MADRI Working Group Meeting

Town Center DER Microgrids Pilots

NJBPU Formal proceeding to develop DER Tariffs

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DER/Microgrid Policy Goals/Action Items in the NJ Energy Master Plan

Develop 1500 MW of Combined Heat and Power (CHP) and Distributed Generation (DG)

Increase the Use of Town Center DER Microgrid Technologies and Distributed Energy Resources (DER)

Create Long-Term Financing for Local Energy Resiliency Measures including Town Center DER microgrids Through an ERB and other financing mechanisms

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

Improve and Enhance the EDC Smart Grid and Distribution Automation Plans

Objectives of the Report

- **To provide information for the Board's consideration for potentially establishing New Jersey's initial microgrid policies.**

- To provide 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.

- Provide data and technical analysis to the Board and provide Staff's response for emergency operations (black and grey sky conditions) of a microgrid with multiple customers in response to Superstorm Sandy and other major grid outages.

- Provides a general technical analysis for operating a microgrid with multiple customers and multiple DER under normal conditions (blue sky conditions) for 24/7 operations.

Key questions evaluated in the Report:

- 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?

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)

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	201,76
Winter Weather/Nor'easters	8	1,636,000	29.6	204,50
Hurricane/Tropical Storm	6	5,718,500	22.2	953,08
Totals	27	9,977,500		

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

Definition of DER or DG - USDOE

Distributed energy resources consists of a range of smaller-scale and modular generation and storage devices (LTE 20 MW) designed to provide electricity, and sometimes also thermal energy, in locations close to consumers or end user.

Does not include EE or DR which are DSM

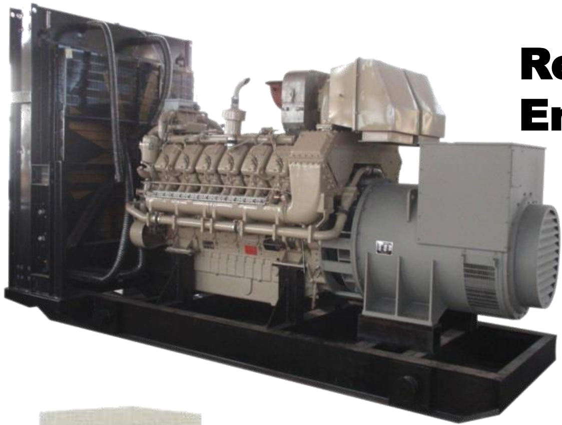
Some DER technologies as standalone generations would NOT be defined as Energy Efficiency depending on location/operations.

Types of DER

- Solar Photovoltaic
- Wind Turbines
- Engine Generator Sets
- Turbine Generator Sets
- Fuel Cells
- Batteries
- Capacitors
- Flywheels
- Thermal Storage
- Ice Storage
- Solar Thermal

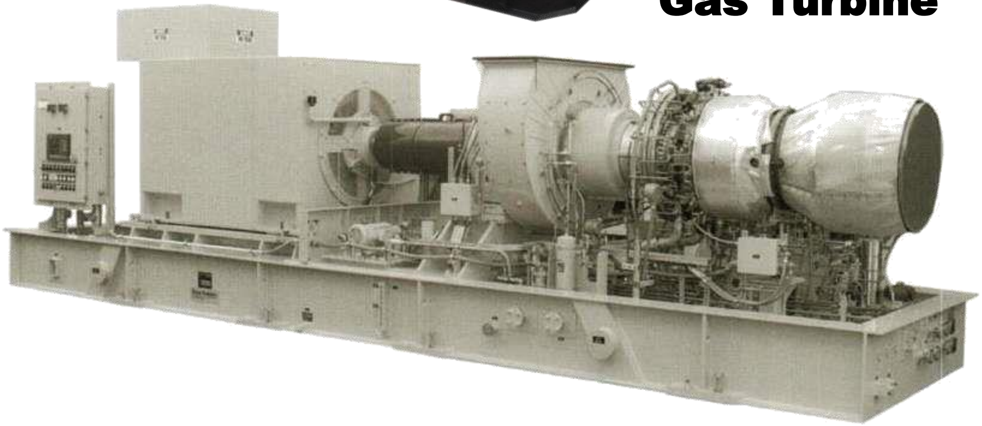
Examples of DER – Electric Generation

Microturbine

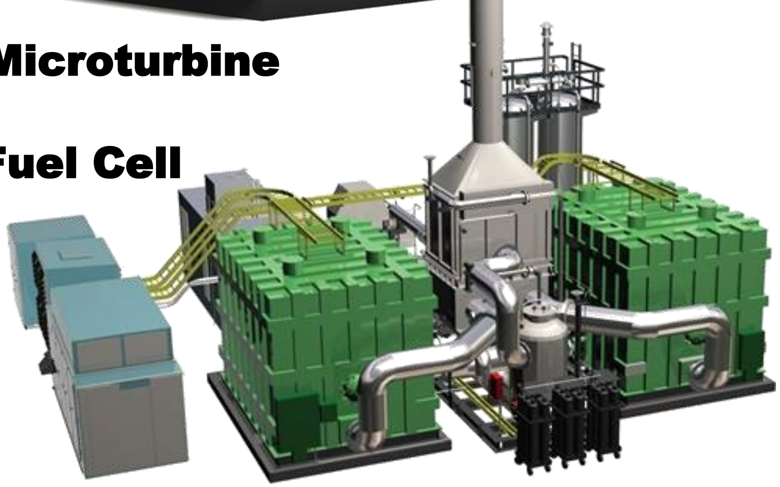


Reciprocating Engine

Gas Turbine



Fuel Cell

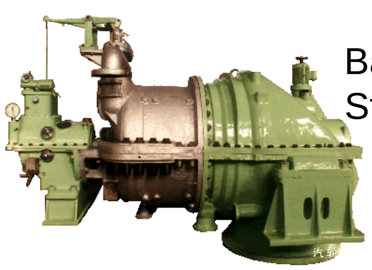


Thermally Activated Technologies (uses for heating component of CHP)

Single-Effect Hot Water Absorption Cooling
150 F to 270 F
COP 0.5 to 0.7

Double-Effect Steam Absorption Cooling
High and Medium pressure steam
COP 1.1 to 1.7

