean, reliable, safe, and sufficient supplies of energy is essential to New Jersey's economy and way of life. Energy is a vital tool of economic growth and job creation across New Jersey's entire economy. Economic growth depends on abundant, affordable supplies of energy. When considering where to locate or expand businesses often identify energy costs as second only to labor costs in their decision-making process. The energy costs must be balanced with the benefits provided by energy policies.

The 2011 EMP Update contains five overarching goals:

1. Drive Down the Cost of Energy For All Customers
2. Promote a Diverse Portfolio of New, Clean, In-State Generation
3. Reward Energy Efficiency and Energy Conservation/Reduce Peak Demand
4. Capitalize on Emerging Technologies for Transportation and Power Production
5. Maintain Support for the Renewable Energy Portfolio Standard

A Statewide microgrid policy and development of microgrids at the local level addresses all of the five overarching goals of the EMP Update. The microgrid can assist the local government in controlling its energy costs. The technologies in a microgrid helps to promote diverse clean instate generation as well as promoting emerging technologies and renewable energy. The operations of a microgrid can enhance the energy efficiency of the local government and other facilities as well as reduce the impacts of peak energy demand on the grid.

The EMP Update set forth a Plan for Action that grouped 31 policy recommendations into four general sections listed below. A microgrid developed at a local level touches on a majority of these policy areas.

- ❖ Expand In-State Electricity Resources
  - Build new in-state generation
  - Develop 1500 MW of CHP and DG
  - Promote expansion of gas pipelines
  - Clean energy to be 70% of supply by 2050

- ❖ Cost Effective Renewable Resources
  - Extend the EDC's solar programs
  - Evaluate solar incentives
  - Promote certain solar photovoltaic (PV) installations

- Reduce the cost of solar panels
- Promote effective use of biomass
- Support other renewable technologies

❖ Promote Cost Effective Conservation and Energy Efficiency
  - Monitor EE effect on solar
  - Promote EE and Demand Response (DR) in State buildings
  - Monitor PJM's DR programs
  - Apply cost benefits test to EE programs
  - Evaluate dynamic pricing and metering
  - Add aggressive EE building codes
  - Increase natural gas EE
  - Expand education and outreach
  - Monitor energy storage developments

❖ Support the Development of Innovative Energy Technologies
  - Improve vehicle efficiency and funding
  - Support emerging technologies

This EMP Update adds a new section, "Improve Energy Infrastructure Resiliency & Emergency Preparedness and Response," based upon New Jersey's Plan for Action in the aftermath of Superstorm Sandy. A statewide microgrid policy can addresses each of these new policy areas in the EMP Update

❖ Improve Energy Infrastructure Resiliency & Emergency Preparedness and Response
  - Protect the State's critical energy infrastructure
  - Improve EDC emergency preparedness and response
  - Increase the use of microgrid technologies and applications for distributed energy resources (DER)
  - Create long-term financing for local energy resiliency measures through the ERB and other financing mechanisms
  - Specially the EMP Updated highlighted several action items and recommendations related to microgrids and DER: *The increase in in-state electricity generation to maintain the progress on controlling energy costs must also include newer, more efficient distributed generation such as combined heat and power, fuel cells and solar. Interest in local generation is growing alongside interest in DG. Distributed generation technologies can also improve and enhance the State's energy resiliency at the local level through the development and implementation of microgrids.*

  - *The State will continue to encourage new DG of all forms and keep a focus on expanding use of CHP by reducing financial, regulatory and technical barriers and identifying opportunities for new entries. The BPU should initiate a stakeholder process to determine how to reduce these barriers and increase the development of DG with a focus on CHP, fuel cells within a* *microgrid. This should include evaluating revisions to the CHP and fuel cell incentives to promote local energy resiliency.*

- *The State should continue its work with the USDOE, the utilities, local and state governments and other strategic partners to identify, design and implement TCDER microgrids to power critical facilities and services across the State.*

4. **Advanced Microgrid Energy Manager**

The key to the efficient and effective management of an advanced microgrid or a TCDER microgrid is what entity manages the two way flow of power to and from the advanced microgrid. This section addresses some of the initial technical, regulatory and policy issues and barriers.

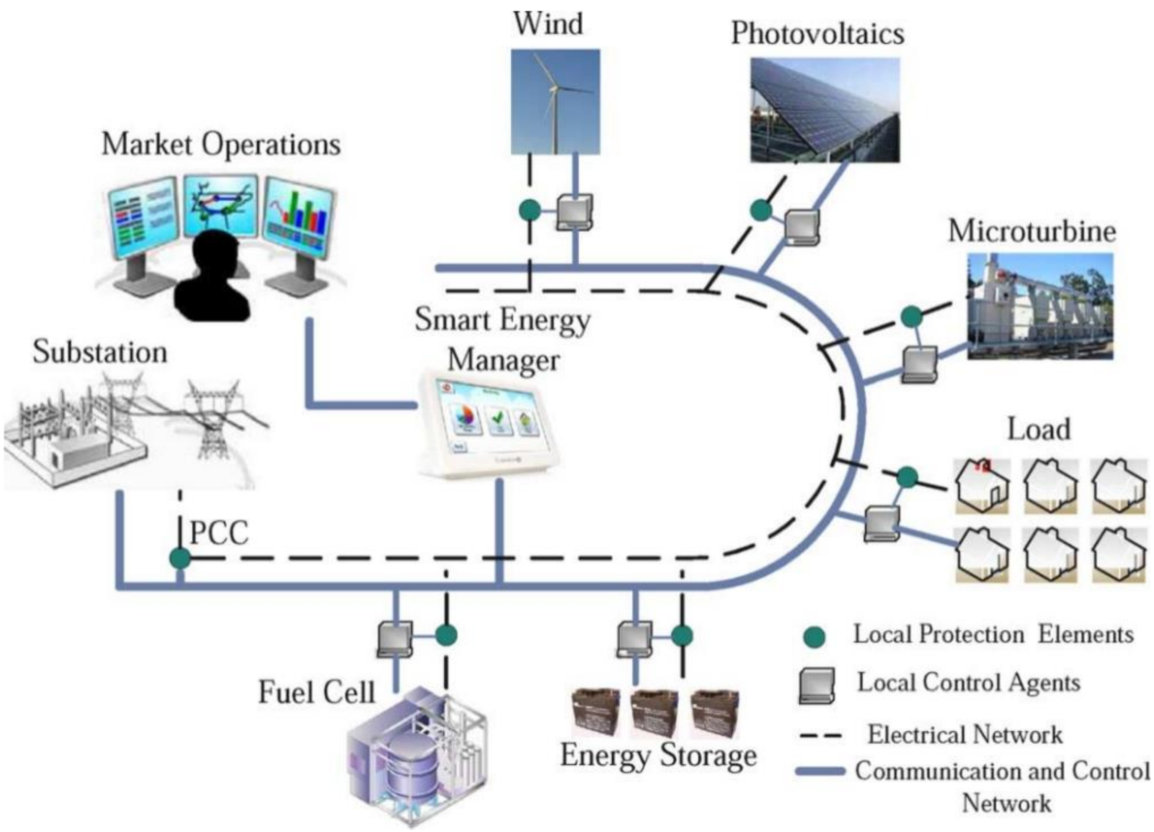
The definition of a microgrid focuses on the electrical boundaries even though, to be cost effective, most microgrids will also provide thermal energy and storage. This focus on electric boundaries is because of the more complex nature of the electric systems in the DER microgrid. Electricity flowing between and among different metered customers and across multiple ROW while still connected and running in parallel with the existing distribution grid has a higher degree of complexity as compared to moving thermal energy to various off-site thermal energy customers.

In the microgrid electric system, the energy manager has to account for the electricity quality within the microgrid and how the microgrid will impact the larger distribution grid. While this operational accountability is present in Level 1 or 2 microgrids, it becomes more complicated in an advanced microgrid.

There are essentially two levels of energy management in a microgrid. For this discussion, this report presents these two functions as the DER Energy Manager and the Systems Energy Manager. The terms are not important; which entity performs them and how they are performed are the key issues. There are currently no defined demarcations that separate these two energy management functions and they operate more on a continuum than absolute defined criteria. For discussion purposes only, this report separates these two functions. The below schematic shows these functions as one Smart Energy Manager, and for a Level 1 and 2 microgrid, these two functions are performed by the microgrid owner/operator.

The DER Energy Manager operates the functions of the microgrid to optimize the DER operations within the microgrid. The Systems Energy Manager manages the two way power flow and interconnection to the grid to optimize utilization.

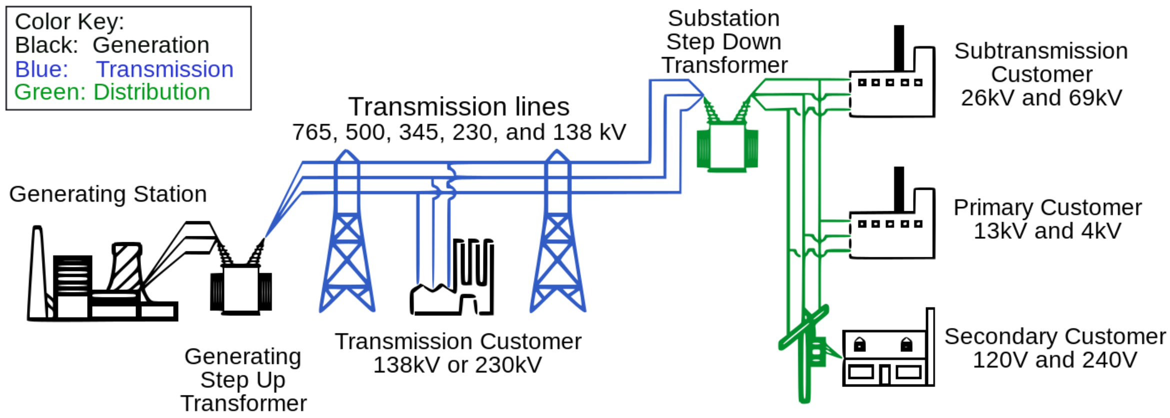
Therefore, a priority of Public Utility Commissions will be to determine who will be the DER Energy Manager of the level 3 advanced microgrids.



(Image 4.a)

Current Wholesale Electric Energy Manager

As noted in diagram 4.a, the Systems Energy Manager of a typical central electric generating station within the transmission system grid is the Independent System Operator or Regional Transmission Operator (ISO/RTO). There are seven (7) ISO/RTO within the United States. Within the Mid-Atlantic states including New Jersey, this energy manager is the Pennsylvania, New Jersey, Maryland Interconnection, LLC (PJM). PJM is regulated by the Federal Energy Regulatory Commission (FERC). PJM is an independent agency that does not own or operate any electric generation units (EGU) or transmissions systems, but manages the non-discriminatory access to transmission by EGUs. It also performs the planning functions to insure that the appropriate infrastructure is available to have reliable delivery of electricity. PJM is the RTO in 13 States plus the District of Columbia, encompassing more than 72,000 miles of transmission wires and over 170,000 MW of generations.



(Image 4.b)

A microgrid, even an advanced microgrid, is likely too small for the ISO/RTO to effectively manage the operations of the microgrid. While small DER systems like solar PVs or CHP facilities are registered in PJM, they are not FERC jurisdictional unless they are selling power at the wholesale level. PJM monitors these facilities, but does not directly manage the flow of electricity, communications or perform other load management functions for or with the microgrid as it does with the larger central power plants or EGUs. It does not directly provide the System Energy Manager functions. These energy management issues for small DER systems are typically addressed through a Wholesale Market Participation Agreement (WMPA). These small DER systems are typically viewed as behind the meter in the transmission system.

ISOs do require metering in their system for any behind the meter generation in their transmission system. Although smaller DER systems are required to be interconnected through the distribution system as noted in Section 3, the interconnection requirements are set for facilities 20 MW or larger. This is the upper capacity size of most DER facilities and microgrids. It is also unclear how changes in PJM requirements will impact the operations on DER microgrid systems in general. Given these issues, the ISO/RTO is focused on the current EGU/transmission system and is probably not in any practical or reasonable position to be the System Energy Manager of an advanced microgrid.

The Energy Manager for Advanced Microgrids

The key function for the Systems Energy Manager is to maximize the advance microgrid benefits and minimize the costs to both the advance microgrid customers and the customers of the distribution grid. The operations of advanced microgrids are significantly more complex than a level one (1) or two (2) microgrid because of the additional and separate loads served by the advanced microgrid

With the potential impacts of an advanced microgrid on the local distribution grid and the need to determine if and when the advanced microgrid operates islanded or in parallel with the distribution system, even when limited to emergency situations, the advanced microgrid owner/operator may not be in a better position to operate as the System Energy Manager. The EDC has the statutory obligation to operate the distribution grid to provide safe, adequate and proper services at reasonable non-discriminatory rates to all customers. Therefore, the EDC may be in a better position to be the System Energy Manager.[49]Conversely, the advanced microgrid owner/operator is in a better position to be the DER Energy Manager.

Also, the advanced microgrid owner/operator would be in a better position to optimize the efficiencies of the individual component systems of the advanced microgrid behind the point of common coupling and the revenues streams of these components for the microgrid as a whole. However, the need to maximize those revenue streams may result in an internal conflict of the advanced microgrid owner/operator as the System Energy Manager as it impacts the distribution system.

There is currently no clear opinion to whether the EDC or owner/operator is best option as the Systems Energy Manager for the advanced microgrid. This needs to be further vetted and discussed with stakeholders and evaluated by the BPU. The operations of the first advanced microgrids may initially require both of these entities to be the Systems Energy Manager

The advance microgrid can potentially provide benefits to the distribution grid as follows:

1. Produce electric and thermal energy for its customers and therefore reduce the amount of electric power that must be generated and transmitted.
2. Provide ancillary services and reduce the peak demand.
3. Produce and deliver energy to its customers more efficiently and with less environmental impacts than through the transmission and distribution grid.
4. Provide islanding and blackstart capabilities of the advanced microgrid to reduce outages under emergency conditions which can enhance the resiliency and reliability of the local grid.

The advanced microgrid in turn can receive the benefit from of taking supply from the distribution grid. Nevertheless, the advanced microgrid can impact the distribution grid in other ways. While upgrades to the distribution system can sometimes be deferred, such upgrades may not be fully avoidable in order to accommodate an expansion of advanced microgrids. Moreover, if not properly managed, the advanced microgrid could reduce the reliability of the grid.

An advanced microgrid should be responsible for costs associated with the benefits they receive from the distribution grid. Otherwise, this cost could be passed on to other ratepayers. These benefits are typically paid for by a microgrid to the distribution system through the EDC's tariffs and standby charges.[50]

Likewise, a distribution grid should be responsible for the benefits they receive from the advanced microgrid. Currently, the distribution system does not pay for these benefits. However, the microgrid receives the benefits of the avoided cost of energy. A microgrid can also receive

[49]But the EDC may have an internal conflict as the System Energy Manager in determining the best use of the microgrid operations because of the potential impact on the EDC's revenue within the current tariff system.

[50] See the individual EDC tariffs at http://www.state.nj.us/bpu/about/divisions/energy/tariffs.html

the benefits of capacity and energy payments along with other ancillary benefit payments from the wholesale energy market. The benefits received by the microgrid may not balance the overall cost at the distribution level.

The development of advanced microgrids must balance costs and benefits to the EDC, the owner/operator of the advanced microgrid, ratepayers and the advanced microgrid customers.

The above issue to balance the costs and benefits would ultimately be addressed in a DER or microgrid tariff. There are a number of technical guidance documents on this issue but the Regulatory Assistance Project (RAP) *Designing Distributed Generation Tariffs Well Fair Compensation in a Time of Transition* 2013 is a good compilation of many of the issues. This document recommends 12 factors to consider in developing a fair DER or microgrid rate. In summary, the guidance recommends that the tariff should be simple and straight forward. It should not be used as an incentive for the DER microgrid nor should it address reduced throughput revenues. The issues of incentives and reduced revenue throughputs should be addressed in separate proceedings.

The balancing of these issues should recognize that valuing those costs and benefits are reciprocal. This latter point means that an acceptable valuation methodology should be determined and implemented as part of the process upfront.

The RAP Whitepaper on Designing Tariffs for DG Customers lists 4 basic principles to consider when designing a rate for DG customers as follows:[51]

1. A customer should be able to connect to the grid for no more than the cost of connecting to the grid;
2. Customers should pay for grid services and power supply in proportion to how much (and when) they use these services and how much power they consume;
3. Customers who supply power to the grid should be fairly compensated for the full value of the power they supply, no more and no less; and
4. Tariffs should fairly balance the interests of all stakeholders: the utility, the non-DG customer, and the DG customer.

[51] file:///C:/Users/winka/Downloads/RAP_MADRI_DesigningTariffsForDGCustomers_FINAL%20(1).pdf

5. Cost Benefit Analysis of Advanced Microgrids

Background – Why States are Experiencing an Increase in Microgrid Development

There is a collective movement across the country to address the development and implementation of microgrids. There are a number of states that are currently establishing microgrid and DER policies and programs. Both the National Association of Regulatory Commissions (NARUC) and the National Association of State Energy Official (NASEO) quarterly and annual conferences have several panels addressing microgrid, or distributed energy resource (DER) policies. These panels include proposals for new utility business models to develop advanced DER microgrids. The USDOE and several of its national energy labs have developed microgrid models and technology guides to assist in evaluating and optimizing microgrids. Several electricity codes and standard entities, such as the IEEE, have begun to improve, enhance and upgrade their codes related to the interconnection and operations of microgrids.

One of the reasons states are developing microgrid policies and programs is to improve and enhance energy resiliency especially within local critical facilities that operate as shelters when the grid is off-line during or after an emergency. One of the objectives of this report is to address the this specific issue of operating the DER as a microgrid during an emergency – in a black sky scenario.

This report also addresses the larger issue of operating the advanced microgrid 24/7 under blue sky conditions. Other states are currently evaluating advanced microgrids future cost effectiveness compared to traditional energy system costs. This section discusses some of those broader issues related to advanced microgrid operations.

The decrease in cost of some DER technologies that is one of the key drivers of microgrid development. To illustrate this point, this section walks through a simple economic analysis of the DER system availability and cost trends. This analysis is not a detailed cost benefit analysis that would be required to establish utility regulations or statutes. It is solely intended to provide a simple directional analysis to assist in the Board's policy discussion of these issues. Also, the following is not a comparison of the most cost effective microgrid DER technologies within an advanced microgrid. It is just a simple directional analysis that indicates why the grid system may become more distributed over time as opposed to the current centralized power plant and transmission system. The majority of the cost and efficiency data on this directional analysis comes from solar projects due to the data being readily available through the Board's Clean Energy programs.

Solar PV installation costs were $10 to $12 per watt when the BPU solar PV program was started in 2001. At that time, the NJCEP solar PV rebates were 50% to 60% of the total system installation cost in $/kW.[52] The New Jersey solar PV program incentives also include net metering and solar renewable energy certificate (SREC). The SRECs, when first established by the Board in 2005, were capped at $200 per MWh.[53] The efficiencies of the solar panel system, at the initiation of the NJCEP solar program, was in the 8 to 12% range.[54] The NJCEP in its approved Energy Resource Savings and Generation protocols currently use 1,200 kilowatt-hours per kW installed or 13.7% efficiency.[55] In 2001 there were only 6 solar PV projects installed for a total of 9 kW.

In 2001, micro-CHP costs were approximately $50,000 per kW installed, and battery storage was not available. There were no installed micro CHP systems and no installed battery storage systems.[56] The NJCEP CHP rebate program was initiated in 2005 and did not address islanding or black-start equipment for these systems. Although, as noted in Section 6.1, a number of the CHP systems from the beginning of the NJCEP CHP incentive program were installed with energy resiliency equipment. The islanding or energy resiliency equipment was included as part of the total CHP system cost. NJCEP incentives for CHP systems is based on a percentage of the total installed system cost in $/kW including energy resiliency equipment.[57]

The installation costs for DER technologies have declined significantly in recent years. For example, 2015, some large commercial and grid connected solar PV panels, for grid supply installations, could be procured at $1 per watt and installed for less than $2 per watt.[58] In fact, there are numerous reported utility scale solar projects installed at less than $2 per watt and approaching $1 per watt.[59] In addition, solar PV panel efficiencies have increased to the 15% to 20% range.[60]

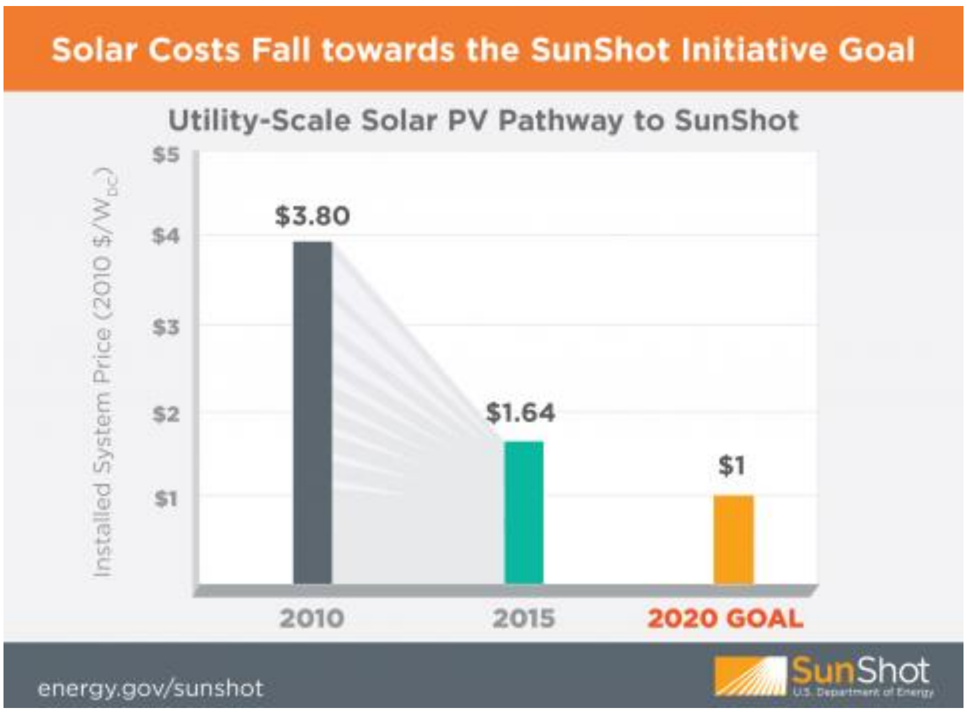
The USDOE Sunshot program goal for solar PV panel installation is to achieve installation costs of $1 per watt by 2020 and less than $0.75 per watt by 2030. [61] This goal was initially established for utility scaled solar installation and is equivalent to $0.06 per kilowatt-hour. The Sunshot program goal of $0.06 per kilowatt-hour is at the wholesale rate and not the cost of rooftop solar on the distribution system. This is not fully applicable in New Jersey because all

---

[52] NJCEP Solar data
[53] NJDEP Solar data
[54] http://www.nrel.gov/ncpv/images/efficiency_chart.jpg
[55] NJCEP Evaluation Protocols http://www.njcleanenergy.com/main/public-reports-and-library/market-analysis-protocols/market-analysis-baseline-studies/market-an
[56] NJCEP solar data http://www.njcleanenergy.com/renewable-energy/project-activity-reports/installation-summary-by-technology/solar-installation-projects
[57] Energy resiliency equipment is defined as the cost to install islanding and black start equipment.
[58] USDOE EERE NREL Sunshot-Vision-Study and SEIA GTM reports
[59] http://www.nrel.gov/docs/fy15osti/64746.pdf and http://pv.energytrend.com/research/Installed_Cost_of_Utility_Scale_PV_System_in_the_US_Down_17percent_YoY_in_3Q15.html and http://www.njcleanenergy.com/renewable-energy/project-activity-reports/project-activity-reports
[60] http://www.nrel.gov/ncpv/images/efficiency_chart.jpg
[61] USDOE EERE

solar that generates SRECs must be connected to the distribution system. The Sunshot program goal is more applicable to grid connected solar PV in New Jersey. However, the USDOE has stated that this goal will also contribute to a decrease in rooftop solar installation costs in the future.[62]

The reported LCOE for new utility solar systems is between $0.07 and $0.13 per kWh depending on the location within the US.[63] It is estimated that achieving the USDOE Sunshot goals could result in 14% of U.S. electricity being supplied by solar PV by 2030. The current U.S. electricity supply from solar is 0.4% in 2014.[64] This total would be higher in New Jersey given that New Jersey's current solar electricity supply is almost 3%.[65]



(Image 5.a)

Solar PV with an eight (8) hour battery storage system run time could more than double the cost of a current solar PV system. The industry is currently seeing a decrease in the standard grid-tied inverter costs and movement to micro-inverters which may allow for a more plug and play PV installation. The DC electricity generated in the solar panel must be converted to AC in order to be used in homes and businesses. This conversion is performed by the inverter. If off-grid or

[62] The comparable Sunshot goal for commercial and residential sector solar is $0.07 and $0.09 per kWh.

[63] Technology Advances Needed for PV to Achieve Widespread Grid Price Parity, USDOE and NREL

[64] USDOE EERE NREL Sunshot- Vision-Study

[65] NJCEP solar data http://www.njcleanenergy.com/renewable-energy/project-activity-reports/installation-summary-by-technology/solar-installation-projects

dynamic inverters are required for enhanced resiliency as opposed to the standard and less expensive grid-tied inverters there may be an increase in overall costs.

