PUC/CHP Discussion
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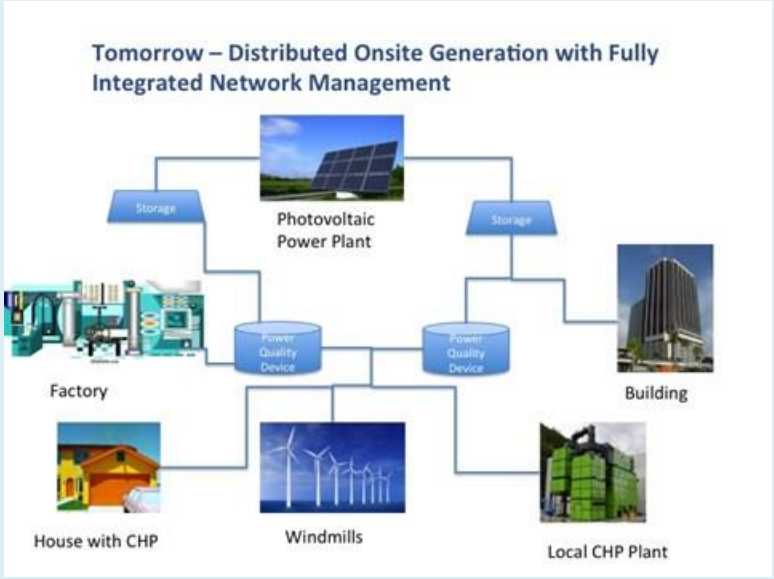
On-Site Generation Provides Several Options

- Distributed Generation
- Cogeneration
- Peak Shaving
- Stand-by Power (normal and emergency)



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Definitions

Combined Heat and Power (CHP)

- The production of electric power and thermal energy from one source of fuel

Distributed Generation

- Generation on-site can be CHP, generators w/emissions control, emergency generators, solar PV, battery Storage

Microgrid (DOE & EPRI)

- A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid and that connects and disconnects from such grid to enable it to operate in both grid-connected or “island” mode

Major Power Failures

- 2003 Northeast Blackout (manmade crisis)
- Hurricane Ike
- Hurricane Irene
- Hurricane Katrina
- Super Storm Sandy 820 miles in diameter on 10/29/12
  - 21 states 8,100,000 homes lost power
  - Double the landfall size of Isaac & Irene combined
  - Caused 106 fatalities
- Total estimated cost to date:
  - $71 billion+ (dni lost business)
  - New York - $42 billion
  - New Jersey - $29 billion

What We Should Learn from Recent Events

- Super Storm Sandy has shown that our electric power infrastructure has vulnerabilities.
- Objectively no system can be 100% safe against natural or manmade disasters.
- If correctly engineered, distributed generation (DG) and combined heat and power (CHP) can contribute to providing critical power during emergencies.
- This is particularly important for our hospitals and health care assets that simply cannot be allowed to suffer the kinds of long-term energy outages that we have repeatedly seen in recent years.

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Sandy Prompts NJ Transit Microgrid Project

- The DOE to partner with New Jersey, NJ Transit and the New Jersey Board of Public Utilities to assess NJ Transit's energy needs and help develop a conceptual design of an advanced microgrid system.

- The project, which is part of the Obama Administration's ongoing efforts to provide support to communities affected by Superstorm Sandy, will see Sandia National Laboratories assist NJ Transit in its efforts to enhance the reliability and resiliency of electricity used for its rail and system operations.

- According to the Energy Department, the NJ Transit system is a critical transportation corridor and evacuation route for Manhattan. Superstorm Sandy, Hurricane Irene and other natural disasters have exposed the vulnerability of the transit system to power outages. The NJ TransitGrid, is considered critical for New Jersey's economy and emergency and evacuation-related activities.

- $1.9 million

Energy Department Partners with State to Help Hoboken Improve Its Electric Grid in the Aftermath of Hurricane Sandy

- As part of the Obama Administration's ongoing commitment to provide support to communities affected by Hurricane Sandy, the Energy Department today announced that it will partner with the New Jersey Board of Public Utilities, City of Hoboken and Public Service Electric & Gas Company (PSE&G) to help assess and develop strategies for improving the reliability and resiliency of the local electric grid in Hoboken.

- The collaboration will help Hoboken in its efforts to rebuild and upgrade its electricity infrastructure by delivering a strategic design that identifies priority energy needs and energy system functions for various outage durations, evaluates potential system improvements, and estimates cost.

