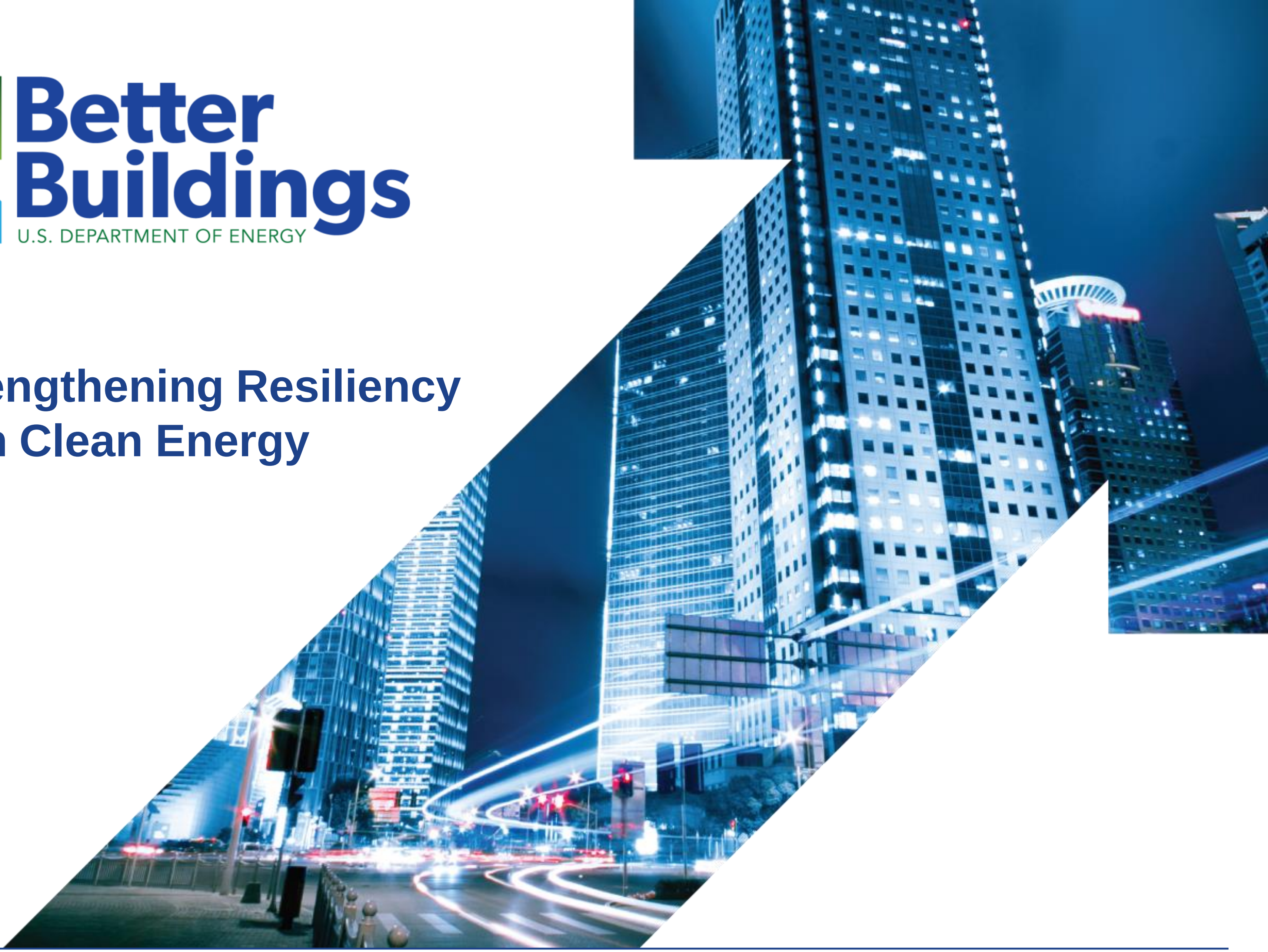
Better Buildings
U.S. DEPARTMENT OF ENERGY

Strengthening Resiliency with Clean Energy



U.S. DEPARTMENT OF ENERGY

Strengthening Resiliency through Clean Energy

Better Buildings Summit

Andrew Peterman | 28 May 2015 | Washington DC, USA

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What is resilience?

Resilience is more than Disaster Risk Recovery

THE ROCKEFELLER FOUNDATION ARUP

Resilience is the capacity of people, organizations and systems to prepare for, respond to, recover from and thrive in the face of hazards, and to adapt to continual change.

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Why Resilience?

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Land availability
Water scarcity
Availability of skills
Decision making
Lack of diversity
Lack of funds
Migration
Lack of open space
Disruption to business
Hurricane
Drought
Labour crisis
Landslides
Trust in government
Ground subsistence
Pollution
Power-failure
Lack of data
Capacity of health services
Transport connectivity
Contamination
Access to finance
Traffic congestion
Uncoordinated of effort
Planning
Land availability
Epidemic
Housing
Crime
Flood
Flood management
Growth
Corruption
Earthquake
Governance
Sewage buildup
Public health
Unemployment
Damaged infrastructure
Panic
Economic crisis
Fires
Disease
Resource scarcity
Communal tension
Terrorism
Trust
Disruption to business
Energy
Religion
Education
Awareness
Density
Corruption
Illiteracy
Trust in policing
Food
Environmental degradation
Civil Unrest Violence

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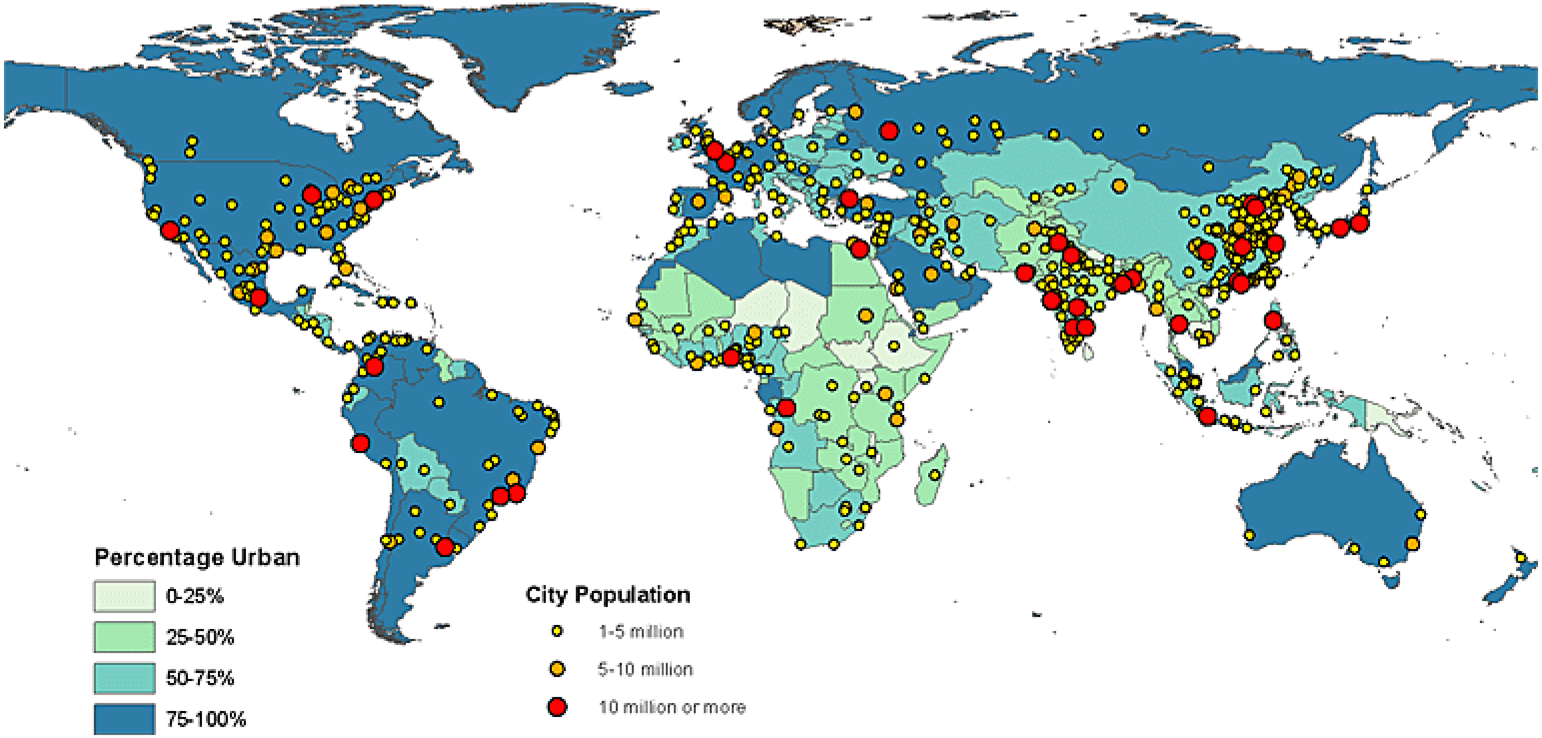
Increasing urbanization

Increasing urbanization



Source: United Nations, Department of Economic and Social Affairs, Population Division: World Urbanization Prospects, the 2011 Revision. New York 2012.

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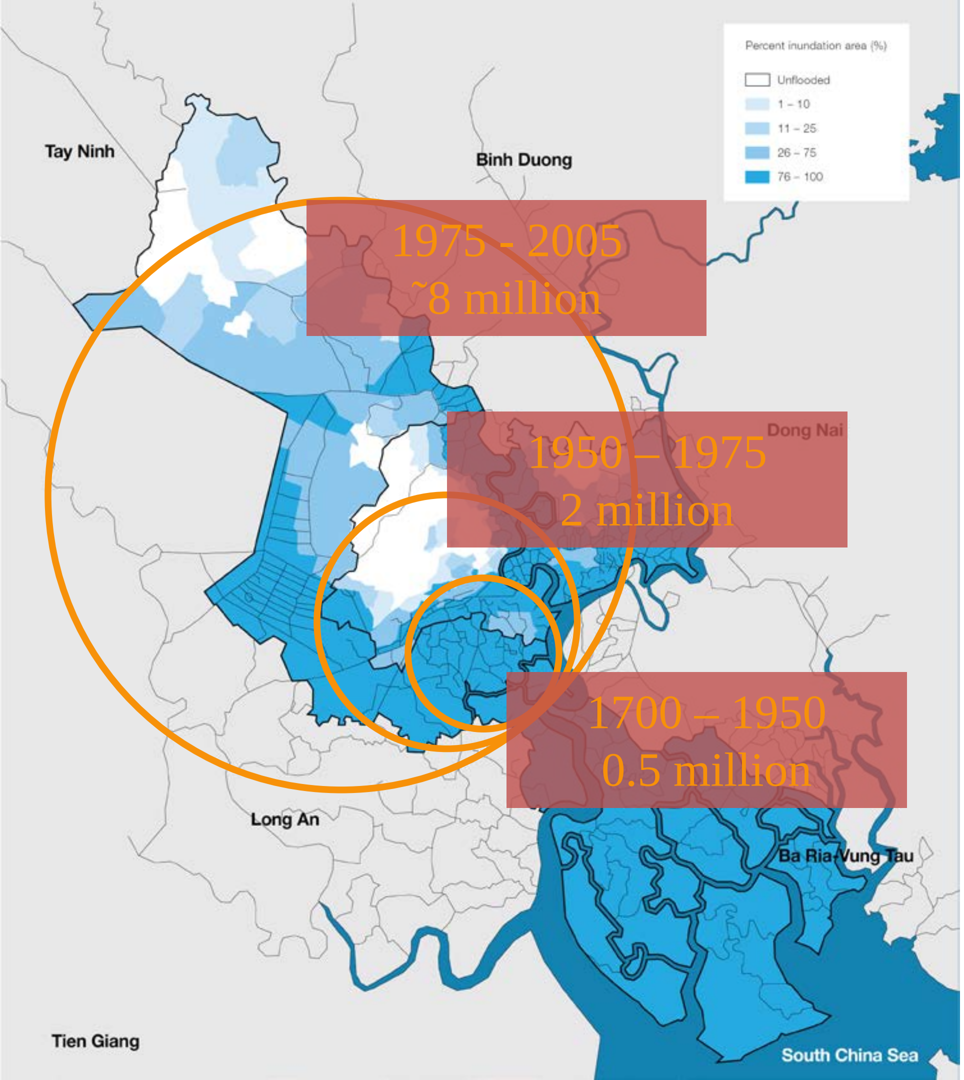

Cities expanding into risk zones

Ho Chi Minh City and other fast-growing urban zones are developing into risk areas.