An off-grid or dynamic inverter would allow the solar PV system to operate in island mode when the distribution grid is down. Currently, all New Jersey solar PV systems operate with grid-tied inverters and do not operate when the distribution grid is down. If off-grid or dynamic inverters become standard, the costs will decrease over time. Currently these inverters are more costly than standard grid-tied inverters.

The cost breakdown for a solar PV installation is 50% panel costs, 30% balance of system (BOS), 10% inverter costs and 10% installation costs.[66] BOS costs include the racking equipment, combiners, controllers and wiring. The USDOE research is focused on the reduction of BOS costs as well as labor costs related to permits and zoning. The BPU is working with Sustainable Jersey to assist municipalities in lowering some of these costs.

USDOE has a similar goal for reducing the cost of micro-CHP to $1,000 per kW installed, as well as a similar goal for battery storage cost and battery density improvements. USDOE's goal for batteries is to reduce costs and increase power by five (5) times in five (5) years.[67]

At the current residential and non-residential rooftop solar installation costs, the cost of solar electricity is in the same range of retail electricity prices in states with the highest average rates.[68] At $2 per watt installed with 20% efficiency, the solar levelized energy cost could be below the national average electricity rates.[69] If this is in fact the case, installing DER solar may become cheaper than any other grid power source. This fact alone is changing the distribution system.

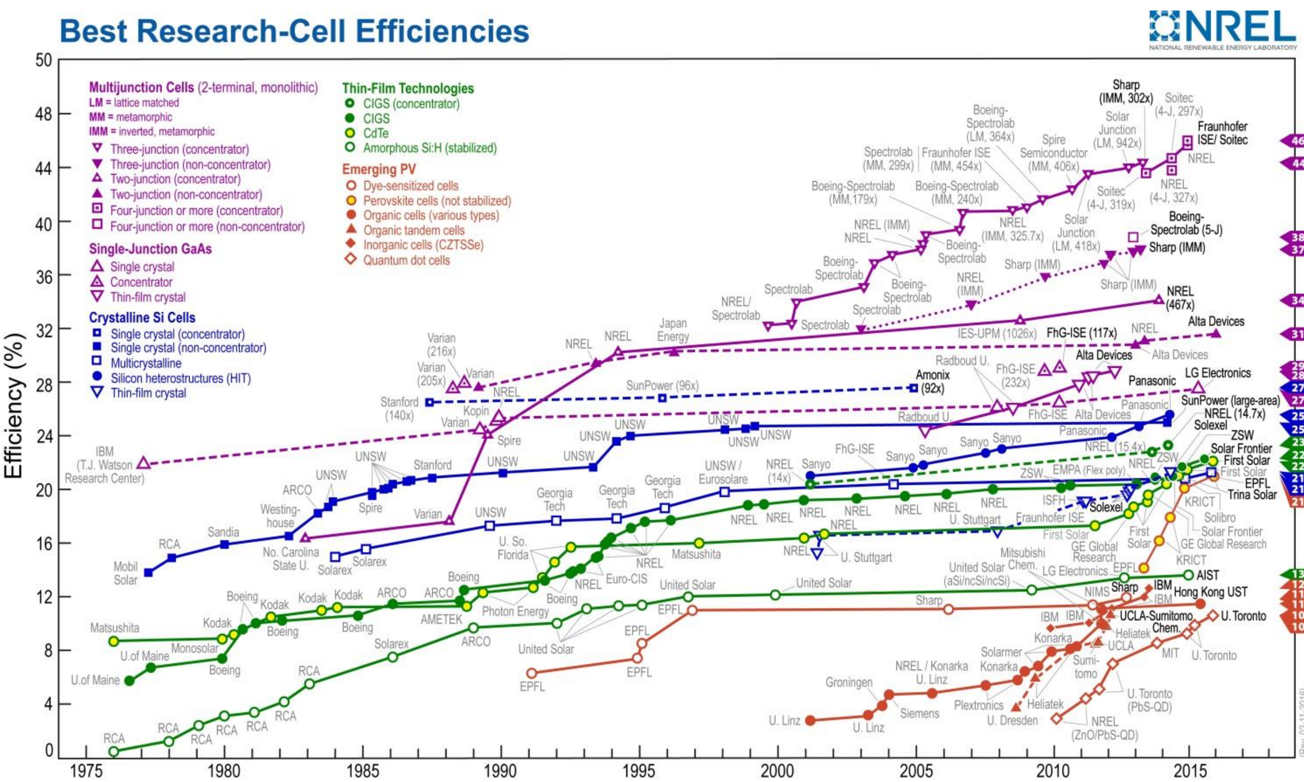
The average US residential price for electricity is over $0.12 per kWh.[70] New Jersey's average electricity price is approximately $0.15 per kWh averaged across all customer classes and EDC.[71] In recent years, because of the decreasing cost of natural gas, electricity prices have declined. Historically, electricity prices have increased over time even under energy deregulation and electricity discount price caps. EIA is projecting flat electricity prices in the near term and less than a 1% annual increase through the end of the next decade.

Natural gas prices were historically around $5 per MMBtu and increased to $12 per MMBtu in the beginning of 2000 and are now approximately $4 per MMBtu. EIA Energy Outlook 2015 project low natural gas prices through the end of the next decade.[72] Oil prices were

[66] USDOE SunShot data - NREL
[67] USDOE EERE
[68] http://www.nrel.gov/analysis/tech_lcoe.html
[69] http://www.nrel.gov/analysis/tech_lcoe.html
[70] https://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a
[71] EIA electricity data
[72] https://www.eia.gov/forecasts/steo/report/natgas.cfm and http://www.eia.gov/forecasts/aeo/

approximately $30 to $50 per barrel, increased to one hundred ($100) per barrel, and are now approximately $50 per barrel.[73] Given the current supply for oil and gas internationally and now nationally, these low prices may be around through the end of the decade and possibly longer.

The 2004 Renewable Energy Market Assessment performed by Navigant estimated a total New Jersey installed capacity potential of 17,000 MW of solar PV.[74] This technical market potential for installed solar PV capacity was based on New Jersey's estimated un-shaded commercial and residential roof space with southern exposure. This solar market potential was estimated at a 15% capacity factor (1,300 MWh per MW installed). The technical potential included only a limited capacity of ground mounted systems and did not include installations on available roof space with southwestern exposure. Currently, commercial solar panel systems are in the 20% range and typical residential system efficiencies are in the 17% range.[75] See chart 5.b for a summary of the solar panel efficiencies.



(Image 5.b)

If solar PV panels are manufactured at 25% efficiency, based upon the PV capacity analysis performed in 2003 by Navigant in their Renewable Energy Market assessment for the BPU, there is sufficient roof space capacity to generate approximately 80% of New Jersey's annual average

[73] http://www.eia.gov/forecasts/steo/ and http://www.eia.gov/forecasts/aeo/
[74] NJCEP RE Evaluation Reports – Navigant 2005
[75] NREL

electricity needs.[76] Solar PV at $1 per watt installed is an electric generation cost that the New Jersey ratepayers would not have to subsidize in rates. A cost-effective solar PV system could be installed without rebates, SREC or retail net metering. Unless electricity prices drop substantially, solar PV could be cost effective at $1 per watt based on the avoided costs of electricity alone.

If the micro-CHP costs approach $1,000 per kW installed, a homeowner can install a micro-CHP that would generate the same amount of hot water, heat, ventilation and air conditioning as a high efficiency hot water, heating system and central air conditioning at the same cost as the installation of a high efficiency HVAC system. In addition, for the same or less cost, the micro-CHP will also generate all the electricity the homeowner would need for the entire year. The use of a micro-CHP to generate a home's total energy needs may be accomplished at approximately the same current natural gas usage as today's heating and electric generation systems' usage.

This report does not advocate one DER technology selection over the other – solar, batteries or micro-CHP. The combination and use of these technologies can potentially lower the overall cost and energy demand profile at the point of use on the distribution system. The above direction analysis is for individual DER systems and not advanced microgrids. The next logical step is to link DER systems to improve the effectiveness and efficiency of the grid.

In recent years the growth in electric peak has significantly exceeded the growth in average electric energy use. This means that the current system is increasing in inefficiency and has more generation systems in standby not being used. The solution is a more efficient tariff. The tariff is the appropriate place to balance the costs and benefits of an advanced microgrid. It should not be the place to provide incentives but fairly provide for the payment of costs and benefits. The expansion of the tariffs will require input and cooperation from all of the stakeholders.

Potential Impacts on Electric Retail Sale

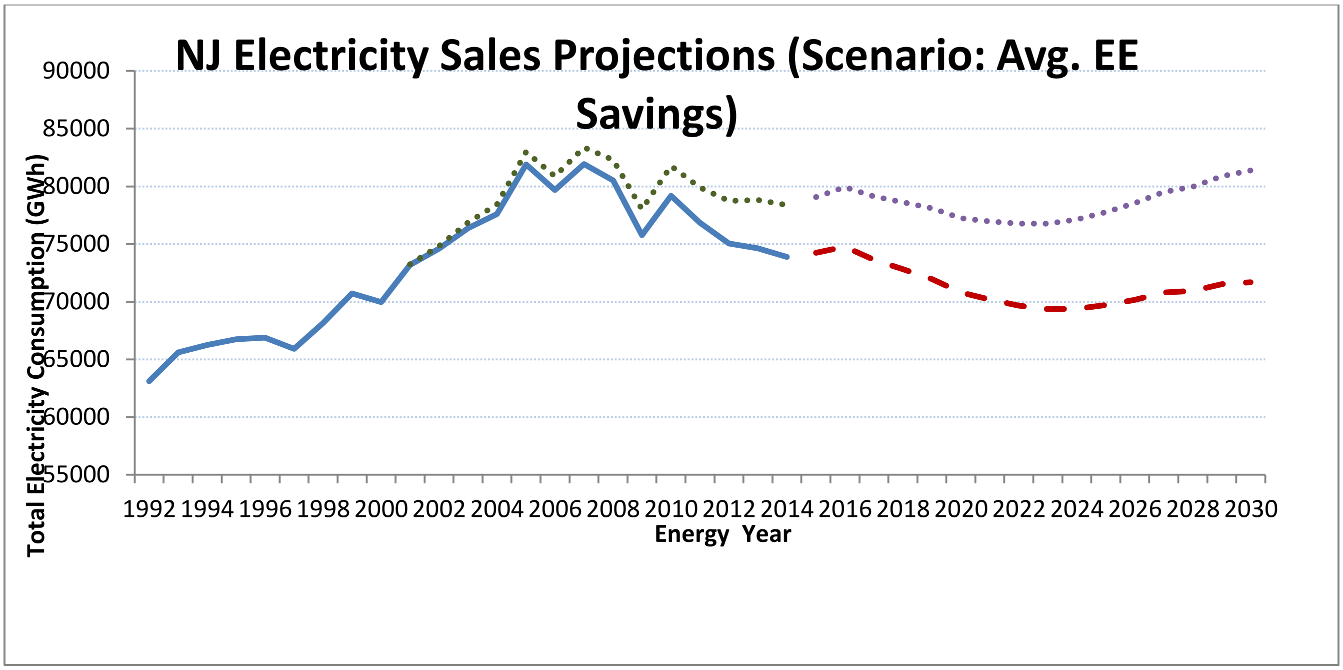
Two additional points in this simple directional analysis that will impact the change in energy use, is the overall impact of energy efficiency on the current demand for electricity and the potential growth of electric vehicles (EV) actually increasing demand.

Noted in the chart 5.b, due to the energy savings from the BPU's NJCEP energy efficiency programs, it is estimated that New Jersey electric customers used approximately 6% less electricity in 2014.[77] That energy savings approximately 4.5 million megawatt-hours less in 2014 and approximately 22 million megawatt-hours since the initiation of the NJCEPEE

[76] This is calculated on an annual basis and would be different as calculated on a monthly or daily basis. At a higher PV panel efficiency a greater amount of solar MW capacity can occupy the same square footage of the 17,000 MW capacity estimated by Navigant. This additional MW capacity will also generate more electric energy MWh at the higher efficiency.
[77] NJBPU Energy Master Plan Update 2015

programs in 2001. While the direct savings from the BPU's EE programs go to the program participants, all electric and natural gas customers benefit because in total there is 4.5 million MWh less electricity that needs to be generated, some of which occurs during peak system usage which reduces costs for all ratepayers.

Some of these savings are now locked in with upgrades to building energy codes and appliance standards. New Jersey has some of the most progressive energy building codes in the U.S.[78] Carried forward a new home constructed today on a per square footage basis, uses significantly less energy than the same size existing home built prior to the implementation of model building energy codes in the 1970s.[79] The combination of a solar and micro-CHP system to power this more efficient home would be smaller and the overall capital cost less.



(image 5.c)

According to the Electric Vehicle Transportation Center the current status of EV sales for 2014 in the U.S. show that 118,773 vehicles were sold as compared to 96,700 vehicles in 2013. The total cumulative number of EVs sold over the five year sales period is now at 286,390 vehicles. Assuming a conservative 20% growth rate, then the U.S. sales in 2024 will be 740,000 EVs per year with cumulative number of vehicles at 4.0 million.[80] As of December 2015, there were

[78]See https://www.energycodes.gov/status-state-energy-code-adoption
[79] See https://www.energycodes.gov/development
[80] http://www.fsec.ucf.edu/en/publications/pdf/FSEC-CR-1998-15.pdf

7,818 electric vehicles registered in New Jersey. This number includes Battery Electric Vehicles, Plug-in Hybrid Electric Vehicles, and Neighborhood Electric Vehicles. In 2012, there were only 1,741 electric vehicles registered in the state.[81] New Jersey had approximately 6.6 million registered vehicles in 2010 of which 3.9 million were automobile vehicles.

The above analysis is a simple view of the DER market costs and capacity availability. It is not a full or detailed economic or technological analysis of what New Jersey's future energy resource mix should include.

The analysis is simply to provide the Board with a directional evaluation as a reason the current grid model is changing, or will change. It will take a decade or more for these costs and efficiencies to be seen industry wide. In terms of utility regulation timeframe this is a relatively short period. Nationwide both utilities and PUCs are performing similar analyses.

If the above described cost decreases and efficiency increases happen, you will see a migration of customers from the current distribution grid. This will also impact the configuration of the current RTO/ISO system. The current trends of DER system efficiency increases and cost reductions are on course with USDOE projections.[82] Couple this with the current relatively flat trend in energy usage and increased energy prices, the future energy system will be dramatically different than the systems that have been in place for over one hundred (100) years. Even if EV sales increase and demand for electricity increases, the system will still have to change but it will have to respond to two new issues – increasing DER and increasing EV usage.

The migration from the grid will not happen overnight, but it will happen if the DER prices and efficiencies are achieved in the near future. The current configuration of the distribution grid could not adequately handle this mass migration. The distribution grid would need to be upgraded to accommodate these less expensive and more efficient DER technologies and advanced microgrids in the future. The distribution grid upgrades need to provide a two-way communication between the customer and the EDC, as well as a two way flow of electricity. Some have termed this upgrade as "Smart Grid" while the general term is Distribution Automation.

The upgrade of the distribution system will take planning and time to implement these systems across all customer classes and users of the system. This upgrade of the distribution system also has a cost that must be accounted for across all customer classes and users of the upgraded system.

While the above directional analysis includes solar PV it is not likely that solar PV will be the initial technology that drives advanced microgrids. Solar PV may be a key in the blue sky

[81] http://www.drivegreen.nj.gov/electric.html
[82] USDOE EERE and NREL

conditions but is an issue in the development of advanced microgrids to continue to protect the distribution system. It is the biggest technical challenge for Solar PV within advanced microgrids. Tested technologies, consistent with IEEE 1547 microgrid standards, are just entering the market. But an intermittent resource like solar PV increases that technical challenge. Storage can aid in this challenge but also adds significant costs.

Upgrading the distribution system will also have a number of benefits besides providing for a greater penetration of DER on the system. New Jersey could see an increase in economic development. The prime economic driver would be construction to upgrade the grid and to install advanced microgrids.

This could also include increased manufacturing. There are currently two companies that have been funded by the NJCEP and through the NJBPU/EDA programs that manufacture products in New Jersey and support advanced microgrid development. Princeton Power in Lawrenceville is a manufacturer of off grid inverters and manufactures solar-based energy storage microgrids. EOS in Edison is a manufacturer of zinc-air rechargeable battery storage systems. Development of upgraded grids could increase this manufacturing sector in New Jersey.

Each state's response to developing and enhancing advanced microgrid policies will be different. That is because the suite of available DER technologies, the financing options and the utility regulatory approaches to microgrids will be different. See Appendix F for a summary of some of the key states that are in the process of developing DER and microgrid guidance and policies, as well as utility statutes and regulations including rate and tariff design.[83]

These states, and others, are seeing clean energy technology availability increase, and associated cost decrease, such that there is a growing need to change the current utility regulatory structure that manages energy infrastructure. Without changing the energy regulatory structure, New Jersey could be trying to pay for a landline infrastructure in a cell phone world. An available option could be to determine that there will be no advanced microgrids in New Jersey. But given the cost trends and technology advances, that is not a realistic approach.

The customer's perspective is also changing. There is a segment of the population that no longer has a landline and just uses a cellphone or other mobile devices. This same segment most likely has a mobile hot spot or Wi-Fi connection that provides their news and entertainment. Their computer system is not a desktop tied to a cable modem but a mobile pad linked to a mobile hotspot. This energy utility customer will want to have their service provided in a different manner than the current one way communication by a centralized transmission/distribution grid.

If the USDOE cost and efficiency targets for DER are achieved or even partially achieved in the near future, the current utility grid model will not be able to adequately respond to the requests by customers to be 'disconnected' from the grid. It is better to help shape this change and what

[83] The State summary is up through the end of 2015

the future utility model should be in a more DER centric model as opposed to having to manage that utility business model in the middle of the actual change.

New Jersey Resilient DER

Superstorm Sandy also demonstrated the value of having more resilient energy technologies at critical facilities. Despite widespread failure of the electric distribution system, there were several entities throughout New Jersey in storm-impacted areas that maintained full power despite prolonged and diffuse failures of the larger electric grid. These "islands of power" had distributed generation units, which allowed the facilities to operate as microgrids while the electric grid was down.

However, not all 50 microgrid facilities that could island when the grid was down did so after the storm. Less than a dozen facilities operated in island mode when the grid was down. Two notable CHP facilities that could have islanded were Rutgers' CHP facility and Princeton Hospital. The Rutgers CHP facility did not update the microgrid controls to match the electric distribution system and could not island. The Princeton Hospital had just installed the CHP system with islanding capabilities but the technical staff was not yet trained to operate the system in island mode. These situations point to the need to ensure appropriate operational training and periodic testing.

Conversely, Princeton University's CHP microgrid operated for a week when the larger grid failed. This saved the University millions in avoided losses of irreplaceable research projects. The College of New Jersey's CHP microgrid had capacity to provide heat, power, hot food and hot showers to 2,000 mutual aid workers from other states that were helping to restore power after the storm.

As noted in the DER tables in Appendix E, several New Jersey Colleges and Universities have CHP systems that can isolate from the grid and operate during an outage are Rutgers University, St. Peters College, Rowan University and Rider University. Even small community colleges like Raritan Valley and Salem Community College operate CHP facilities that can island. Several medical facilities are also able to maintain power through their CHP microgrids, becoming larger shelters as well as accepting patients from other facilities. President Obama's Hurricane Sandy Rebuilding Task Force described the Bergen County Utilities Authority in Little Ferry, New Jersey, as a model for the region and nation because it was able to use a biogas CHP system to keep its sewage treatment facilities working during and after the storm in the face of a prolonged power outage.[84]

While no detailed cost benefit analysis has been performed after Sandy on microgrids that operated in island mode when the grid was down. It is estimated, based on qualitative data, that the microgrids that operated in island mode, provided a significant value that if monetized could have exceeded the total installation cost from this one single event.

New Jersey does relatively well when compared to other States in incentives for the development and implementation of DER. But two additional items are needed to assist in the development of advanced microgrids. One is an incentive to fund the development of advanced microgrid feasibility studies. At the feasibility stage, there is a high level of risk on any Town Center DER microgrid development. Assisting project development at this point can result in a high return on a small investment. The other item is the development of a financing mechanism. Secure and stable financing sources will be required to enhance the development of advanced microgrids, especially Town Center DER microgrids. There are several options including green banks, energy bonds, portfolio certificates or utility structures to develop this financing mechanism.

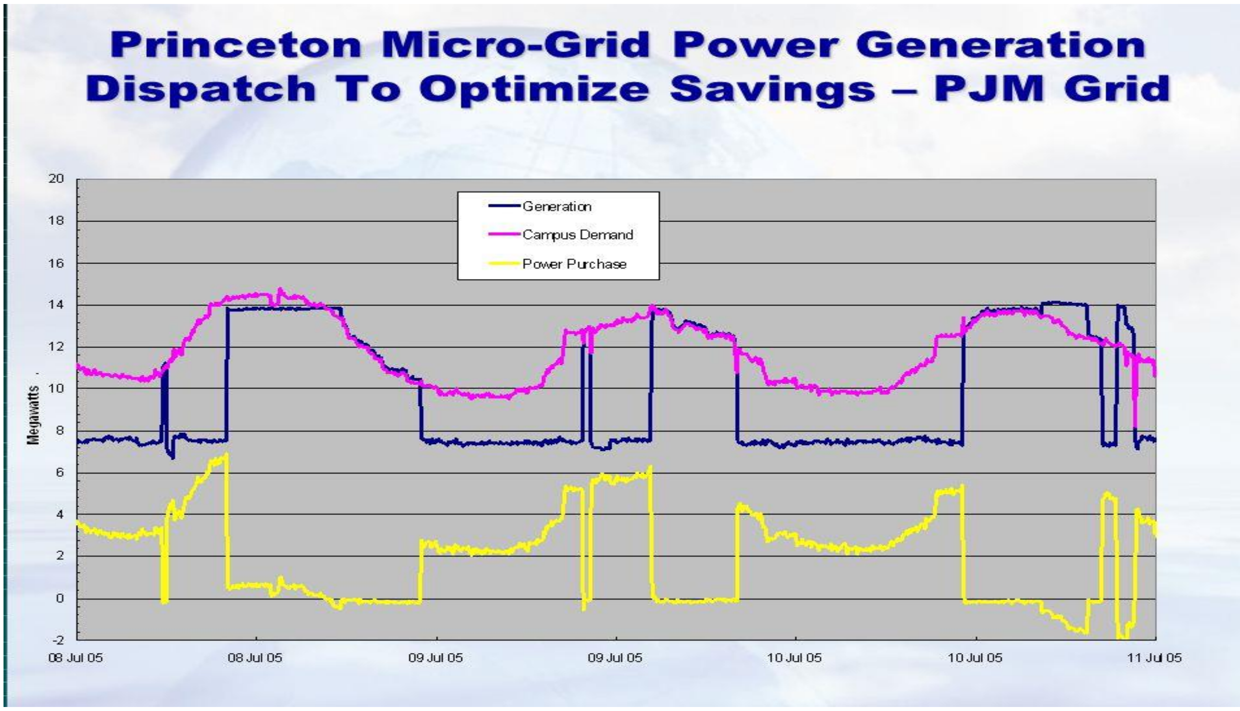
The Economics of Microgrids

Princeton University's microgrid system was initially developed for economic reasons and not for energy resiliency. Energy resiliency was considered an added bonus. The charts below generally show how Princeton University normally operates its system to generate energy and cost savings 24/7 under blue-sky conditions.

The Princeton University microgrid is always buying some electricity from the grid. When the cost for electricity is high, the campus uses more of their CHP generated electricity. When the price for electricity is low, the campus uses less electricity from their CHP facility and purchases more electricity from the grid. Princeton University does not run their CHP system 100% of the time under blue sky conditions.

This is the same economic model that most advanced microgrids will need to follow in order to be cost effective. In the future, with a built out microgrid system, advanced DER microgrids may buy their excess electricity from other DER facilities and other advanced DER microgrids.