- $29 million

Federal CHP Policy

- White House Executive Order, Aug 30, 2012
- Increase CHP capacity by 40 GW (50%) by 2020
- Convene federal and regional stakeholders to address barriers – policy, financial, regulatory
- Accounting for potential emission reduction benefits of CHP in State Implementation Plans (SIPs); employ output-based emissions approaches
- Providing incentives for CHP deployment of CHP; emissions allowance trading program, state implementation plans, grants, and loans
- Expand participation and tools of Clean Energy Application Centers and support DOE Better Buildings, Better Plants to reduce energy intensity

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Federal Government - H.R. 1424
Emergency Economic Stabilization Act of 2008
(expires 2016)

- New Combined Heat and Power
- Bill authorizes a new Investment Tax - CHP property qualifies for a 10% ITC under section 48(a)(3)(A)(v) of the Internal Revenue Code (IRC).
- This ITC is equal to 10% of the costs of the first 15 megawatts of qualifying CHP "energy property." Eligible CHP property includes systems up to 50 MW in capacity that exceeds 60% energy efficiency.
- CHP and other energy property, as defined under section 48(a)(3)(A), also qualify for 5 year accelerated depreciation.

Recent Department of Energy Award DE-FOA-0000997

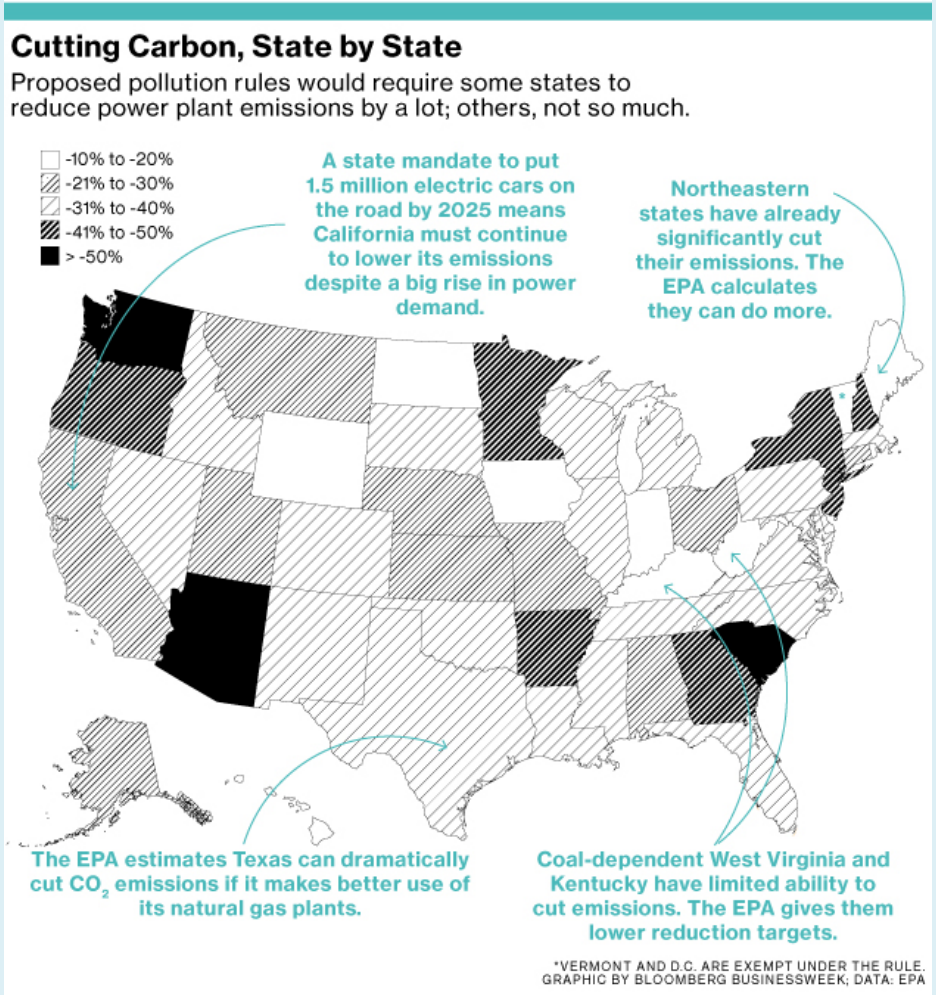
- The US Department of Energy (DoE) has granted more than $8 million for microgrid projects to help communities better prepare for adverse weather events and other potential electricity disruptions.