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Increasing and changing hazards

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Increasing natural disasters

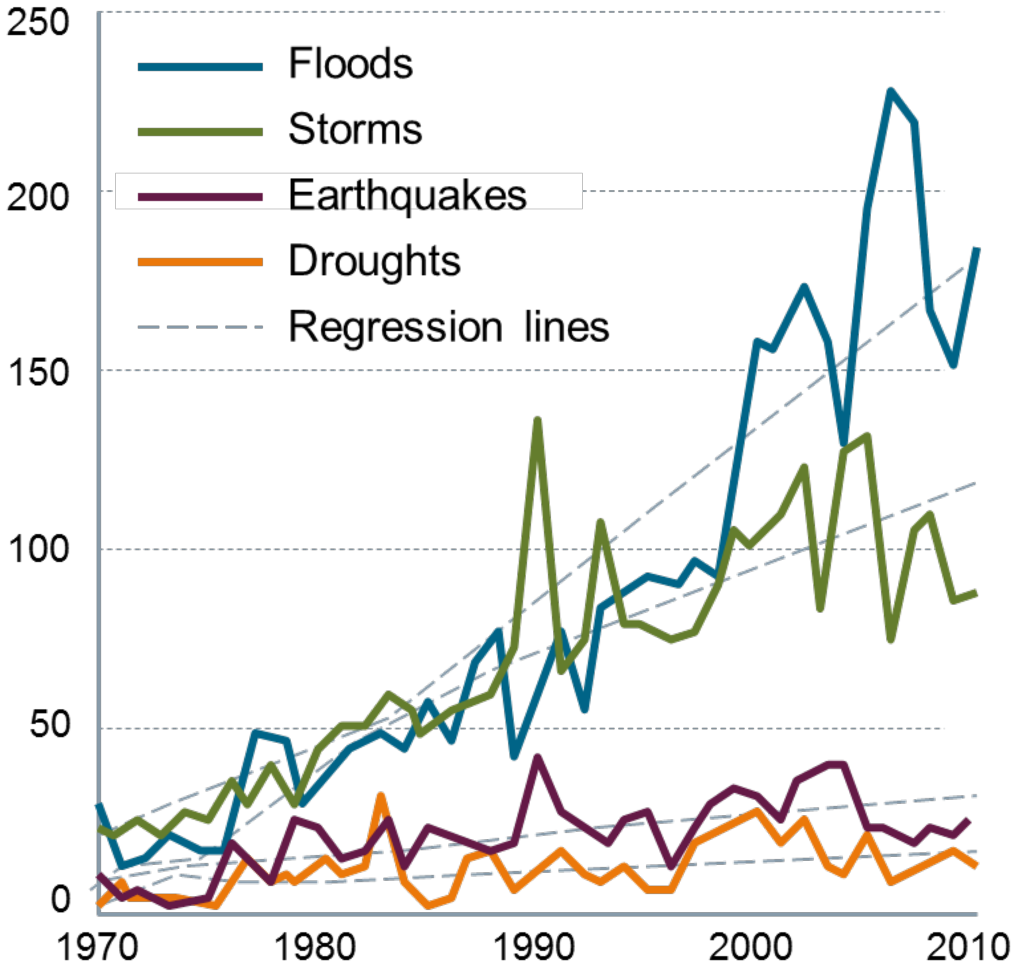

Figure 1: Number of recorded disasters
Source: EMDAT-CRED, Brussels

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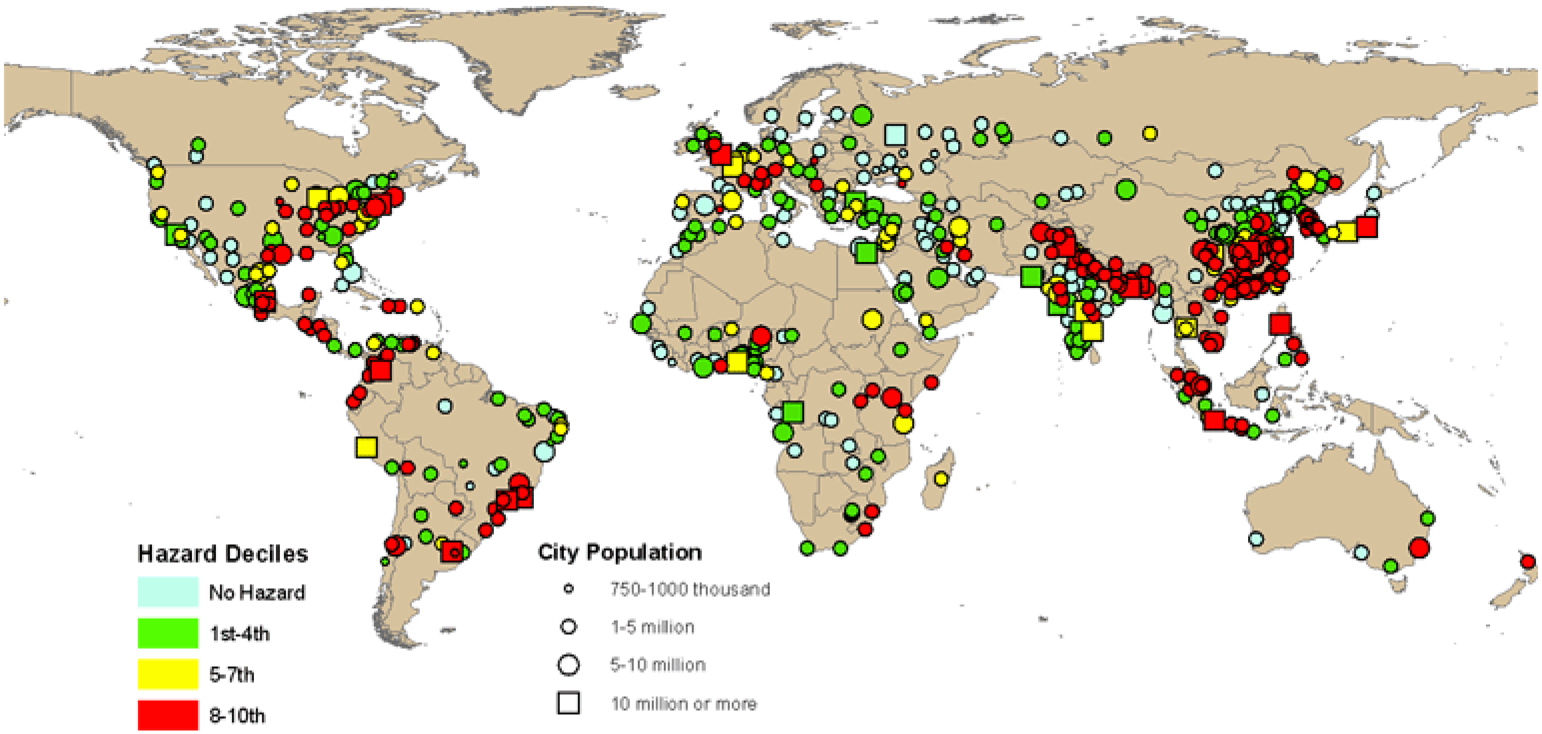
Increasing flood risk



Source: United Nations, Department of Economic and Social Affairs, Population Division: World Urbanization Prospects, the 2011 Revision. New York 2012.

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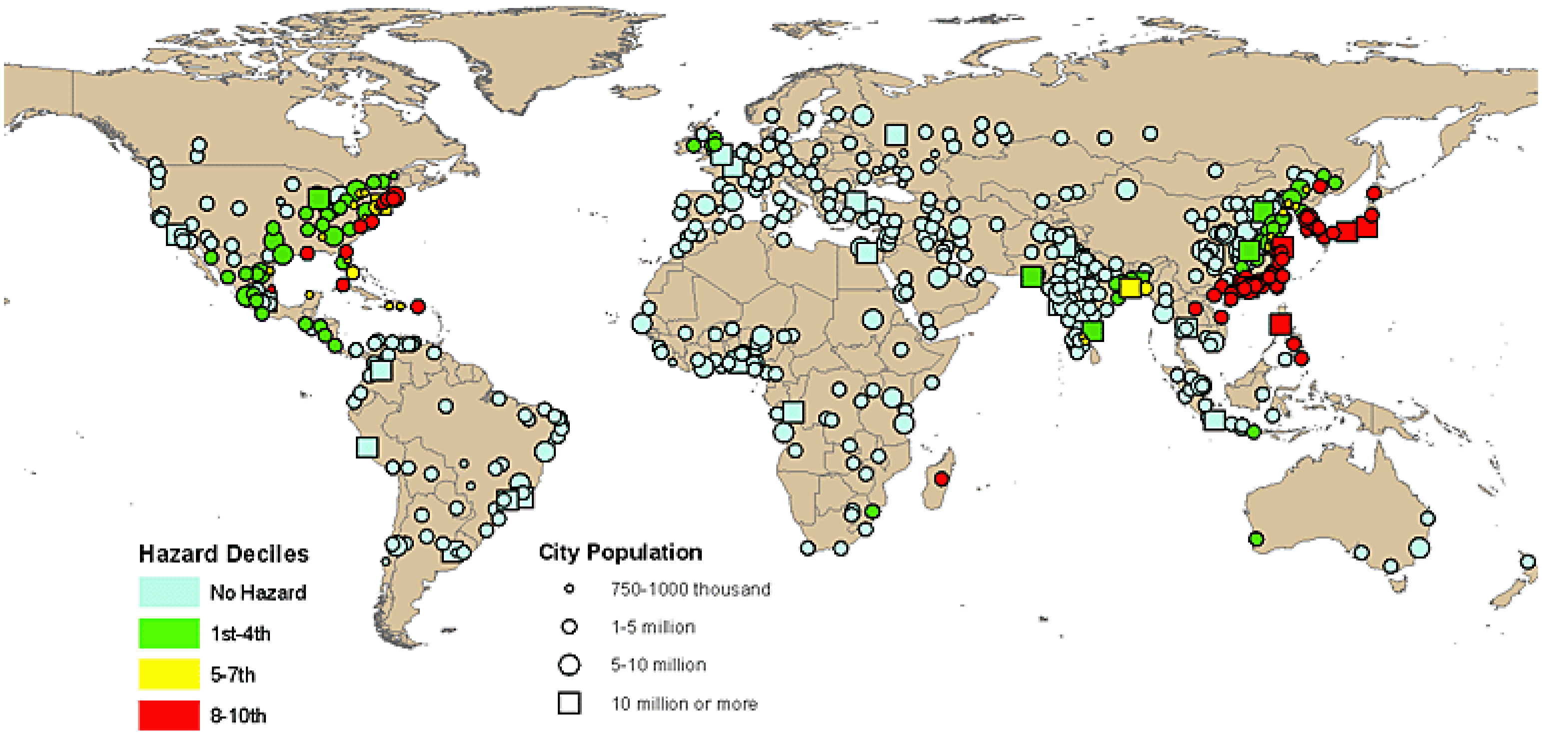
Increasing hurricane risk



Source: United Nations, Department of Economic and Social Affairs, Population Division: World Urbanization Prospects, the 2011 Revision. New York 2012.

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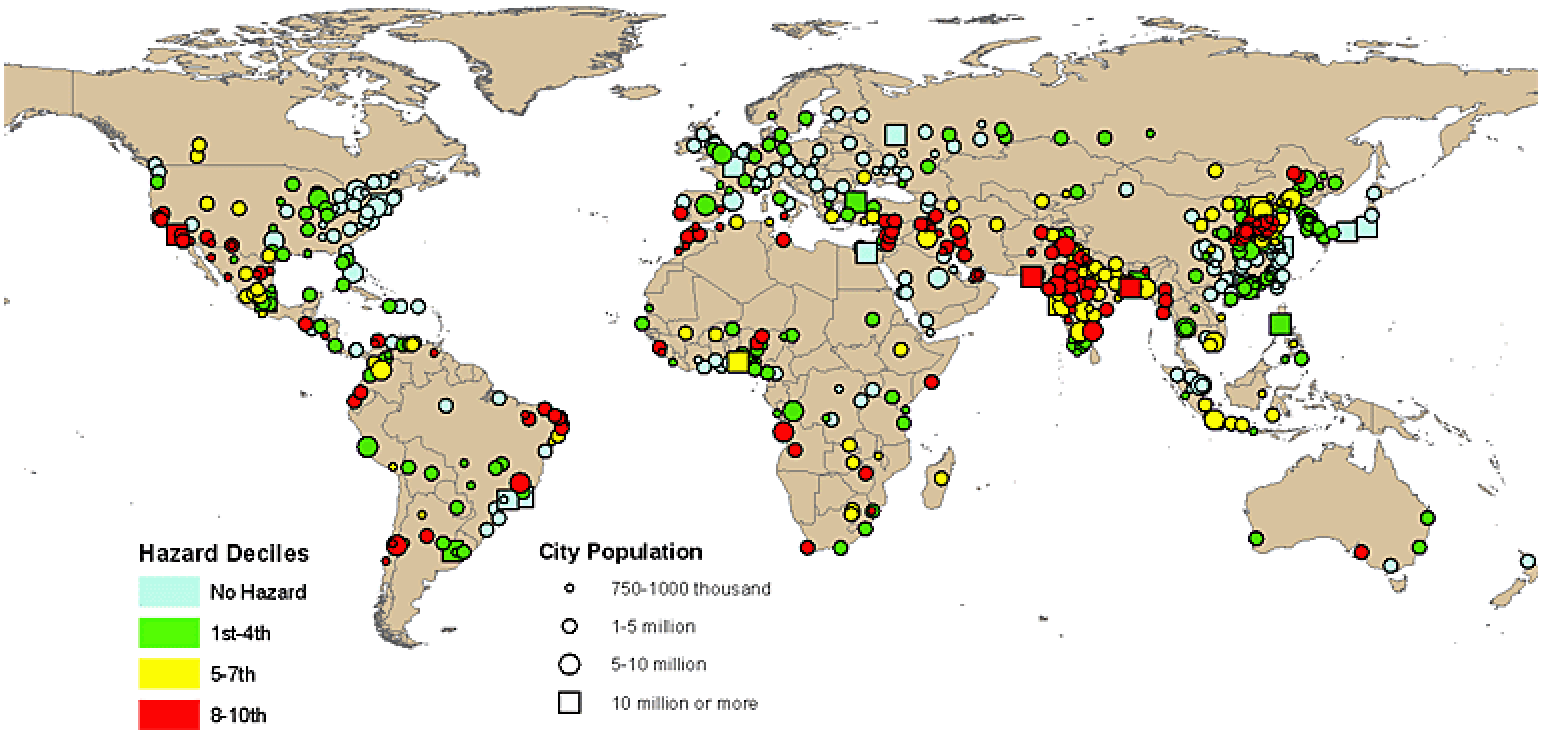
Increasing drought risk



Source: United Nations, Department of Economic and Social Affairs, Population Division: World Urbanization Prospects, the 2011 Revision. New York 2012.