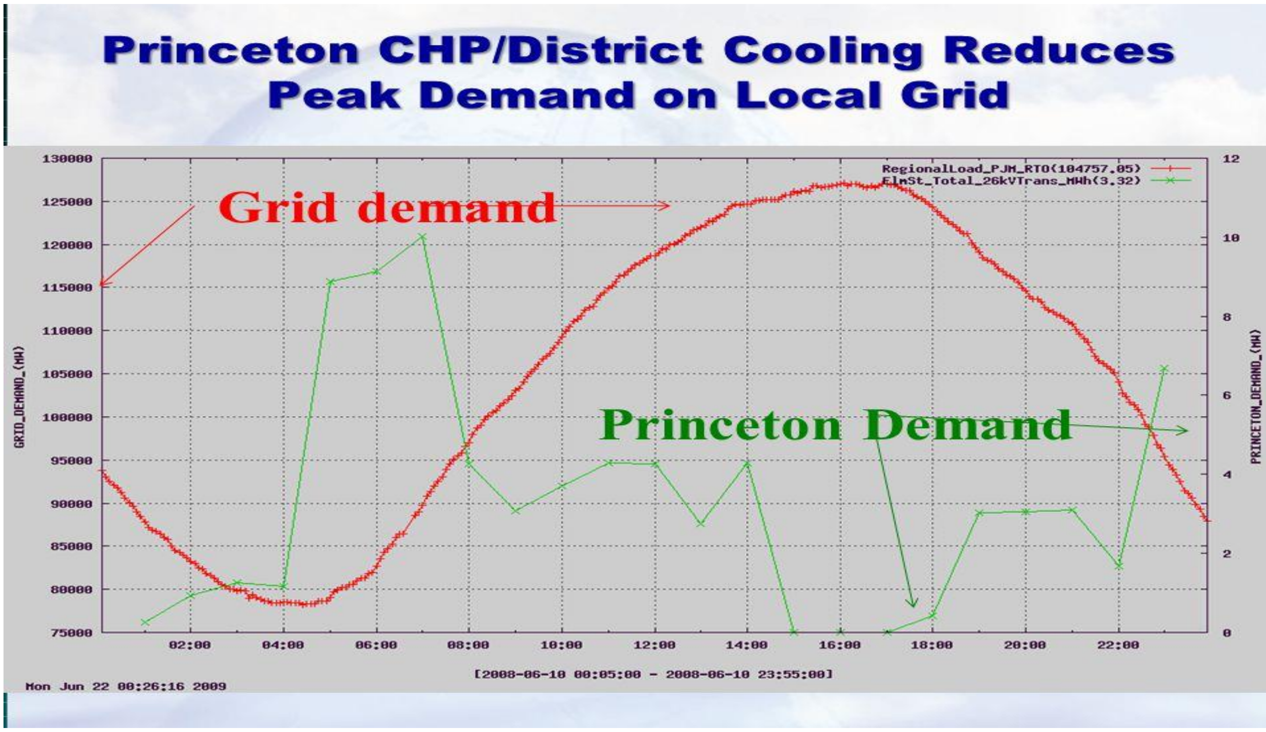
[84] http://portal.hud.gov/hudportal/documents/huddoc?id=HSRebuildingStrategy.pdf



(Image 5.d)

In addition to the direct cost saving to the University, the Princeton microgrid generates societal benefits by reducing the larger grid peak demand. The university is able to provide this larger societal benefit because their microgrid system incorporates storage. Further, their system's operations monitors and responds to the energy market conditions on the larger grid. While they appropriately pay for the benefit of being connected to the grid, they do not see the full monetary value of the benefits they provide to the grid directly. They receive some of these benefits in the avoided costs and saving from operating their system and from the larger energy market. Princeton University does participate in the PJM capacity and energy markets as well as the PJM ancillary service markets. But these monetary benefits come from the wholesale market not the retail distribution system.

The societal benefits provided by Princeton University, because of its size, are mainly to the distribution system and to a lesser degree the transmission system. This is the same societal benefits model that most advanced microgrids will follow which will allow for more efficient use of the grid. The DER tariff is the mechanism to balance these costs and benefits of the advanced microgrid. The advanced microgrid should pay for the cost of using the grid and likewise should be paid for the benefits to the grid it provides.



(image 5.e)

The resilience of these facilities after Superstorm Sandy highlighted opportunities to protect certain critical infrastructure by pursuing commercially available technologies allowing facilities to operate independently from the grid. These technologies have the added benefit of being cost-effective, energy efficient and cleaner power with lower overall emission. HUD, the USDOE, and the U.S. Environmental Protection Agency (EPA) all recognize that DER technologies, in addition to providing resilience, reduce monthly energy costs, reduce emissions, provide stability in the face of uncertain electrical prices, and increase overall efficiency.

6. EDC Smart Grid and Distribution Automation (SG/DA) Plans

General Definition of Distribution Automation

As noted in previous sections, the full development of DER microgrids and advanced microgrids cannot occur within the current structure of the distribution grid. While the current configuration of the distribution grid can support a significant capacity of DER and several advanced microgrid projects, it cannot support the full development of these technologies. The key component to enhancing the current development and implementation of advanced microgrid, or any DER microgrid, is the ability for the DER customer to communicate with the distribution grid and the larger energy market. This can be either through the EDC or directly to the wholesale market. The process that supports this communication on the electric distribution system (distribution grid) is Distribution Automation (DA). This has also been termed "Smart Grid" (SG).

What is "Smart Grid"?

A Smart Grid is not just a new "smart" meter. Advanced metering infrastructure (AMI) is a part of a Smart Grid but it may not be the most important or most essential part of the Smart Grid. A Smart Grid is not just two-way communication with the customer to turn appliances on and/or off. It is not just time of use, time of day, or dynamic pricing. Those items are a part of the Smart Grid but are not the only part of a Smart Grid.

Smart Grid is enhancing the digital grid technologies and processes that allow for two-way communication between the EDCs and the customer that adds value to both. That customer could be a large industrial customer on a transmission tariff supplied by a Third Party Supplier (TPS) or a low-income residential customer on a fixed Basic Generator Service (BGS) provider rate. This enhanced process can be for a single customer or for all customers in the EDC's territory or statewide.

While Smart Grid technologies were first implemented in the 1980's and 90's, the following are several of the important and initial legislative mandates, regulations and guidance documents that assisted in developing the "Smart Grid" initiative.

1. The "Smart Grid" initiative was definitively established with the IEEE 2003 guidance document entitled "Smart Grid Initiative 2030 National Vision." IEEE has recently updated this guidance entitled "Smart Grid Initiative 2030.2." The guidance document is designed for stakeholders to provide expertise and guidance in modernizing the grid.[85]

2. The Energy Policy Act of 2005 required FERC to prepare a report by region for demand response and smart meters including time of use (TOU) and critical peak pricing (CPP) rates. FERC, with DOE assistance and guidance, after several regional town hall meetings,

[85] http://amfarid.scripts.mit.edu/resources/Books/SPG-B02.pdf

published the "Assessment of Demand Response and Advanced Metering Staff Report" in August 2006.[86]

3. The Energy Independence and Security Act (ESIA) in 2007 at 42 U.S. Code sec 17383 set the national policy to support modernization of the grid. EISA also directed the National Institute of Standards and Testing (NIST) as lead organization to develop interoperability standards. Interoperability standards are the key to two way communication in the modernization of the grid. EISA recognized that all grid systems across the US need to talk in the same language. In 2007, NIST established two new committees which continue today to be the forums to address Smart Grid issues. They include the Smart Grid Advisory Committee and Smart Grid Task Force, both led by USDOE. EISA also included the first major funding for Smart Grid Demonstration Initiatives.[87]

4. In 2009, Smart Grid initiatives were a top priority for the Energy portion of the American Recovery and Reinvestment Act (ARRA) programs and funding. This funding was the catalyst for the exponential growth of "Smart Grid" programs.[88]

5. In July 2009, FERC established the federal Smart Grid policy setting priorities for the grid's development that emphasized such areas as cybersecurity, dynamic pricing, and the need for technology that can facilitate off-peak charging for electric vehicles.[89]

6. In June 2011, FERC published its Smart Grid policy framework prepared by the National Science and Technology Council entitled "*A Policy Framework for the 21st Century Grid: Enabling Our Secure Energy*".[90] This is a key issue in the development of the Smart Grid initiative since it helps to define utility cost recovery for new technology investment. Up until this policy, the question of whether any utility could recover their Smart Grid cost or whether the new technologies were cost effective was in question.

7. In 2012, NIST published their draft Interoperability standards for Smart Grid. Then, in September 2014 NIST issued its 3rd Update of their final report entitled "*NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 3.0*."[91]

---

[86] http://www.ferc.gov/legal/staff-reports/demand-response.pdf
[87] http://energy.gov/oe/technology-development/smart-grid/federal-smart-grid-task-force
[88] http://energy.gov/oe/recovery-act-smart-grid-investment-grants
[89] http://www.ferc.gov/industries/electric/indus-act/smart-grid.asp and http://www.ferc.gov/whats-new/comm-meet/2009/031909/E-22.pdf
[90] http://www.ferc.gov/industries/electric/indus-act/smart-grid/21st-century-grid.pdf
[91] http://www.nist.gov/smartgrid/upload/NIST-SP-1108r3.pdf

8. In 2012, EPRI published their draft cost/benefit analysis update and guidance. It was most recently updated in August 2015 entitled *"Guidebook for Cost/Benefit Analysis of Smart Grid Demonstration Projects"*.[92]

What is "Distribution Automation"?

Distribution Automation ("DA") is defined by the National Institute of Standards and Testing (NIST) to include any automation used in the planning, engineering, construction, operations, and maintenance of the distribution grid. This includes the connection with the larger transmission grid, interconnecting DER and automated interface with the end user or customer.

DA functions include monitoring and controls on substations, local automation equipment on feeders, monitoring and control on feeders, management of DER equipment, and distribution systems analysis. DA can also include advanced metering infrastructure (AMI). AMI can be the primary objective of DA, but does not have to be. In advancing DA, an outcome can be the option to pursue AMI. The other alternative would be a directive to advance AMI that pushes DA.

The key component to Smart Grid is automation of the distribution feeders and substations to increase the reliability and resiliency of the distribution grid. This automation allows for the enhanced communication with the consumer and in turn expands the ability to advance innovative technologies.

The following are examples of Distribution Automation technologies to develop and implement feeder and substation automation as part of an overall Distribution Management System (DMS) and Outage Management System (OMS):

1 Automatic circuit reclosers (ACR),
2 Automation sectionalizing and restoration (ASR),
3 Advanced voltage control,
4 VARs control,
5 Network protection/monitoring/controls,
6 Remote terminal units,
7 Remote fault detection,
8 Smart relays,
9 Equipment health sensors,
10 Outage detection devices, and
11 Smart meters

All New Jersey EDCs have, to varying degrees, been implementing DA as part of their routine operations and maintenance (O&M) responsibilities and as directed by Board Orders and BPU staff. The costs for these upgrades are part of the ongoing and routine O&M infrastructure plans or part of an approved filing within an approved stipulation.

[92] file:///C:/Users/winka/Downloads/000000003002006694%20(1).pdf

U. S. Pilot Project Summary Results

There are a number of studies on the costs and benefits of DA. Most notable is the California Energy Commission's (CEC) reports on the Value of DA.[93] The CEC evaluated both the DA technologies and the economic benefits of using DA technologies in the Investment Owned Utility (IOU) distribution grid. While each state and IOU distribution grid is different, the CEC study found that a full-scale deployment of distribution automation could produce $600 million in annual benefits in 2005. This would be accomplished through greater reliability and improved O&M of the distribution grids. The report found the largest savings were from improved reliability and the increased use of DER.

The USDOE, under the American Recovery and Reinvestment Act of 2009, provided $3.4 billion in grant funding for Smart Grid projects through their Smart Grid Investment Grants (SGIG) program. The project recipients of the federal grant also invested $4.5 billion in these same projects for a total of $7.9 billion invested in smart grid and distribution automation. The DOE's objectives in SGIG were to accelerate the deployment of smart grid technologies, assess the impacts and benefits, and strengthen cybersecurity of the grid. Almost 70% of this funding was in the area of DA and AMI. There were a total of 208 projects in the USDOE Smart Grid pilots. The projects, funded in 2010 through 2013, have completed their final reports.[94]

Below is a summary of the Smart Grid pilots that were awarded grants by USDOE and were completed.[95]

1. Advanced Metering
    a. Peak and Overall demand reduction 62 projects
    b. Operational Efficiency Improvement 63 projects

2. Distribution Automation
    a. Reliability Improvement 48 projects
    b. Efficiency Improvements 25 projects

3. Transmission System Application
    a. Reliability and Efficiency Improvement 10 projects

In addition to the USDOE Smart Grid pilots, EPRI also implemented a Smart Grid Demonstration program. In EPRI's Smart Grid Demonstration there were 25 Collaborator projects including both national and international projects from investor owned regulated utilities, municipal utilities and rural coops.

---

[93] http://www.energy.ca.gov/2007publications/CEC-500-2007-103/CEC-500-2007-103.PDF
[94] A copy of the report presentation is available on the USDOE Smart Grid website at http://energy.gov/oe/technology-development/smart-grid
95 A summary of the results and status of the Smart Grid pilot is available at the following: http://energy.gov/sites/prod/files/Smart%20Grid%20Investment%20Grant%20Program%20-20Progress%20Report%20July%202012.pdf

One of the USDOE Smart Grid pilots was on the deployment of automated switches on feeders along with enhanced communication. This DA improvement resulted in shorter and less frequent outages and fewer customers impacted. Another showed that employment of DA technologies resulted in voltage conservation in the range of 1 to 2.25% during peak periods.

In their report, *Grid Reliability, Resilience and Storm Responses* dated November 2014, the USDOE documented the findings on grid improvements from their Smart Grid projects.[96] Some of the key results are summarized below as follows:

1. One EDC reduced cumulative restoration times by up to 17 hours. Of the 80,000 customers impacted 40,000 were restored instantaneously;
2. The service restoration times in another EDC were reduced by 36 hours and saved the EDC $1.4 million;
3. Another EDC avoided more than 6,000 responses and reduced service restoration by 2-3 days;
4. With AMI an EDC was able to restore power 3 days faster and automatically restore 37,000 customers in less than 5 minutes; and
5. This same EDC improved their SAIDI and SAIFI results and was able to ping customers to remotely verify that they were either out, still connected or restored.[97]

Again each EDC grid system is different and the improvements in reliability depend on the starting point baseline of the EDC's distribution system. New Jersey's EDCs as well as EDCs in the northeast would generally be defined as having a high reliability baseline in terms of System Average Interruption Duration Index (SAIDI) and Customer Average Interruption Duration Index (CAIDI).[98] One of the USDOE SGIG pilot projects was with PECO in the Philadelphia area and the results from a recent 2014 snow/ice storm documented improved reliability through DA.

New Jersey Distribution Automation/Smart Grid pilots

In 2009 ACE, through Pepco, was awarded USDOE funding for DA to match their current 2009 Smart Grid funding level. The total USDOE funding for DA and load control was $18.7 million as a 50% match to ACE's current funding. The pilot, as approved by the NJBPU, started in 2010 and included 8 substations and 27 feeders. The pilot was completed in 2013. Based upon a prior Pepco pilot, ACE estimated a 20-50% improvement in feeder reliability performance.

In 2011 RECO received funding for a Smart Grid pilot from USDOE. The pilot was to upgrade the Darlington and South Mahwah substations with state of the art smart grid technology. The

---

[96] http://energy.gov/sites/prod/files/2014/12/f19/SG-ImprovesRestoration-Nov2014.pdf

[97] SAIFI, and SAIDI are reliability indices set by the IEEE in their standard number P1366 "*Guide for Electric Distribution Reliability Indices*"

[98] CAIDI is another reliability index set by the IEEE in their standard number P1366 "*Guide for Electric Distribution Reliability Indices*".

pilot was implemented over 3 years at a total cost of $19.4 million. Both of these NJ EDC smart grid projects are summarized in the USDOE report.

JCP&L had a pilot demonstration with EPRI called the Integrated Distributed Energy Resources (IDER) also known as Easy Green. Easy Green, as approved by the NJBPU, was designed to test the real time monitoring of the distribution system status and peak load management. The JCP&L full report is available on the EPRI website http://www.epri.com/Our-Work/Pages/Grid-Modernization.aspx

There were no ARRA or EPRI smart grid or distribution automation pilots with PSE&G.

Summary of Smart Grid Cost/Benefits Analysis

The statewide development and build-out of an advanced DA or SG has a significant cost. Requiring the statewide implementation of DA/SG would have a rate impact to New Jersey ratepayers, the magnitude of which would depend on the statewide directives. Some of this work has already been undertaken by some of the EDC in Hurricane Irene and Superstorm Sandy storm response recovery and mitigation initiatives as directed by the BPU.

EPRI has undertaken a process to document the methodology, key assumptions and results of a quantitative evaluation of the costs and the benefits of implementing smart grid enhancements and investments. In summary, their cost benefit report documents a total national 20 year cost of between $338 billion to $476 billion of investment with a range of $1,294 billion to $2,028 billion in benefits for a benefits to cost ratio of between 2.8 to 6.0.[99]

One of the key issues in advancing the benefits of Smart Grids is connected to dynamic pricing or critical time of use rates. As part of the USDOE Smart Grid pilots, several of the projects are evaluating time of use (TOU) critical peak pricing (CPP) and time of day (TOD) models. The evaluations are from a customer's perspective within different customer classes. The key objective is to determine if all customer classes benefit with a potential for bill savings, better control, and better reliability. These studies also include an evaluation of the privacy issues and metering costs associated with AMI and dynamic pricing.

The results from the OG&E pilots on dynamic pricing found that all customers reduced load and showed savings. There are several recent studies evaluating the impact of dynamic pricing with low income customers, and while the results are mixed, low income customers do participate and respond to load reduction and savings.[100]

---

[99] A copy of the update evaluation is available at the following address:
http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000000001022519

[100] A copy of these studies are available at the following address:
http://www.edisonfoundation.net/IEE/Documents/IEE_LowIncomeDynamicPricing_0910.pdf

http://www.brattle.com/_documents/UploadLibrary/Upload936.pdf

In New Jersey, the issue of these different pricing systems and the impact they will have on the BGS auction process is a key concern. Several Mid-Atlantic competitive pricing states that also run auctions are in the process of developing various dynamic and peak pricing systems. New Jersey could gain from the experiences in other northeast and PJM States.

Summary of State Smart Grid and AMI Deployment

To unlock the Smart Grid benefits along with dynamic pricing will require the implementation of advanced meters. The Institute for Electric Innovation (IEI) of the Edison Foundation issues an annual report on the deployment of smart meters. While it is not the only indicator of grid modernization, it is one of the easier metrics to report. As of July 2014 there were over 50 million installed smart meters throughout the US. This means that 43% of the homes have installed smart meters or advanced meters.[101]

As defined by IEI in their annual report, a smart meter is a digital electric meter that measures and records usage data at least hourly and allows for two-way communications between the EDC and their customers. In recent years the cost for smart meters has decreased dramatically. At this point there is relatively little cost differential between a smart meter and a standard meter. The key difference is in the computer logic of the smart meter as now defined through NIST interoperability standards.[102]

EDCs in these areas are leveraging smart meters to provide for systems integration including outage management systems (OMS) and distribution management systems (DMS) to enhance outage management and restoration. DMS provides a platform to integrate DER including microgrids. The IEI annual report documents operational savings including bill management, smart pricing and demand response programs.

In the Mid-Atlantic/Northeast states, the following smart meters have been installed as of July 2014[103]

Connecticut	169,455
District of Columbia	279,000
Delaware	326,982
Massachusetts	67,162
Maryland	1,878,000
Maine	743,914
New Hampshire	158,326
New York	24,681
Pennsylvania	2,698,716
Rhode Island	201
Virginia	389,385
Vermont	305,464

[101] http://www.edisonfoundation.net/iei/Documents/IEI_SmartMeterUpdate_0914.pdf
[102] http://www.nist.gov/smartgrid/upload/NIST-SP-1108r3.pdf
[103] http://www.edisonfoundation.net/iei/Documents/IEI_SmartMeterUpdate_0914.pdf

West Virginia	1,140

New Jersey has no smart meter installations reported through the IEI annual report. Nationwide, 27 EDCs have reported complete system-wide deployment of smart meters as of December 2013. This includes Pepco (DC), Delmarva Power (DE), and PPL (PA).

It should be noted that advanced or smart meters and time of use rates are only one component of Distribution Automation. Some of the benefits of Distribution Automation can be achieved without smart meters but implementation of smart meters allows for a wider range of benefits to be implemented.

USDOE

The USDOE has issued the first installment of their Quadrennial Energy Review (QER) on Energy on April 21, 2015, titled, *"Energy Transmission, Storage, and Distribution Infrastructure."* This review examined the Nation's infrastructure for transmission, storage, and distribution, including liquid and natural gas pipelines, the grid, and shared transport such as rail, waterways, and ports.[104] A key component of the Energy QER is DA or Smart Grid deployment. The Energy QER highlighted the growing dependencies of all critical infrastructures and economic sectors on electricity. Based on this finding the second QER installment, after stakeholder meetings in 2016 will focus on the Nation's electricity system, from generation to end use.

In addition to the Energy QER, the USDOE in 2015 issued the Quadrennial Technology Review (QTR).[105] The QTR focused on the technology assessment of the energy systems and the research, development, demonstration, and deployment (RDD&D) opportunities across energy technologies. A large focus in the QTR is on the electric system for grid modernization, EE and clean energy generation.

In November 2015 the USDOE issued its Grid Modernization Multi-Year Program Plan (MYPP) under their Smart Grid – Grid Modernization Initiative (GMI)[106] . This plan is coordinating a portfolio of activities to help set the nation on a cost-effective path to a resilient, secure, sustainable and reliable grid that is flexible enough to provide an array of emerging services while remaining affordable to consumers. These elements with the MYPP of the USDOE GMI are the key components to developing and implementing advanced microgrids within the distribution system. Also the MYPP sets forth the new metric for measuring the performance of the utilities in addition to reliability.

[104] http://energy.gov/epsa/quadrennial-energy-review-qer
[105] http://energy.gov/quadrennial-technology-review-2015
[106] http://energy.gov/sites/prod/files/2016/01/f28/Grid%20Modernization%20Multi-Year%20Program%20Plan.pdf

New Jersey's Storm Response DA and SG Plan Status

January 23, 2013 EPP Order

After Hurricane Irene and the October 2011 snowstorm, Governor Chris Christie directed the BPU to conduct an investigation of the electric distribution utilities (EDC) storm planning and preparedness actions. The BPU, under a Master Reliability Agreement with the Utilities, engaged Emergency Preparedness Partnerships (EPP) to evaluate the measures that worked well after the storm and those issues that needed improvement. During the spring and summer of 2012 the BPU held several meeting on the EDC storm preparedness and restoration performance.

The BPU issued the EPP prepared report on the EDC's storm preparedness and restoration performance on September 12, 2012, during a special Board agenda meeting. During this special agenda meeting EPP presented their report and their analysis of the four EDC's storm readiness, preparedness and restoration performance. The Board established a public comment period on the observations, findings and recommendations of the consultant's report regarding the EDC's response to Hurricane Irene and the October 2011 snow storm. The comment period was open through September 20, 2012. [107]

The Board was set to take action on the recommendations in the EPP report. However, on October 29, 2012, Superstorm Sandy hit New Jersey. When restoration and rebuilding started after Superstorm Sandy, the BPU and other elected officials across New Jersey held hearings on the EDC preparedness and restoration performance in regard to Superstorm Sandy. These hearings, along with the hearing and comments on the EPP Report informed the Board's further actions.

On January 23, 2013, based on EPP's report, staff's review and evaluation, and input from the public and elected officials, the BPU issued its Order in the Review of the Utilities' Response to Hurricane Irene, Docket Number EO11090543 (January 23, 2013 Order). The January 23, 2013 Order accepted the EPP report and set additional staff recommendations, directed at the utilities, to improve their performance.[108]

The January 23, 2013 Order established 103 measurable performance provisions and directives on the utilities to improve their preparedness in regard to future storm events, to improve their ability to communicate accurate and timely information regarding outages and restoration to all parties, and to improve the effectiveness of their storm recovery operations.

[107] A copy of the EPP Report is available at http://www.nj.gov/bpu/pdf/announcements/2012/stormreport2011.pdf .

[108] The January 23, 2013 Order is available at http://www.nj.gov/bpu/pdf/boardorders/2013/20130123/1-23-13-6B.pdf.

In addition to directing the utilities to improve their outage communication activities, the effectiveness of their storm recovery operations and storm planning/preparedness, the January 23, 2013 Order directed the Utilities to take specific measures to target hardening and resiliency of the distribution system. These measures included substation flood mitigation, selective circuit undergrounding, tactical hardening of utility poles and other utility infrastructure, improved vegetation management including more aggressive tree trimming within the right of way (ROW) and preventing damage from trees outside of the ROW and upgrading the smart grid/ distribution automation (DA/SG) plans.

As part of the January 23, 2013 Order, the four EDCs were directed to file SG/DA plans. These plans were filed by May 1, 2013 and were reviewed by Board staff. The SG/DA Plans were to include the development and implementation of feeder and substation automation as part of an overall Distribution Management System (DMS) and Outage Management System (OMS).

The SG/DA plans were to include but not be limited to the following:

Automatic circuit reclosers (ACR), automation sectionalizing and restoration (ASR), advanced voltage control, volts, amps, resistance (VARs) control, network protection/monitoring/controls, remote terminal units, remote fault detection, smart relays, equipment health sensors, outage detection devices and smart meters. In addition the SG/DA Plan filing was to include the timeframe for the development of each component and the overall plan, as well as the costs and benefits of each individual component and the entire plan to the EDC and the ratepayer. The SG/DA plan shall be developed with the goal to implement a more resilient and “self-healing” distribution grid with the objective to improve the distribution system reliability and optimize the distribution grid operation overall with a specific focus during and after storm events such as Hurricane Irene.

The SG/DA Plan filings were to include the status of the current and planned smart grid pilots either managed with or through the USDOE as funded under the American Recovery and Rebuilding Act or the Edison Electric smart grid pilots. The SG/DA Plan filings were also to include the current and planned actions, costs, and timeframes to modernize the grid to be more resilient and storm responsive. The SG/DA plans filed by each of the EDCs are available on the BPU website[109].

NJBPU staff worked with Rutgers University to develop and issue an RFP for the cost benefit analysis of the storm response measures including the SG/DA plans. On September 11, 2013, Rutgers University selected GE to perform the January 23, 2013 Order reviews.