- The investments in new projects seek development of advanced microgrid controllers and system designs for microgrids less than 10MW.

- The seven awardees, which secured approximately $1.2 million of DOE investments each, include Alstom Grid, Burr Energy, Commonwealth Edison Company, Electric Power Research Institute, General Electric Company, TDX Power and The University of California.

EPA

- Environmental Protection Agency's 2030 emissions reduction targets, assigns each state a emissions reduction target for carbon reductions without proscriptive implementation



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Changing Rules

- Historic Sizing CHP Onsite Generation
  - 65% to 75% of Electric Peak
  - High Thermal Utilization
  - Operate in Electric Load Following
- Impact on Local Distribution
- Impact on Regional ISO

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FERC 745

- On May 23, the U.S. Court of Appeals for the D.C. circuit vacated Federal Energy Regulatory Commission (FERC) Order 745, a directive which brought wholesale demand response regulation and pricing under FERC's jurisdiction
- Repeal of FERC 745 endangers the PJM Ancillaries Market which impacts CHP and microgrids
- Former FERC Chairman and demand response champion Jon Wellinghoff called the ruling a "devastating" blow for demand response; generators deemed it a victory
- PJM is current appealing this decision as are several public service commissions

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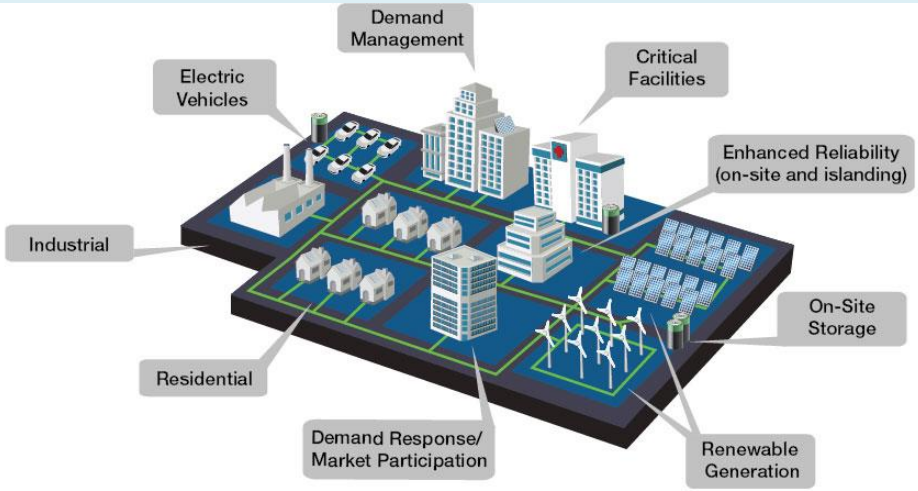
Appeals Court Denies Rehearing on FERC Order 745

- The US Court of Appeals for the DC Circuit 9/19/2014 denied FERC's request for an en banc rehearing on Order 745. The court's order was only a paragraph long, saying a majority of justices on the Circuit voted not to take up the issue on appeal.
- This will have broad implications in the Demand Response and ancillary services markets. PJM had been maintaining a status quo approach pending this decision.
- The ruling is not necessarily the end of the road for the issue as the case could be appealed to the Supreme Court, and even failing that, regulators and the courts will likely have to decide what, if any, impact the case would have on capacity market DR.
- A petition for certification is expected to come out of FERC. Which means this goes on to the Supreme Court. The Supreme Court can choose to or not to hear the case. It is more likely that they will as this is a States rights/interstate commerce issue.

How FERC 745 Impacts CHP Sizing



Rough numbers:

- Each MW of Dispatchable CHP is worth up to:
  - $90,000 as a cost avoidance in Capacity/Transmission benefit
  - $300,000 in FR (could go higher with FERC 755)
  - $200,000 in DR (FERC 745)

These ancillary benefits would support sizing on-site microgrids to have 85%-110% of the critical facility electric peak power needs.