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Other Vulnerabilities

Aging infrastructure

High density

Lack of preparedness

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How can we measure City Resilience?

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New York City Energy Resilience

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Changing Frequencies (New York City)

Frequency of Occurrence	Flooding Events	Drought	Heat Wave	Wind events (Nor'easter, Hurricane)
Past (1970-2000)	• 1 in 100 years	• 1 in 100 years	• 2 per year	• 1 storm per 3 years
Projected Future	• 1 in 15 years	• Unclear	• 8 per year	• More frequent

Source: NYC Panel on Climate Change, 2009; ClimAID, NYSERDA, 2012.

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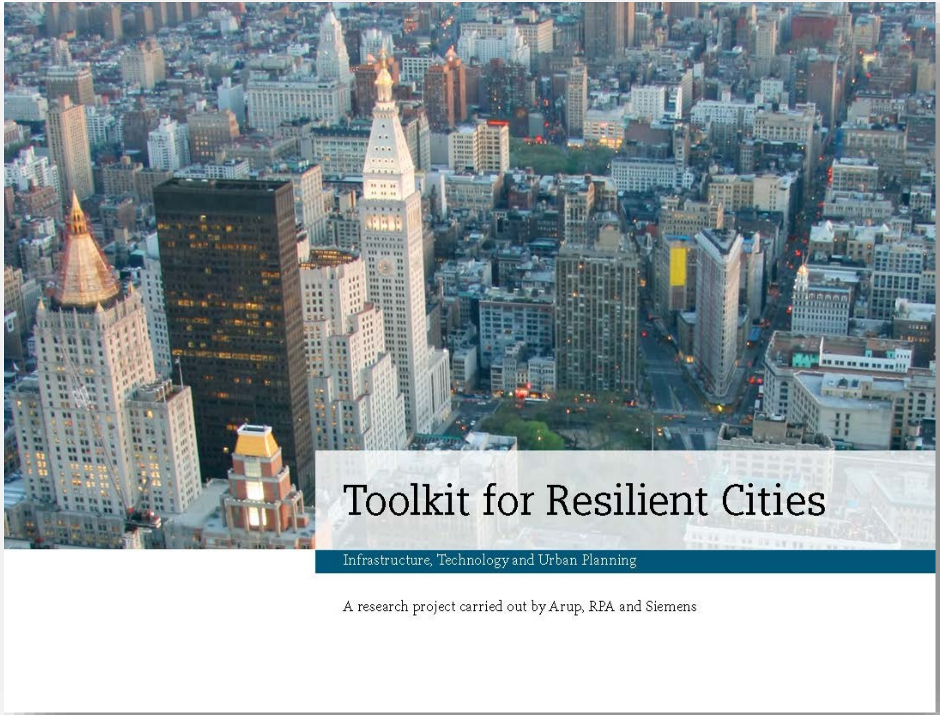
Toolkit for Resilient Cities

Siemens, RPA and Arup



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Case Study: New York City Electrical Grid

High-level review of vulnerabilities in the NYC electrical grid and assessment of impacts from four types of natural hazards:

- Drought
- Heat wave
- High winds
- Flooding

From an analysis of threats to the grid a wide range of investment options were developed, including:

- Equipment hardening
- Peak demand reduction
- Smart grid implementation

Contribution of potential investments to advancing resilience characteristics

Robustness	Gas insulated switchgear Flood proofing and water proofing Undergrounding Hydrophobic coatings Fuse saving technologies Voltage/VAR controls
Redundancy	Battery storage Vehicle-to-grid Demand reduction and energy efficiency
Diversity and flexibility	Distributed generation Intelligent feeders and relays Automated switches Battery storage Vehicle-to-grid
Responsiveness	Advanced Metering Infrastructure (AMI) including smart meters Automated Demand Management Intelligent feeders and relays Automated switches
Coordination	Advanced Metering Infrastructure (AMI) Geographic Information Systems (GIS)

Why Corporate Resilience?

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Large Portfolio Resilience

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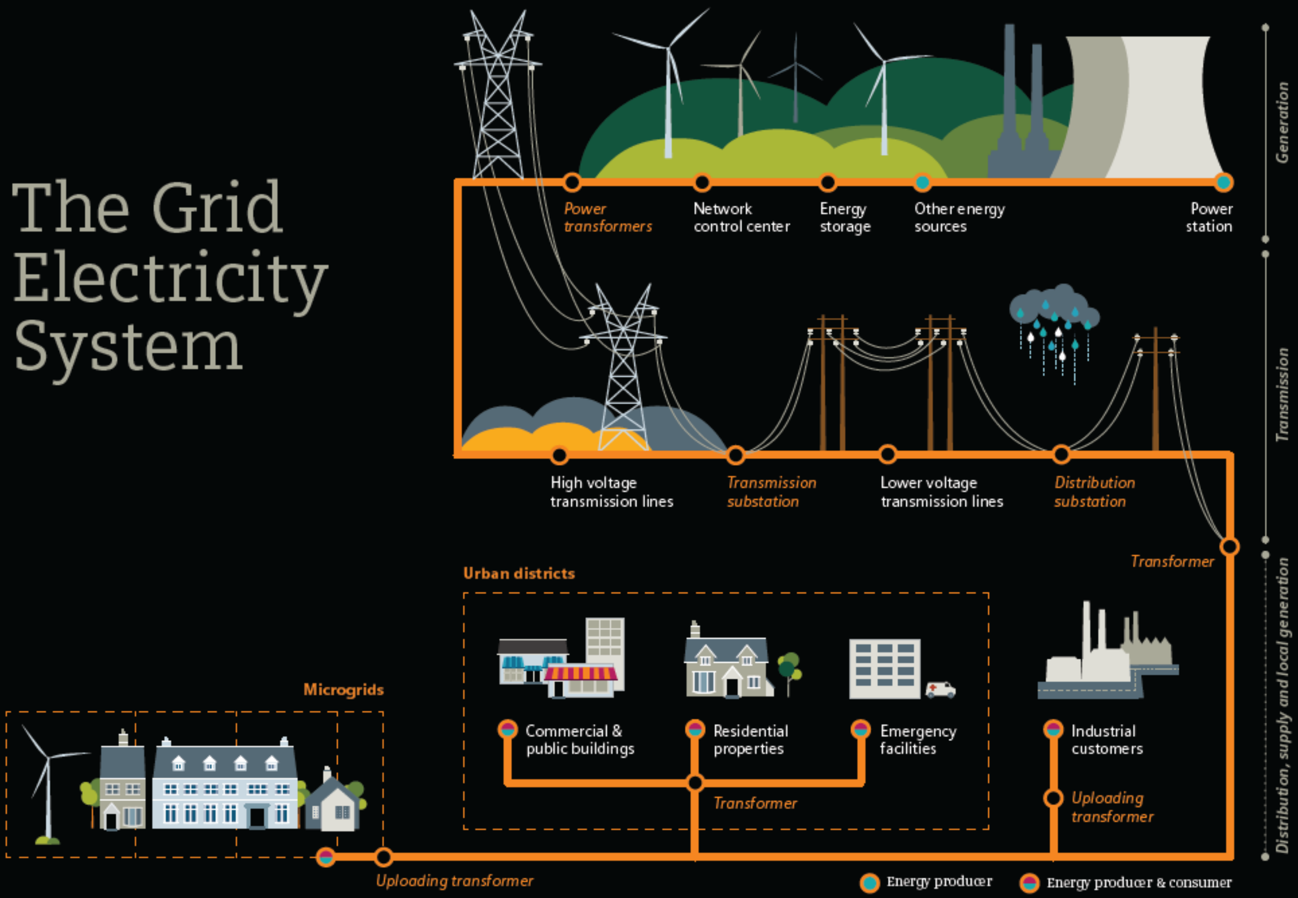
The Grid Electricity System



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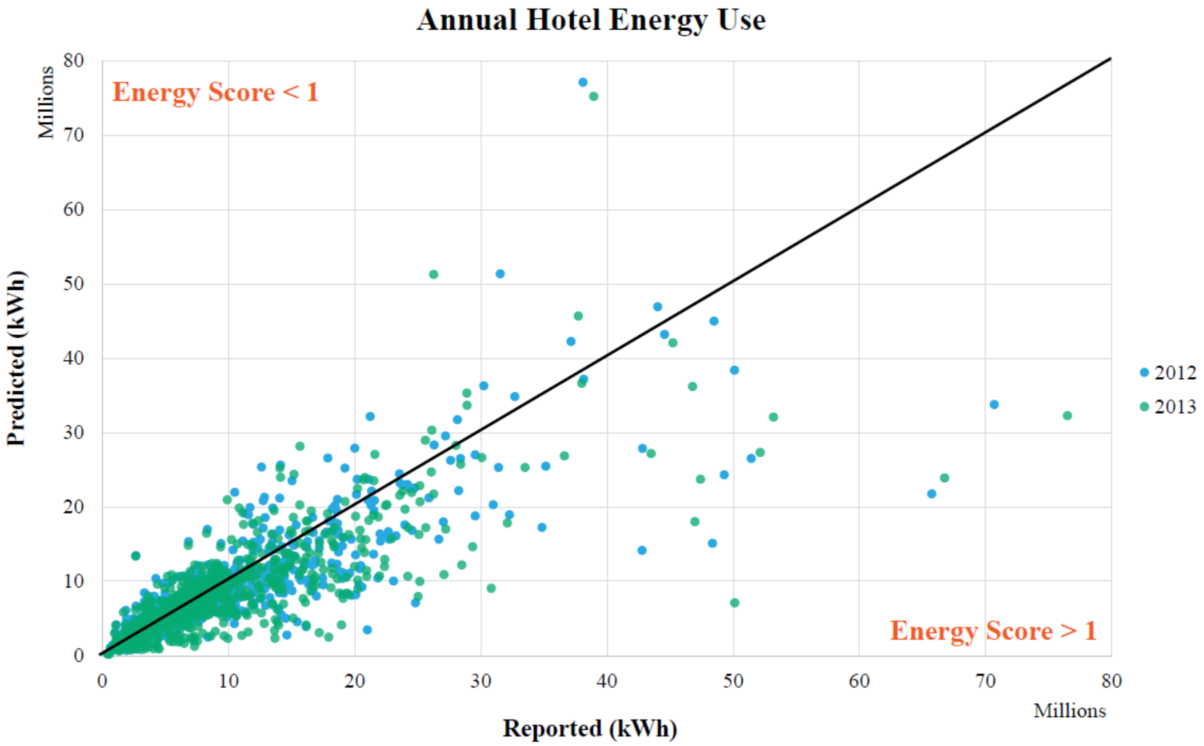