[109] at www.bpu/reports

On May 23, 2014 GE presented its preliminary findings to the Staff and on August 1, 2014 GE presented initial report to Commissioners. On October 20, 2014 GE presented its final report to Commissioners and on November 28, 2014 GE submitted its final report to the BPU.[110]

A summary of the resiliency SG/DA plans are as follows:[111]

1. ACE has automated sectionalization and reclosers (ASR) to 33 substations and is currently installing ASR in 19 substations and will install a similar amount annually until all ACE substations have ASR.

2. JCPL has installed programmable reclosers at targeted substations and new substations and has added remote switching at 10 additional substations.

3. RECO has installed mid-point reclosers on 30 circuits and 30 circuits have automatic loops and 10 circuits have smart loops.

4. PSE&G has installed SCADA at 100 substations and will install 10 per year until all substations have full SCADA.

In addition to the above and during the interim timeframe, the EDCs have proceeded with various degrees of DA upgrades as part of their routine equipment upgrades and in response to storm outage management as directed by BPU staff in the Division of Energy.

EDC Additional Storm Response DA/SG Status

In its March 20, 2013 Order, Docket No. AX13030197 (March 20 Order), the Board established a generic proceeding to review the costs, benefits and reliability impacts of the utilities' major storm event mitigation efforts.[112] The Board found that there remains a very real threat from future major storm events and that it is critical to investigate prudent, cost efficient and effective opportunities to protect New Jersey's utility infrastructure against damage from future major

---

[110] NJ Storm Hardening Recommendations and Review/Comments on EDC Major Storm Response Filings Prepared by GE Energy Consulting Final Report Nov 26, 2014. http://www.nj.gov/bpu/pdf/reports/NJ_Major_Storm_Response-GE_Final_Report-2014.pdf

[111] This is the status as of plans as of May 2013 and the BPU Division of Energy is in the process of updating this status as directed in the Update of the Energy Master Plan.

[112] http://www.state.nj.us/bpu/pdf/boardorders/2013/20130320/3-20-13-2K.pdf

storm events.[113] In this Order the Board requested the submission of proposals by the State's utilities for upgrades designed to protect the State's utility infrastructure from future major storm events.

PSE&G filed a petition for Board approval of a program to enhance its electric and gas infrastructure to make them more resilient. The PSE&G request was initially for $3.9 billion to be managed in two phases. Phase 1 was to be for $2.6 billion and $1.3 billion for phase 2. The initial investment would have been $2.8 billion for electric upgrade and $1.1 billion for natural gas infrastructure. PSE&G termed their filing "Energy Strong." The Board's March 20 Order rejected this petition because it did not provide the required costs and benefits or rate impacts, nor did it separate storm hardening upgrades from normal routine maintenance. The Board requested PSE&G to refile to meet the directives in the March 20 Order.

In its May 21, 2014 Order, Docket Nos. EO13020155 and GO13020156, the Board approved the Energy Strong filing for a total of $1 billion of which $600 million was for electric systems upgrades and $400 million for natural gas systems upgrades.[114] While not specifically termed SG/DA $200 million in their approved Contingency Reconfiguration ($100 million) and Advanced Technologies ($100 million) could be defined as SG/DA. The implementation period was 36 months.

Consistent with the March 20 Order, on November 27, 2013, RECO filed a petition in the base rate proceeding, the base rate petition, among other things, contained proposals to implement various incremental storm hardening and resiliency projects. On March 16, 2015, RECO filed an amended petition for hardening and increasing the resiliency of its electric distribution system. In its filing, RECO requested $61.1 million over 5 years for what RECO termed its "Storm Hardening Program" (SHP) and $4.2 million in operation and maintenance costs related to implementation of the subprograms.

In its January 27, 2016 Order, Docket Nos. AX13030197 and ER14030250, the Board approved RECO's SHP for a total of $15.7 million over three years. Among the specific areas approved by the Board is $8 million for Distribution Automation/Smart Grid Expansion. The goal of these programs is to provide prudent, cost efficient and effective opportunities to protect New Jersey utility infrastructure against damage from extreme events and provide resiliency in response to future major storm events.

2007 ACE submitted a petition entitled the *Blueprint for the Future*. The petition addressed ACE's proposal for demand-side management programs for demand response programs, new

[113] This would also include potential damage from cybersecurity and other impacts to the utility infrastructure
[114] http://www.state.nj.us/bpu/pdf/boardorders/2014/20140521/5-21-14-2I.pdf

dynamic electricity pricing and a new comprehensive energy savings pilot program. The petition proposed an advanced metering infrastructure upgrade. Their plan also included proposals for rate decoupling and additional transmission enhancements.

As noted above on May 2, 2013, ACE submitted is SG/DA plan in response to the January 23, 2013 Order. ACE was awarded an $18.7 million USDOE Smart Grid Investment grant which it matched for a total of $37.4 million. In summary ACE's DOE SG pilot was allocated between direct load control and communications infrastructure upgrades.

On March 22, 2016 ACE, along with its base rate case, filed a proposed request for a grid resiliency initiative called Power Ahead Forward. The proposal is in addition to their historical investment in their distribution assets. Consistent with the Board's Order, Docket No. AX13030197, Power Ahead Forward is ACE's comprehensive plan to advance the modernization of the distribution grid through EE, increased DG and resiliency. The objective is to improve the distribution system's ability to withstand major storm events.

JCP&L has not yet submitted a petition in response to the March 20, 2014 Order.

In its 3rd Annual "*Grid Moderization Index (GMI) Report*" dated January 2016, the Gridwise Alliance ranks the States in regard to the progress they have made in actually implementing grid modernization measures.[115] The ranking is statewide, and consists of 3 broad categories as follows:

1. State Support category which ranks states on policies to advance grid modernization including incentives, mandates and investments. (30 points);
2. Customer Engagement category ranks states on how well its utilities involve customers in their smart grid implementation. (34 points); and
3. Grid Operations category ranks the states on the actual deployment of technologies that represent a modern grid. (36 points).

New Jersey is ranked by the Gridwise Alliance as 40th in State support, 43rd in customer engagement and 9th in grid operations for a total ranking of 26th out of the 50 States.

115 See http://www.gridwise.org/report_download.asp?id=17

SG/DA Benefits for Innovative and Advanced DER Technologies

SG/DA technologies allow the customer and the EDC to integrate, interface and control innovative and advanced technologies on the customer's side of the meter or the EDC's side of the meter without either giving up control.

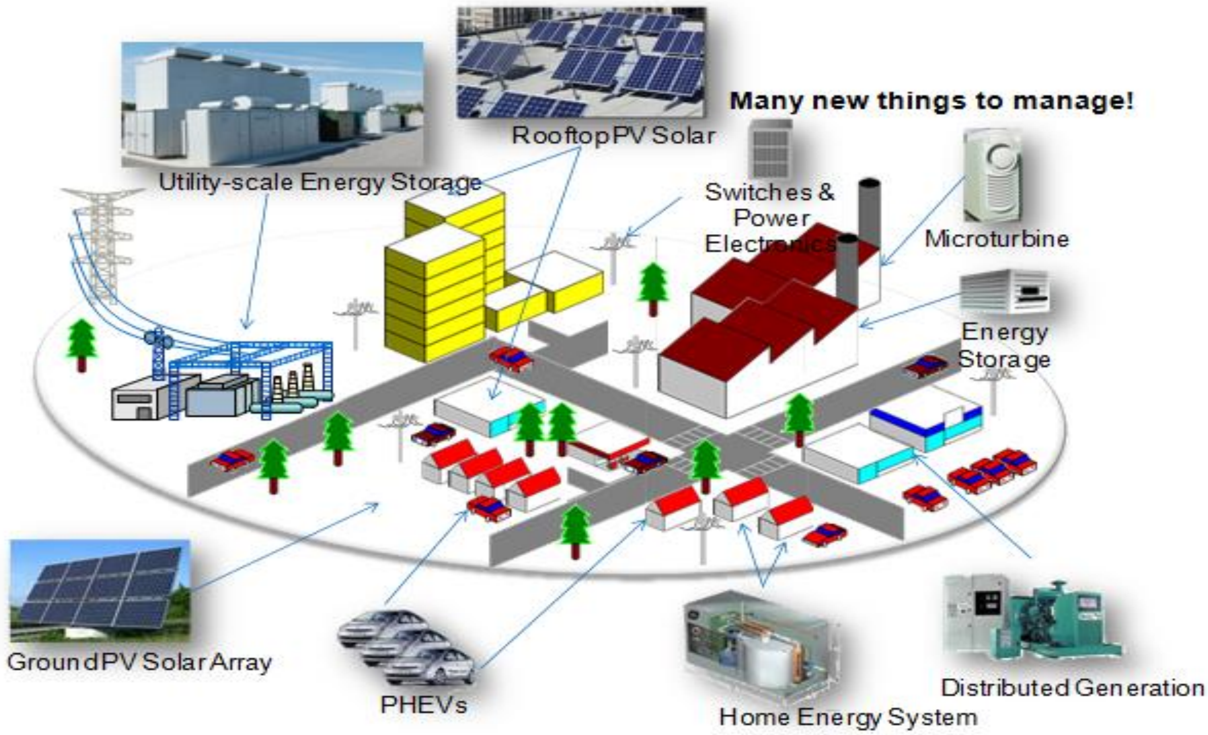
These innovative and advanced DER technologies can include:

1. Plug in hybrids, electric or Compressed Natural Gas (CNG) vehicles;
2. Storage;
3. Distributive Generation (DG) technologies including:
   a. Combined Heat and Power (CHP)/Fuel Cells (FC)
   b. Clean DG (example NJDEP full permit diesel gen set with air quality controls for NOx and particulates
   c. Renewables wind, biomass, solar
4. Enhanced customer choice
5. Energy Efficiency (EE)
6. Demand Response (DR)

DER was discussed with the EDCs as part of their storm preparedness and restoration performance. New Jersey is a competitive retail State, as opposed to others who are vertically integrated. New Jersey's EDCs can provide generation in certain limited cases.

For renewable energy (RE) and energy efficiency (EE), as set forth in N.J.S.A. 48:3-98.1, the EDC and GDC can file to develop RE and EE generation facilities on their side of the meter or the customers side of the meter. In addition, with approval by the BPU, these RE and EE filings can also determine recovery of the cost to the utilities either through societal benefit charges (SBC), rate recovery, or other mechanisms as approved by the BPU.

Image 6.a shows Smart Grid graphics document how the modernized grid with fully implemented Distribution Automation can enable innovative DER technologies and advanced microgrids.



(image 6.a)

SG/DA Action Items in the EMP Update

The 2011 EMP and the 2015 EMP Update action items and recommendations regarding SG/DA and DER noted that the four EDCs should update their SG/DA plans to detail the progress related to DER and microgrids. Specifically, the EDC's SG/DA plans should assist in the development of new DER and microgrids, as well as advancing EE and demand reduction.

In addition, the new section of the EMP Update, *Improve Energy Infrastructure Resiliency & Emergency Preparedness and Response*, states that the community preparedness and assessment of vulnerabilities and threat response of the electric distribution systems must be continually upgraded with the most current technology to improve and enhance the grid's reliability and resiliency. A key component of this review should focus on critical facilities. A smarter grid through distribution automation can address increased DER systems, including renewables and storage on the grid, as well as demand response and advanced meters options in a smarter grid.

A key component in developing a detailed TCDER microgrid policy is enhanced distribution automation and smart grid policy that enables and supports DER and advanced microgrids. The ability to communicate between and among several different DER technologies at several different critical facilities with the distribution grid and to the larger electric market is the key to advancing this policy.

Getting the utility business model and the DER tariff structures right are extremely important to developing TCDER microgrids. In addition, providing the right technical, regulatory and financial support to reduce barriers is just as important for advancing Town Center DER microgrids. However, BPU microgrid support policies will not work to actually advance the development of TC DER microgrids without a modernized grid. SG/DA policy is the essential critical policy for DER and advanced microgrids.

7. BPU Advance Microgrid Stakeholder Meetings

In order to further assist the Board in its evaluation of advanced microgrids or TCDER microgrid policies BPU staff set up individual microgrid meetings with four different stakeholder groups.[116] The policy directive for the Microgrid Stakeholder meetings was set forth in the ERB Order dated September 27, 2014. The specific comment from the August 27, 2014 ERB Stakeholder meeting on the draft program Guide and the BPU staff's responses as provided in Appendix B of the Board's Order dated October 6, 2014 approving the ERB Guide is as follows:

> ***Comment 116 Submitted by Concord Engineering***
>
> *To enable multi user applications the BPU should adopt rules that define the provision of emergency power as being exempt from utility franchise restrictions and allowing a direct wire connection from an onsite generator to nearby critical facilities. This would need to include appropriate safeguards similar to emergency generator transfer trip devices to prevent back feeding power onto utility lines which would be a safety hazard.*
>
> ***Response***
>
> *The issues raised by this comment are beyond the scope of the ERB Guide and Product; further, the rules recommended by the commenter may be outside the authority granted to the Board. Staff will recommend that the Board direct staff to initiate a stakeholder process on issues related to the provision of emergency power, including power to critical facilities, and report back to the Board on whether statutory and/or regulatory changes are necessary and, if so, with recommended statutory and/or regulatory provisions*

The above comment and response, as well as additional related comments submitted by Morgan Lewis on behalf of the electric utilities and the NJBPU's responses to these related comments, were provided to the microgrid proceeding participants in the meeting agenda package. All of the related comments and responses on this issue are attached as Appendix B.

Full text of N.J.S.A. 48:3-51 and 48:3-77.1 were provided to all meeting participants. These statutes are attached as Appendix A.

The Advanced Microgrid meetings included the following four separate meetings with the following stakeholders:

Microgrid Developer Associations
New Jersey EDC & GDC through New Jersey Utility Authority
Rate Counsel

[116] In the context of these separate and individual meetings the discussions was on a specific type of advanced microgrid – a Town Center DER microgrid. As discussed in this Report a Town Center DER microgrid is an advanced of Level 3 microgrid connecting multiple critical facilities crossing multiple ROWs at the local level.

Microgrid Customer/Market Sectors Associations

The attendees list for each of the four Advanced Microgrid meetings is attached as Appendix C.

The agenda for each of the four meetings was as follows:

Introductions
Discussion of the Board's directions related to the microgrid comments in the September 27, 2014 Order
Discussion of the statutes/regulations related to the microgrid comments
Discussion of the questions/issues related to the technical ability to address the comments
Any additional microgrid questions/issues
Next steps

The following set of questions to assist in the Microgrid Stakeholder discussion was sent out to all meeting participants prior to the meetings:

Are there examples of advanced microgrids currently operating in New Jersey?
If so how were they established? Under what orders, directives, regulation, statutes?
Are advanced microgrids operating in other states – if so under what provisions?
What entity operates these advanced microgrids – the customer, developer, utility other?
What NJ regulations specifically apply to advanced microgrids?
What NJ statutes specifically apply to advanced microgrids?
Should the regulation/statutes that address advanced microgrids remain the same or change?
If revisions are needed what specific revisions would be required?
Who best should operate the advanced microgrids in NJ?
What are the benefits of microgrids? What are the costs? Are they cost effective?

The objective for the meetings was not to define the legal authority or sufficiency for operating an advanced microgrid under emergency conditions when the distribution grid is down, but rather to assess whether it would be technically feasible to address the question raised by the commenter noted above given the current statutes and under what conditions and criteria.[117] Basically what is a workable solution for an advanced microgrid to operate under the current statutes, regulations and policies? All of the above questions were not addresses in the meetings. To accomplish this would require a multi-stakeholder set of meetings in a more formal proceeding.

The following is a summary of the issues raised and discussed in the meetings but not fully resolved.

[117] Within this Repost the term Town Center DER Microgrid is used to describe an advanced or Level 3 microgrid that includes multiple DER technologies at multiple critical facilities at the local level.

1. Would the advanced microgrid connections and operations be only during emergencies under black sky conditions when the distribution grid is down or failed; or available 24/7 under blue sky condition?
2. Who would determine that an emergency condition is occurring?
3. What is the overall timeframe for the grid outage to determine that it is an emergency?
4. Who owns the advance microgrid wires and transfer switches?
5. Who designs and builds the advance microgrid system and to what specifications?
6. Who makes the decision to actually island the advance microgrid system?
7. What is a reasonable advanced microgrid DER tariff and how should it be calculated?

In summary, the EDC/GDC and the Microgrid Developers Associations, based on the current statutes, independently came to relatively the same potentially workable position. Under the current statutes, an advanced microgrid could technically connect multiple critical customers and cross multiple ROW to provide power under emergency conditions when the distribution system is down under certain specific conditions. In order to do this, the advanced microgrid could be technically developed in the following manner as a potential workable system:

> The owner/operator of the advance microgrid, at their cost, would construct the advanced microgrid and all the pipes and wires/lines connecting the multiple critical customers over multiple ROW. The wires/lines connecting multiple microgrid customers across several ROWs would be constructed to the EDC's established specifications. This would include all interconnection devices and any other related distribution grid required equipment.
>
> Once the advance microgrid system and the wires/lines were constructed the owner/operator of the advanced microgrid would "turn over" the microgrid wires/lines connecting multiple critical customers over multiple ROW to the EDC. The advance microgrid wires/lines would become part of the EDC's system including the One Call system.
>
> There would be a Town Center DER microgrid tariff established that pays for the ongoing maintenance of the wires/lines.
>
> The Town Center DER microgrid tariff would be a cost based tariff and include the overall costs and benefits to the advance microgrid customers and to the overall EDC system and its customers.

While not discussed in the microgrid stakeholder meetings, the guiding principle of the Town Center DER tariff should be consistent with the following:

1. A customer should be able to connect to the grid for no more than the cost of connecting to the grid;
2. Customers should pay for grid services and power supply in proportion to how much (and when) they use these services and how much power they consume;

3. Customers who supply power to the grid should be fairly compensated for the full value of the power they supply, no more and no less; and
4. Tariffs should fairly balance the interests of all stakeholders: the utility, the non-DG customer, and the DG customer.

These guiding principles are discussed in further detail in RAP's Whitepaper on Designing Tariffs for DG Customers and their technical guidance document *Designing Distributed Generation Tariffs Well Fair Compensation in a Time of Transition*.[118]

Rate Counsel's position was that while the above was a potentially workable technical option for the operations of an advanced microgrid for critical facilities, the Governor would have to declare an emergency in order for the advance microgrid to operate. In that case, under an emergency declaration, the operations of an advance microgrid would not be a public utility. Other than that situation, the advanced microgrid would need to be regulated as a public utility.

The Microgrid Market Sector Customers Associations agreed in general with the above potentially workable position. The League of Municipalities (LOM), while agreeing with the concept, maintain that it was their position that there is a carve-out in the current statutes for municipalities to develop municipal microgrids as general improvements in their own ROW. The LOM cite N.J.S.A. 40:56-1 as municipal authority to construct and operate a municipal microgrid as general improvements and that municipalities retain the right to construct in their municipal ROW. Their position is attached to this report as Appendix D.[119]

There is broad consensus among the various groups that addressing the comments on an advanced microgrid to operate during emergencies when the grid is down to provide electricity to multiple critical customers crossing multiple ROW has a workable potential solution within the existing statutes, regulations and policies.

[118] file:///C:/Users/winka/Downloads/RAP_MADRI_DesigningTariffsForDGCustomers_FINAL%20(1).pdf
[119] The BPU has not determined whether the LOM's interpretation is legally accurate

8. Next Steps – Conclusion and Recommendations

This report examines what microgrids are, the different classifications of microgrids, how they function, how they can be helpful for New Jersey and how the state can help facilitate microgrids. We examined what we are doing in our state and others. What we found is a budding of ideas and ways to make it possible. This section gives recommendations to the Board.

Summary of the background issues in the Report

Superstorm Sandy caused significant damage to the distribution and transmission systems. Superstorm Sandy and other recent extreme weather events have shown that power outages negatively impact our economy, and the lives of New Jersey citizens, businesses, and critical facilities. Despite BPU funding and EDC efforts to mitigate risks our current electrical grid system with mostly above ground wires remains vulnerable during extreme weather events.

New Jersey government entities responded to Superstorm Sandy by requesting over 800 MW of backup generation. This was an estimated cost of approximately $500 million. The availability of energy, if and when the grid goes down at critical facilities is still a large unmet demand in New Jersey.

If the past predicts the future, storms will come that causes major power outages in New Jersey. We do not know when the next major outage will occur, but we can be better prepared for when it does happen. The Rutgers Outage Report shows 1.3 major storms will probably impact New Jersey, that does not mean there will be significant outages but would test the resiliency of the grid. It also documents a major outage from a tropical storm or hurricane once every five years. The 2016 hurricane season will be the 4th hurricane season after Sandy.

The analysis in this report, and the documents referenced, point to a more efficient and effective way to provide this emergency power for a specific set of critical facilities without relying solely on standby emergency generators. These energy resiliency systems need to be designed so that they can operate 24/7 under blue sky conditions and during and after an emergency.

The cost trends for DER are continuing to decrease over time compared to the current energy market costs. DER technologies are moving in the direction to achieve grid parity in the near future. It is likely, given the current downward trend of DER technologies and the current energy system costs, that New Jersey could see migration of customers from the electric distribution system to DER systems. That migration will need a vibrant and robust distribution system and an energy market manager to effectively manage the flow of electricity within the distribution system.

Resilient DER systems have additional costs and provide additional benefits to the customers, society in general, and to the utilities. Implementation and development of advance microgrids will depend on the balancing of the costs and benefits. The development of advanced microgrids depends on the establishment of reasonable cost and benefit payments to both the advanced microgrid and distribution system. The key to balancing these cost and benefit payments is through an appropriate tariff and rate making structure.

In addition to New Jersey other States are beginning to address the issue of changing the current utility business model – New York in Reforming the Energy Vision, Massachusetts in its Grid Modernization project, Maryland in its Utility 2.0, California in its DG program, and Connecticut in its microgrid program. This movement is driven mostly by the USDOE DER technology cost reduction goals. New Jersey is seeing an uptick in the application of resilient DER technology development.

The general directional analysis in this report points to a system that may rely on more DER in the future for a larger portion of the State's energy and capacity depending on if and when these DER technologies achieve the USDOE cost reduction and efficiency improvement goals.

New Jersey currently has fifty (50) operating microgrids and two (2) district thermal energy facilities. These facilities are mostly level 1 microgrids. Twelve (12) of the 50 microgrids are level 2 microgrids at New Jersey Colleges and University campuses as well as several hospitals. Some of these level 2 microgrids have multiple public roadways and other rights of way that intersect and transect their campuses and the level 2 microgrid hardware. A majority of these projects were funded through the BPU's Clean Energy Program.

Also highlighted in this report are several pilot projects that are in various stages of developing advanced microgrids, including: New Jersey Transit Grid, Hoboken Microgrid, Trenton District Thermal Energy Complex and Atlantic City Mid-Town Thermal Facility. These projects could assist in educating the BPU, EDCs, microgrid developers, and microgrid customers regarding how advanced microgrid systems will operate within the current distribution grid, and provide a pathway to the grid of the future. These projects and a handful of other key pilots will determine what the reasonable costs will be in this new DER grid, who should pay for those costs, what are the benefits, and who should pay for and receive those benefits.

The potential effectiveness of a microgrid can be seen in applications and projects currently subscribed to the New Jersey Energy Resilience Bank program. The program was designed to fund resiliency and self-sustainability measures for facilities in the water/waste water treatment and hospital sectors. There are currently three projects that implement a Level 1 microgrid set up: two hospitals and one waste water treatment facility. They will use turbines and reciprocating engines, with various energy savings methods such as on site demand response and specialize thermal equipment, to provide electrical and thermal energy to their respective campuses and facilities. The DER equipment, approximately 300 KW for the waste water facility and approximately 2 MW for each hospital, will be fueled by natural gas and/or bio gas produced on site. All projects will provide full islanding and black-start capability. In several current and pending applications, the DER systems along with microgrid set up will provide the primary energy source for the facilities. All facilities will be able to operate at or above critical load requirements in the event of an emergency outage situation. The annual savings projected for the hospitals is between $900,000 and $1.2 million independently.

A key component in developing microgrids is the advancement of DA or smart grid technologies within the current distribution grid. The scenario that links the distribution grid of today, with only a few operating microgrids, to the distribution grid of the future is addressing the development and advancement of Distribution Automation or Smart Grid. Specifically, Smart Grid technologies allow for the two way flow of power and communication between the distribution grid and the advance microgrid owner/operators and its customers. Other states are proceeding to initiate and complete a statewide smart grid deployment. While the New Jersey EDCs are, as a matter of routine operations, implementing DA, New Jersey currently does not have a plan for statewide implementation or development of DA or a smart grid build out. While there is a cost to advancing DA development, there is also a benefit to the ratepayer and both the costs and benefits need to be addressed through an appropriate filing.

Conclusion

The Report examined the following key issues:

- Can the advance microgrid operate in a manner that provides resiliency for the state or local government and critical facilities than the current central generator, transmission and distribution grid system?
- Can the advance microgrid operate in a manner that provides additional reliability to the current transmission and distribution grid system?
- Can the advance microgrid operate more efficiently than the current central generator, transmission and distribution grid system saving the microgrid customers, owners and/or operators energy costs?
- Can the advance microgrid operate in a more environmentally effective manner lowering air emissions, water usage, wastewater discharges, waste generation and land use impacts than the current central generator, transmission and distribution grid system?
- Can the advance microgrid provide benefits to the distribution grid overall?
- What benefits does the distribution grid supply to the advance microgrid?
- What are the costs the advance microgrid imposes on the distribution grid?
- What are the costs that the distribution grid imposes on the advanced microgrid?