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The 10 MW Example

- **Conventional**
  - 7 MW CT
  - HRSG 35,000 pph
  - Grid supplied peak 3 MW
  - 70% of Peak KW
  - 85% of KWh
  - Load follows electric
  - Supplemental duct burner and or boilers
- Payback on incremental Cost to provide 100% peak >15 years

- **Grid Demand Integrated**
  - 10 MW CT
  - HRSG 50,000 pph
  - Normal operation 7 MW
  - ISO Dispatched 3 MW (100% peak)
  - Earns Load Management Demand Response Payment (CSP)
- Payback to provide 100% peak < 2 years

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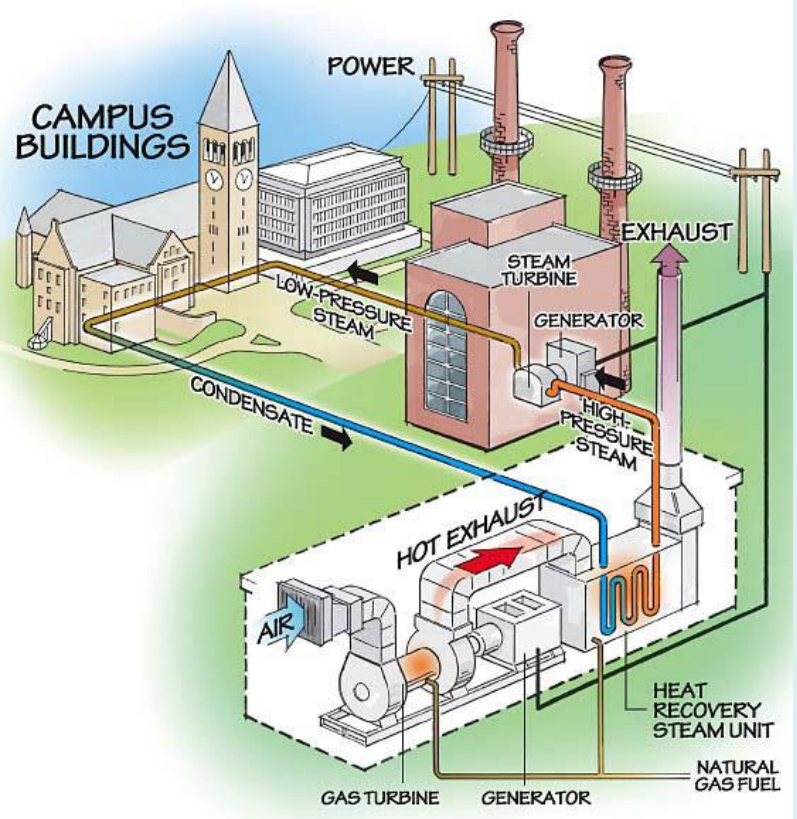
Operating Paradigm

- This requires not just building a HHP or CCHP - it also requires building a larger plant to serve multiple loads
- Ideally a microgrid or district energy plant needs to become an integrated part of the local electric distribution system and regional ISO not a peaking parasite (a really smart grid)
- A typical CHP energy plant stands on three legs; **Electric, Chilled Water and Heating**

Why Microgrids? (it is the new buzz word)



- A microgrid is differentiated from a campus energy grid by being fully capable of black start and island operation
- Although reliable the grid is not 100% and natural disasters can cripple critical infrastructure
- Campus CCHP is a good example of a microgrid

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Where is this Evolving?

Traditional Private Wires

- College and University Campus
- Military Governmental Complex
- Hospitals
- Pharmaceutical Campus
- Manufacturing
- Ports
- Refineries

The Utility as Distribution Company

- Con Edison (new tariff)
- Connecticut Energy Improvement Districts
- Princeton University
- ?

Private Wires

Advantages

- If as on a single campus displaces full retail electric cost
- Subject to standby or demand charges
- Can be optimized for CHP
- Can incorporate demand response generation
- Can operate in Island Mode

Disadvantages

- Limited to contiguous property or Energy Improvement District (EID)
- Utility opposition on franchise and safety issues
- Duplicates existing infrastructure at high cost to developer
- Difficult to integrate renewable or remote resources

Utility as Distribution Provider

Advantages

- Can revitalize older thermal district energy systems
- Can optimize CHP
- Can serve non-contiguous loads
- Avoids cost of building parallel wires
- Avoids conflict with utility EDC over franchise issues
- Avoids safety issue for parallel wires

Disadvantages

- Will need to pay for use of utility wires
- The system cannot island
- Requires regulatory process or legislation
- Distribution without transmission cost would generate loss revenue for EDC

Examples

Private Wires

- NYU
- Princeton University
- MIT
- Federal Bases (some)
- VA Hospitals (some)
- Pharmaceutical Campus
- Military Bases (few)