Data-driven approach to energy resilience

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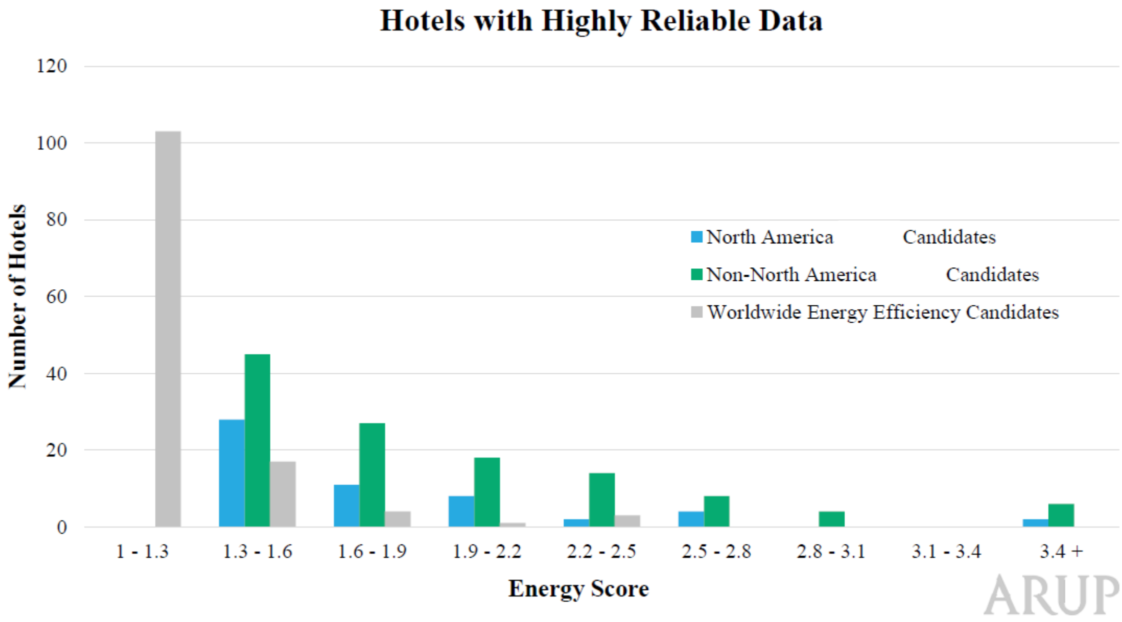
		Arup Energy Score	Difference Between Reported Energy Use & Predicted	Number of Hotels
North America	Candidates	≥ 1.3	≥ 1,000,000 kWh/yr	57
Non-North America	Candidates	≥ 1.3	≥ 1,000,000 kWh/yr	122
Worldwide Energy Efficiency Candidates		≥ 1.0	0 - 1,000,000 kWh/yr	126



Increasing resilience *through* energy efficiency

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Conclusion

- 305 properties across a global portfolio were identified as potential candidates for energy efficiency investment, consuming more energy than expected over the past 2-3 years (nearly 25% of the portfolio).
- The 305 poor energy performing buildings represent over $300M in total energy costs per year.
- Bringing all properties in line with their expected performance would reduce portfolio-wide energy consumption by 1,100 GWh per year.

Resilience Trend

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HABITAT MANAGEMENT

We propose the protected nature preserve to be managed and maintained by the Department of Parks in collaboration with the learning center as the learning center provides educational programs within the nature preserve and adjacent park. The conference center can generate revenue for funding of the learning center and the maintenance of nature preserve. We envision the Department of Parks and Recreation to be the owner of the parks and provide funding generated on site for the high-level maintenance of the parks.

LEARNING CENTER

The protected nature preserve provides an undisturbed natural habitat for local flora and fauna with raised boardwalks for educational viewing that is supported by the learning center. The learning center provides valuable education programs for school children, including the community gardens and ecosystem education. The site, especially close to the nature preserve, offers a fantastic retreat location for a conference center, with its close proximity to public transportation, JFK airport, and Manhattan. We see opportunities to combine the Learning Center with the Conference Center as the functional requirements are similar and the programs carefully designed benefit each other. The conference center could create revenue for funding of the learning center and the maintenance of public space within the development.

We propose the protected nature preserve to be managed and maintained by the Department of Parks as suggested previously by the Final Environmental Impact Statement of 2003. The learning center can provide collaborative services for habitat management, and provide educational pograms within the nature preserve and adjacent park. The conference center can generate revenue for funding of the learning center and the maintenance of nature preserve.

TOWN SQUARE

A new town square is located at the boulevard connecting Beach 44st Station directly to the boardwalk and the beach beyond. In addition to being a main attraction for visitors to the Rockaways, this boulevard forms the center of the development with public and commercial functions. The Arverne East Center creates a focal point for the development with taller building types. The boulevard extends to the north side of the A-train overpass, where it connects to, and serves, the adjacent housing area. It also provides opportunities for future development north of the A-train overpass. As the town square stretches toward the beach it forms a plaza, a platform for urban leisure, culminating in a pier that extends over the sea.

The Arverne East community heart can be celebrated with a building that expresses the aspiration of: warmth, friendliness, colorfulness and community. This building will provide a focal point and an identity to encourage visitors to enjoy the Rockaway beaches and associated facilities.

COMMUNITY CENTER

The building has a transparent façade to clearly communicate its function to the community. The southern façade cantilevers slightly outwards to introduce the building from the boardwalk and the central boulevard and also to reduce undesired warming by direct sunlight. The multifunctional Community Center houses, supports, and enables community organizations and initiatives such as children activitites, cultural groups, religious observance and senior services.

PUBLIC LANDSCAPE

The landscape is shaped, respecting the existing site conditions. A set of unique public spaces, small and large scale, are designed to provide diverse functions and resistance to stormwater.

The most generous space is dedicated to the nature preservation area to the west; it is fenced and designed give protection to flora and fauna. Here, running tracks and nature promenades connect the urban fabric to the learning center and a Bird watching tower. Adjacent to the nature preserve, a natural playground shapes the transition to the sport fields, allotment gardens and one of the two stormwater parks. These stormwater parks represent the key concepts of the overall masterplan. These parks are multifunctional spaces, providing areas for social activities, from picnic to ball games, and foremost the parks play an important role to the concept for hurricane resiliency. Due to the lowered topography and their scale, they are able to break down water flows into smaller streams and serve as retention areas. These stormwater parks also handle heavy rainfall. Activities, which require a continuous protection, are placed on elevated areas within the masterplan. These are for example playgrounds for kids, a teaching orchard, pocket parks and recreational zones, ranging from urban farming to outdoor fitness areas.

The ecological backbone is the wetlands found in the north east corner of the site, lowered to about 4 ft., they have the ability to handle large amounts of stormwater or serve as buffer zones during flooding. The most active social meeting point however, is the town square with the adjacent beach theater and pier. Here we expect an intense social life, created by local entrepreneurs and a strong community desire. This public space provides the opportunity for a farmers market, public shows, concerts and so on. The close proximity of public transport, a close connection to the beach, and the sea frontage all add to the potential commercial and social success of this urban realm.

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USDOE Better Buildings

Strengthening Resiliency with Better Buildings

Michael Winka – Sr Policy Advisor
New Jersey Board of Public Utilities
aka the New Jersey State Energy Office

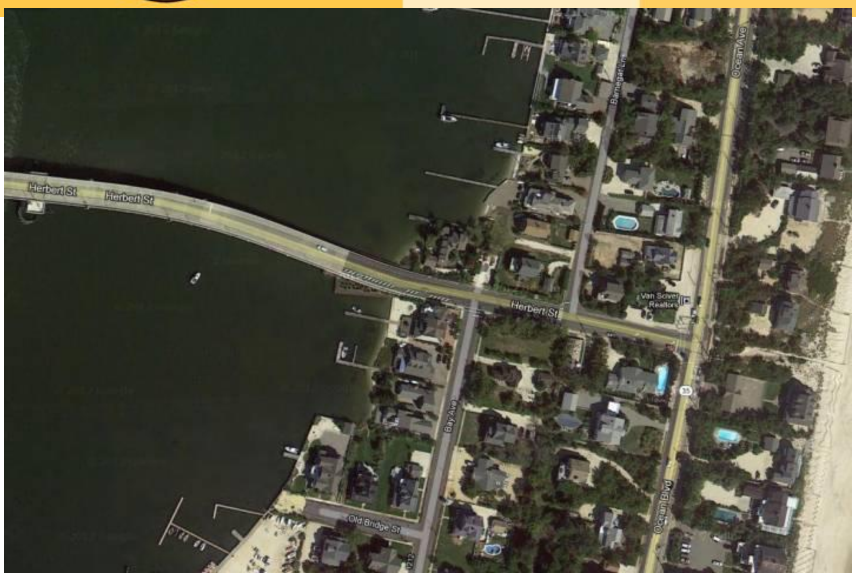
May, 2014

Resiliency and Better Buildings

- Background on the storm and the reason for DER
- What is DER and Microgrid
- Background on the current system
- Costs and benefits of DER Microgrids
- NJ Financing/Incentive Programs

SOURCE: NASA GSFC

Breach at Rte 35 Mantoloking



Before

After

Houses destroyed in Tuckerton Beach

Poles down across the state – Grid down

Impacted Liquid fuels

Critical Infrastructure Flooded and without power

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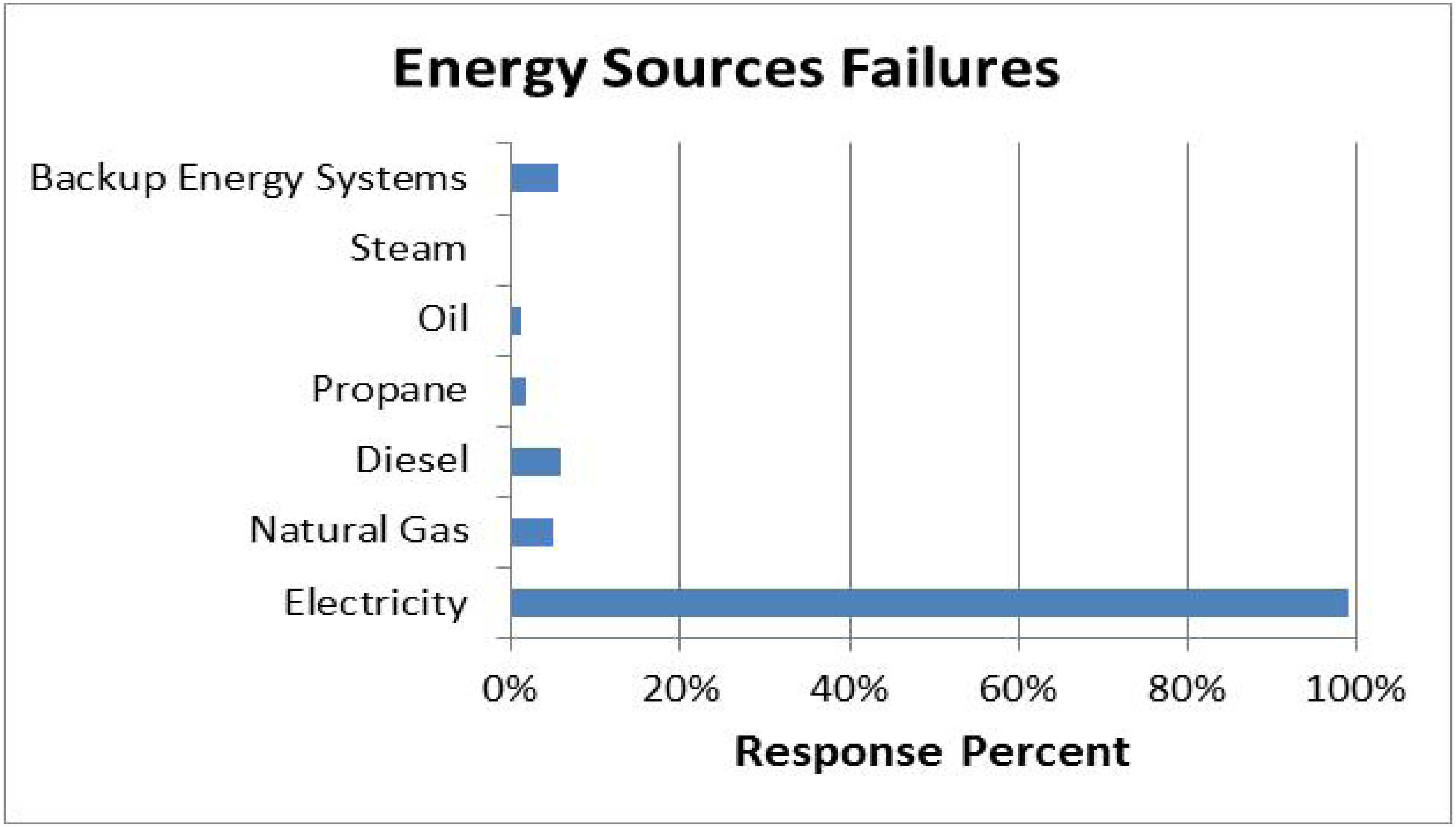
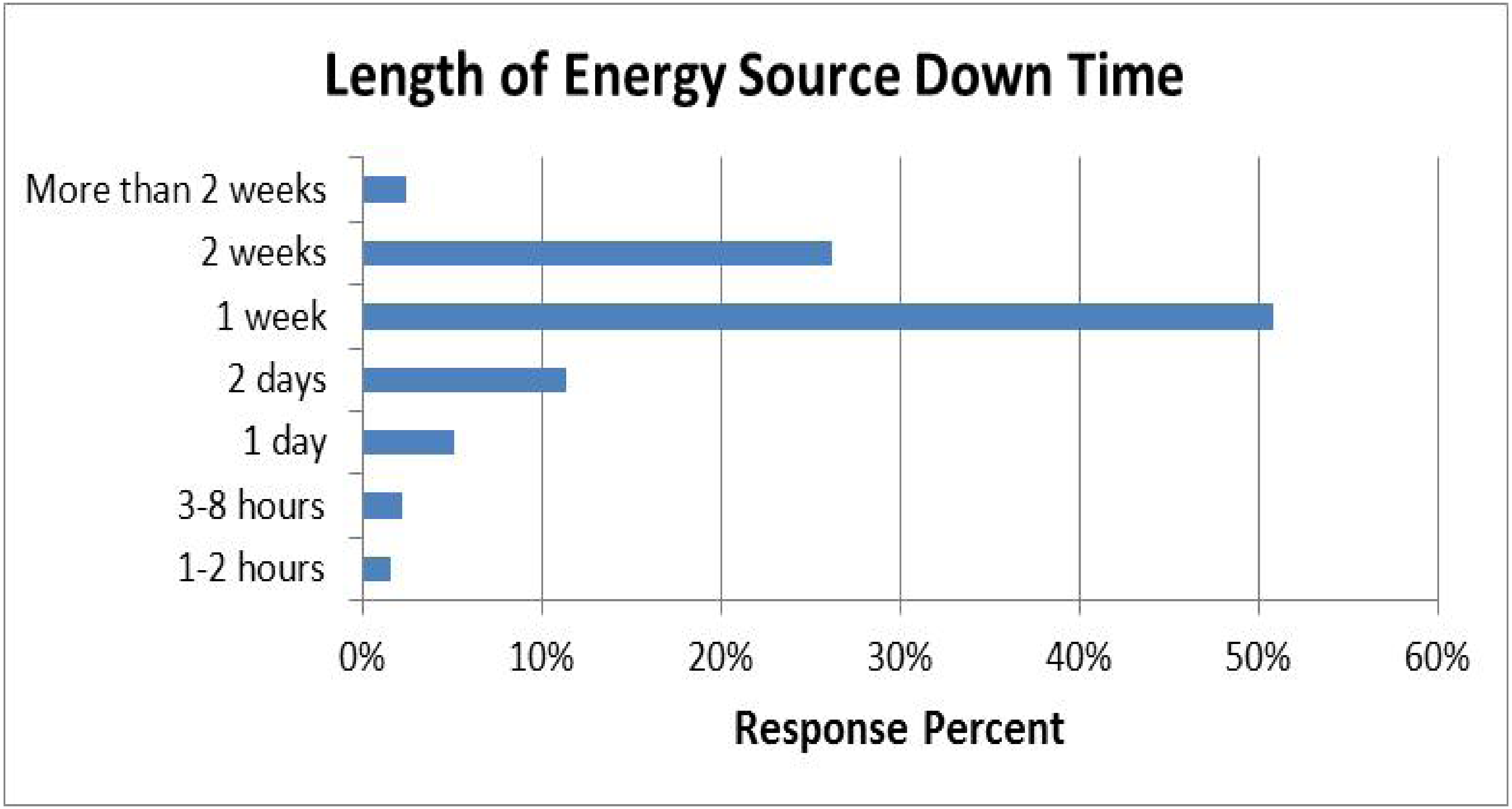