<u>Cooling Technologies</u>



Back Pressure Steam Turbine

<u>Power Generation Technologies</u>

Heat Recovery Steam Generator

Exhaust Gas Heat Recovery Boiler

Shell & Tube Heat Exchanger

Plate & Frame Heat Exchanger

<u>Heating Technologies</u>

Electric storage

Courtesy of Beacon Power

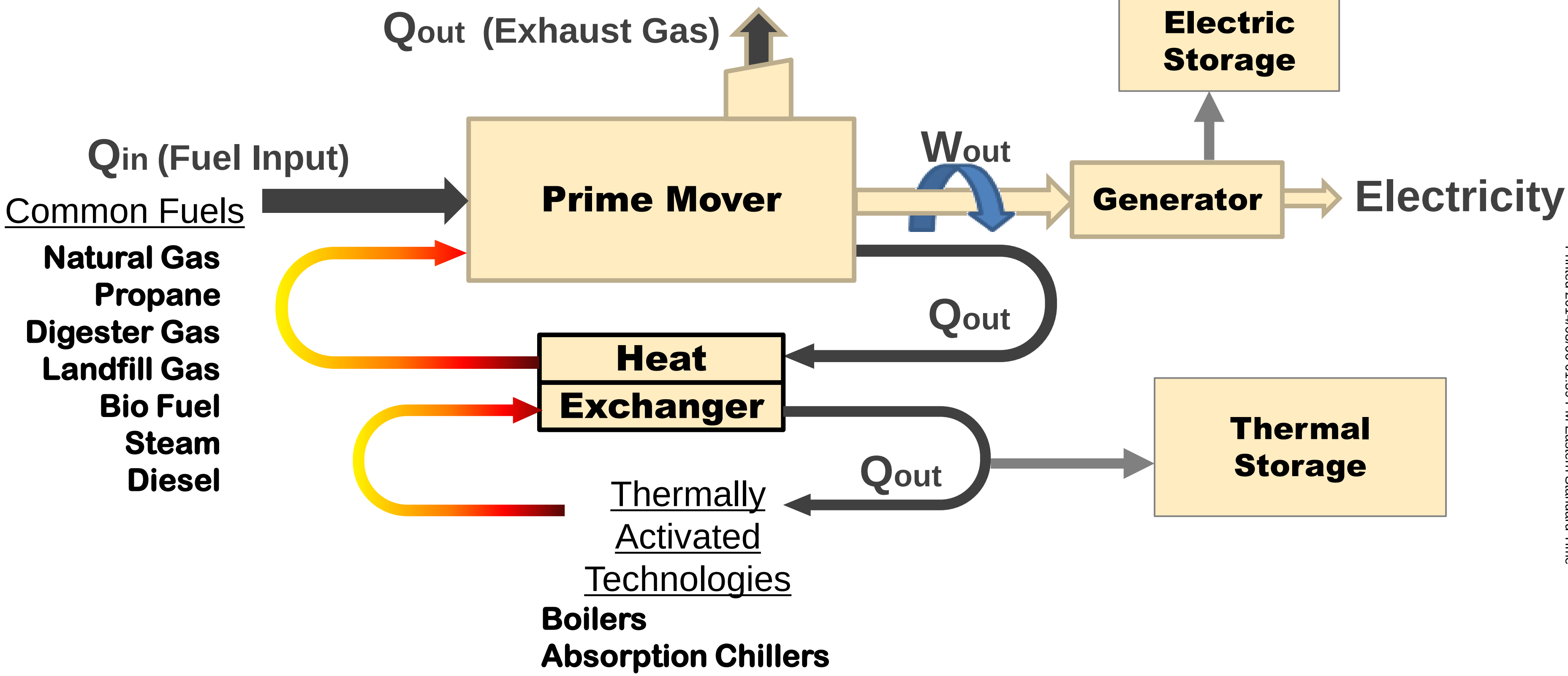
Definition of CHP – USDOE and USEPA

CHP is on-site electricity generation system that utilizes waste heat to provide useful thermal energy such as steam or hot water that can be used for space heating, cooling, domestic hot water and industrial processes.

CHP is a form of DG/DER and is defined as an integrated system that generates a portion of the electricity requirements of a facility, and recycles the thermal energy exhausted from the electric generation equipment to provide: - space heating / cooling - process heating / cooling - dehumidification - domestic hot water