Utility as Distribution Provider

- ConEdison Case 11-E-0299 (implementation delayed to October 25, 2012)
- Connecticut Energy Improvement Districts
- Princeton University

Princeton University

- NJ P.L. 2009 ch. 240
- Allows a CHP plant supplying a customer not contiguous to be sold electric power if they are purchasing/using thermal energy
- Princeton was able to optimize operation of their 15 MW campus CHP to serve electric power to additional buildings not on the CHP substation
- Distribution cost is the full EDC Tariff but is not specifically defined by the law as such

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Trenton District Energy Company

- Operated as a full CHP 80% plus efficiency and 90% availability with a utility PPA
- Recipient of EPA Energy Star Award
- Upon expiration of PPA CHP operates based on day ahead pricing < 20%
- Without electric sale capability investment in repowering uneconomic.

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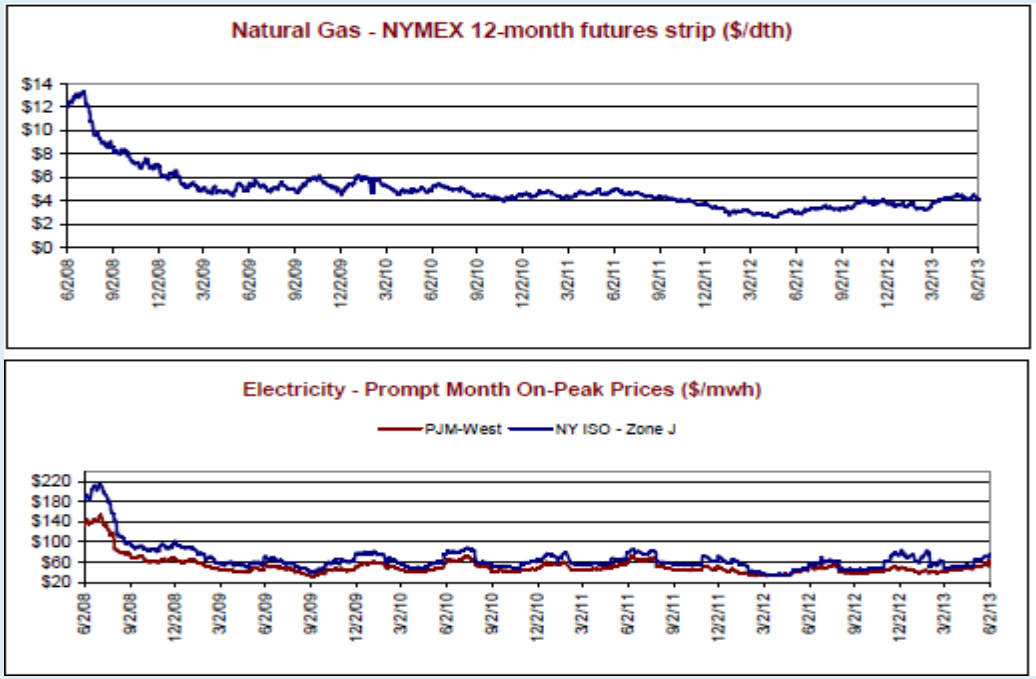
ConEdison CASE 11-E-0299

- Originally issued and effective September 7, 2012
- State of New York Department of Public Service Tariffs, Electric Supply and Small Utility Rates
- Edison Company of New York, Inc. to expand applicability of former Service
- Classification No. 14 – Standby Service Special Provision E (former P.S.C. No. 2 - Retail Access), now General Rule 20.2.1 - Standby Service, P.S.C. No. 10 - Electricity, to multiple dwellings or campus style buildings and to PASNY

Risk of Using Natural Gas for Electric Power

Natural Gas is the fuel for the last dispatched generator in PJM so although in different units electric price has high correlation to gas price



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On-Site Generation Offers Multiple Benefits

- Operating Cost Savings
- System Efficiency
- Reliability
- Flexibility

Common Mistakes

- Knee jerk reactions such as simply adding more simple diesel powered emergency generators or even natural gas generators

- Diesel powered electric generation facilities may appear to be the cheapest and quickest fix to the reliability problem, but frequently is not even close to the most economical solution.

- Installing natural gas generators solves one issue - fuel delivery, but does not generate revenue to help defray the costs. It is also important to understand that a natural gas generator cannot take on load as rapidly as a diesel engine can.

What Enables an On-Site Generator to Meet Site Power Needs?