From NREL Survey - Alternative Energy Generation Opportunities in Critical Infrastructure *New Jersey*

E. Hotchkiss, I. Metzger, J. Salasovich, P. Schwabe



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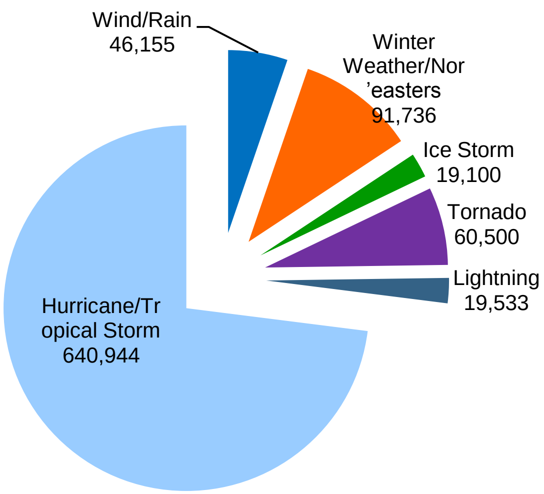
Breakdown of Storm Event "Types" and their respective Mean Outages (1985 – 2013)



Mean # of Outages Per Storm Type

	# 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**		

Table 1: Database storm event totals and proportion of storm types/mean outages; from CEEEP Storm Events Database)

Outages refer to outage for a meter and not for a consumer

Breakdown of Storm Event "Types" and their respective Mean Outages (1985 – 2013)

All Storms – Outages: 1985 - 1995

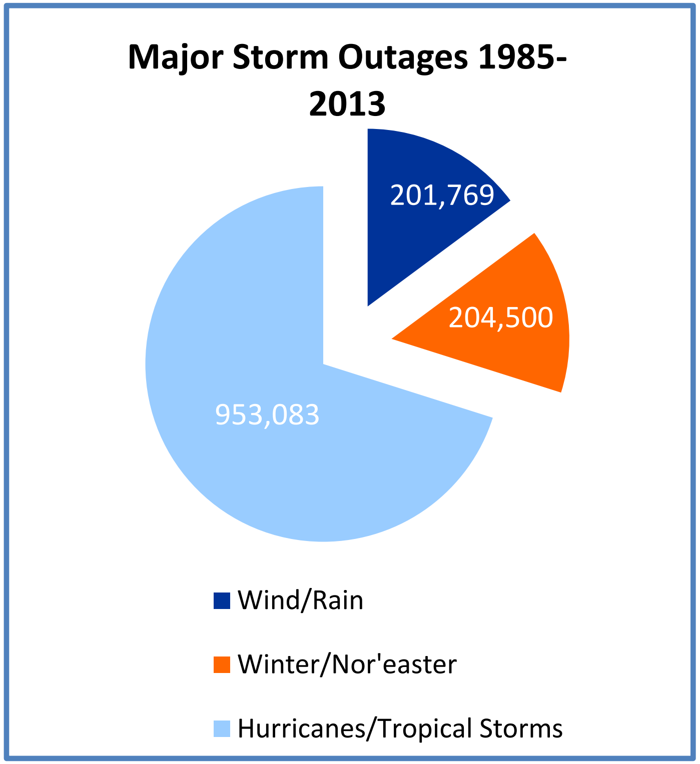
Storm Type	Total # of Storms	Total # Outages
Hurricane/ Tropical Storm	2	277,000
Winter Weather/ Nor'easter	2	140,000
Wind/Rain	Not Reported	Not Reported
Ice Storm	Not Reported	Not Reported
Tornado	Not Reported	Not Reported
Lightning	Not Reported	Not Reported
Total	**6**	**417,000**

All Storms – Outages: 1996 - 2013

Storm Type	Total # of Storms	Total # Outages
Hurricane/ Tropical Storm	7	5,491,500
Winter Weather/ Nor'easter	20	1,878,200
Wind/Rain	96	4,430,900
Ice Storm	5	95,500
Tornado	2	121,000
Lightning	9	175,800
Total	**139**	**12,192,900**

No consistent data available over long period in the way that storms have been reported. The reporting of outages for more types of storms is apparent in these two year brackets.

"Major Storms" 1985 – 2013: 100,000 + outages reported/ event



	# 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**		

Table 2: "Major" Storms and their outages (by totals, proportion, and mean outages); from CEEEP Storm Events Database)

Resilient Energy System

Are Back-up Generators the Answer?

Is 14 days the ability to spring back or recover quickly?

There is a better way –

if we plan for local energy resiliency

There were locations in New Jersey that operated
During and after the storm when the grid was down

And not just with a diesel generator

Clean Distributed Generation that can
operate 24/7 under blue skies
and Islanded from the grid
when there is an emergency – a Microgrid

DER Potential Resiliency Response to Superstorm Sandy Size of the NJ DER Market DER Microgrids

New Jersey current DER		
DER	**Number of Systems**	**MW**
CHP/FC total	219	2,900
CHP/FC DG	68	309
CHP/FC (renewable)	15	15
PV total	27,866	1,273
PV (grid supply)	115	245
PV behind the meter	27,751	1,028
Total DG	**27,834**	**1,352**

Total DG generates approx. 3,534,000 MWh of electricity annual or approx. 4.4% of NJ total electricity
No PV currently can operate in island mode and 80% of new CHP/FC are designed to be islandable.

Definition of DER or DG

Distributed energy consists 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 consumers or end user.

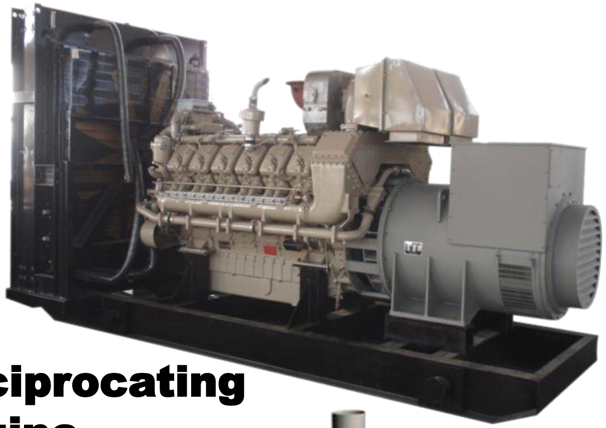
Definition of Microgrid

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. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.

Types of DER

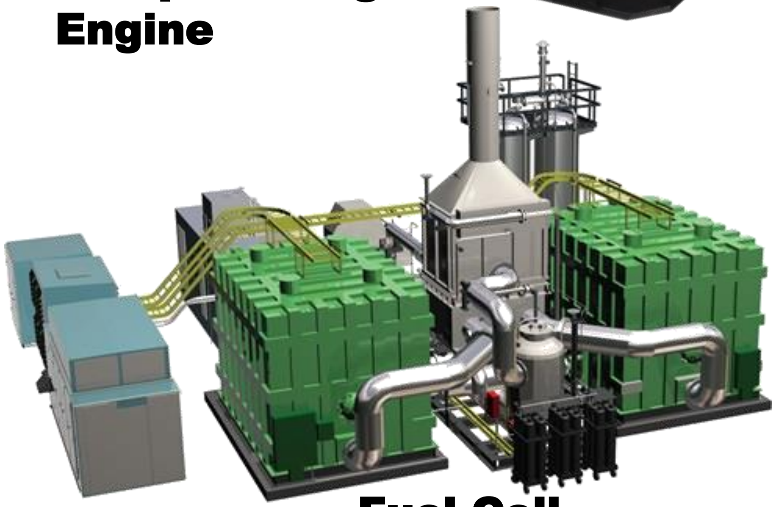
Solar Photovoltaic
Wind Turbines
Engine Generator Sets
Turbine Generator Sets
Fuel Cells
Batteries
Capacitors
Flywheels
Thermal Storage
Ice Storage
Solar Thermal