Examples of Prime Movers

CHP Basic Components



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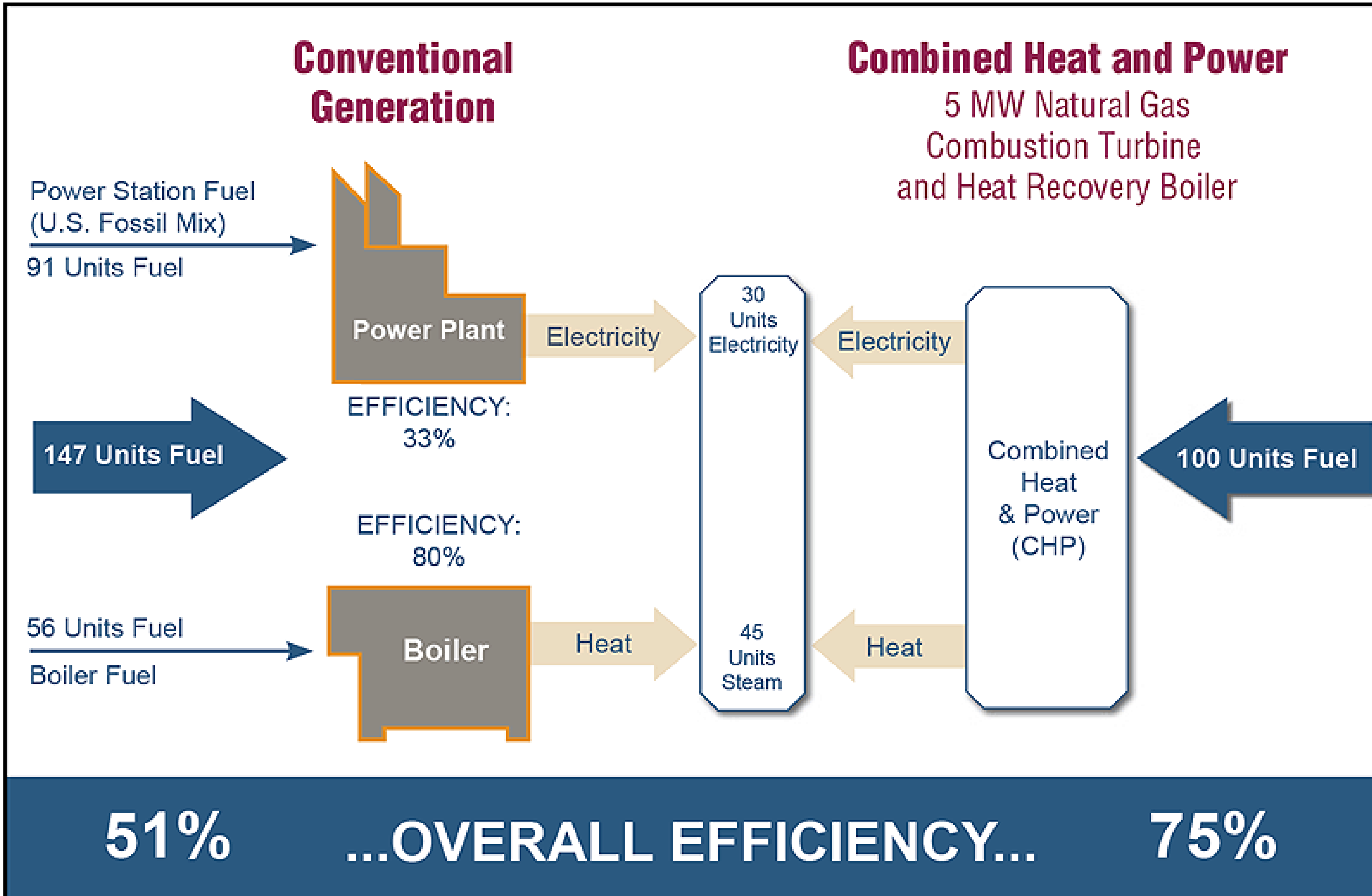
Energy Benefits of DER Combined Heat and Power



DER	**Number**	**MW**
CHP/FC total	230	2,910
CHP/FC DER	**107**	**355**
CHP/FC RE DER	**21**	**31**
PV total - all DER	**59,950**	**1,833**
PV Behind the Meter	59,803	1,433
PV Grid Supply	147	450
Other DER renewables	64	65
TOTAL DER	**60,078**	**2,219**

Over 10% capacity and 5% energy

Definition of Microgrid - USDOE

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.

- **Level 1 or single customer microgrid:** This is a single DER system such as a PV system, combined heat and power (CHP) or fuel cell system that is serving one customer and that is connected to and can island from the distribution grid.
- **Level 2 or single customer – campus setting:** This is a single or multiple DER systems with multiple buildings, but controlled by one meter at the point of common coupling that is connected to and can island from the distribution grid.
- **Level 3 or multiple customers / advanced microgrid:** 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 would be designed with 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 Microgrids - Total 50 – all CHP

Level 1 or single customer microgrid --- 38

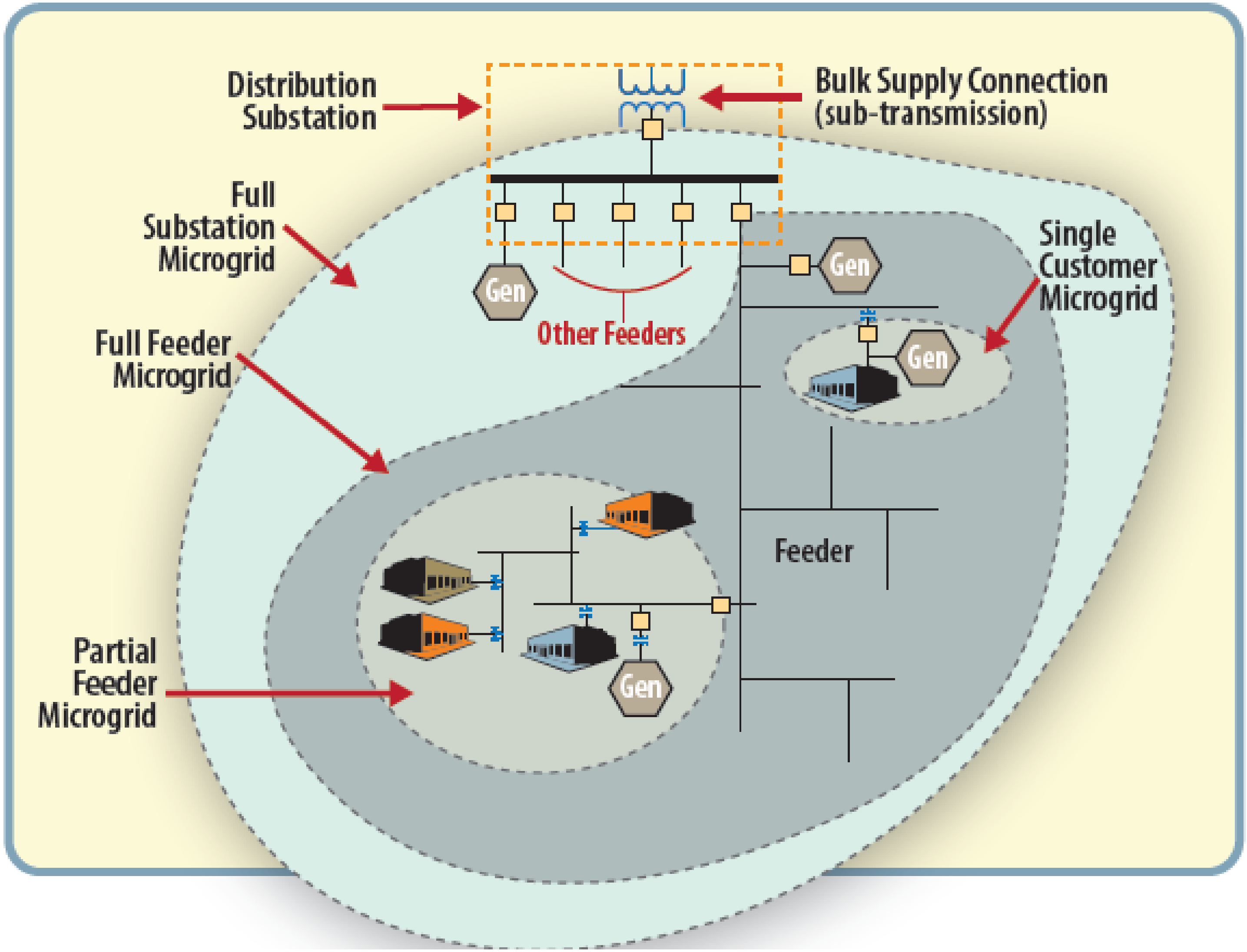
Level 2 or single customer – campus setting – 12

Level 3 or multiple customers / advanced microgrid.