- If you wait until you lose power, it is too late
- What size CHP, emergency generation combinations
- Islanding
  - What is it?
  - When do you do it?
- Black Start
  - Starter motor (electric)
  - Natural gas compressors
  - Dual fuel
- Safety Grid Isolation
- Return to Grid Connect

Technologies

- Reciprocating I.C. Engines
- Combustion Turbines
- Steam Turbines
- Micro turbines
- Fuel Cells

I.C. Engines Pros and Cons

Reciprocating I.C. Engine - Most Widely Used Prime Mover

Advantages:

- Prime mover Efficiency (25-50%)
- Size Selection (100 KW to 15 MW)
- Low First Cost
- Equipment Life
- Fast Start-up (10 Seconds on diesel)
- Do not require high pressure gas and large compressors

Disadvantages:

- Heat recovery Characteristics
- Uncontrolled Emissions (45 – 200 PPM NOx, down to 5 ppm with NOx control)
- Reliability (95%)
- Vibration, Size, & Noise

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Combustion Turbine Pros and Cons

Combustion Turbines - 1MW to 250MW in a Base Loaded Mode

Advantages:

- Overall System Efficiency (45 – 85%)
- Reliability (97 – 98%)
- High Grade of Heat Recovery (Steam)
- Low Maintenance Costs (0.006 – 0.010 ¢/kwh)
- High power to weight ratio

Disadvantages:

- System cost
- Incremental size
- Long lead time
- Gas requirements
  - 350-600 psi compressors
  - Clean gas soloxane
- Sensitivity to Ambient Temp.
- Maximum turndown of 50%

Micro Turbines

- 30-200 kW power output
- Multi-fuel capability
- High reliability
- Maintenance costs
- Low emissions (<9 ppm NOx)
- High Cost
- Compressor required
- Ultra Clean gas required
- 2 to 100 unit multi packing
- Plant sizes from 30 kW to 6 MW

Fuel Cells

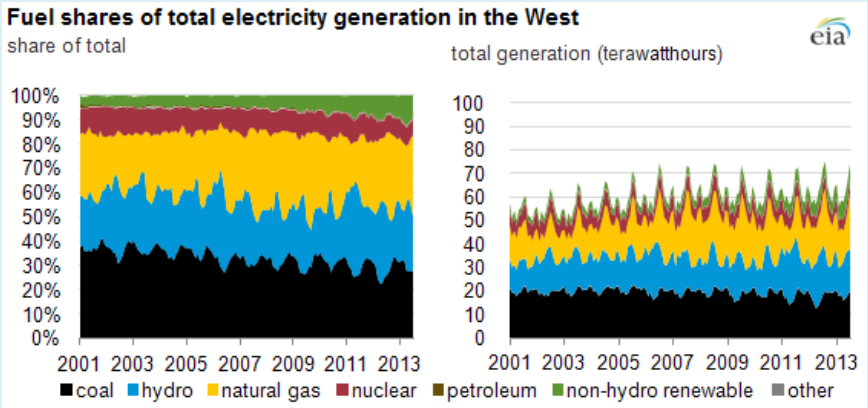
- 200-2,000 kW power output
- Very sensitive to gas quality
- High reliability
- High Maintenance costs
- Low emissions (<9 ppm NOx)
- High Cost
- Not good at load following or grid independent operation

Massachusetts Grid Modernization
Department of Public Utilities (DPU)

- D.P.U Order 12-76 B, outlines four objectives that prioritize grid modernization and innovative technologies as a means to achieve long-term energy efficiency.
- The first objective is to reduce the effects of power outages by minimizing the number and impact of outages through technology designed to quickly isolate problems on the grid, while also communicating with customers and providing them with information.
- The second objective for the DPU is to optimize demand, "which includes reducing system and customer costs." In other words, reducing peak demand and driving greater overall end-use efficiency through smart grid and energy efficiency initiatives.
- The third objective is to integrate distributed resources. Utilities in Massachusetts are finding growing penetrations of rooftop solar, energy storage and other customer-site energy resources in their service territories.
- The fourth objective seeks to improve workforce and asset management. End-use efficiency is more visible, but the DPU has asked utilities to extend greater efficiency through their daily operations and infrastructure investments.
- Massachusetts utilities have nine months to come up with a 10-year Grid Modernization Plan to meet these four objectives. The DPU wants utilities to provide a timeline for the various aspects of the plan, a business case analysis into possible costs and benefits, and a way to measure performance.