As discussed in this report a TCDER microgrid is a specific type of advanced or level 3 microgrids. Based on an evaluation of the reference documents cited in this report, a review of microgrid projects in New Jersey and other states, illustrate that TCDER microgrids for multiple critical facilities in general can provide enhanced energy resiliency for critical customers at the local level as well as enhanced reliability and efficiency for usage of the distribution system grid.

The TCDER microgrids can accomplish this through enhanced energy efficiency, clean energy generation including both renewables and natural gas combined heat and power, lower air emissions and other environmental impacts, and overall energy cost savings to the multiple critical customers.

A specific finding of the benefits will depend on a case by case based on the specific design and operations of the Town Center DER microgrid. It will also depend on how the barriers that could limit the Town Center DER microgrid's effectiveness and efficiency are addressed. This general assessment must be confirmed through a detailed cost benefit analysis of each specific TCDER microgrid. As performed in other state microgrid programs, the cost benefit analysis would be accomplished through a detailed feasibility study of the specific TCDER microgrid. A key to the balancing of these costs and benefit payments will be through a reasonable tariff structure that is fair to the advanced microgrid owner/operator, the advanced microgrid customers, the EDCs and the ratepayers.

It is also worth noting that the experience and knowledge of developing, implementing and operating advanced microgrids within the local distribution system is greatly expanding every day in states throughout the nation. This report is just a snap shot of that progress to evolve and modernize the grid. A key component to the development of advanced microgrids is the development and implementation of Smart Grid or Distribution Automation.

States, along with the federal government, are experimenting with an array of DER technologies and utility business models within a changing and modernized grid. It is clear that the systems and equipment within the current distribution grid and that have remained virtually unchanged for the last 100 years have served states and the country well. However, the metric for measuring adequate performance of the distribution system is changing to include not just reliability but resilience, flexibility, and sustainability in terms of environmental attributes.

In summary, there are two key issues that can be further developed by the BPU to implement advanced microgrids and specifically TCDER microgrids. One is advancing DA and the other is developing TCDER microgrid pilot projects.

Recommendations

For the above reasons and others provided in this Report, staff makes the following recommendations:

1. Establish New Jersey definitions for DER, microgrids and the different levels of microgrids.
2. Establish a stakeholder process to develop and implement TCDER microgrid pilot projects.
3. The 2015 EMP Update recommends the EDC's continue enhancement of SG/DA within their systems. This enhancement

should include a SG/DA filing to provide for the optimized use of DER microgrids within their systems that enables an expansion of the capacity for a two-way flow of power and communications between the EDC and the DER microgrid. This optimization for DER microgrids within an EDC's system should be based on the overall costs and benefits of the DER microgrid and should include an integrated capacity analysis. Staff should work with the EDCs to establish the parameters and timeframe for filings.

4. Develop and implement a Town Center microgrid feasibility study incentive program as part of the current NJCEP budget. This Town Center microgrid feasibility incentive program should provide funding for the upfront feasibility and engineering evaluation project development costs of a Town Center DER microgrid at the local level. This incentive should be a phased approach as beginning with an initial feasibility study, followed by detailed engineering designs. Staff should implement a stakeholder process to determine the terms and conditions of this Town Center microgrid incentive program. This incentive should be provided through an MOU structure.
5. Initiate a TCDER microgrid pilot within each EDC service territory. This should initially be limited to the municipalities within the 9 FEMA designated counties or municipalities that meet the same criteria identified in the NJIT report. These pilots should include, at a minimum, an initial feasibility study of the TCDER microgrid. This process should assist in the development of a Town Center DER microgrid tariff.
6. Develop and implement a Town Center microgrid financing program. Staff should implement a stakeholder process to determine the terms and conditions of this Town Center microgrid financing program.
7. Review any BPU funding for DER and determine if there is a need to consolidate existing funding and whether other DER advanced microgrid financing mechanisms might prove beneficial in the future.
8. Expand the NJIT/RPA Town Center Microgrid Potential study to the 12 non-FEMA Superstorm Sandy designated counties and hold meetings with the local governments to explore the potential for developing microgrids for improved and enhanced resiliency.

In conclusion, this report represents staff's recommendations to the Board. Staff believes the implementation of microgrids is a positive step towards a more energy resilient New Jersey.

Appendix A

AN ACT concerning on-site generation facilities, providing a sales and use tax exemption for the purchase of natural gas and utility service used for co-generation, amending and supplementing P.L.1999, c.23, and amending P.L.1997, c.162.

BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey:*

1. Section 3 of P.L.1999, c.23 (C.48:3-51) is amended to read as follows:

C.48:3-51 Definitions relative to competition in the electric power and gas industries.

3. As used in this act:

"Assignee" means a person to which an electric public utility or another assignee assigns, sells or transfers, other than as security, all or a portion of its right to or interest in bondable transition property. Except as specifically provided in P.L.1999, c.23 (C.48:3-49 et al.), an assignee shall not be subject to the public utility requirements of Title 48 or any rules or regulations adopted pursuant thereto;

"Basic gas supply service" means gas supply service that is provided to any customer that has not chosen an alternative gas supplier, whether or not the customer has received offers as to competitive supply options, including, but not limited to, any customer that cannot obtain such service for any reason, including non-payment for services. Basic gas supply service is not a competitive service and shall be fully regulated by the board;

"Basic generation service" means electric generation service that is provided, pursuant to section 9 of P.L.1999, c.23 (C.48:3-57), to any customer that has not chosen an alternative electric power supplier, whether or not the customer has received offers as to competitive supply options, including, but not limited to, any customer that cannot obtain such service from an electric power supplier for any reason, including non-payment for services. Basic generation service is not a competitive service and shall be fully regulated by the board;

"Basic generation service transition costs" means the amount by which the payments by an electric public utility for the procurement of power for basic generation service and related ancillary and administrative costs exceeds the net revenues from the basic generation service charge established by the board pursuant to section 9 of P.L.1999, c.23 (C.48:3-57) during the transition period, together with interest on the balance at the board-approved rate, that is reflected in a deferred balance account approved by the board in an order addressing the electric public utility's unbundled rates, stranded costs, and restructuring filings pursuant to P.L.1999, c.23 (C.48:3-49 et al.). Basic generation service transition costs shall include, but are not limited to, costs of purchases from the spot market, bilateral contracts, contracts with non-utility generators, parting contracts with the purchaser of the electric public utility's divested generation assets, short-term advance purchases, and financial instruments such as hedging, forward contracts, and options. Basic generation service transition costs shall also include the payments by an electric public utility pursuant to a competitive procurement process for basic generation service supply during the transition period, and costs of any such process used to procure the basic generation service supply;

"Board" means the New Jersey Board of Public Utilities or any successor agency;

"Bondable stranded costs" means any stranded costs or basic generation service transition costs of an electric public utility approved by the board for recovery pursuant to the provisions of P.L.1999, c.23 (C.48:3-49 et al.), together with, as approved by the board: (1) the cost of retiring existing debt or equity capital of the electric public utility, including accrued interest, premium and other fees, costs and charges relating thereto, with the proceeds of the financing of bondable transition property; (2) if requested by an electric public utility in its application for a bondable stranded costs rate order, federal, State and local tax liabilities associated with stranded costs recovery or basic generation service transition cost recovery or the transfer or financing of such property or both, including taxes, whose recovery period is modified by the effect of a stranded costs recovery order, a bondable stranded costs rate order or both; and (3) the costs incurred to issue, service or refinance transition bonds, including interest, acquisition or redemption premium, and other financing costs, whether paid upon issuance or over the life of the transition bonds, including, but not limited to, credit enhancements, service charges, overcollateralization, interest rate cap, swap or collar, yield maintenance, maturity guarantee or other hedging agreements, equity investments, operating costs and other related fees, costs and charges, or to assign, sell or otherwise transfer bondable transition property;

"Bondable stranded costs rate order" means one or more irrevocable written orders issued by the board pursuant to P.L.1999, c.23 (C.48:3-49 et al.) which determines the amount of bondable stranded costs and the initial amount of transition bond charges authorized to be imposed to recover such bondable stranded costs, including the costs to be financed from the proceeds of the transition bonds, as well as on-going costs associated with servicing and credit enhancing the transition bonds, and provides the electric public utility specific authority to issue or cause to be issued, directly or indirectly, transition bonds through a financing entity and related matters as provided in P.L.1999, c.23, which order shall become effective immediately upon the written consent of the related electric public utility to such order as provided in P.L.1999, c.23;

"Bondable transition property" means the property consisting of the irrevocable right to charge, collect and receive, and be paid from collections of, transition bond charges in the amount necessary to provide for the full recovery of bondable stranded costs which are determined to be recoverable in a bondable stranded costs rate order, all rights of the related electric public utility under such bondable stranded costs rate order including, without limitation, all rights to obtain periodic adjustments of the related transition bond charges pursuant to subsection b. of section 15 of P.L.1999, c.23 (C.48:3-64), and all revenues, collections, payments, money and proceeds arising under, or with respect to, all of the foregoing;

"British thermal unit" or "Btu" means the amount of heat required to increase the temperature of one pound of water by one degree Fahrenheit;

"Broker" means a duly licensed electric power supplier that assumes the contractual and legal responsibility for the sale of electric generation service, transmission or other services to end-use retail customers, but does not take title to any of the power sold, or a duly licensed gas supplier that assumes the contractual and legal obligation to provide gas supply service to end-use retail customers, but does not take title to the gas;

"Buydown" means an arrangement or arrangements involving the buyer and seller in a given power purchase contract and, in some cases third parties, for consideration to be given by the buyer in order to effectuate a reduction in the pricing, or the restructuring of other terms to reduce the overall cost of the power contract, for the remaining succeeding period of the purchased power arrangement or arrangements;

"Buyout" means an arrangement or arrangements involving the buyer and seller in a given power purchase contract and, in some cases third parties, for consideration to be given by the buyer in order to effectuate a termination of such power purchase contract;

"Class I renewable energy" means electric energy produced from solar technologies, photovoltaic technologies, wind energy, fuel cells, geothermal technologies, wave or tidal action, and methane gas from landfills or a biomass facility, provided that the biomass is cultivated and harvested in a sustainable manner;

"Class II renewable energy" means electric energy produced at a resource recovery facility or hydropower facility, provided that such facility is located where retail competition is permitted and provided further that the Commissioner of Environmental Protection has determined that such facility meets the highest environmental standards and minimizes any impacts to the environment and local communities;

“Co-generation” means the sequential production of electricity and steam or other forms of useful energy used for industrial or commercial heating and cooling purposes;

"Combined heat and power facility" or "co-generation facility" means a generation facility which produces electric energy, steam, or other forms of useful energy such as heat, which are used for industrial or commercial heating or cooling purposes. A combined heat and power facility or co-generation facility shall not be considered a public utility;

"Competitive service" means any service offered by an electric public utility or a gas public utility that the board determines to be competitive pursuant to section 8 or section 10 of P.L.1999, c.23 (C.48:3-56 or C.48:3-58) or that is not regulated by the board;

"Commercial and industrial energy pricing class customer" or "CIEP class customer" means that group of non-residential customers with high peak demand, as determined by periodic board order, which either is eligible or which would be eligible, as determined by periodic board order, to receive funds from the Retail Margin Fund established pursuant to section 9 of P.L.1999, c.23 (C.48:3-57) and for which basic generation service is hourly-priced;

"Comprehensive resource analysis" means an analysis including, but not limited to, an assessment of existing market barriers to the implementation of energy efficiency and renewable technologies that are not or cannot be delivered to customers through a competitive marketplace;

"Customer" means any person that is an end user and is connected to any part of the transmission and distribution system within an electric public utility's service territory or a gas public utility's service territory within this State;

"Customer account service" means metering, billing, or such other administrative activity associated with maintaining a customer account;

"Demand side management" means the management of customer demand for energy service through the implementation of cost-effective energy efficiency technologies, including, but not limited to, installed conservation, load management and energy efficiency measures on and in the residential, commercial, industrial, institutional and governmental premises and facilities in this State;

"Electric generation service" means the provision of retail electric energy and capacity which is generated off-site from the location at which the consumption of such electric energy and capacity is metered for retail billing purposes, including agreements and arrangements related thereto;

"Electric power generator" means an entity that proposes to construct, own, lease or operate, or currently owns, leases or operates, an electric power production facility that will sell or does sell at least 90 percent of its output, either directly or through a marketer, to a customer or customers located at sites that are not on or contiguous to the site on which the facility will be located or is located. The designation of an entity as an electric power generator for the purposes of P.L.1999, c.23 (C.48:3-49 et al.) shall not, in and of itself, affect the entity's status as an exempt wholesale generator under the Public Utility Holding Company Act of 1935, 15 U.S.C.s.79 et seq.;

"Electric power supplier" means a person or entity that is duly licensed pursuant to the provisions of P.L.1999, c.23 (C.48:3-49 et al.) to offer and to assume the contractual and legal responsibility to provide electric generation service to retail customers, and includes load serving entities, marketers and brokers that offer or provide electric generation service to retail customers. The term excludes an electric public utility that provides electric generation service only as a basic generation service pursuant to section 9 of P.L.1999, c.23 (C.48:3-57);

"Electric public utility" means a public utility, as that term is defined in R.S.48:2-13, that transmits and distributes electricity to end users within this State;

"Electric related service" means a service that is directly related to the consumption of electricity by an end user, including, but not limited to, the installation of demand side management measures at the end user's premises, the maintenance, repair or replacement of appliances, lighting, motors or other energy-consuming devices at the end user's premises, and the provision of energy consumption measurement and billing services;

"Electronic signature" means an electronic sound, symbol or process, attached to, or logically associated with, a contract or other record, and executed or adopted by a person with the intent to sign the record;

"Energy agent" means a person that is duly registered pursuant to the provisions of P.L.1999, c.23 (C.48:3-49 et al.), that arranges the sale of retail electricity or electric related services or retail gas supply or gas related services between government aggregators or private aggregators and electric power suppliers or gas suppliers, but does not take title to the electric or gas sold;

"Energy consumer" means a business or residential consumer of electric generation service or gas supply service located within the territorial jurisdiction of a government aggregator;

"Financing entity" means an electric public utility, a special purpose entity, or any other assignee of bondable transition property, which issues transition bonds. Except as specifically provided in P.L.1999, c.23 (C.48:3-49 et al.), a financing entity which is not itself an electric public utility shall not be subject to the public utility requirements of Title 48 or any rules or regulations adopted pursuant thereto;

"Gas public utility" means a public utility, as that term is defined in R.S.48:2-13, that distributes gas to end users within this State;

"Gas related service" means a service that is directly related to the consumption of gas by an end user, including, but not limited to, the installation of demand side management measures at the end user's premises, the maintenance, repair or replacement of appliances or other energy-consuming devices at the end user's premises, and the provision of energy consumption measurement and billing services;

"Gas supplier" means a person that is duly licensed pursuant to the provisions of P.L.1999, c.23 (C.48:3-49 et al.) to offer and assume the contractual and legal obligation to provide gas supply service to retail customers, and includes, but is not limited to, marketers and brokers. A non-public utility affiliate of a public utility holding company may be a gas supplier, but a gas public utility or any subsidiary of a gas utility is not a gas supplier. In the event that a gas public utility is not part of a holding company legal structure, a related competitive business segment of that gas public utility may be a gas supplier, provided that related competitive business segment is structurally separated from the gas public utility, and provided that the interactions between the gas public utility and the related competitive business segment are subject to the affiliate relations standards adopted by the board pursuant to subsection k. of section 10 of P.L.1999, c.23 (C.48:3-58);

"Gas supply service" means the provision to customers of the retail commodity of gas, but does not include any regulated distribution service;

"Government aggregator" means any government entity subject to the requirements of the "Local Public Contracts Law," P.L.1971, c.198 (C.40A:11-1 et seq.), the "Public School Contracts Law," N.J.S.18A:18A-1 et seq., or the "County College Contracts Law," P.L.1982, c.189 (C.18A:64A-25.1 et seq.), that enters into a written contract with a licensed electric power supplier or a licensed gas supplier for: (1) the provision of electric generation service, electric related service, gas supply service, or gas related service for its own use or the use of other government aggregators; or (2) if a municipal or county government, the provision of electric generation service or gas supply service on behalf of business or residential customers within its territorial jurisdiction;

"Government energy aggregation program" means a program and procedure pursuant to which a government aggregator enters into a written contract for the provision of electric generation service or gas supply service on behalf of business or residential customers within its territorial jurisdiction;

"Governmental entity" means any federal, state, municipal, local or other governmental department, commission, board, agency, court, authority or instrumentality having competent jurisdiction;

"Market transition charge" means a charge imposed pursuant to section 13 of P.L.1999, c.23 (C.48:3-61) by an electric public utility, at a level determined by the board, on the electric public utility customers for a limited duration transition period to recover stranded costs created as a result of the introduction of electric power supply competition pursuant to the provisions of P.L.1999, c.23 (C.48:3-49 et al.);

"Marketer" means a duly licensed electric power supplier that takes title to electric energy and capacity, transmission and other services from electric power generators and other wholesale suppliers and then assumes the contractual and legal obligation to provide electric generation service, and may include transmission and other services, to an end-use retail customer or customers, or a duly licensed gas supplier that takes title to gas and then assumes the contractual and legal obligation to provide gas supply service to an end-use customer or customers;

"Net proceeds" means proceeds less transaction and other related costs as determined by the board;

"Net revenues" means revenues less related expenses, including applicable taxes, as determined by the board;

"Off-site end use thermal energy services customer" means an end use customer that purchases thermal energy services from an on-site generation facility, combined heat and power facility, or co-generation facility, and that is located on property that is separated from the property on which the on-site generation facility, combined heat and power facility, or co-generation facility is located by more than one easement, public thoroughfare, or transportation or utility-owned right-of-way;

"On-site generation facility" means a generation facility, and equipment and services appurtenant to electric sales by such facility to the end use customer located on the property or on property contiguous to the property on which the end user is located. An on-site generation facility shall not be considered a public utility. The property of the end use customer and the property on which the on-site generation facility is located shall be considered contiguous if they are geographically located next to each other, but may be otherwise separated by an easement, public thoroughfare, transportation or utility-owned right-of-way, or if the end use customer is purchasing thermal energy services produced by the on-site generation facility, for use for heating or cooling, or both, regardless of whether the customer is located on property that is separated from the property on which the on-site generation facility is located by more than one easement, public thoroughfare, or transportation or utility-owned right-of-way;

"Person" means an individual, partnership, corporation, association, trust, limited liability company, governmental entity or other legal entity;

"Private aggregator" means a non-government aggregator that is a duly-organized business or non-profit organization authorized to do business in this State that enters into a contract with a duly licensed electric power supplier for the purchase of electric energy and capacity, or with a duly licensed gas supplier for the purchase of gas supply service, on behalf of multiple end-use customers by combining the loads of those customers;

"Public utility holding company" means: (1) any company that, directly or indirectly, owns, controls, or holds with power to vote, ten percent or more of the outstanding voting securities of an electric public utility or a gas public utility or of a company which is a public utility holding company by virtue of this definition, unless the Securities and Exchange Commission, or its successor, by order declares such company not to be a public utility holding company under the Public Utility Holding Company Act of 1935, 15 U.S.C.s.79 et seq., or its successor; or (2) any person that the Securities and Exchange Commission, or its successor, determines, after notice and opportunity for hearing, directly or indirectly, to exercise, either alone or pursuant to an arrangement or understanding with one or more other persons, such a controlling influence over the management or policies of an electric public utility or a gas public utility or public utility holding company as to make it necessary or appropriate in the public interest or for the protection of investors or consumers that such person be subject to the obligations, duties, and liabilities imposed in the Public Utility Holding Company Act of 1935 or its successor;

"Regulatory asset" means an asset recorded on the books of an electric public utility or gas public utility pursuant to the Statement of Financial Accounting Standards, No. 71, entitled "Accounting for the Effects of Certain Types of Regulation," or any successor standard and as deemed recoverable by the board;

"Related competitive business segment of an electric public utility or gas public utility" means any business venture of an electric public utility or gas public utility including, but not limited to, functionally separate business units, joint ventures, and partnerships, that offers to provide or provides competitive services;

"Related competitive business segment of a public utility holding company" means any business venture of a public utility holding company, including, but not limited to, functionally separate business units, joint ventures, and partnerships and subsidiaries, that offers to provide or provides competitive services, but does not include any related competitive business segments of an electric public utility or gas public utility;

"Resource recovery facility" means a solid waste facility constructed and operated for the incineration of solid waste for energy production and the recovery of metals and other materials for reuse;

"Restructuring related costs" means reasonably incurred costs directly related to the restructuring of the electric power industry, including the closure, sale, functional separation and divestiture of generation and other competitive utility assets by a public utility, or the provision of competitive services as such costs are determined by the board, and which are not stranded costs as defined in P.L.1999, c.23 (C.48:3-49 et al.) but may include, but not be limited to, investments in management information systems, and which shall include expenses related to employees affected by restructuring which result in efficiencies and which result in benefits to ratepayers, such as training or retraining at the level equivalent to one year's training at a vocational or technical school or county community college, the provision of severance pay of two weeks of base pay for each year of full-time employment, and a maximum of 24 months' continued health care coverage. Except as to expenses related to employees affected by restructuring, "restructuring related costs" shall not include going forward costs;

"Retail choice" means the ability of retail customers to shop for electric generation or gas supply service from electric power or gas suppliers, or opt to receive basic generation service or basic gas service, and the ability of an electric power or gas supplier to offer electric generation service or gas supply service to retail customers, consistent with the provisions of P.L.1999, c.23 (C.48:3-49 et al.);

"Retail margin" means an amount, reflecting differences in prices that electric power suppliers and electric public utilities may charge in providing electric generation service and basic generation service, respectively, to retail customers, excluding residential customers, which the board may authorize to be charged to categories of basic generation service customers of electric public utilities in this State, other than residential customers, under the board's continuing regulation of basic generation service pursuant to sections 3 and 9 of P.L.1999, c.23 (C.48:3-51 and 48:3-57), for the purpose of promoting a competitive retail market for the supply of electricity;

"Shopping credit" means an amount deducted from the bill of an electric public utility customer to reflect the fact that such customer has switched to an electric power supplier and no longer takes basic generation service from the electric public utility;

"Social program" means a program implemented with board approval to provide assistance to a group of disadvantaged customers, to provide protection to consumers, or to accomplish a particular societal goal, and includes, but is not limited to, the winter moratorium program, utility practices concerning "bad debt" customers, low income assistance, deferred payment plans, weatherization programs, and late payment and deposit policies, but does not include any demand side management program or any environmental requirements or controls;

"Societal benefits charge" means a charge imposed by an electric public utility, at a level determined by the board, pursuant to, and in accordance with, section 12 of P.L.1999, c.23 (C.48:3-60);

"Stranded cost" means the amount by which the net cost of an electric public utility's electric generating assets or electric power purchase commitments, as determined by the board consistent with the provisions of P.L.1999, c.23 (C.48:3-49 et al.), exceeds the market value of those assets or contractual commitments in a competitive supply marketplace and the costs of buydowns or buyouts of power purchase contracts;

"Stranded costs recovery order" means each order issued by the board in accordance with subsection c. of section 13 of P.L.1999, c.23 (C.48:3-61) which sets forth the amount of stranded costs, if any, the board has determined an electric public utility is eligible to recover and collect in accordance with the standards set forth in section 13 of P.L.1999, c.23 (C.48:3-61) and the recovery mechanisms therefor;

"Thermal efficiency" means the useful electric energy output of a facility, plus the useful thermal energy output of the facility, expressed as a percentage of the total energy input to the facility;

"Transition bond charge" means a charge, expressed as an amount per kilowatt hour, that is authorized by and imposed on electric public utility ratepayers pursuant to a bondable stranded costs rate order, as modified at any time pursuant to the provisions of P.L.1999, c.23 (C.48:3-49 et al.);

"Transition bonds" means bonds, notes, certificates of participation or beneficial interest or other evidences of indebtedness or ownership issued pursuant to an indenture, contract or other agreement of an electric public utility or a financing entity, the proceeds of which are used, directly or indirectly, to recover, finance or refinance bondable stranded costs and which are, directly or indirectly, secured by or payable from bondable transition property. References in P.L.1999, c.23 (C.48:3-49 et al.) to principal, interest, and acquisition or redemption premium with respect to transition bonds which are issued in the form of certificates of participation or beneficial interest or other evidences of ownership shall refer to the comparable payments on such securities;

"Transition period" means the period from August 1, 1999 through July 31, 2003;

"Transmission and distribution system" means, with respect to an electric public utility, any facility or equipment that is used for the transmission, distribution or delivery of electricity to the customers of the electric public utility including, but not limited to, the land, structures, meters, lines, switches and all other appurtenances thereof and thereto, owned or controlled by the electric public utility within this State; and

"Universal service" means any service approved by the board with the purpose of assisting low-income residential customers in obtaining or retaining electric generation or delivery service.

2. Section 28 of P.L.1999, c.23 (C.48:3-77) is amended to read as follows:

C.48:3-77 Charges for sale, delivery of power to off-site customer.