Proposed - Town Center microgrids for critical facilities
Hoboken and New Jersey Transit Grid

NJIT Town Center Mapping for 9 Sandy Designated counties - 24 Town Center MG in 17 municipalities
2 Inter-District Thermal Plants – AC and Trenton
44 are Natural gas CHP and 6 are RE CHP
Only approx. 12 of the microgrids operated in island mode after Sandy

Illustration of a Microgrid by Levels



Current New Jersey Statutes Impacting Microgrids

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

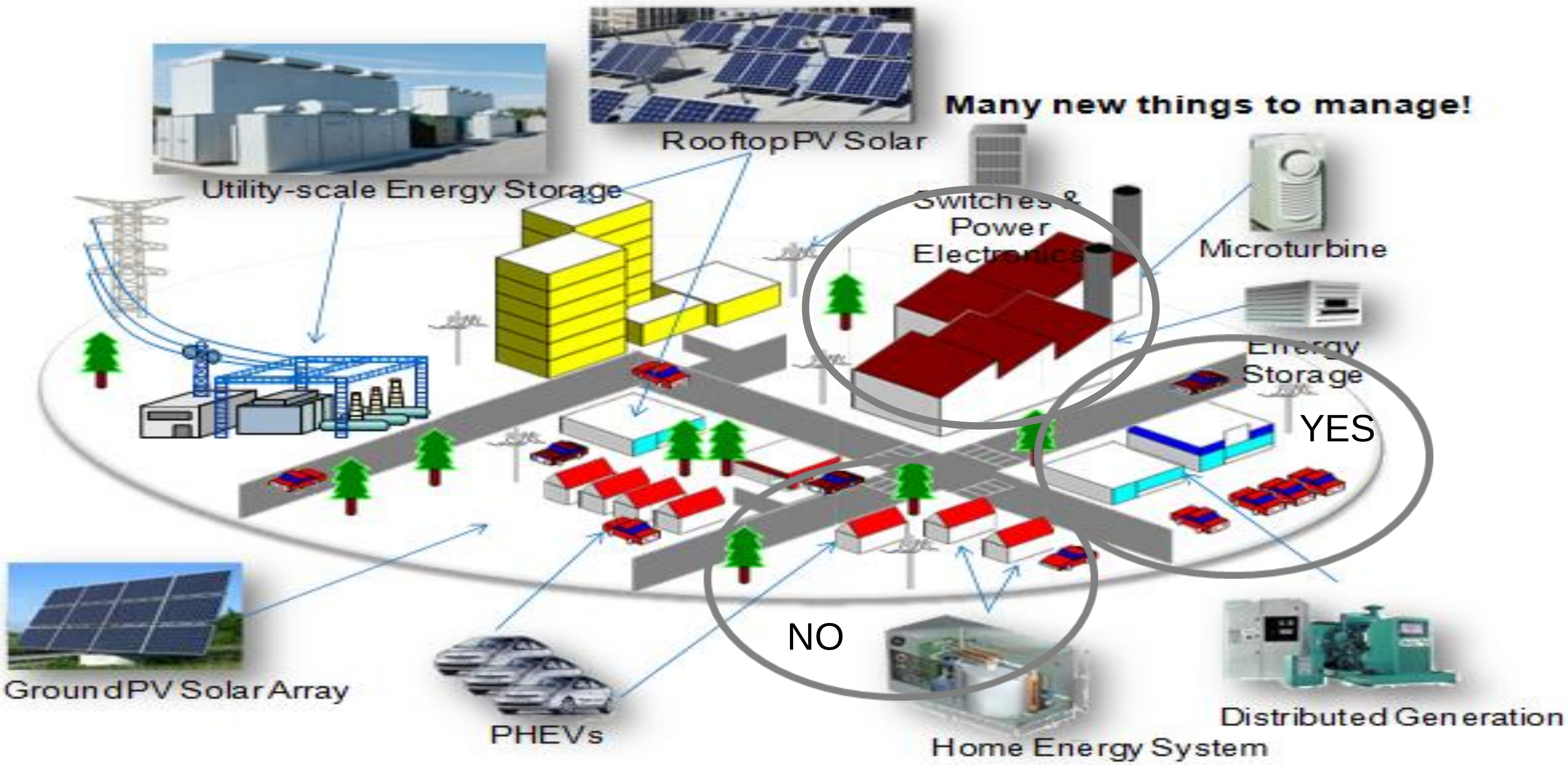
Definitions:

- Off-site end use thermal energy services customer
- On-site generation facility

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

- Utilization of locally franchised public utility electric distribution infrastructure

Types of MG Distributed Generation or Distributed Energy Resources



The Microgrid Proceeding meetings included the following stakeholders: Microgrid Developer Associations, New Jersey EDC & GDC through New Jersey Utility Authority, Rate Counsel, Microgrid Customer/Market Sectors Associations

Discussion revolved around:

- The advance microgrid, at their cost, would construct all the wires connecting the multiple customers over multiple ROW constructed to the EDC's established specifications.
- The advanced microgrid would "turn over" the microgrid wires connecting multiple customers over multiple ROW to the EDC to be part of the EDC's system including the One Call system.
- There would be a tariff established that pays for the ongoing maintenance of the wires/lines.
- The tariff would include the overall costs and benefits to the advance microgrid customers and to the overall EDC system and its customers.