New York Reforming the Energy Vision (REV)

- New York's PSC Reforming the Energy Vision calls for an overhaul of the regulation of the state's distribution utilities to achieve five policy objectives:
  - Increasing customer knowledge and providing tools that support effective management of their total energy bill
  - Market animation and leverage of ratepayer contributions
  - System-wide efficiency
  - Fuel and resource diversity
  - System reliability and resiliency
- The traditional utilities would become Distributed System Platform Providers (DSPPs) and continue to provide continuity and essential services



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New York

- New York will utilize federal funds from Superstorm Sandy to harden the State's existing electrical grid
- Create 10 Microgrids - $40,000,000
- Under an innovative program to create at least 10 "microgrids" (independent community-based electric distributions systems) statewide, the State will launch NY Prize, a $40 million competition, to help build community-scale power grids for areas with approximately 40,000 residents.
- Microgrids can operate in tandem with existing power supply during normal conditions, but will disconnect and operate as an independent power system to keep the lights on during an emergency.

Connecticut

Initial proposal in 2007 was for Energy Improvement Districts featuring parallel wires within utility franchise. This was justified as a reliability need however none were built.

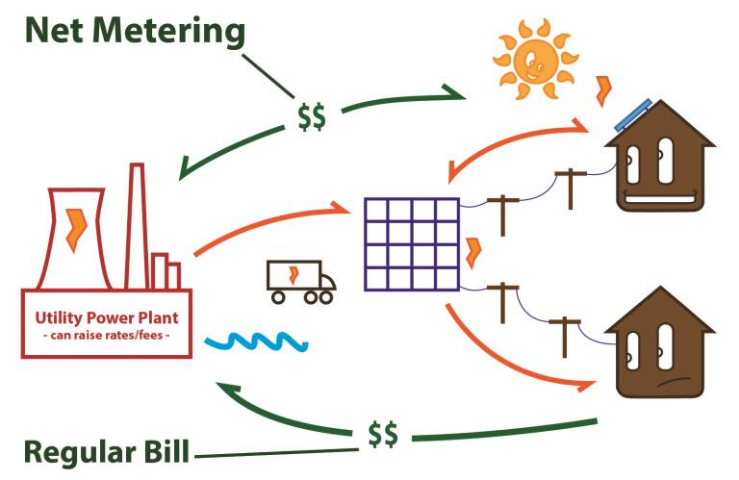
Under the new Connecticut Microgrid Grant and Loan Pilot Program to develop microgrid solutions that can provide power to critical facilities. The state will:

- Invest $1.5 million upfront to fund preliminary design and engineering costs for selected finalists
- The state will invest an additional $13.5 million for microgrid projects selected in the final round.

CHP qualifies for Class III Renewable Portfolio Standard

- CHP Grant Level 1 $750/kW
- CHP Grant Level 2 $950/kW
- CHP Grant Level 3 $1,100/kW

Maine



- Net metering is available to owners of eligible, qualified facilities, including facilities generating electricity using eligible combined heat and power (CHP) systems.
- CHP systems must meet efficiency requirements in order to qualify for net metering: micro-CHP 30 kW and below must achieve combined electrical and thermal efficiency of 80% or greater, and micro-CHP 31 kW to 660 kW must achieve combined efficiency of 65% or greater.

Maryland

Grid Resiliency Task Force recommendations included the following:

- The current level of reliability and resiliency during major storms is not acceptable.
- Severe weather events resulting from climate change are likely to continue to occur. Utilities, government and citizens must be prepared for severe weather events.
- If done strategically and appropriately, increased expenditures by the utilities to improve resiliency and harden the grid will lead to fewer outages during storms and shorter outages when interruptions happen.
- Calls for widespread deployment of various kinds of microgrids in MD, but focuses on public purpose microgrids (police stations, hospitals, shelters, stores, etc.) first because they offer a quick path to grid resiliency.
- Utilities get the first crack at development because MD law already allows them to own microgrids. State law allows them to own generation to meet long-term demand and to sell services from the microgrid into the wholesale market, the PJM Interconnection.
- Recommends legislative changes to allow competition for development of public purpose microgrids.
- Recommends exemptions from rate regulation for smaller microgrids, or for those that can prove to state regulators that they serve the public interest and do not harm customers.
- Under the task force plan, rules would vary somewhat depending on whether the independent microgrid built its own distribution system or used the utility's wires. If it used the utility's wires, the public purpose microgrid would own only the generation, storage and control systems, and it would operate similar to a competitive retail supplier

Michigan

- HB 5673 lifts caps on the state's net metering law.
- HB 5674 adds a new section to PA 295, defining "community renewable energy gardens" as those that generate 2 megawatts or less, include a minimum of 10 subscribers and are owned either by a utility or a third party.
- HB 5675 essentially asks the Michigan Public Service Commission to study microgrid development and also permits all forms of utilities to establish them in their service area.
- HB 5676, could pay customers rates for electricity based on demand and that would serve as an alternative to net metering. Rates would be based on the hourly electricity prices on the MISO wholesale market, which sets prices for the Midwest region.