Examples of DER – Electric Generation

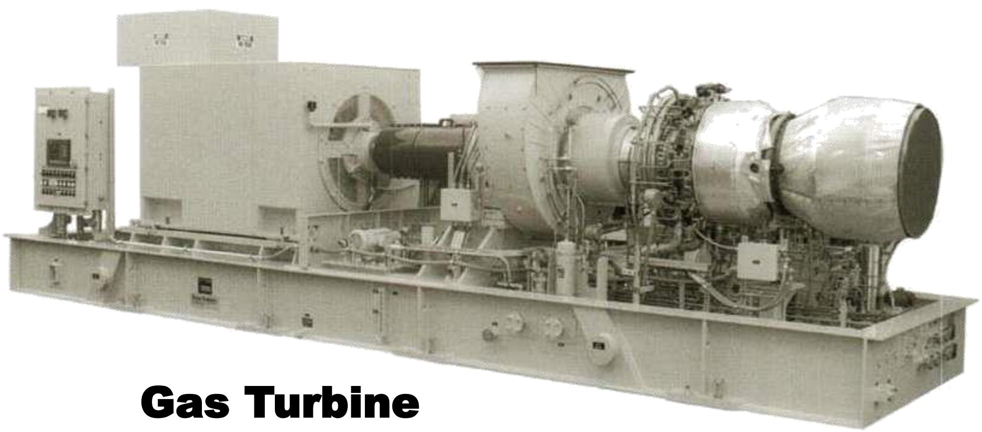


Reciprocating Engine

Microturbine



Fuel Cell



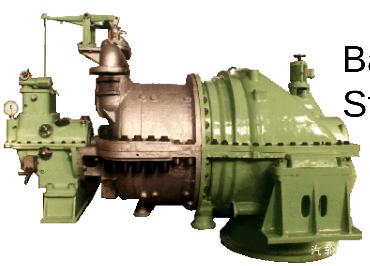
Gas Turbine

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

Cooling Technologies



Back Pressure Steam Turbine

Power Generation Technologies

Heat Recovery Steam Generator

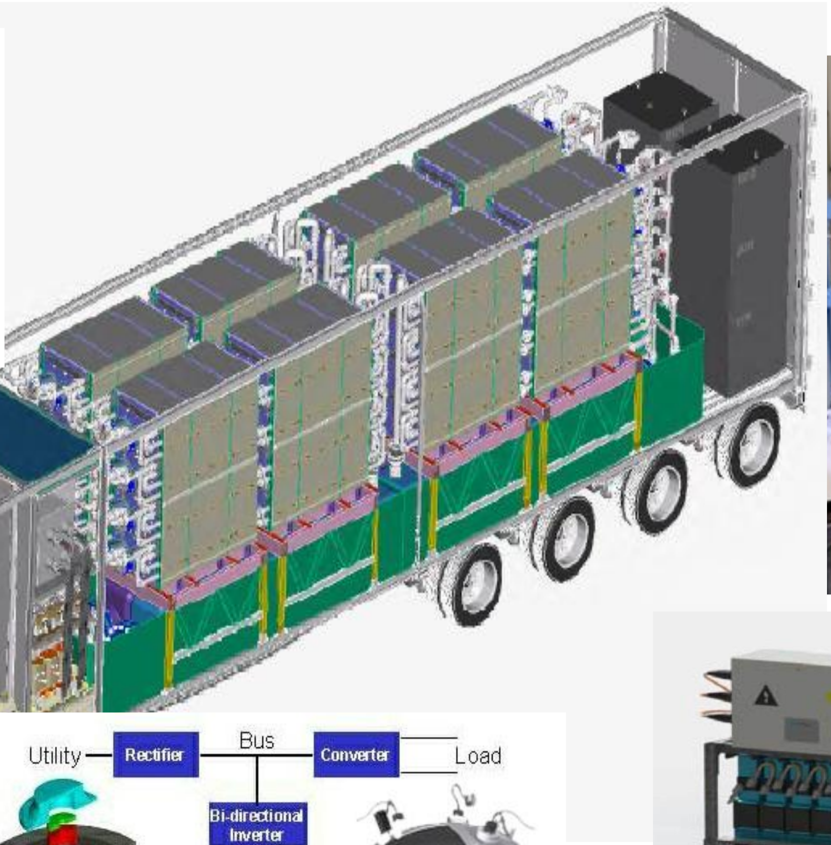
Exhaust Gas Heat Recovery Boiler

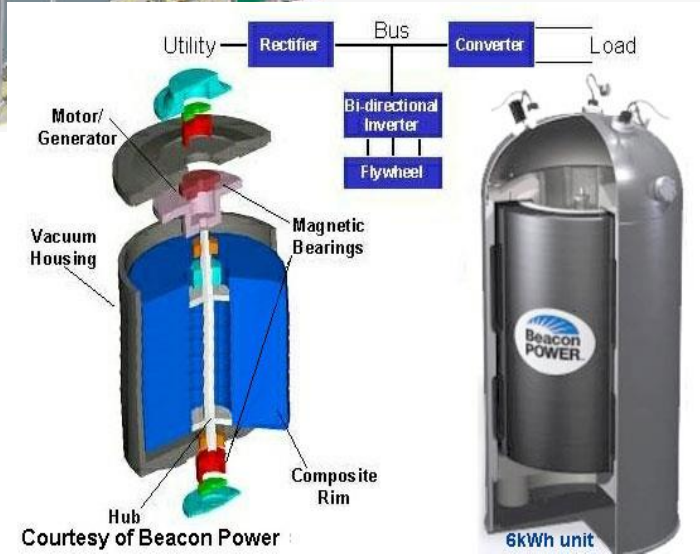
Shell & Tube Heat Exchanger

Plate & Frame Heat Exchanger

Heating Technologies

Electric storage

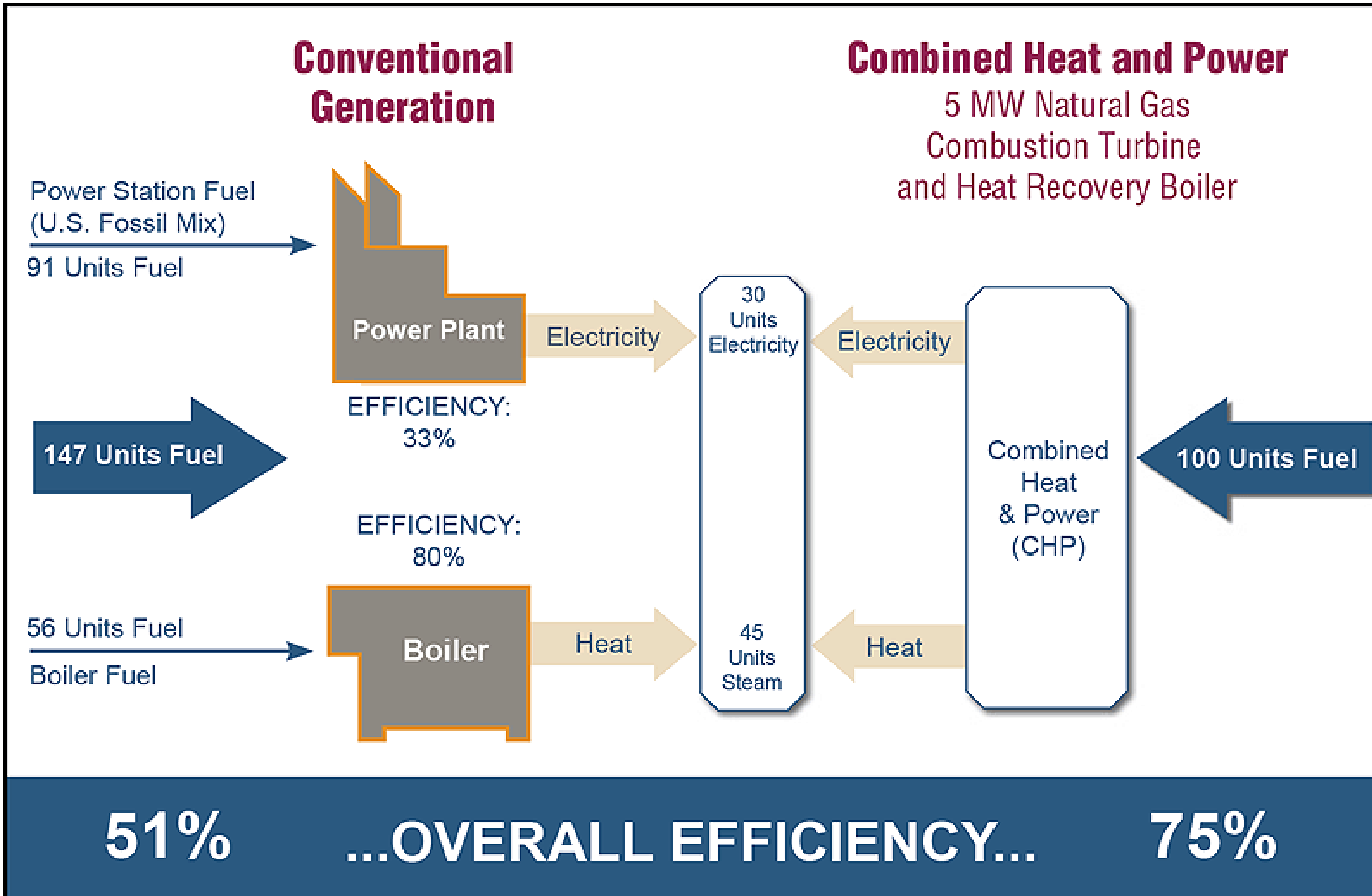




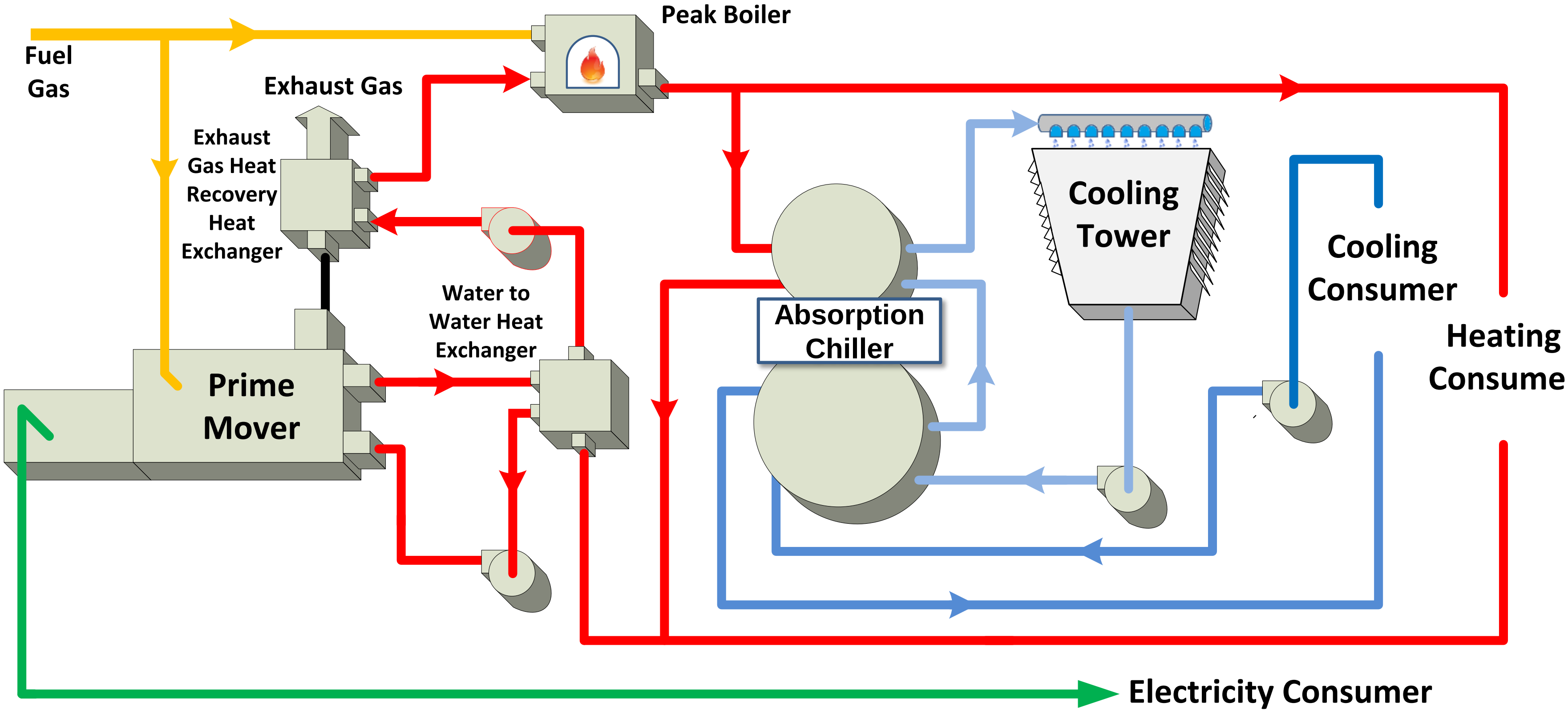
Courtesy of Beacon Power

Thermal Storage

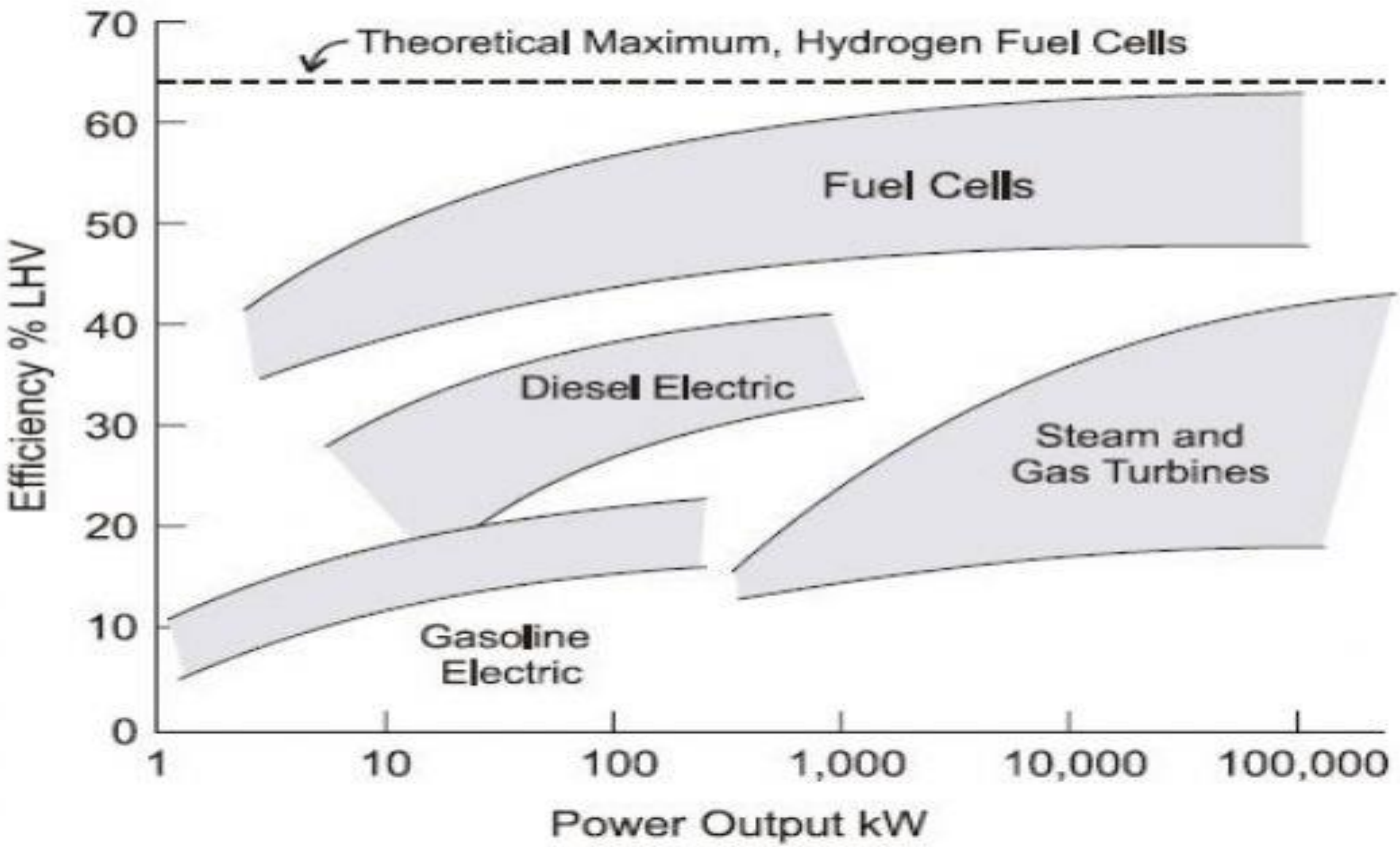
Energy Benefits of DER Combined Heat and Power