Costs of Backup Generation vs DER ($/kW)

Backup Generators or CCNG - $600 per kilowatt (kW)

CHP - $2,000 to $3,000 per kW - islanding could add up to 30%

CHP at Wastewater facilities - $5,000 to $10,000 per kW plus

Fuel Cells - $5,000 to $7,000 per kW - islanding could add up to 30%

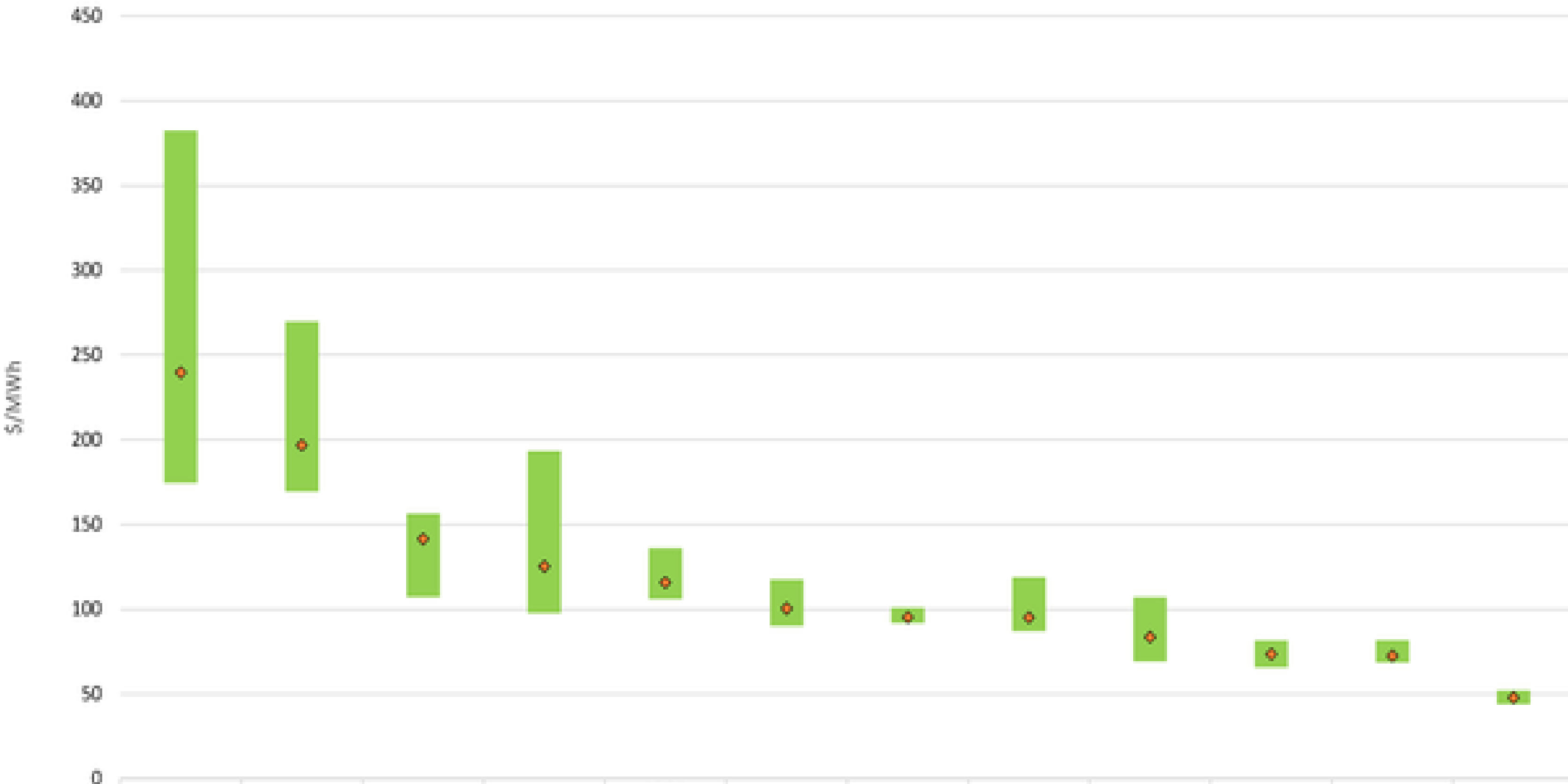
Solar PV - $2,000 to $4,000 per kW

Battery/Inverter - $1,000 per kW (1 hr runtime) cost increase w/runtime

Advanced Microgrid – Town Center DER Microgrid $5,000 to $10,000

Installed Cost ($/kW) is just one factor to consider
There is also the LCOE ($/kWh) – Eff, Cap, reliability, envi

Projected LCOE in the U.S. by 2020 (as of 2015)



	Solar Thermal	Wind offshore	Natural Gas: Conventional Combustion Turbine	Solar PV	IGCC (Integrated Coal-Gasification Combined Cycle)	Biomass	Advanced Nuclear	Conventional Coal	Hydro	Wind onshore	Natural Gas: Advanced Combined Cycle	Geothermal
Minimum	174	170	107	98	106	90	92	87	69	66	69	44
Average	240	197	142	125	116	101	95	95	84	74	73	48
Maximum	383	270	156	193	136	117	101	119	107	82	82	52