Minnesota

- The Minnesota Department of Commerce selected Microgrid Institute for a two-part project addressing combined heat and power (CHP) stakeholder engagement in the state.

- The project includes a pair of contracts to perform work that will assist the Department of Commerce, Division of Energy Resources, in its efforts to develop a CHP Action Plan for the state. Microgrid Institute's work under the contracts will include facilitating CHP stakeholder engagement meetings and performing a series of stakeholder surveys. Project deliverables will include survey results, reports, analysis, and recommendations, as well as a CHP Stakeholder Database and a CHP Education & Training plan.

New Jersey

- Combined Heat and Power Clean Energy Grants

- New Energy Resiliency Bank (ERB) to provide grants, forgivable loans and long term low interest financing 20%/ 20%/60% (2%)

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NJ Energy Resiliency Bank

- On Wednesday, August 27th the BPU held a public meeting to present their proposal for the Energy Resiliency Bank (ERB). This phase one of the ERB is for public Water Treatment Plants (WTP) and for public Waste Water Treatment Facilities (WWTF).
- The hospital program is expected to rollout in October. Although specifics are not currently available we anticipate that the hospital and public buildings ERB will closely mirror the Water and Waste Water treatment program.
- The evaluation criteria include microgrids and serving multiple buildings/functions.
- As discussed, the Energy Resiliency Bank is going to be offering a combination of grant (20%) forgivable loan (20%) and low interest (2%) financing for up to 100% of a project's cost for Water and Waste Water Treatment Facilities.
- The ERB will be funded under the Federal Community Disaster Block Grant (CDBG) Disaster Recovery Program funds allocated to New Jersey by the US Department of Housing and Urban Development (HUD). The plan proposes a $535 million investment in infrastructure which includes $200 million of funding to create an energy bank to fund resiliency projects. This first phase is $65 million for water and waste water facilities which would leave $135 million for the balance of the program.

ERB vs. CEP CHP Grants

- A ERB project can receive a total of 40% in grant funds and the remaining 60% with a 2% loan.
- The existing Combined Heat and Power (CHP) grants for projects > 1 MW < 3 MW provide $550/kw which provides 20-30% of a project's cost
- Grant maximum $3,000,000
- As currently proposed projects must choose between the Clean Energy-funded CHP grants and the ERB as they cannot qualify for both.
- The first phase of the program provides $65 million for Water and Waste Water Treatment Utilities
- The second phase includes public buildings, hospitals and higher education and is $135 million

Pennsylvania
Proposed Rule - Making Public Utilities Commission

- Proposed changes:
  - The addition of definitions for aggregator, default service provider, grid emergencies, microgrids and moving water impoundments.
  - Revisions to the interconnection rules to reflect the increase in limits on customer-generator capacity contained in the Act 35 of 2007 amendments.
  - Revisions to net metering rules and inclusion of a process for obtaining Commission approval to net meter alternative energy systems with a nameplate capacity of 500 kilowatts or greater.
  - Clarification of the virtual meter aggregation language.
  - Clarification of net metering compensation for customer-generators receiving generation service from electric distribution companies (EDCs), default service providers (DSPs) and electric generation suppliers (EGSs).
  - Revisions to the definitions for low-impact hydropower and biomass to conform with the Act 129 of 2008 amendment.
  - Addition of provisions for adjusting Tier I compliance obligations on a quarterly basis to comply with the Act 129 of 2008 amendments.
  - Addition of provisions for reporting requirements for new low-impact hydropower and biomass facilities in Pennsylvania to comply with the Act 129 of 2008 amendments.
  - Clarification of Commission procedures and standards regarding generator certification and the use of estimated readings for solar photovoltaic facilities.
  - Clarification of the authority given to the Program Administrator to suspend or revoke the qualification of an alternative energy system and to withhold or retire past, current

Thank You for Your Time Today - Questions?

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