28. a. whenever an on-site generation facility produces power that is not consumed by the on-site customer, and that power is delivered to an off-site end-use customer in this State, all the following charges shall apply to the sale or delivery of such power to the off-site customer:

(1) The societal benefits charge or its equivalent, imposed pursuant to section 12 of P.L.1999, c.23 (C.48:3-60);

(2) The market transition charge or its equivalent, imposed pursuant to section 13 of P.L.1999, c.23 (C.48:3-61); and

(3) The transition bond charge or its equivalent, imposed pursuant to section 18 of P.L.1999, c.23 (C.48:3-67).

b. None of the following charges shall be imposed on the electricity sold solely to the on-site customer of an on-site generating facility, except pursuant to subsection c. of this section:

(1) The societal benefits charge or its equivalent, imposed pursuant to section 12 of P.L.1999, c.23 (C.48:3-60);

(2) The market transition charge or its equivalent, imposed pursuant to section 13 of P.L.1999, c.23 (C.48:3-61); and

(3) The transition bond charge or its equivalent, imposed pursuant to section 18 of P.L.1999, c.23 (C.48:3-67).

c. Upon finding that generation from on-site generation facilities installed subsequent to the starting date of retail competition as provided in subsection a. of section 5 of P.L.1999, c.23 (C.48:3-53) has, in the aggregate, displaced customer purchases from an electric public utility by an amount such that the kilowatt hours distributed by the electric public utility have been reduced to an amount equal to 92.5 percent of the 1999 kilowatt hours distributed by the electric public utility, the board shall impose, except as provided in subsection d. of this section, the charges listed in subsections a., b., and c. of this section on the on-site customer. Such charges shall not be levied on any power consumption that is displaced by an on-site generation facility that is installed before the date of such finding:

(1) The societal benefits charge or its equivalent, imposed pursuant to section 12 of P.L.1999, c.23 (C.48:3-60);

(2) The market transition charge or its equivalent, imposed pursuant to section 13 of P.L.1999, c.23 (C.48:3-61); and

(3) The transition bond charge or its equivalent, imposed pursuant to section 18 of P.L.1999, c.23 (C.48:3-67).

d. Notwithstanding the provisions of subsection c. of this section, a charge shall not be imposed on power consumption by the on-site customer that is derived from an on-site generation facility:

(1) That the on-site customer or its agent installed on or before the effective date of P.L.1999, c.23 (C.48:3-49 et al.), including any expansion of such a facility for the continued provision of on-site power consumption by the same on-site customer that occurs after the effective date of P.L.1999, c.23; or

(2) For which the on-site customer or its agent has made, on or before the effective date of P.L.1999, c.23 (C.48:3-49 et al.), substantial financial and contractual commitments in planning and development, including having applied for any appropriate air permit from the Department of Environmental Protection, including any expansion of such a facility for the continued provision of on-site power consumption by the same on-site customer that occurs after the effective date of P.L.1999, c.23.

e. A societal benefits charge, market transition charge, transition bond charge, and transitional energy facilities assessment or their equivalent, shall be imposed on the sale or delivery of power to an off-site end use thermal energy services customer that is derived from the on-site generation facility serving that customer.

3. Section 26 of P.L.1997, c.162 (C.54:32B-8.46) is amended to read as follows:

C.54:32B-8.46 Receipts from sale, exchange, delivery, use of electricity; purchase or use of natural gas or utility service.

26. a. Receipts from the sale, exchange, delivery or use of electricity are exempt from the tax imposed under the "Sales and Use Tax Act," P.L.1966, c.30 (C.54:32B-1 et seq.) if the electricity:

(1) (a) Is sold by a municipal electric corporation in existence as of December 31, 1995 and used within its municipal boundaries except if the customer is located within a franchise area served by an electric public utility other than the municipal electric corporation. If a municipal electric corporation makes sales of electricity used outside of its municipal boundaries or within a franchise area served by an electric public utility other than the

municipal electric corporation, then receipts from those sales of electricity by the municipal electric corporation shall be subject to tax under P.L.1966, c.30; or

(b) Is sold by a municipal electric utility in existence as of December 31, 1995, and used within its municipal boundaries. However, a municipal electric utility's receipts from the sale, exchange, delivery or use of electricity used by customers outside of its municipal boundaries and within its franchise area existing as of December 31, 1995 shall be subject to tax. If a municipal electric utility makes sales of electricity used outside of its franchise area existing as of December 31, 1995, then receipts from those sales of electricity by the municipal electric utility shall be subject to tax under P.L.1966, c.30;

(2) Was generated by a facility located on the user's property or property purchased or leased from the user by the person owning the generation facility and such property is contiguous to the user's property, and the electricity was consumed by the one on-site end user on the user's property, and was not transported to the user over wires that cross a property line or public thoroughfare unless the property line or public thoroughfare merely bifurcated the user's or generation facility owner's otherwise contiguous property or the electricity was consumed by an affiliated user on the same site, or by a non-affiliated user on the same site with an electric distribution system which is integrated and interconnected with the user on or before March 10, 1997; the director may promulgate rules and regulations and issue guidance with respect to all issues related to affiliated users; or

(3) Is sold for resale.

For the purpose of electric sales by an on-site generation facility pursuant to this subsection, an end use customer's property shall be considered contiguous to the property on which the on-site generation facility serving that customer is located if the customer is purchasing thermal energy services produced by the facility, for use for heating or cooling, or both, regardless of any intervening property, public thoroughfare, or transportation or utility-owned right-of-way.

The State Treasurer shall monitor monies deposited into the Energy Tax Receipts Property Tax Relief Fund on an annual basis and may report the results of the State Treasurer's analysis on the fund to the Governor and the Legislature, along with any recommendations on the exemptions in this subsection.

b. Receipts from the purchase or use of the following are exempt from the tax imposed under the "Sales and Use Tax Act," P.L.1966, c.30 (C.54:32B-1 et seq.):

(1) Natural gas or utility service that is used to generate electricity that is sold for resale or to an end user other than the end user upon whose property is located a co-generation facility or self-generation unit that generated the electricity or upon the property purchased or leased from the end user by the person owning the co-generation facility or self-generation unit if such property is contiguous to the user's property and is the property upon which is located a co-generation facility or self-generation unit that generated the electricity;

(2) Natural gas and utility service that is used for co-generation at any site at which a co-generation facility was in operation on or before March 10, 1997, or for which an application for an operating permit or a construction permit and a certificate of operation in order to comply with air quality standards under P.L.1954, c.212 (C.26:2C-1 et seq.) has been filed with the Department of Environmental Protection on or before March 10, 1997, to produce electricity for use on that site; and

(3) Natural gas and utility service that is used for co-generation at a co-generation facility that is constructed after January 1, 2010.

c. Notwithstanding any provisions of this section to the contrary, any co-generation facility that was in operation prior to January 1, 2010 and was subject to the tax imposed under the "Sales and Use Tax Act," P.L.1966, c.30 (C.54:32B-1 et seq.) for the purchase and use of natural gas and utility service for co-generation purposes shall continue to be subject to, and responsible for payment of, such tax after the effective date of P.L.2009, c.240 (C.48:3-77.1 et al.).

C.48:3-77.1 Utilization of locally franchised public utility electric distribution infrastructure.

4. In order to avoid duplication of existing public utility electric distribution infrastructure, and to maximize economic efficiency and electrical safety, delivery of electric power from an on-site generation facility to an off-site end use thermal energy services customer as defined in section 3 of P.L.1999, c.23 (C.48:3-51), shall utilize the existing locally franchised public utility electric distribution infrastructure. The New Jersey electric public utility having franchise rights to provide electric delivery services within the municipality shall provide electric delivery services at the standard prevailing tariff rate that is normally applicable to the individual off-site end use thermal energy services customer.

5. This act shall take effect immediately.

Approved January 16, 2010.

Appendix B Comments and Responses from the ERB August 27, 2014Stakeholder Meeting
Comments/Questions and Responses – Appendix C of the Board's October6, 2014 Order

Concord Engineering submitted the following comment:

Comment 116

To enable multi user applications the BPU should adopt rules that define the provision of emergency power as being exempt from utility franchise restrictions and allowing a direct wire connection from an onsite generator to nearby critical facilities. This would need to include appropriate safeguards similar to emergency generator transfer trip devices to prevent back feeding power onto utility lines which would be a safety hazard.

Response

The issues raised by this comment are beyond the scope of the ERB Guide and Product; further, the rules recommended by the commenter may be outside the authority granted to the Board. Staff will recommend that the Board direct staff to initiate a stakeholder process on issues related to the provision of emergency power, including power to critical facilities, and report back to the Board on whether statutory and/or regulatory changes are necessary and, if so, with recommended statutory and/or regulatory provisions.

4. In addition to Comment 116 the following comment are related to the direction of the Board submitted by Morgan Lewis on behalf of the electric utilities

Comment 68.

The EDCs are concerned about the leap taken in the Program Guide, when discussing microgrids, to using imprecise descriptions of potential configurations that may be eligible for ERB funding- but may not be consistent with existing law or regulation.

Response

ERB Staff disagree that there is a "leap" taken in the Guide when discussing microgrids. The specific configuration of a planned DER microgrid will vary from project to project on a case-by-case basis. A microgrid can have three basic configurations as follows:
1. The DER microgrid facility itself as one building with one meter or in a campus-type setting that may be served by one meter;
2. The DER microgrid facility is a net metering configuration that is also defined as behind the meter (BTM); or
3. An advanced microgrid is where more than one building/facility with more than one meter is connected to

The DER microgrid can be developed for continuous operation 24 hours a day and seven days a week or limited to supplying power when there is a grid outage. The microgrid can supply either solely electricity or solely thermal energy as steam and chilled water or both thermal energy and electricity. The Guide described a DER microgrid but not the microgrid configuration or the energy supplied by the DER microgrid. That would be the applicant's decision as the project is designed. All such projects or DER microgrid configurations and their overall energy supply, must be consistent with all applicable federal, State and local statutes and regulations. It will be the applicant's responsibility to ensure that all permits and approvals are acquired and all applicable permit requirements are met.

Comment 69.

Disclaimer should be added: *"Nothing contained in this Program Guide* is *intended to promote project configurations that are*, or *may be, inconsistent with existing law or regulation. Applicants should consult with appropriate energy and legal ad11isors and with their local EDC regarding the operational and legal feasibility of proposed project configurations.*

Response

BPU and EDA as public entities are prohibited from funding projects which are illegal or violate any existing law or regulation. While this requirement was expressed in the Guide, an additional disclaimer has been added to Section 4.3.2.

Comment 70

Clarify that applicants must adhere to applicable EDC tariffs and work with EDCs on other important project components such as interconnectivity. Raised concerns regarding net metering and potential loss of revenues from incorporation of DER technologies at critical facilities.

All applicants will be required to adhere to applicable EDC tariffs and will be encouraged to contact the EDCs early in the application process to fully understand the requirements for interconnection and charges. The existing tariff and specific guidelines for each EDC must be followed by the applicant, especially on interconnection matters. Net-metering concerns must be addressed by the Board and the EOCs if concerns arise. Regarding the concern over erosion of revenue, such concerns can be brought to the attention of the BPU in the form of a rate case.

Comment 71

EDCs believe more DER behind-the-meter based would lead to further EDC revenue erosion which will eventually need to be recovered from the EDC's remaining ratepayers.

Response

Under the proposal, these facilities will continue to pay capacity and standby charges and will therefore contribute to upkeep of the distribution system while reducing the need for additional investment in infrastructure that might otherwise be required to service this load. ERB Staff will monitor this issue on an ongoing basis.

Appendix C Attendees at one of the Four Microgrid Proceeding meetings

Developers December 3, 2014

Name	Company/Affiliation	Email
Michael Winka	NJBPU - President's Office	michael.winka@bpu.state.nj.us
Baird Brown	Drinker Biddle	baird@dbr.com
Gearoid Foley	DOE	gearoid@XXXXX
Mike Webster	Icetec	mwebster@icetec.com
Robert Morin	Ameresco	rmorin@ameresco.com
Jim Thoma	Bernhard Energy	jim.thomas@bernhardenergy.com
Steve Goldenberg	Fox Rothschild	sgoldenberg@foxrothschild.com
Tom Nyquist	Princeton University	tnyquist@princeton.edu
Ted Borer	Princeton University	etborer@princeton.edu

GDC/EDC December 10, 2014

Name	Utility	Email
Michael Winka	BPU	michael.winka@bpu.state.nj.us
Kenny Esser	PSE&G	kenneth.esserjr@pseg.com
Joe White	RECO	whitejoe@oru.com
Ed Gray	PSE&G	edward.gray@pseg.com
Tom Donadio	JCP&L	tdonadio@firstenergycorp.com
Lee Wasman	ACE	lee.wasman@atlanticcityelectric.com
John Stadziola	SJG	jstadziola@sjindustries.com
Wayne Barndt	ACE	wayne.barndt@pepcoholdings.com

Steve Steffel	ACE	steve.steffel@pepcoholdings.com
Tom Massaro	NJNG	tjmassaro@njng.com

Rate Counsel December 16, 2014

Name	Utility	Email
Michael Winka	BPU	michael.winka@bpu.state.nj.us
Stephanie Brand	NJ RPA	sbrand@rpa.state.nj.us
Sarah Steindel	NJ RPA	ssteindel@rpa.state.nj.us

Market Sector Customer March 13, 2015

Name	Utility	Email
Michael Winka	BPU	michael.winka@bpu.state.nj.us
Tyla Housman represented by Al Lobiondo of MedGap	NJ Hospital Association	THousman@NJHA.com (alobiondo@medgapsolutions.com)
Ed Purcell	NJ League of Municipalities	epurcell@njslom.org
Loren Wizman	NJ Association of Counties	loren@njac.org
Allison Durham	NJ Association of Housing and Redevelopment Authorities	ADurham@NewarkHA.org
Steven Jenks	NJ Transit	SJenks@NJTransit.com

APPENDIX D League of Municipalities' letter

March 17, 2015

Re: Follow Up to March 13th Meeting

Dear Mr. Winka,

On March 13th Board staff discussed possible configurations that would allow for the emergency use of microgrids in a configuration that would comply with N.J.S.A. 48:3-77.1. The practical effect of this provision has been to constrain the adoption of microgrids by requiring that "*end use thermal energy services customer* as defined in section 2 of P.L. 1999, c. 23 (C.48:3-51), shall utilize the existing locally franchised public utility distribution infrastructure."

The League agrees with the concept laid out by Board staff where, broadly speaking, a microgrid's infrastructure would be constructed by the developer, but maintained and operated by a utility which will levy a tariff on the customer for that service.

The League would like to make one additional point. There is a carve out, under current law, for municipalities to construct and operate, as general improvements, "municipal microgrids" in their own municipal right of way (ROW), beyond and separate from the configuration discussed above.

This carve out exists for the following four reasons. First, municipalities may construct and operate municipal microgrids as general improvements pursuant to N.J.S.A. 40:56-1. Second, municipalities have retained the right to construct general public improvements, like microgrids, in their municipal ROW. Third, because municipalities have a superior non-possessory interest in their ROW, such a microgrid is outside of N.J.S.A. 48:3-77.1. Fourth, a utility's franchise rights are not violated if a municipality constructs a microgrid to only connect municipal buildings, and does not sell energy to current utility customers.

I. Municipalities may construct and operate municipal microgrids as general improvements pursuant to N.J.S.A. 40:56-1

A municipality may erect the necessary components of a microgrid pursuant to N.J.S.A. 40:56-1 which provides:

> Any municipality may undertake any of the following works as a local improvement; and the governing body thereof may make, amend, repeal and enforce ordinances for carrying into effect all powers granted in this section…

> j. the installation of service connections to a system of water, gas, light, heat, or power works by a municipality or otherwise, including all such works whose benefit such services are provide; service connections including the laying, construction or placing of mains, conduits or cables in, under or along a street, alley or other public highway or portion thereof.

II. Municipalities have retained the right to construct general public improvements, like microgrids, in their municipal ROW

Municipalities have retained the right to construct general public improvements, like microgrids, in their municipal ROW. A ROW is nothing more than an easement, possessed by a municipality, to property abutting public streets. As is commonly understood, the rights associated with property ownership represent a "bundle of sticks." A ROW is created when a municipality enacts an ordinance which takes possession of some rights or sticks from the bundles of private property owners adjacent to public streets.

During the franchising process, the municipality, in turn, grants some sticks or rights to a utility to run its infrastructure within the municipal ROW. N.J.S.A. 48:7-2. In sum, in relation to a utility, a municipality maintains a superior non-possessory interest in its ROW.

III. Because municipalities have retained a superior non-possessory interest in their ROW, a municipal microgrid is outside of N.J.S.A. 48:3-77.1

Because municipalities have retained a superior non-possessory interest in their ROW, a municipal microgrid is outside the purview of N.J.S.A. 48:3-77. This statute is intended to regulate *private* generation facilities and *private* customers is obvious because N.J.S.A. 48:3-51 defines an "on-site generation facility" as a generation facility which sells energy to an end use customers separated by "an easement, public thoroughfare, transportation, or utility owned right of way." Because a municipality may construct a microgrid which is connected from an on-site generation facility, through its ROW, back to its own property, these properties are not separate. Therefore, a municipality is not an "end use thermal energy services customer" pursuant to N.J.S.A. 48:3-77.1.

IV. A utility's franchise rights are not violated if a municipality constructs a microgrid that only connect municipal buildings, and does not sell energy to current utility customers

The authority may be exercised without violating the franchise rights of incumbent utilities. Franchise rights protect incumbent utilities from competition, not from a municipality making use of its own ROW. A municipality may not create a duplicative system to compete with an incumbent utility. *See* IMO Petition of the Borough of Woodland Park Seeking a Declaration with Respect to Its Rights and Obligations to New Jersey American Water Company, Inc. BPU DKT. No. WO09020148.

In sum, if a municipality were to create a microgrid which connected only municipal facilities located on municipal properties, and does not provide service to current utility customers; the system is not duplicative and violative of a utility's franchise rights.

Very Truly Yours,

Edward Purcell Esq.

League Associate Counsel-Staff Attorney

Appendix E New Jersey DER and Microgrid Examples

New Jersey's Current DER Market

New Jersey has a significant number of currently operating microgrids. The majority of these are either single facility/building level 1 microgrids or campus-wide level 2 microgrids.

As of September 2016, the current New Jersey CHP and fuel cell report documents that 44 natural gas and 6 biomass NJCEP approved CHP projects can island and operate isolated from the local distribution systems to function as a microgrid.[120] This includes large MW-sized CHP projects at hospitals, pharmaceutical companies or college/universities to small kW sized micro-CHP at multi-family buildings, restaurants, supermarkets and secondary schools that can operate in island mode.

In Chart E-1 below, New Jersey has approximately 3, 000 MW of facilities that either have been defined or reported as CHP facilities. However, the majority of these sites would not be defined as DER. These larger non-DER facilities provide thermal energy to one customer and sell electricity on the wholesale market. In addition, some of the facilities classified as CHP only use thermal energy in a limited manner to preheat the combustion air or water for steam generation used in a turbine.

New Jersey has been over 380 MW CHP/FC projects installed in over 100 locations throughout the state that could be defined as DER. This includes both fossil fuel and renewably fueled CHP/FC. If you include the other Class I renewable facilities DER, there are over 59,105 DER facilities for over 1,900 MW. [121] The majority of the installed DER in New Jersey is solar. No

[120] http://www.njcleanenergy.com/commercial-industrial/programs/combined-heat-power/combined-heat-power

[121] The information in the table is pulled together from several database sources include EIA State generation sources, DOE CHP Technical Assistance Program and EPA CHP Partnership

single New Jersey DER program coordinates or tracks all the New Jersey DER projects and their performance.

Chart E-1 New Jersey CHP/FC and DER Facilities

DER	Number	MW
CHP/FC total	230	2,910
CHP/FC DER	**107**	**355**
CHP/FC RE DER	**21**	**31**
PV total - all DER	**59,105**	**1,535**
PV Behind the Meter	57,380	1,410
PV Grid Supply	146	445
TOTAL DER	**59,233**	**1,921**

programs as well as NJDEP air permit tracking system and NJBPU NJCEP CHP/FC and RE programs. New Jersey has no one source that reports all CHP/FC facilities.

Charts E-2, E-3 and E-4 below list all of the CHP and fuel cell projects, both natural gas powered and renewably fueled projects that were funded through the NJCEP since 2001 through present.[122] Of the total approved CHP projects, 47 of the 70, almost 70% of the CHP projects including both natural gas and renewably fueled projects have islanding capacities and can function as Level 1 or 2 microgrids.[123] The NJCEP program has funded 15 fuel cell projects for 6.1 MW of which 8 fuel cell projects for 1.5 MW were funded as renewable. [124] No fuel cell projects have islanding capabilities. In addition, 21 biomass CHP or Landfill gas projects for 40.7 MW were also approved as renewable projects. Six of the renewable energy projects including to landfill gas projects have islanding capabilities and can be classified as a level 1 microgrid. These lists do not include the several CHP facilities such as at The College of NJ (TCNJ), Rutgers and others that were operating before the NJCEP incentive program and that can operate in the island mode as a microgrid.

[122] Reported by TRC, EDA and Honeywell as the CHP/FC Projects that have been approved for an NJCEP CHP/FC incentive. Some projects may have ceased operations.

[123] This includes several biomass or renewably fueled CHP projects that the BPU or NJCEP has no information on their islanding capabilities. If just evaluating the natural gas CHP facilities this percentage of facilities with islanding or energy resiliency capabilities increases to 73%. (41 of 56)

[124] Per EDECA fuel cells were a Class I renewable which could generate RECs under the NJ RPS. The BPU clarified the definition of fuel cells in 2003 to require the fuel cell to be powered by a renewably fuel. See NJAC 14:8-2.5 – Energy that Qualifies for a Class I REC.

Chart E-2

CHP						
Applicant	**City**	**Facility Type**	**Year Applied**	**Service Territory**	**System Size (kW)**	**Capable of Operating Off the Grid**
Ortho-Clinical Diagnostics, Inc.	Raritan	Healthcare/Lab	2005	PSE&G	1,500	No response
Raritan Valley Community College	Somerville	College/Univeristy	2005	JCP&L	1,425	Yes
Rowan University	Glassboro	College/Univeristy	2005	ACE	4,700	Yes
Browertown Associates Inc., TIA	Hackensack	Healthcare/Data	2005	PSE&G	140	No
Regent Care Center, Inc.	Hackensack	Healthcare/Home	2005	PSE&G	140	No
Salem Community College	Carney's Point	College/Univeristy	2006	ACE	130	Yes
Johnson Matthey	West Deptford	Pharmaceutical	2006	PSE&G	200	Yes
E.R. Squibb and Sons/BMS	New Brunswick	Pharmaceutical	2006	PSE&G	2,000	Yes
Christian Health Care Center	Wyckoff	Healthcare/Home	2006	PSE&G	230	Yes
KPMG LLP	Montvale	Office	2006	RECO	796	Yes
Princeton University	Princeton	College/Univeristy	2006	PSE&G	486	Yes
Ortho McNeil Pharmaceuticals	Raritan	Pharmaceutical	2007	PSE&G	3,000	Yes
Jersey Shore University Medical	Neptune	Hospital	2007	JCP&L	1,900	Yes
Infineum USA LP	Linden	Manufacturing	2007	PSE&G	275	Yes
Overlook Hospital	Summit	Hospital	2010	JCP&L	2,000	Yes
Ocean County College	Toms River	College/Univeristy	2010	JCP&L	1,100	Yes
ACB Energy Partners LLC	Atlantic City	Hotel/Casino/Retail	2010	ACE	7,965	Yes
ACI Energy Partners LLC	Atlnatic City	Hotel/Casino/Retail	2010	ACE	7,965	Yes
DSM - Nutritional Products, Inc	White	Healthcare/Nutrition	2010	JCPL	9,500	No
RED-Burlington National Gypsum	Burlington	Manufacturing	2010	PSE&G	3,370	No
NRG Thermal LLC	Plainsboro	Energy	2010	PSE&G	4,600	Yes
St. Peter's College	Jersey City	College/Univeristy	2011	PSE&G	320	Yes
Newark Housing Authority	Newark	Multifamily	2011	PSE&G	75	No
Newark Housing Authority	Newark	Multifamily	2011	PSE&G	150	No
Newark Housing Authority	Newark	Multifamily	2011	PSE&G	150	No
Viking Yacht	New Gretna	Manufacturing	2012	ACE	390	No
Rider University	Lawrenceville	College/Univeristy	2012	PSE&G	1,100	Yes
Metro YMCAs of the Oranges	Wayne	Multipurpose	2012	PSE&G	150	No
Fellowship Village	Basking Ridge	Multifamily	2012	JCP&L	225	Yes
Bristol Myers Squibb	Pennington	Pharmaceutical	2012	PSE&G	4,110	Yes
Monmouth Medical Center	Long Branch	Hospital	2012	PSE&G	3,000	Cancelled
New CMC Inc	Toms River	Hospital	2012	PSE&G	3,000	Cancelled
UMM - Energy Partners LLC	Little Fall	College/Univeristy	2012	PSE&G	5,670	Yes
Douglas Electrical Components	Randolph	Manufacturing	2013	JCP&L	75	Yes
Steve & Cookies By the Bay	Margate City	Restaurant	2013	ACE	20	Yes
Rose Garden Nursing & Rehab Center	Toms River	Multifamily/Assisted	2013	JCP&L	75	No
St. Peter's College - Student Center	Jersey City	College/Univeristy	2013	PSE&G	160	Yes
Riviera Towers Corp.	West New York	Multifamily	2013	PSE&G	400	Yes
Hallmark Investments LLC	Newark	Multifamily	2013	PSE&G	100	Yes
Masonic Charity Foundation of NJ	Burlington	Multifamily/Assisted	2014	PSE&G	498	No
New Brunswick Board of Education - MS	New Brunswick	K-12	2014	PSE&G	75	Yes
New Brunswick Board of Education - CS	New Brunswick	K-12	2014	PSE&G	75	Yes
New Brunswick Board of Education - HS	New Brunswick	K-12	2014	PSE&G	100	Yes
Camden Tech School	City of Camden	K-12	2014	PSE&G	200	Yes
Green Hill, Inc	West Orange	Multifamily/Assisted	2014	PSE&G	75	No
Nicolas Market	North Haldon	Retail/Supermarket	2014	PSE&G	350	Yes
Westin-Jersey City Newport	Jersey City	Hotel/Casino/Retail	2014	PSE&G	300	Yes
Holiday Inn - Hunts Mill Assoc.	Clinton	Hotel/Casino/Retail	2014	JCP&L	100	Yes
Steven's Insitute of Technology	Hoboken	College/Univeristy	2014	PSE&G	100	Yes
Shop Rite of Toms River	Toms River	Retail/Supermarket	2015	JCP&L	450	Yes
Shop Rite of Oakland	Oakland	Retail/Supermarket	2015	PSE&G	450	Yes
Shop Rite of Burlington	Burlington	Retail/Supermarket	2015	PSE&G	450	Yes
Hillsborough BOE HS	Hillsborough	K-12	2015	PSE&G	100	Yes
Parsippany Hills HS	Parsippany	K-12	2015	PSE&G	100	Yes
Hillsborough BOE Middle School	Hillsborough	K-12	2015	PSE&G	100	Yes
JFK Rec Ctr City of Newark	Newark	Muni/Rec	2015	PSE&G	100	Yes
1415 Park Ave	Jersey City	Multifamily	2015	PSE&G	75	No
ShopRite of Hainesport (Eickhoff)	Hainesport	Retail/Supermarket	2015	PSE&G	450	Yes
ShopRite Rio Grande (Village Supermarket Inc)	Rio Grande	Retail/Supermarket	2015	PSE&G	450	Yes
Clement Pappas	Bridgeton	Manufacturing	2015	ACE	1,000	No
Middlesex High School	Middlesex	K-12	2015	PSE&G	75	No
Luteran Crossing	Moorsetown	Nursing Care Facility	2015	PSE&G	75	No
Readington Farm Inc	Whitehouse	Manufacturing	2015	PSE&G	1,200	Yes
Total					73,540	