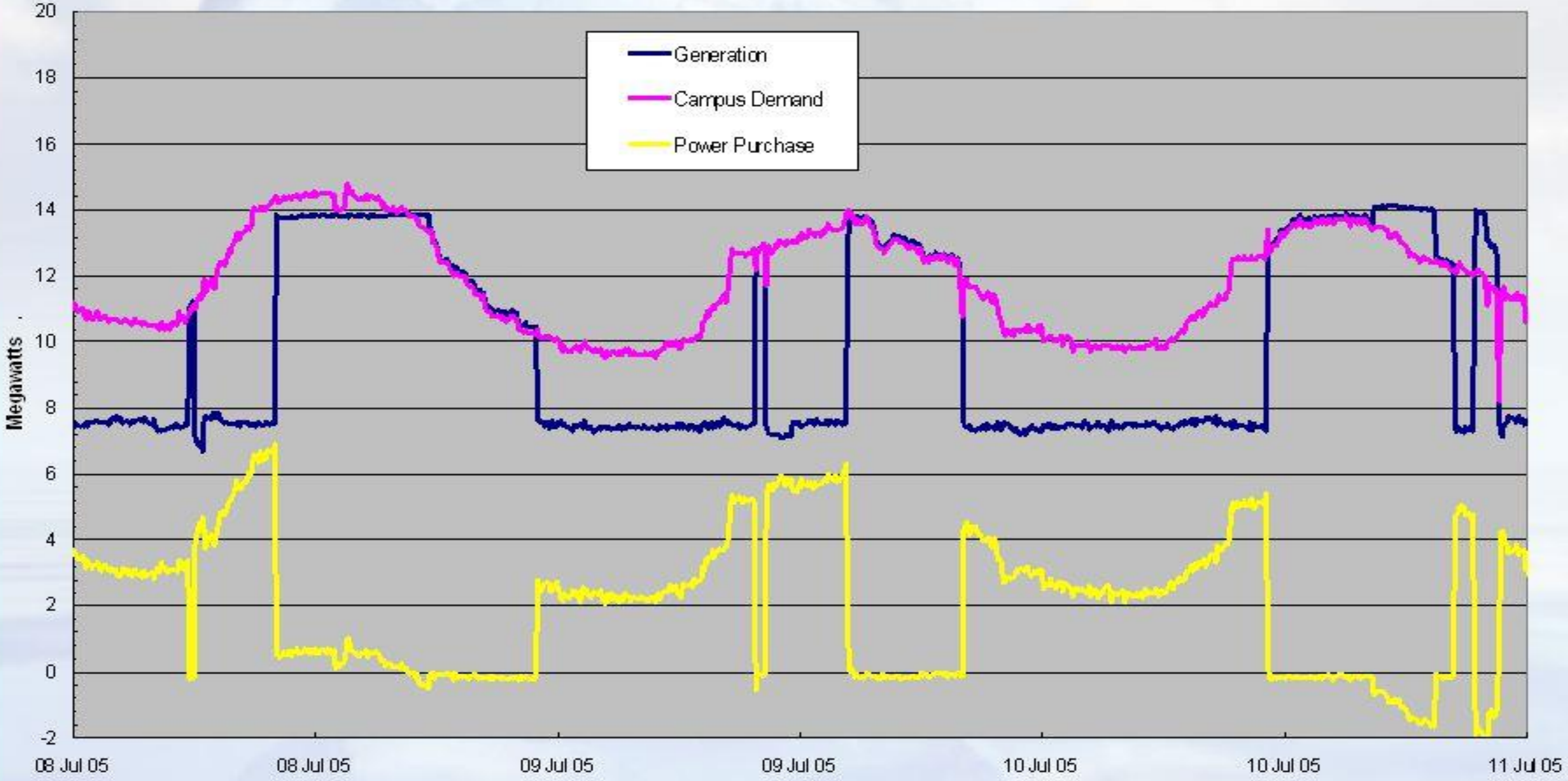
The advance microgrid can provide "benefits" *<u>to</u>* the grid

1. Produces electric and thermal energy for its customers.
2. Provides ancillary services and reduce the peak demand of the grid.
3. Can defer related investment in distribution system upgrades.
4. Produces and delivers energy more efficiently.
5. Reduce outages which can enhance resiliency and reliability.

The advanced microgrid receives "benefits" *<u>from</u>* the grid.

1. If not operating additional energy will need to be supplied by the grid.
2. Upgrades can be deferred but not fully avoided.
3. If not operating environment impacts may increase at peak times.
4. If not properly managed could reduce resiliency and reliability.