Combined Heat & Power System includes Cooling



Benefits of Distributed Fuel Cells



Efficiency Comparison (www.micro-vett.it)

Costs of Backup Generation vs DER

Backup or Standby Generators - $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 hour of runtime)

Why DER – Benefits fourfold

1. **Energy Efficiency - Saves energy uses waste heat – less D&T line losses (avoided GD&T cost to Utilities)**

2. **Environmental Benefits – Lower emissions that system marginal rate NOx, SO2, Hg, CO2**
   Less waste/water usage/wastewater discharge/less land use impacts - MACT standards for boilers

General permit <3 MW (NG) PBR for 500 kW FC

Why DER – Benefits fourfold

3. Economic benefits – jobs and manufacturing competitiveness - hurt in 2008 recession but rebounding Large-scale CHP with NJ EDA

4. Resiliency – operates 24/7 under blue skies and can island and blackstart when the grid is down. Office Emergency Management (FEMA)

Your facility is a good candidate for DER if…

- **You pay more than approximately $.10/ kilowatt-hours on average for electricity (including generation, transmission, and distribution)**
- **Your facility operates for more than 5,000 hours/year**
- **You have thermal loads throughout the year (including steam, hot water, chilled water, hot air, etc.) Does your facility have an existing central plant?**
- **You anticipate a facility expansion or new construction project within the next 3-5 years**
- **You have already implemented energy efficiency measures and still have high energy costs**

Good Facility Candidates for DER
Good Candidates for DER for Resiliency

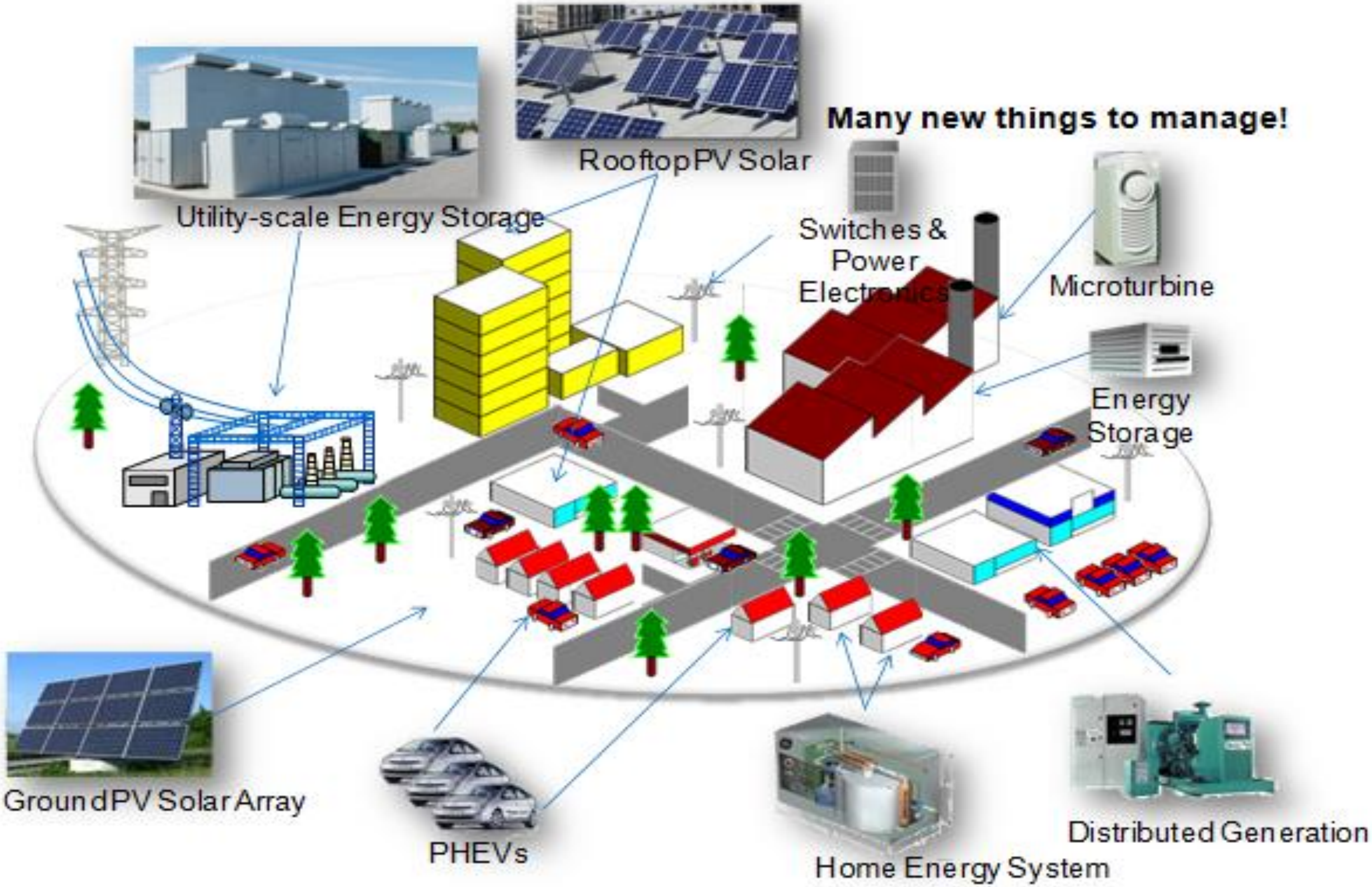
Strong Candidates

- Healthcare (hospitals and long term care facilities)
- Industrial and Manufacturing
- Hotels/Lodging
- Data Centers
- College and Universities (campus settings)
- Multi-Family Housing
- Water Wastewater Facilities

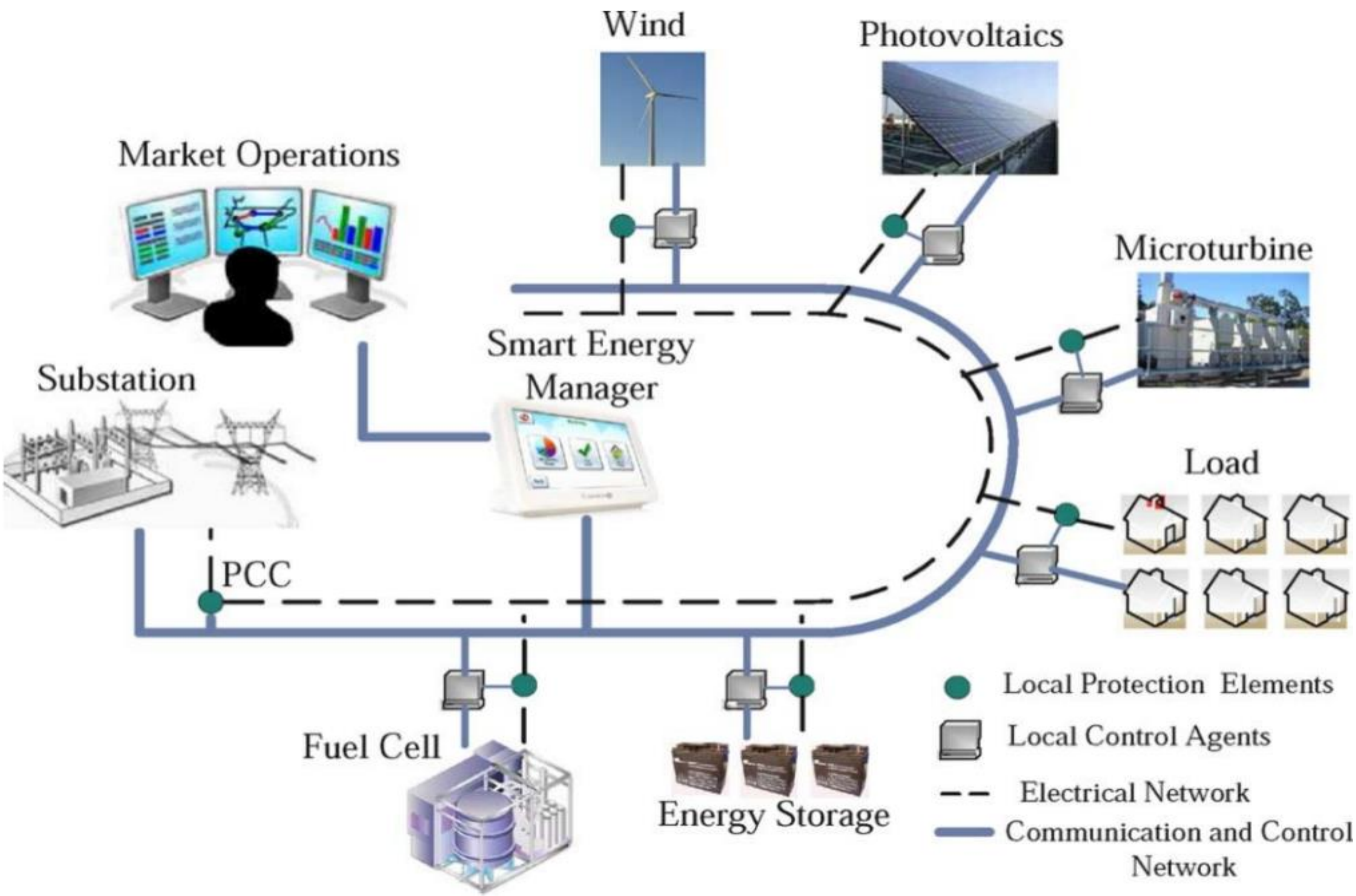
Potential Candidates

- Commercial Office Buildings
- K-12 Education Facilities
- Government and municipal facilities
- Retail Establishments
- Health Clubs