Chart E-3

Fuel Cells						
Applicant	**City**	**Facility Type**	**Year Applied**	**Service Territory**	**System Size (kW)**	**Capable of Operating Off the Grid**
MERCK*	Rahway	Pharmaceutical	2002	PSE&G	200	No
RICHARD STOCKTON COLLEGE*	Pamona	College/Univeristy	2003	ACE	200	No
STARWOOD HOTELS AND RESORTS*	Parsippany	Hotel	2003	JCP&L	250	No
OCEAN COUNTY COMMUNITY COLLEGE	Toms River	College/Univeristy	2004	JCP&L	250	No
THE COLLEGE OF NEW JERSEY	Ewing	College/Univeristy	2006	PSE&G	200	No
THE COLLEGE OF NEW JERSEY	Ewing	College/Univeristy	2006	PSE&G	200	No
THE COLLEGE OF NEW JERSEY	Ewing	College/Univeristy	2006	PSE&G	200	No
RENEWABLE ENERGY HOLDINGS, LLC	West Amwell	Residential	2008	JCP&L	5	No
Verizon	Basking Ridge	Office/Datacenter	2013	PSE&G	2,000	No
AT&T - Freehold	Freehold	Office/Datacenter	2014	JCP&L	600	No
AT&T - Middletown	Middletown	Office/Datacenter	2014	JCP&L	1,000	No
AT&T - Middletown Phase II	Middletown	Office/Datacenter	2014	JCP&L	1,000	No
Walmart	Turnersville	Retail	2015	ACE	250	No
Walmart	Howell	Retail	2015	JCP&L	200	No
Walmart	Mays Landing	Retail	2015	ACE	200	No
Total					6,105	
* Currently not operating						

Chart E-4

Renewables						
Applicant	**City**	**Facility Type**	**Year Applied**	**Service Territory**	**System Size (kW)**	**Capable of Operating Off the Grid**
REX LUMBER	Manalapan	Millworks	2001	JCP&L	150	No
NJ ECO COMPLEX/RUTGERS	Florence	Research & Development	2002	PSE&G	120	No
SOUTH MONMOUTH REGIONAL SA	Belmar	Sewage Treatment Plant	2002	JCP&L	30	No
ALUMINUM SHAPES	Pennsauken	Manufacturing	2003	PSE&G	1,850	No
RAHWAY VWALLEY SEWERAGE AUTHORITY	Rahway	Sewage Treatment Plant	2003	PSE&G	6,000	Yes
JOINT MEETING OF ESSEX & UNION COUNTIES	Elizabeth	Sewage Treatment Plant	2005	PSE&G	3,240	Yes
ATLANTIC COUNTY UTILITIES AUTHORITY	Pleasantville	Landfill	2005	ACE	1,500	No
CAPE MAY COUNTY MUA	Woodbine	Landfill	2006	ACE	2,000	Yes
COUNTY OF MONMOUTH	Tinton Falls	Landfill	2006	JCP&L	1,000	Yes (partial)
LANDIS SEWERAGE AUTHORITY	Vineland	Sewage Treatment Plant	2006	Vineland	185	No
OCEAN COUNTY	Manchester	landfill	2006	JCP&L	9,600	Yes (but no load)
WARREN COUNTY	Oxford	Landfill	2006	JCP&L	3,800	No
BURLINGTON COUNTY	Florence	Landfill	2008	PSE&G	7,150	No
RUTGERS UNIVERSITY	Piscataway	Greenhouse	2008	PSE&G	250	No
SALEM COUNTY UA	Alloways	Landfill	2008	PSE&G	1,600	No
S. MONMOUTH REG. SA	Belmar	Sewage Treatment Plant	2009	JCP&L	280	No to be upgraded
RUTGERS UNIVERSITY DINING SERVICES	Piscataway	College/Univeristy	2012	PSE&G	10	No
VILLAGE OF RIDGEWOOD DPW	Ridgewood	Sewage Treatment Plant	2012	PSE&G	240	No
LIVINGSTON TWP WATER POLLUTION CF	Livingston	Sewage Treatment Plant	2012	PSE&G	150	Not operational
BERGEN COUNTY UTILITIES AUTHORITY	Little Ferry	Sewage Treatment Plant	2014	PSE&G	1,400	Yes
HANOVER SEWERAGE AUTHORITY	Hanover	Sewage Treatment Plant	2015	JCP&L	100	No
Total					40,655	
TOTAL					120,300	

Chart E-5 below is the cumulative and annual installation summary of all the NJBPU CHP and fuel cell program results.

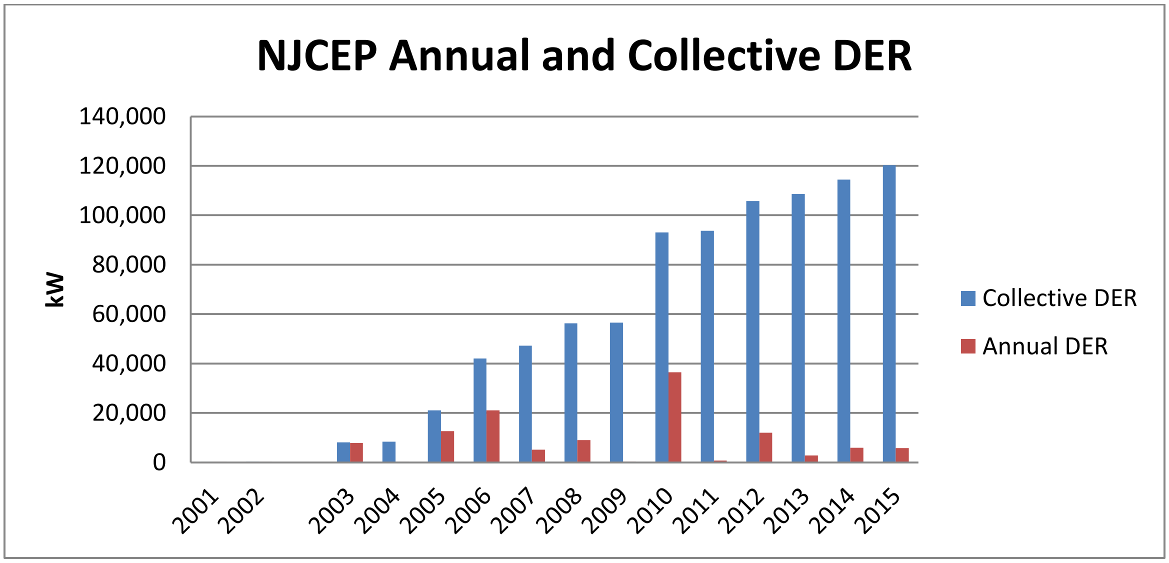
New Jersey had several programs that supported DER microgrids including:[125]

1. NJCEP small-scale and large-scale CHP and Fuel cells program is a Commercial and Industrial EE program that provides between 30 to 60% of the project costs at between \$0.35 to \$4.00 per watt up to a cap between \$2 to \$3 million depending on the DER technology and size.
2. NJCEP Biopower program is a renewable energy program that is currently a competitive solicitation.
3. NJCEP Energy Storage program is a renewable energy program that is currently a competitive solicitation.
4. Energy Resilience Bank is an EDA program that provides grants and low interest loans for DER technologies including CHP, fuel cells and battery storage.
5. Energy Saving Improvement Program is a BPU program that provides a mechanism for local government to finance energy conservation measures
6. PSE&G Energy Efficiency Economic (E3) program provides zero interest financing for hospital CHP projects

The above incentive programs listed in items 1, 2, 3, are now all consolidated under one NJCEP incentive program under DER incentives.

[125] With the award of the new Program Administrator, AEG and their subcontractor ICF, for the NJCEP the CHP/FC will undergo refinement of the overall program and as such incentive levels may be revised.

Chart E-5



USDOE MOUs to Support Developing New Jersey Advanced Microgrid for Resiliency

In 2013, the BPU with the USDOE entered into two Memorandums of Understanding (MOUs) with:

1. NJ Transit; and
2. City of Hoboken and PSE&G.

These MOUs were established to evaluate the potential to develop microgrids within:

1. The northeast portion of the NJ Transit system; and
2. PSE&G service area in the City of Hoboken.

The USDOE provided funding directly to Sandia National Energy Lab to utilize the microgrid model developed by Sandia called the Energy Surety Design Methodology (ESDM) in a preliminary analysis of both the Hoboken and NJ Transit advanced microgrid projects. ESDM is a risk-based assessment approach to help communities evaluate regional and critical energy needs to identify and optimize solutions that include DER.

The ESDM modeling that Sandia performed has previously been on energy systems on military bases to improve their energy resiliency in times of emergencies. This is the first expansion of the ESDM tool in non-military applications for microgrids. Sandia developed feasibility studies for both the NJ Transit Grid and Hoboken advanced microgrid projects.[126]

The evaluation for Hoboken and NJ Transit included optimizing the smart design approaches to enable the energy systems to operate grid-connected or to island as a microgrid. The key focus of the Sandia evaluation is to improve the resiliency of the PSE&G service area in Hoboken and of a portion of the NJ Transit northeast corridor energy system in times of emergencies when the grid is down.

The BPU's responsibilities set forth in the MOUs are to provide technical assistance to DOE, Sandia, Hoboken and NJ Transit. The NJ Transit Grid submitted a proposal to the Federal Transit Administration (FTA) in response to a FTA funded competitive grant solicitation. The Proposal was selected for funding by the FTA along with several other NJ Transit projects. NJ Transit was awarded $410 million for their Transit Grid project. This is the first of its kind in the country. NJ Transit is proceeding with the development and issuance of 2 RFPs for project development and implementation; one is for the central plant for traction power, and the second is for the DER technologies at several transit stations.

Subsequently in 2015, Hoboken worked with the Rocky Mountain Institute's (RMI) e-Lab program to accelerate their advanced microgrid project. Through the RMI e-Lab program Hoboken developed a straw proposal for development of the project for consideration by the MOU participants.[127]

NJIT Town Center Microgrids Report

The BPU, through the NJ Energy Resilience Bank, engaged the New Jersey Institute of Technology (NJIT) and the Regional Planning Association (RPA) to map town centers that could be potential microgrids.[128] The mapping was limited to the nine FEMA designated Sandy impacted counties and was designed to be a first cut screening tool to identify municipalities that have a number of critical facilities in close proximity that are good candidates for DER microgrid technologies. The findings in the *New Jersey Town Centers Distributed Energy Resource Microgrid Potential Report GIS Analysis* and Technical memo dated October 2014 are incorporated by reference into this report and are available at www.bpu/reports.

The NJIT Report mapped 27 potential town center microgrids in 19 municipalities in the nine FEMA Superstorm Sandy designated counties. The report describes the process used by NJIT

[126] http://www.hobokennj.org/washingtonstreet/files/hoboken-microgrid-report.pdf and http://www.njtransit.com/tm/tm_servlet.srv?hdnPageAction=PressReleaseTo&PRESS_RELEASE_ID=2884
[127] http://www.rmi.org/elab_accelerator_2015_hoboken_microgrid_development
[128] BPU Order moving the ERB to the EDA and not jointly BPU and EDA Need cite

and RPA to identify the 27 potential Town Centers and provides a chapter on each County mapping the potential Town Centers in that county.

The USDOE provided both NJ Transit Grid and Hoboken advanced microgrid projects with grant funds and technical support through Sandia National Laboratory to develop a feasibility study for each project. However, the upfront cost for the development of an advanced microgrid feasibility study is a barrier to municipalities and other critical facilities. In order to reduce this barrier, New Jersey has developed an advanced microgrid feasibility grant program similar to the programs in New York, California and Connecticut to assist in the upfront project development costs.

District Thermal Energy Facilities as Advanced Microgrid Pilots

The Trenton District Energy Complex facility and the Atlantic City Mid-Town Thermal Energy facility provide thermal energy to multiple customers and cross multiple rights of ways (ROW). The customers of these on-site generators are defined as off-site end use thermal energy service customers. Both these facilities could extend electric services to contiguous customers in their area. In the case of the Trenton District Energy Company, it would consist of several state offices and a hotel and conference hall in the area. For the Mid-Town Thermal facility, it would consist of a hospital, several stores, and casinos/hotels in the area.

In addition to the on-site generation, the two district-wide thermal plants in Trenton and Atlantic City could be developed as pilot programs to provide electricity to the buildings they were supplying thermal energy to. They could then operate in emergency situations. The electricity from these plants would flow through the existing infrastructure to off-site thermal customers.

Appendix F Examples of other states

California

The California Public Utility Commission (CAPUC) staff released *Microgrids: A Regulatory Policy* on April 14, 2014. The report is a white paper on issues related to microgrids in California. The California Energy Commissioner in July 2014 issued an RFP to fund the development of microgrids for critical facilities.

The CAPUC opened a rulemaking to investigate the equity of the current rate design and whether an alternative rate design is more appropriate.[129] The CAPUC has opened a DER proceeding termed their Integrated Distributed Energy Resource (IDER) proceeding.[130] Per California statute, DER is defined as distributed renewable generation resources, energy efficiency, energy storage, electric vehicles, and demand response technologies. The CAPUC has developed a methodology for the utilities to optimize the location of DER on their system called Integrated Capacity Analysis (ICP). The CAPUC required a DER Plan be submitted by their utilities. The DER plans were filed on July 1, 2015 termed their Demonstration Projects. The CAPUC also developed a goal and program for energy storage procurement. The storage goals are highlighted in the CAPUC Smart Grid report on grid modernization.

The Utility DER plan filings are currently under review by the CAPUC. In November 2015 the CAPUC issued its Distribution Resources Plan (DRP) Roadmap and Straw Proposal. The DRP Roadmap and Straw Proposal is intended to serve as a starting point for a broader effort to integrate planning efforts in several open proceedings including the IDER proceeding. The Roadmap lists staff's recommendations for the timing and scope of potential decisions in the DRP proceedings.

In November 2015, under the DER proceeding the CAPUC held several workshops on their proposed ICA and Demonstration Project. The objective of the workshops is to provide the utilities the opportunity to address questions on their ICA evaluations and Demonstration Projects. The utility's ICA and Demonstration Projects will establish and detail how much DER can be developed on the utility's system under business as usual (BAU) conditions. In addition, it will build a portfolio of DER alternatives to traditional grid infrastructure and improve the efficiency of the interconnection process for DER. The outcome of the ICA and demonstration Project workshop will be a report issued by the utilities.

[129] Details of the CAPUC rulemaking can be found at http://delaps1.cpuc.ca.gov/CPUCProceedingLookup/f?p=401:56:16696140068869::NO:RP,57,RIR:P5_PROCEEDING_SELECT:R1408013

[130] Details of the CAPUC IDER proceeding can be found at http://www.cpuc.ca.gov/General.aspx?id=5071.

Connecticut

In response to Superstorm Sandy, Connecticut (CT) enacted PA 12-148 – An Act Enhancing Emergency Preparedness and Response. One of the provisions of the Act required the Department of Energy and Environmental Protection (DEEP) to establish a microgrid pilot program. The Pilot Program is developing sixty five (65) MW of microgrid at critical facilities. With this law, Connecticut is among the first states to define microgrids. The grant and loan program has provided funding to nine (9) of thirty six (36) proposals in Round 1 (municipal microgrids) and two (2) in Round 2 (non-municipal microgrids). [131]

Twenty seven (27) of the thirty six (36) projects that submitted feasibility study proposals in Round 1 were assessed by CT DEEP and the local electric distribution company. The twenty seven (27) projects were moved to the final round of assessment. The EDC will enter into a Standard Operating agreement with each approved microgrid that defines the roles and responsibilities of each for installation, operation and maintenance. The CT Green Bank, formerly the CT Clean Energy Finance and Investment Authority (CEFIA), will fund the twenty seven (27) project feasibility studies. The CT Green Bank will ultimately finance the microgrid projects. In 2011, CT shifted its Clean Energy incentive and rebate programs to a financing program under the Green Bank.

In December 2015 the CT DEEP opened the 3rd round of its microgrid incentive program. The budget for the 3rd round is up to $30 million with $20 million for municipal projects. Awarded projects have 36 months to construct after a contract is executed. Currently 3 of the 1st round projects are operational and located at Wesleyan University, the town of Fairfield and the University of Hartford. Both the Wesleyan and Hartford projects would be classified as Campus or a Level 2 microgrids. The Fairfield microgrid enhances the municipality's emergency generators.

Maryland

On February 25, 2014 Maryland (MD) issued a report on microgrids entitled, *Resiliency Through Microgrids Task Force Report*.[132] MD Public Service Commission (PSC) and Energy Administration (EA) has a robust program that supports and encourages CHP projects, many of which operate as microgrids. The MD report addressed what it termed "public purpose microgrids." Public purpose microgrids connect multiple customers over multiple properties and across public rights of way with a discrete public purpose. The MD Report focuses on the deployment of utility owned public purpose microgrids through advocacy and incentives. The report recommends a pilot process that would serve as a model for future deployment and

[131] Details of the CT DEEP microgrid program can be found at http://www.ct.gov/deep/cwp/view.asp?a=4405&Q=508780.

[132] See http://energy.maryland.gov/documents/marylandresiliencythroughmicrogridstaskforcereport_000.pdf

recognizes the paradigm shift in the current utility regulatory compact. The report recommends that EDCs incorporate public purpose microgrids into their existing grid upgrade planning processes. The report recommends that the MD PSC and EA review the EDC's interconnection, tariff and planning process to assist in enhancing microgrids.

On March 15, 2013, Maryland's Energy Future's Coalition issued a final report entitled, *Utility 2.0 – Piloting the Future for Maryland's Electric Utilities and their Customers.*[133] The report highlighted the need to optimize automated systems for sectionalizing and reclosing for reliability and resiliency, including facilitating the development of microgrids.

In December 2015 Maryland Clean Energy Center issued its *Green Bank Study – Final Report* to the Maryland General Assembly. The Green Bank Report recommends the establishment of a Green Bank to assist in the development of clean energy investments in Maryland, including microgrids.

Massachusetts

The Massachusetts (MA) Department of Public Utilities (DPU) is addressing microgrid issues through their Grid Modernization process.[134] In the MA DPU Grid Modernization Work Group Process Report dated July 2, 2013, MA identified microgrid controls and integrated distributed generation as a key component to assist in upgrading the changing grid.

In February 2014 the MA Clean Energy Center funded a microgrid study performed by KEMA to promote and advance the development of microgrids entitled: *Microgrids –Benefits, Models, Barriers and Suggested Policy Initiatives for the Commonwealth of Massachusetts.*[135] The objective of the study was to evaluate several different microgrid business models in terms of their overall direct and indirect costs and benefits.

As part of the grid modernization upgrade, the MA Department of Energy Resources (DOER) has issued a $40 million Community Clean Energy Resiliency Initiative grant program using their RGGI and Clean Energy funds to focus on municipal resilience that uses clean energy solutions to protect communities from interruptions in energy services due to severe climate events.[136] In September of 2014, the MA DOER made 6 awards for over $7 million. The projects include battery storage, solar, diesel generators, biogas and CHP. Of the 6 projects 4 are Level 1 microgrids in single buildings and 2 can be classified as Level 3 advanced or multiple building microgrids.

---

[133] http://cleanenergytransmission.org/uploads/Utility%202-0%20Pilot%20Project-reduced.pdf
[134] http://www.mass.gov/eea/energy-utilities-clean-tech/electric-power/grid-mod/grid-modernization.html
[135] http://www.masscec.com/microgrids-%E2%80%93-benefits-models-barriers-and-suggested-policy-initiatives-commonwealth-massachusetts
[136] Details of the MA program can be found at http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/resiliency/resiliency-initiative.html

In January 2015 the MA DOER awarded over $18 million to 15 projects that include wastewater treatment facilities, hospitals, community centers, fire/police stations, and community schools. The technologies include CHP, solar with battery storage and backup diesel generators. Of the 15 projects 13 are Level 1 single building microgrids and 2 could be classified as advanced or multiple building microgrids.

In addition to the grant awards in their Community Clean Energy Resiliency Program, the MA DOER provided technical assistance in evaluating the potential to develop a microgrid in 27 municipalities. This technical assistance was provided through Cadmus Consulting.

New York

The New York State Energy Research and Development Authority (NYSERDA) in its report, *Microgrids: An Assessment of the Value, Opportunities, and Barriers to the Deployment in New York State (NYS)* dated September 2010, defined microgrid ownership models and regulatory barriers as well as the overall value stream and costs. The NYSERDA report established a roadmap for NYS to develop microgrids with a series of recommendations.

On April 25, 2014, The NYS Department of Public Service (NYSDPS) issued its procedural Order establishing the Reforming the Vision (REV) process. The initial NYS DPS Order set out 6 objectives for the REV process: enhance customer knowledge of their energy bills; enhance market issues to leverage ratepayer's contribution; enhance system efficiency; enhance fuel and resource diversity; improve system reliability; and reduce carbon emissions.

The initial procedural REV Order was based upon the NYS DPS staff report dated April 24, 2014. The REV staff report was directed by the DPS Commissioners in their Energy Efficiency Portfolio Standard (EEPS) Order dated December 26, 2013. The REV Staff report was developed to answer the question of what changes should be made in the current regulatory, tariff, market design, and incentive structure in NY to better align utility interests with achieving the State's energy policies. The Staff REV report recommended a proposed platform to transform the NYS electric industry for both the regulated and un-regulated participants. The Staff report cited that the energy industry is on the verge of a change.

On December 2014 NYSERDA issued its report to the NYS Legislature on Microgrids for Critical Facility Resiliency – report# 14-36.[137] The objective of the report was to assess the practical feasibility of establishing microgrids to enhance resiliency of facilities that provide public safety, health and security support when the grid is down. The major findings were under most situations under current regulatory structures microgrids for critical infrastructure is usually not feasible or cost as effective as a backup system. The cost effectiveness improves if the facility is operated more frequently rather than just as a backup. There is a lack of information

[137] http://www.nyserda.ny.gov/About/Publications/Research-and-Development-Technical-Reports/Electric-Power-Transmission-and-Distribution-Reports

on developing microgrids and local governments have constraints and implements to implementing microgrids without funding support.

The following is a summary of some of the key REV documents to date. A detail list of the REV Order, Rulings, Notices, DPS Staff Reports can be found at; http://www3.dps.ny.gov/

On August 22, 2014 the NYS DPS issued its Staff Straw Proposal. The straw proposal recommended increasing the use and coordination of DER through markets operated by Distribution Service Platform Providers (DSP). The straw proposal set forth critical path objectives and findings. This Straw Proposal focused on the near term issues as opposed to the April staff report and Order which established long term visions.

On February 12, 2015 NYSERDA issued its RFP for community microgrids for Stage 1 feasibility assessments. The stage 1 feasibility assessments will be followed by a stage 2 audit grade engineering financial and business plan and a stage 3 microgrid build-out. The total budget is up to $40 million and the cap on the stage 1 funding is $100,000 for each feasibility assessment.