Princeton Micro-Grid Power Generation Dispatch To Optimize Savings – PJM Grid



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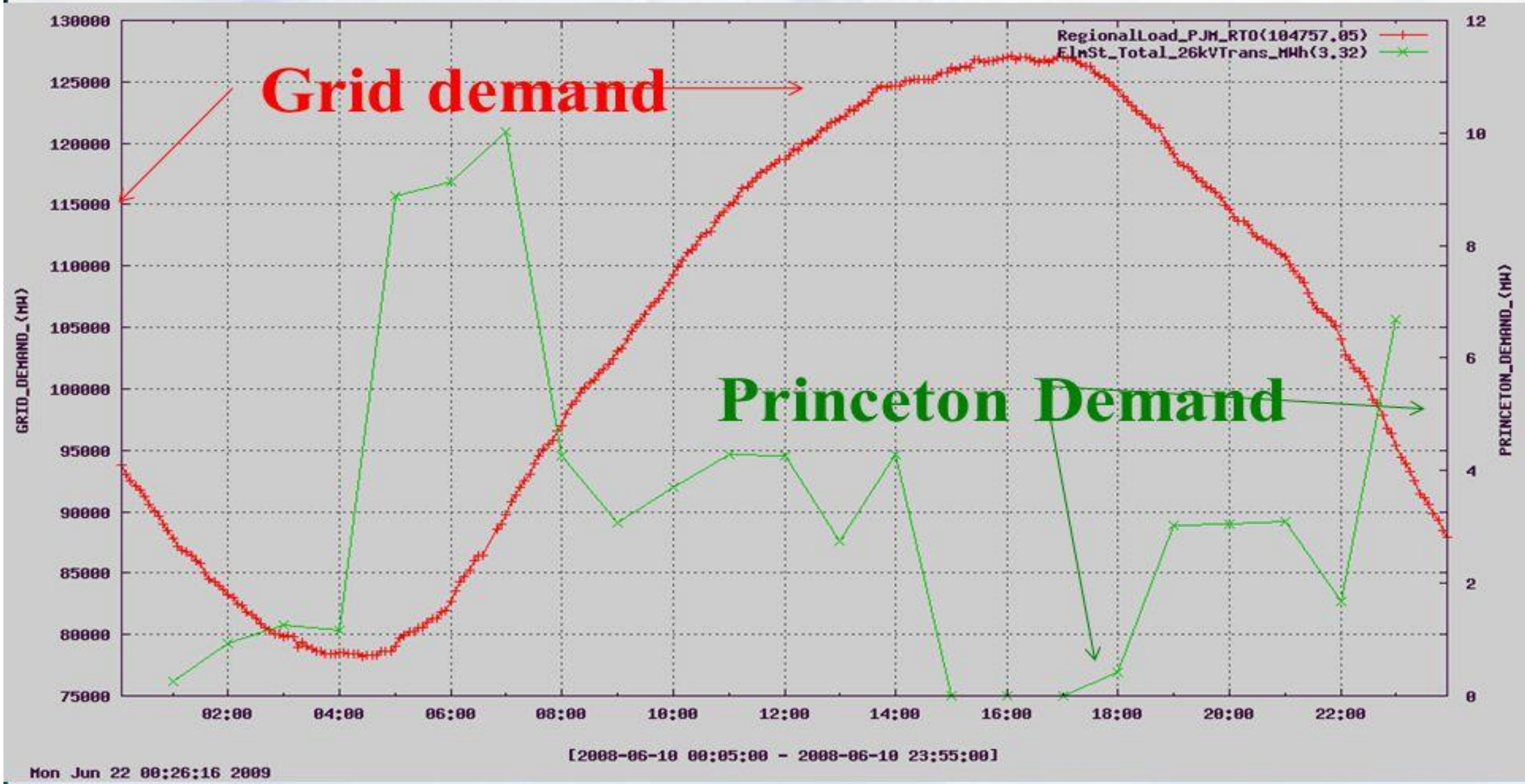
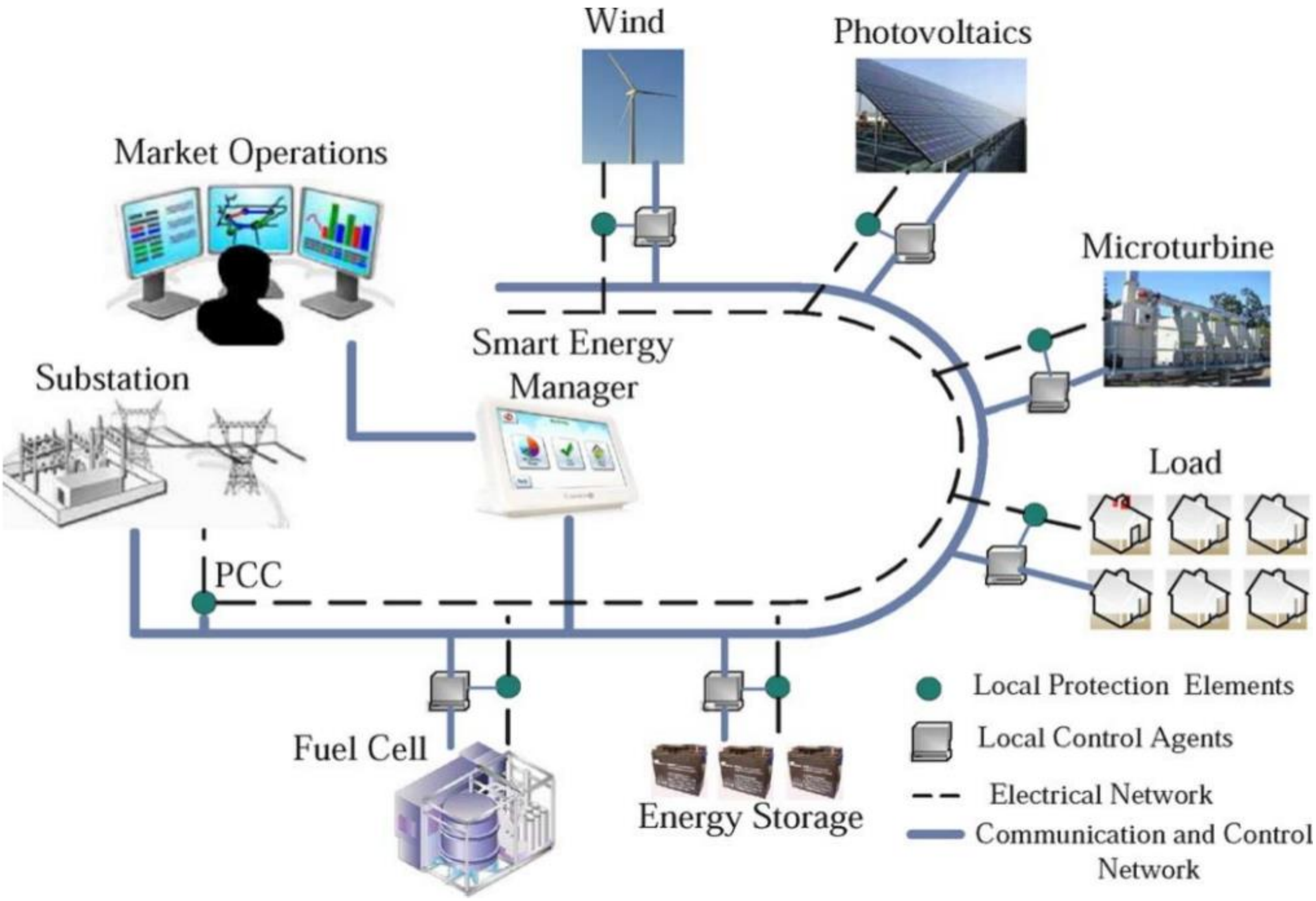
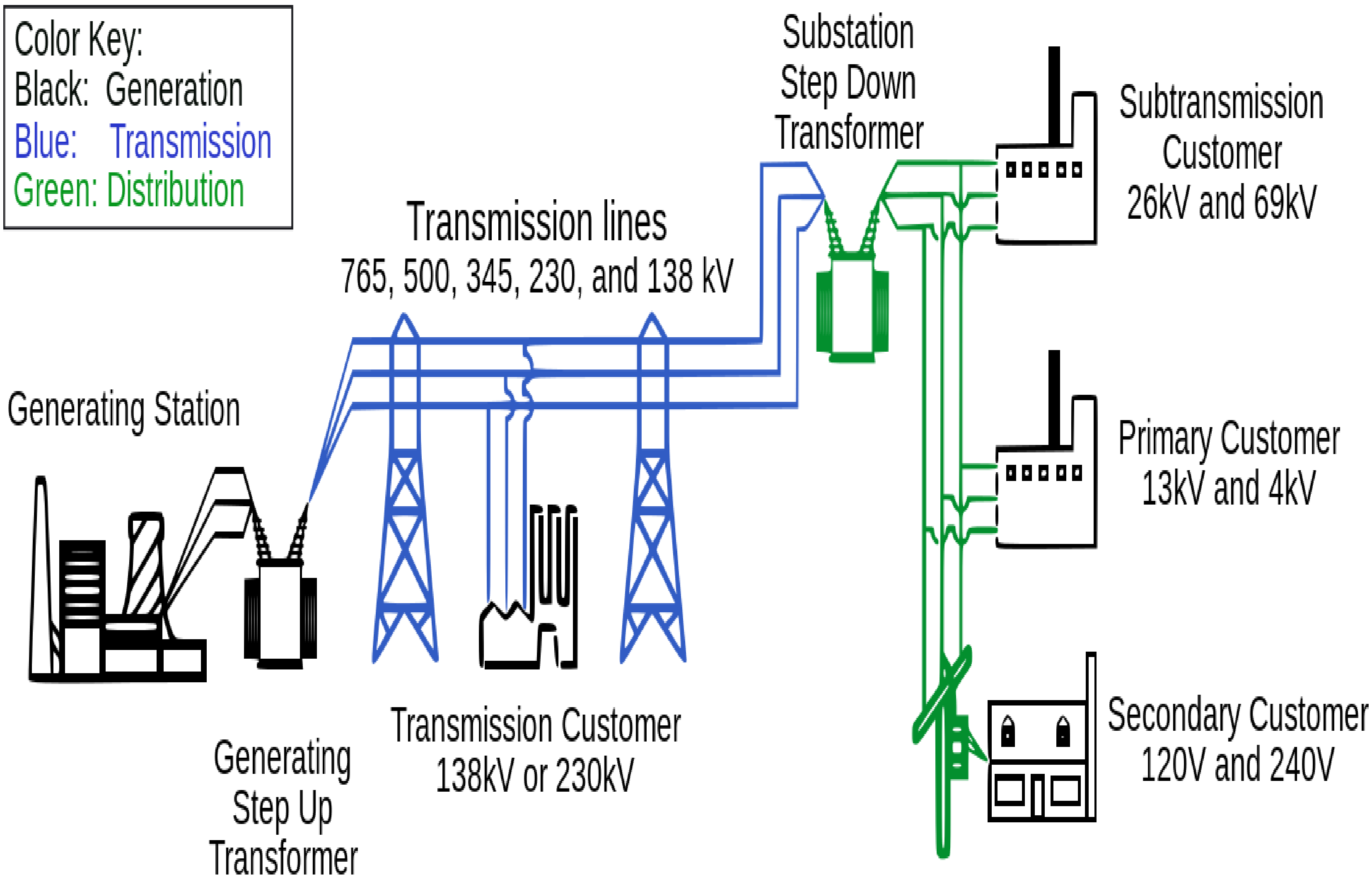
Princeton CHP/District Cooling Reduces Peak Demand on Local Grid




Wind
Photovoltaics
Market Operations
Microturbine
Smart Energy
Manager
Substation
Load
PCC
Local Protection Elements
Local Control Agents
Fuel Cell
Electrical Network
Energy Storage
Communication and Control
Network

Examples of the Generator – Transmission – Distribution systems



- DER that can be interconnected to the distribution system is the provision related to the 15% peak load screen

- Distribution Automation or Smart Grid as defined by the National Institute of Standards and Testing (NIST) includes any automation and digital enhancement of the distribution grid. This includes the connection with the transmission grid, interconnecting DER and automated interface with the end user that allows for two-way communication between the Electric Distribution Company (EDC) and the customer that adds value to both.

- Grid Interconnection:
    - Safety: …of customers, …of line workers, …of general public
    - Integrity: …of the grid, …of the quality of service
    - Protection of equipment
    - System Control by the utility

NARUC DER Tariff Guidance / RAP Designing DG Tariffs Well/ LBNL Distribution System Pricing w DER / Gridwise The Future of the Grid

1. Net metering
2. Valuation
3. Value of Resource
4. Value of Service
5. Transactive Energy
6. Demand Charges peak/nonpeak
7. Fixed Charges
8. Standby/backup Charges
9. Interconnection /metering fees

RAP DER Tariff Guidance John Sherot and Janine Midgen-Ostrander Designing Tariffs DG Customers

1. Customers should be able to connect at the cost of connecting
2. Customers should pay for grid services based on what they use
3. Customers should be fairly compensated for the value of the power they supply
4. Tariffs should balance the interest of all shareholders but not the incentive mechanism.

WHY NOW –states are moving on advanced microgrids - Because the Price is getting right - Utility of the Future

Solar approaching $1/W installed across average customer and 20 +% efficiency
In 2001 $10 to $12/W and 10% efficiency

Micro-CHP approaching $ $1 to $5 /W
In 2001 $50/W

Electric Vehicles – ≤ $20K (base) with 300+ mile range

Battery Storage – increasing power density 5X and lower kwh cost 5X equal to solar decline
In 2015 $1W-$3W -- $200-700/kwh

Distribution Automation/Smart Grid – increasing interoperability and lower costs

Building Integration – Building Code

Town Center DER Microgrids Feasibility Incentive

- Multiple Critical Facilities – Public, NFP, Private (tier 1 and shelter)
- All public partners MOU and **LOS from EDC**
- Must be in one town and served by an IOU
- In the NJIT Report or met the mapping criteria (criticality & load)
- DER and interconnections electric and thermal points
- Overall costs and potential financing
- Timeframe
- **Modeling to be used for Cost/Benefit Analysis**.

- Cap $200,000 and one per developer
- Total budget $1 million

Staff's 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. Consistent with the 2015 EMP Update, the EDC's continued enhancement of SG/DA should include a SG/DA filing providing for optimized use of DER microgrids that expand the capacity for a two-way flow of power and communications between the EDC and the DER microgrid.
4. With stakeholder input, develop and implement a Town Center microgrid feasibility study incentive program as part of the current NJCEP budget.
5. Initiate a TCDER microgrid pilot within each EDC service territory, initially limited to municipalities within the 9 FEMA designated counties or municipalities that meet the same criteria identified in the NJIT report.
6. With Stakeholder input, develop and implement a Town Center microgrid financing program.
7. Review 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 explore with local governments the potential for developing microgrids for improved and enhanced resiliency.