On February 27, 2015 the NYS DPS issued its Order adopting the regulatory policy framework and implementation plan for REV called the Track I Order. The Track I Order sets forth the challenges facing NYS and the energy industry including aging infrastructure, declining system efficiencies, and flat energy sales growth which imply cost increases under business-as-usual approaches. The Track I Order cited the trend towards self-generation that increases these challenges and required each utility as the Distributed System Platform (DSP) provider to file a Distributed System Implementation Plan (DISP).

On July 1, 2015 the DPS staff issued its white paper on the Benefit-Cost Analysis Framework. On Oct 15, 2015, the DPS adopted the Framework in an Order. This Order required each utility to file a Benefit-Cost Handbooks by June 30, 2016.

On August 17, 2015 the Market Design and Platform Technology Working Group (MDPT) issued its report on market design recommendations under the Track I Order for the NYS DPS's consideration in the development of its guidance. The key recommendation was that the DSP market structures should complement and not duplicate the existing markets at the NY ISO. [138] It also called for enhancements in the traditional distribution planning process to better integrate DERs into the system.

On October 15, 2015 the NYS DPS staff issued its guidance for the DISP for both a Phase I self-assessment due from each utility by June 30, 2016 and Phase 2 supplement DISP to be filed jointly by all the utilities on the tools needed to modernize the grid due by September 1, 2016.

[138] The NY ISO only serves New York unlike PJM that serves 13 states including NJ.

In its January 21, 2016 Order the NYS DPS approved a ten year $5.322 billion Clean Energy Fund (CEF) as a commitment to clean energy programs in New York State to be managed by NYSERDA under the NYS DPS supervision. The Order also set the ten year goals for the program.

These states, and others, are seeing clean energy technology availability increase, and associated cost decrease, such that there is a growing need to change the current utility regulatory structure that manages energy infrastructure. Without changing the energy regulatory structure, New Jersey could be trying to pay for a landline infrastructure in a cell phone world. An available option could be to determine that there will be no advanced microgrids in New Jersey. But given the cost trends and technology advances, that is not a realistic approach.

The customer's perspective is also changing. There is a segment of the population that no longer has a landline and just uses a cellphone or other mobile devices. This same segment most likely has a mobile hot spot or Wi-Fi connection that provides their news and entertainment. Their computer system is not a desktop tied to a cable modem but a mobile pad linked to a mobile hotspot. This energy utility customer will want to have their service provided in a different manner than the current one way communication by a centralized transmission/distribution grid.

If the USDOE cost and efficiency targets for DER are achieved or even partially achieved in the near future, the current utility grid model will not be able to adequately respond to the requests by customers to be 'disconnected' from the grid. It is better to help shape this change and what the future utility model should be in a more DER centric model as opposed to having to manage that utility business model in the middle of the actual change.

National and International Examples of Microgrids

The following is a list of microgrid projects across the world from the Lawrence Berkeley Lab (LBL) Microgrid website:[139] The majority of these microgrids are US military bases, remote setting such as island community or campus/university complexes.

- Fort Carson
- Mesa del Sol
- Santa Rita Jail
- Sendai Microgrid
- Huatacondo
- Hartley Bay

[139] at https://building-microgrid.lbl.gov/examples-microgrids The LBL microgrid project reports are linked to each project in the BPU on-line report

- New York University
- Borrego Springs
- Fort Collins
- Isle of Eigg
- Illinois Institute of Technology
- UCSD
- Hachinohe
- Bornholm Island
- Kythnos Island
- Mannheim-Wallstadt
- Tecnalia Microgrid Laboratory
- Hangzhou Dianzi University

References

Ameren Illinois. *Ameren Illinois Advanced Metering Infrastructure (AMI) Plan.* June 28, 2012.

Anderson, Robert W., et al. *Distributed Energy Resources Integration. Summarizing the Challenges and Barriers*. Olivine, Inc. January 24, 2014.

Annaswamy, Anuradha M., et al. *IEEE Vision for Smart Grid Controls: 2030 and Beyond.* IEEE Smart Grid Research. IEEE Standards Association. 2013.

Basso, Thomas. *IEEE 1547 and 2030 Standards for Distributed Energy Resources Interconnection and Interoperability with the Electricity Grid.* National Renewable Energy Laboratory. December 2014.

Basso, Thomas & DeBlasio, Richard. *IEEE Smart Grid Series of Standards IEEE 2030 (Interoperability) and IEEE 1547 (Interconnection) Status.* National Renewable Energy Laboratory. Conference Paper. NREL-CP-5500-53028. April 2012. Presented at Grid-Interop 2011, Phoenix, Arizona. December 5-8, 2011.

Beck. R.W. *Distributed Energy Resiliency Study.* Final Report. Prepared for the Oregon Department of Energy. June 29, 2011.

Belden, Andrew, et al. *Powering the Future of Health Care. Financial and Operational Resilience: A Combined Heat and Power Guide for Massachusetts Hospital Decision Makers*. 2013.

Black & Veatch. *Biennial Report on Impacts of Distributed Generation.* Final Report. Prepared in Compliance with AB 578 – with Data through 2011 and Selected 2012 Data. Prepared for California Public Utilities Commission. March 18, 2013.

Bloomberg New Energy Finance & The Business Council for Sustainable Energy. *2015 Factbook. Sustainable Energy in America.* February 2015.

Bourgeois, Tom. *Overview of Issues Pertaining to Combined Heat and Power (CHP) Systems in Hospitals.* Northeast Combined Heat and Power Application Center. Prepared for US EPA CHP Partnership “CHP for Hospitals / Health Care Facilities” Webinar on December 18, 2008.

Brown, Austin, et al. *Estimating Renewable Energy Economic Potential in the United States: Methodology and Initial Results.* National Renewable Energy Laboratory. Technical Report. NREL/TP-6A20-64503. July 2015.

Brubaker & Associates, Inc. and the Regulatory Assistance Project. *Standby Rates for Combined Heat and Power Systems: Economic Analysis and Recommendations for Five States.* Prepared for Oak Ridge National Laboratory. ORNL/TM-2013/583.

Burlingame, Mark & Walton, Patty. *NARUC and MDPSC Cost-Benefit Analysis of Various Electric Reliability Improvement Projects from the End Users' Perspective.* Analysis Summary. November 15, 2013.

CH2M Hill. *Final Report. Integration of Solar Energy in Emergency Planning.* Prepared for New York City Office of Emergency Management. April 2009.

Chittum, Anna & Farley, Kate. *Utilities and the CHP Value Proposition.* Report Number IE134. July 2013.

Chittum, Anna & Kaufman, Nate. *Challenges Facing Combined Heat and Power Today: A State-by-State Assessment.* Report Number IE111. September 2011.

Chittum, Anna & Sullivan, Terry. *Coal Retirements and the CHP Investment Opportunity.* Report Number IE123. September 2012.

Clean Energy Group. *Resilient Power. Evolution of a New Clean Energy Strategy to Meet Severe Weather Threats.* September 2014.

Clean Energy States Alliance; Project Management and Plan Development, Northeast Electrochemical Energy Storage Cluster; U.S. Department of Energy; U.S. Small Business Administration. *Hydrogen and Fuel Cell Development Plan. New Jersey.* Preliminary, March 13, 2012.

ConEdison Solutions. *Combined Heat and Power. How Building Owners can Reap Financial, Environmental, and Resiliency Benefits with Reduced Grid Dependence*. 2014.

Day, Richard F., P.E. *Smart Grid and Advanced Distribution Automation. How Advanced Distribution Automation can become a Reality for any Utility.* A TRC White Paper. November 14, 2013.

Denholm, Paul, et al. *Methods for Analyzing the Benefits and Costs of Distributed Photovoltaic Generation to the U.S. Electric Utility System.* National Renewable Energy Laboratory. Technical Report. NREL/TP-6A20-62447. September 2014.

Eastern Research Group, Inc. and Resource Dynamics Corporation. *Opportunities for Combined Heat and Power at Wastewater Treatment Facilities: Market Analysis and Lessons from the Field.* Prepared for the U.S. Environmental Protection Agency, Combined Heat and Power Partnership. October 2011.

Edison Electric Institute. *Before and After the Storm. A compilation of recent studies, programs, and policies related to storm hardening and resiliency.* Update. March 2014.

Edison Foundation Institute for Electric Innovation. *Utility-Scale Smart Meter Deployments: Building Block of the Evolving Power Grid.* September 2014.

Electric Power Research Institute. *Assessment of California CHP Market and Policy Options for Increased Penetration*. Draft Consultant Report. Prepared for California Energy Commission, Public interest Energy Research Program. April 2005.

Electric Power Research Institute. *EPRI Smart Grid Demonstration Initiative, 4 Year Update, Case Study Brief.*

Electric Power Research Institute. *Estimating the Costs and Benefits of the Smart Grid. A Preliminary Estimate of the Investment Requirements and the Resultant Benefits of a Fully Functioning Smart Grid.* 2011 Technical Report.

Electric Power Research Institute. *Grid Interactive Microgrid Controllers and the Management of Aggregated Distributed Energy Resources (DER), Relationship of Microgrid Controller with Distributed Energy Resource Management System (DERMS) and Utility Distributed Management System (DMS).* 2015 Technical Report.

Electric Power Research Institute. *Guidebook for Cost/Benefit Analysis of Smart Grid Demonstration Projects.* Revision 1, Measuring Impacts and Monetizing Benefits. 1025734

Electric Power Research Institute. *Guidebook for Cost/Benefit Analysis of Smart Grid Demonstration Projects.* Revision 3. 3002006694.

Electric Power Research Institute. *The Integrated Grid, Phase II: Development of a Benefit-Cost Framework.* May 2014.

Electric System Reliability Indices. IEEE. P1366.

Ellis, Abraham, et al. *NJ TransitGrid Feasibility Study.* Prepared by Sandia National Laboratories. Sandia Report. SAND2014-1100. Printed February 2014.

Executive Office of the President. National Science and Technology Council. *A Policy Framework for the 21st Century Grid: Enabling Our Secure Energy Future.* June 2011.

Faruqui, Ahmad, et al. *Impact Evaluation of Ontario's Time-of-Use Rates: First Year Analysis.* Prepared by The Brattle Group, Mountain Economic Consulting and Associates, Inc., and eMeter, a Siemens Company. Prepared for Ontario Power Authority. November 26, 2013.

Federal Energy Regulatory Commission. *Assessment of Demand Response & Advanced Metering.* Staff Report. Docket Number: AD-06-2-000. August 2006.

Federal Energy Regulatory Commission. *Smart Grid Policy.* Docket No. PL09-4-000. Issued March 19, 2009.

Fox-Penner, Peter & Zarakas, William P. *Analysis of Benefits: PSE&G's Energy Strong Program.* Study performed on behalf of PSE&G. October 7, 2013.

Friedman, Julia & Otto, Garth. *Combined Heat and Power: A Resource Guide for State Energy Officials.* National Association of State Energy Officials. 2013.

Fuel Cells 2000. *State of the States: Fuel Cells in America*. June 2011.

Gagnon, Pieter, et al. *Rooftop Solar Photovoltaic Technical Potential in the United States: A Detailed Assessment.* National Renewable Energy Laboratory. Technical Report. NREL/TP-6A20-65298. January 2016.

Gilbert, Stanley W., et al. *Community Resilience Economic Decision Guide for Buildings and Infrastructure Systems.* National Institute of Standards and Technology Special Publication 1197. December 2015.

Goodman, F. *Technical and System Requirements for Advanced Distribution Automation.* Electric Power Research Institute, Inc. Final Report, June 2004.

Gowrishankar, Vignesh, et al. *Combined Heat and Power Systems: Improving the Energy Efficiency of Our Manufacturing Plants, Buildings, and Other Facilities*. NRDC Issues Paper. April 2013.

GridWise Alliance/Smart Grid Policy Center. *2013 Grid Modernization Index (GMI).* July 2013.

GridWise Alliance/Smart Grid Policy Center. *2014 Grid Modernization Index (GMI).* November 17, 2014.

Groberg, Robert, et al. *Promoting Combined Heat and Power (CHP) for Multifamily Properties.* 2008 ACEEE Summer Study on Energy Efficiency in Buildings.

Guttromson, Ross, et al. *City of Hoboken Microgrid Draft Design Meeting.* Sandia National Laboratories. January 22, 2014.

Hadley, Stanton W. & Sanstad, Alan H. *Impacts of Demand-Side Resources on Electric Transmission Planning.* Oak Ridge National Laboratory. January 2015.

Hampton, Anne, et al. *Combined Heat and Power: Enabling Resilient Energy Infrastructure for Critical Facilities.* ICF International. Prepared for Oak Ridge National Laboratory. March 2013.

Hand, M.M., et al. *Renewable Electricity Futures Study.* Executive Summary. National Renewable Energy Laboratory. 2012.

Harvard Law School, Emmett Environmental law & Policy Clinic. *Massachusetts Microgrids: Overcoming Legal Obstacles.* September 2014.

Hedman, Bruce, et al. *The Opportunity for CHP in the United States.* Prepared by ICF International for American Gas Association. May 2013.

Industrial Economics, Incorporated. *NY Prize. Assessing the Benefits and Costs of Developing a Microgrid: Model User's Guide*. March 2015.

John Nimmons & Associates, Inc., et al. *A Framework for Developing Collaborative DER Programs: Working Tools for Stakeholders.* December 2003.

Kind, Peter. *Disruptive Challenges: Financial Implications and Strategic Responses to a Changing Retail Electric Business.* Prepared by Energy Infrastructure Advocates. Prepared for Edison Electric Institute. January 2013.

Lazard. *Lazard's Levelized Cost of Energy Analysis—Version 8.0.* September 2014.

Lazard. *Lazard's Levelized Cost of Energy Analysis—Version 9.0.* November 2015.

Lee, Michael, et al. *Assessment of Demand Response & Advanced Metering Staff Report.* FERC. December 2014.

Linvill, Carl, Shenot, John & Lazar, Jim. *Designing Distributed Generation Tariffs Well. Fair Compensation in a Time of Transition.* The Regulatory Assistance Project. November 2013.

Livingston, O.V., et al. *Building Energy Codes Program: National Benefits Assessment, 1992-2040.* March 2014. Prepared for the U.S. Department of Energy by Pacific Northwest National Laboratory. PNNL-22610 Rev 1.

Maryland. Resilience through Microgrids Task Force Report.

McGuire Woods LLP and McGuire Woods Consulting. *District Energy Systems: An Analysis of Virginia Law.* Prepared for the Northern Virginia Regional Commission. August 2011.

Memorandum of Understanding Between and Among Department of Energy – Office of Electricity Delivery & Energy Reliability, New Jersey Board of Public Utilities, Public Service Electric & Gas Company, and the City of Hoboken, New Jersey. Subject: *Enhancing Electric Power Resiliency Using Advanced System Designs.* June 13, 2013.

Midwest CHP Application Center. *Combined Heat & Power (CHP) Resource Guide for Hospital Applications.* 2007.

Migden-Ostrander, Janine & Shenot, John. *Designing Tariffs for Distributed Generation Customers.* The Regulatory Assistance Project. February 2016.

National Institute of Standards and Technology, U.S. Department of Commerce. *NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0.* NIST Special Publication 1108. January 2010.

National Institute of Standards and Technology, U.S. Department of Commerce. *NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 2.0.* NIST Special Publication 1108R2. February 2012.

National Institute of Standards and Technology, U.S. Department of Commerce. *NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 3.0.* NIST Special Publication 1108r3. September 2014.

Navigant Consulting, Inc. *The Value of Distribution Automation.* Pier Final Project Report. Prepared for California Energy Commission, Public Interest Energy Research Program. March 2009.

New Jersey Board of Public Utilities & New Jersey Department of Environmental Protection. *New Jersey Energy Master Plan Update.* December 2015.

New Jersey Department of Environmental Protection. *Building a Robust and Resilient New Jersey*.

NJIT. *New Jersey Town Centers Distributed Energy Resource Microgrids Potential: Statewide Geographic Information Systems Analysis.* Technical Report. October 2014.

NJIT. *New Jersey Town Centers Distributed Energy Resource Microgrids Potential: Statewide Geographic Information Systems Assessment.* October 2014.

NYS 2100 Commission. *Recommendations to Improve the Strength and Resilience of the Empire State's Infrastructure.*

NYSERDA CHP Systems Manual. Updated October 2010.

Olinsky-Paul, Todd. *Using State RPSs to Promote Resilient Power at Critical Infrastructure Facilities.* Clean Energy States Alliance. May 2013.

O'Malley, Office of Governor Martin. *Weathering the Storm, Report of the Grid Resiliency Task Force.* Executive Order 01.01.2012.15. September 24, 2012.

Perfect Power Institute. *Investing in Grid Modernization: The Business Case for Empowering Consumers, Communities and Utilities.* February 2013.

PJM Manual 14A. *Generation and Transmission Interconnection Process.* Revision 14. Effective Date February 1, 2013. Prepared by Planning Division, Generation Interconnection Department.

Regional Economic Models, Inc. *Measuring the Economic Impact of Improved Electricity Distribution in Connecticut*. Exhibit P-21. Prepared for Connecticut Light & Power. July 2007.

Sanders, Robert G. & Milford, Lewis. *Clean Energy for Resilient Communities: Expanding Solar Generation in Baltimore's Low-Income Neighborhoods.* Report Prepared for The Abell Foundation by Clean Energy Group. February 2014.

Shipley, Anna, et al. *Combined Heat and Power. Effective Energy Solutions for a Sustainable Future.* Prepared by Oak Ridge National Laboratory, managed by Ut-Battelle, LLC, for the U.S. Department of Energy. December 1, 2008.

Stadler, Michael, et al. *Value Streams in Microgrids: A literature Review.* Lawrence Berkeley National Laboratory. LBNL-1003608. To be published in Applied Energy October 2015.

Stamp, Jason, et al. *City of Hoboken Energy Surety Analysis: Preliminary Design Summary.* Sandia Report. SAND2014-17842. Printed September 18, 2014.

Stanton, Tom. *Getting the Signals Straight: Modeling, Planning, and Implementing Non-Transmission Alternatives.* NRRI Report No. 15-02, for EISPC and NARUC. February 2015.

State and Local Energy Efficiency Action Network. *Guide to the Successful Implementation of State Combined Heat and Power Policies*. March 2013.

State of New Jersey Energy Assurance Plan. Draft September 25, 2012.

Stevie, Richard, et al. *Estimating the Value of Service Using Load Forecasting Models.* Presented at the May 2014 Eastern Conference—Center for Research in Regulated Industries.

Sullivan, Michael J., Ph.D., Mercurio, Matthew, Ph.D., Schellenberg, Josh, M.A., Freeman, Sullivan & Co. *Estimated Value of Service Reliability for Electric Utility Customers in the United States.* Ernest Orlando Lawrence Berkeley National Laboratory. LBNL-2132E. Prepared for Office of Electricity Delivery and Energy Reliability, U.S. Department of Energy. June 2009.

Sullivan, Michael J., Schellenberg, Josh, & Blundell, Marshall, Nexant, Inc. *Updated Value of Service Reliability Estimates for Electric Utility Customers in the United States.* Ernest Orlando Lawrence Berkeley National Laboratory. LBNL-XXXX. January 2015.

Thornton, B.A., et al. *Achieving the 30% Goal: Energy and Cost Savings Analysis of ASHRAE Standard 90.1-2010.* May 2011. Prepared for the U.S. Department of Energy by Pacific Northwest National Laboratory.

U.S. Department of Commerce, Economics and Statistics Administration, Office of the Chief Economist. *Economic Impact of Hurricane Sandy. Potential Economic Activity Lost and Gained in New Jersey and New York.* September 2013.

U.S. Department of Energy. *Grid Modernization Multi-Year Program Plan.* November 2015.

U.S. Department of Energy. *The Potential Benefits of Distributed Generation and Rate-Related Issues that may Impede their Expansion*. Study Pursuant to Section 1817 of the Energy Policy Act of 2005. February 2007.

U.S. Department of Energy. *Quadrennial Technology Review.* September 2011.

U.S. Department of Energy. *Quadrennial Technology Review: Energy Transmission, Storage, and Distribution Infrastructure.* April 2015.

U.S. Department of Energy. *Quadrennial Technology Review Framing Document.* March 14, 2011.

U.S. Department of Energy & U.S. Environmental Protection Agency. *Combined heat and Power. A Clean Energy Solution.* August 2012.

U.S. Department of Energy & U.S. Environmental Protection Agency. *Guide to Using Combined Heat and Power for Enhancing Reliability and Resiliency in Buildings.* September 2013.

U.S. Department of Energy, Electricity Delivery & Energy Reliability. *Voices of Experience. Insights into Advanced Distribution Management Systems.* February 2015.

U.S. Department of Energy, Electricity Delivery & Energy Reliability. American Recovery and Reinvestment Act of 2009. *Demand Reductions from the Application of Advanced Metering Infrastructure, Pricing Programs, and Customer-Based Systems—Initial Results.* Smart Grid Investment Grant Program. December 2012.

U.S. Department of Energy, Electricity Delivery & Energy Reliability. American Recovery and Reinvestment Act of 2009. *Experiences from the Consumer Behavior Studies on Engaging Customers.* Smart Grid Investment Grant Program. September 2014.

U.S. Department of Energy, Electricity Delivery & Energy Reliability. American Recovery and Reinvestment Act of 2009. *Fault Location, Isolation, and Service Restoration Technologies Reduce Outage Impact and Duration.* Smart Grid Investment Grant Program. December 2014.

U.S. Department of Energy, Electricity Delivery & Energy Reliability. American Recovery and Reinvestment Act of 2009. *Operations and Maintenance Savings from Advanced Metering Infrastructure—Initial Results.* Smart Grid Investment Grant Program. December 2012.

U.S. Department of Energy, Electricity Delivery & Energy Reliability. American Recovery and Reinvestment Act of 2009. *Reliability Improvements from the Application of Distribution Automation Technologies—Initial Results.* Smart Grid Investment Grant Program. Draft Report, November 2012.

U.S. Department of Energy, Electricity Delivery & Energy Reliability. American Recovery and Reinvestment Act of 2009. *Reliability Improvements from the Application of Distribution Automation Technologies—Initial Results.* Smart Grid Investment Grant Program. December 2012.

U.S. Department of Energy, Electricity Delivery & Energy Reliability. The American Recovery and Reinvestment Act. *Smart Grid Highlights. Jumpstarting a Modern Grid.* October 2014.

U.S. Department of Energy, Electricity Delivery & Energy Reliability. The American Recovery and Reinvestment Act of 2009. *Smart Grid Investment Grant Program.* Progress Report II. October 2013.

U.S. Department of Energy, Electricity Delivery & Energy Reliability. The American Recovery and Reinvestment Act. *Smart Grid Investments Improve Grid Reliability, Resilience, and Storm Responses.* Smart Grid Investment Grant Program. November 2014.

U.S. Department of Energy, Energy Efficiency & Renewable Energy. *Impacts of the 2009 IECC on Residential Buildings at State Level.* September 2009. Prepared by Pacific Northwest National Laboratory for the U.S. Department of Energy Building Energy Codes Program.

U.S. Department of Energy, Energy Efficiency & Renewable Energy. *Impacts of the 2009 IECC on Residential Buildings in New Jersey.* September 2009. Prepared by Pacific Northwest National Laboratory for the U.S. Department of Energy Building Energy Codes Program.

U.S. Department of Energy, Energy Efficiency & Renewable Energy. *Impacts of Standard 90.1-2007 on Commercial Buildings at State Level.* September 2009. Prepared by Pacific Northwest National Laboratory for the U.S. Department of Energy Building Energy Codes Program.

U.S. Department of Energy, Energy Efficiency & Renewable Energy. *Impacts of Standard 90.1-2007 on Commercial Buildings in New Jersey.* September 2009. Prepared by Pacific Northwest National Laboratory for the U.S. Department of Energy Building Energy Codes Program.

U.S. Department of Energy, Oak Ridge National Laboratory. *Combined Heat and Power in Multifamily Housing. User Manual for HUD CHP Feasibility Screening Tool, Version 2.1.* Developed for U.S. Department of Housing and Urban Development. April 30 Draft, 2008.

U.S. Department of Energy, Oak Ridge National Laboratory. *HUD CHP Guide #2: Feasibility Screening for Combined Heat and Power in Multifamily Housing*. Prepared for U.S. Department of Housing and Urban Development. May 2009.

U.S. Department of Energy, Oak Ridge National Laboratory. *HUD Combined Heat and Power (CHP) Guide #3. Introduction to the Level 2 Analysis Tool for Multifamily Buildings.* Prepared for U.S. Department of Housing and Urban Development. September 2010.

U.S. Environmental Protection Agency. Combined Heat and Power. *A Guide to Developing and Implementing Greenhouse Gas Reduction Programs.* 2014.

U.S. Environmental Protection Agency. Combined Heat and Power Partnership. *Catalog of CHP Technologies. Appendix A: Expressing CHP Efficiency*. March 2015.

U.S. Environmental Protection Agency. Combined Heat and Power Partnership. *Opportunities for Combined Heat and Power at Wastewater Treatment Facilities: Market Analysis and Lessons from the Field.* October 2011.

Wilshusen, Gregory C. *Cybersecurity. Challenges in Securing the Electricity Grid.* United States Government Accountability Office. Testimony before the Committee on Energy and Natural Resources, U.S. Senate. July 27, 2012.

Woolf, Tim, et al. *Benefit-Cost Analysis for Distributed Energy Resources. A Framework for Accounting for All Relevant Costs and Benefits.* Prepared for the Advanced Energy Economy Institute. September 22, 2014.