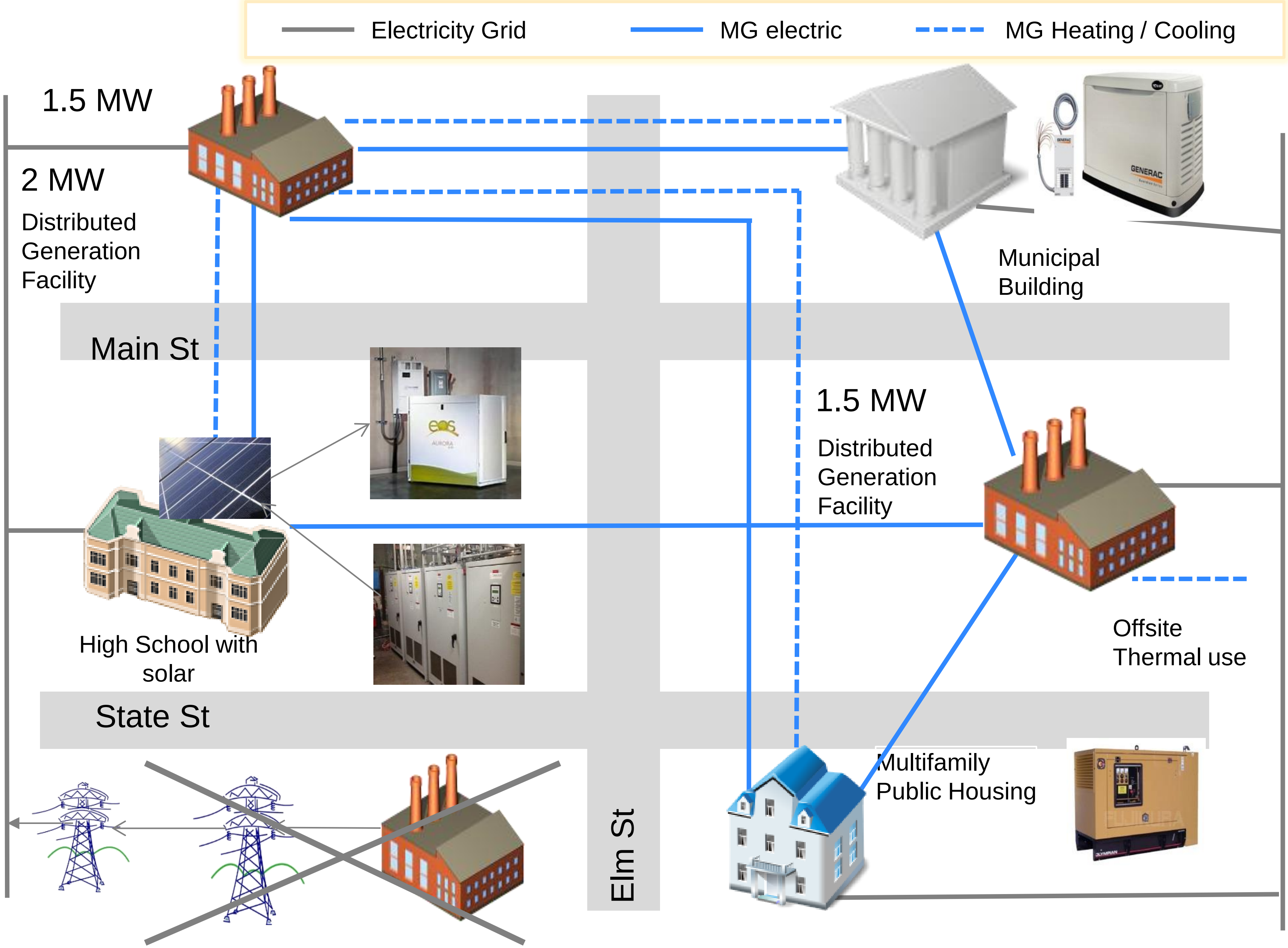
Types of MG Distributed Generation or Distributed Energy Resources



Who will operate the MG to get electrons where they are needed



What are the regulatory issues related to a microgrid



Viking Yacht

- 500,000 ft^2 manufacturing facility
- Combined Heat & Power (CHP)
  - 390 kW installation consisting of six 65 kW inverter-based, grid connect microturbines with integral heat recovery modules
  - Three 30-ton absorption chillers
- Project Cost: $2,367,006
- Incentives: $877,500
- Annual Savings: 979,928 kWh generation; 7,360 MMBtu recovered waste heat to offset 85% of the facility's electrical load and 100% of the heating and cooling loads
- Annual Cost Savings: $111,902
- Payback Period: 10.5 Years
- 200 new jobs added; additional 175 jobs by end of current year as a result of energy and cost savings

Rider University

- 280 acre college campus
- Combined Heat and Power (CHP)
  - 1,100 kW internal combustion engine with heat recovery
  - 80-ton absorption chiller
- Project Cost: $4,594,188 (estimated)
- Incentives: $1,000,000
- Annual Savings: 8,545,053 kWh generation; 21,029 MMBtu recovered waste heat to provide 47% of campus electric load, 76% heating and hot water load, and 23% cooling load
- Annual Cost Savings: $527,973
- Payback Period: 6.8 Years
- Manufacturing and construction anticipated to generate 25 temporary full-time jobs

NJCEP Incentives for CHP/ Fuel Cell

Eligible Technology	Size (Installed Rated Capacity)	Incentive ($/Watt)[2]	P4P Bonus[3] ($/Watt) (cap $250,000)	% of Total Cost Cap per project	$ Cap per project
Combined Heat & Power Powered by non-renewable fuel source – Gas Internal Combustion Engine – Gas Combustion Turbine – Microturbine	≤500 kW	$2.00	$0.25	30-40%[4]	$2 million
	>500 kW – 1 MW	$1.00			
	>1 MW – 3 MW[1]	$0.55		30%	$3 million
	>3 MW[1]	$0.35			
Fuel Cells Powered by non-renewable fuel source. Incentives available for systems both with and without waste heat recovery.	≤1 MW w. waste heat	$4.00		60%	$2 million
	≤1 MW	$3.00			
	>1 MW w. waste heat	$2.00		45%	$3 million
	>1 MW	$1.50			
Heat Recovery[5] Powered by non-renewable fuel source. Heat recovery or other mechanical recovery from existing equipment utilizing new electric generation equipment (e.g. steam turbine)	≤1 MW	$1.00		30%	$2 million
	>1 MW	$0.50		30%	$3 million

NJCEP Incentives for Energy Audits

- Submit Registration to NJCEP including Resolution
- Draft RFP to 5 Pre Qualified Contractors
  - 5 energy firms – substitutes for local bidding
- Evaluate proposals
- Select bid – NJCEP review – enter into Contract
- Up to $1000,000 per year
- 100 percent of energy audit covered
- Investment grade for light – ASHREA level II

- 2400 building audited
- 300 government entities

Energy Saving Improvement Program

- Retrofitting public facilities with Energy Conservation Measures (ECM) without new capital investment
  - Savings from reduced energy use pays for the improvements = No New Money!
- Applies to all government contracting units, including school districts

Energy Savings Improvement Program

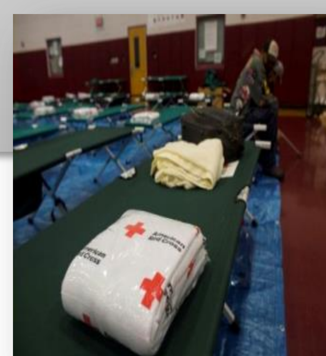
1) Initial Audit
2) **Decide whether to go forward as an ESCO or DIY project**
3) Prepare Draft RFP (Boiler Plate Available) / submit to **BPU for review**
4) RFP proposal **review by the BPU** – completed within 14 days
5) RFP circulation – must be in local newspapers and direct notification to <u>all</u> DPMC-approved ESCO's
6) Select Vendor / award contract
7) Vendor Selection review by the BPU – completed within 14 days

- <u>Send all Bids to BPU for Reporting</u>

8) Investment Grade Audit performed / prepare ESP
9) **Independent Third Party review of ESP (must send to BPU)**
10) Review of Energy Savings Plan by BPU – completed within 14 days
11) Project initiation
12) **Measurement and Verification sent to <u>Entity and BPU</u>**

New Jersey Energy Resilience Bank (ERB) Overview

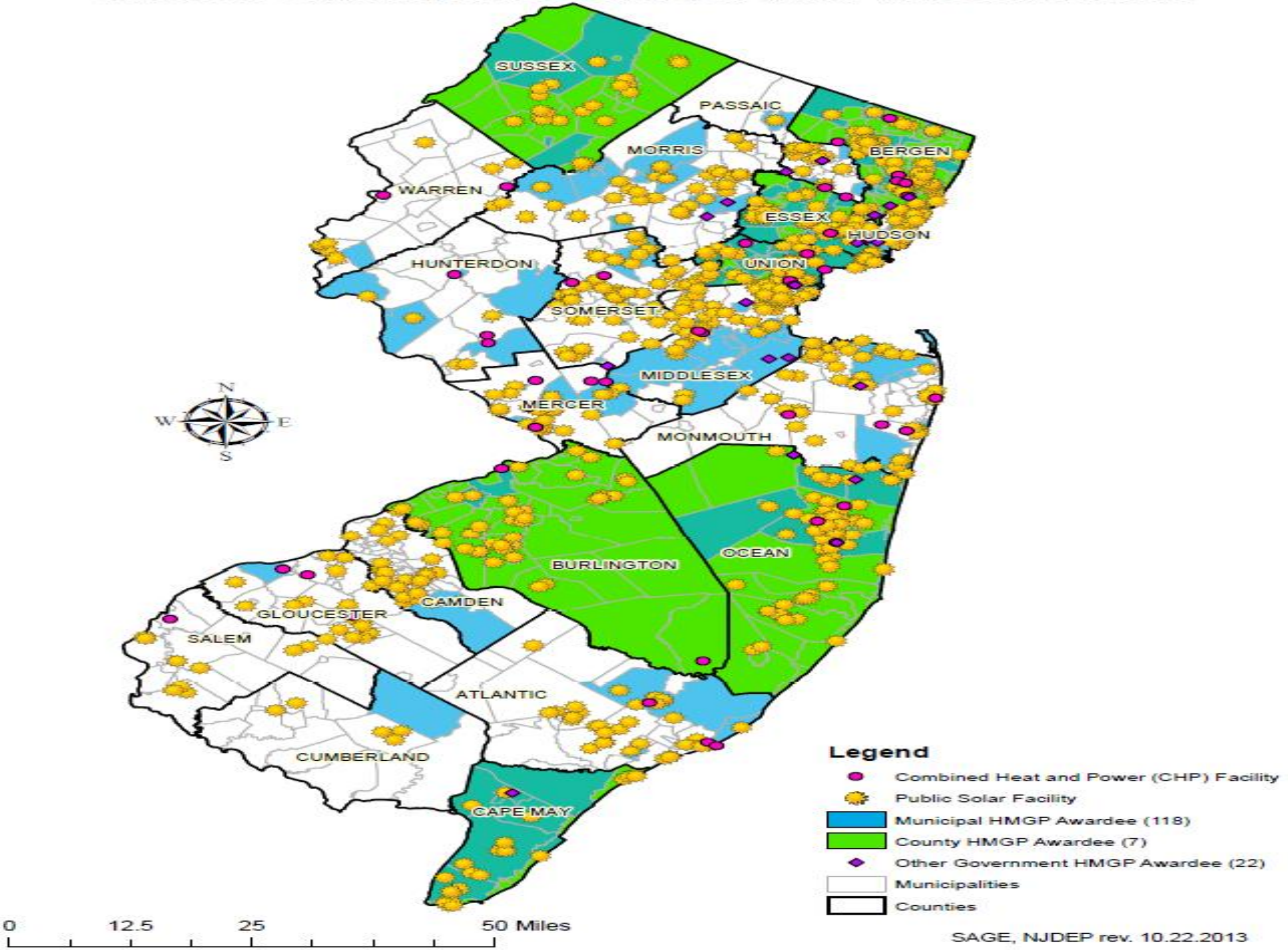
- The extensive damage and outages caused by Superstorm Sandy prompted the state to prioritize its efforts to minimize the potential impacts of future major power outages and increase energy resiliency
- BPU and EDA have partnered to commit $200 million in funding for the ERB to assist critical facilities with securing resilient energy technologies that will make them – and, by extension, the communities they serve – less vulnerable to future severe weather events and other emergencies



High Potential Resiliency System Options

Option		Description	Suitability for potential resiliency options
CHP		▪ Combined heat and power (CHP) is the simultaneous production of electrical or mechanical energy and useful thermal energy from a single energy stream (e.g., reciprocating engines, microturbines)	▪ Offers potential energy savings ($100k per year) ▪ Potentially takes advantage of digester gas to further lower costs ▪ Thermal and electrical load well balanced to make economics favorable, with a technology proven in WWTPs
Fuel Cell		▪ Consists of an anode, a cathode and an electrolyte that allows charges to move between the two sides of the fuel cell ▪ Rapidly-evolving technology that produces electricity from natural gas with no moving parts	▪ Greater capital cost than CHP (e.g., batteries) ▪ No opportunity to take advantage of digester gas ▪ Ideal for situations with a low thermal load
Solar PV		▪ Generates power using a photovoltaic (PV) solar panel that can be fed into an electrical grid or local, off-grid electrical network ▪ Allows the use of ordinary AC-powered equipment ▪ Can only provide power during night/storm if coupled with storage (batteries)	▪ Greater capital cost than CHP (e.g., batteries) ▪ No opportunity to take advantage of digester gas ▪ Reduced ability to capture waste heat for OCUA use (vs. CHP) ▪ Can be adapted for use with PV arrays, including maximum power point tracking and anti-islanding protection
Retrofit		▪ Addition of islanding and blackstart capabilities (e.g., ability to operate independently of the grid) to existing on-site generation system	▪ No existing on-site generation to upgrade
Microgrid		▪ Network combining two or more facilities that share on-site electricity production (and possibly heating), with islanding and blackstart capabilities	▪ No nearby facilities to link to microgrid

Government Hazardous Mitigation Grant Program (HMGP) Awardees Relative to Combined Heat & Power (CHP) and Public Solar Facilities



The ERB will be providing financing for unmet need

FOR DISCUSSION

Calculation of duplication of benefits worksheet

Sources	Uses	Unmet Need ($M)
▪ Insurance	▪	
▪ FEMA	▪	
▪ SBC Funding	▪	
▪ Other State Funding	▪	
▪ Other Federal Funding	▪	

- **100% provided by ERB**
- **20% Grant**
- **80% Loan**
- **20% Loan Forgiveness**

The ERB could support you with comprehensive financing for your resilience project

Overview of Proposed Total ERB Funding:

100% unmet funding	Incentive:	**40% of unmet funding need:** ▪ **Grant:** 20% of unmet funding need provided as a grant ▪ **Loan Forgiveness:** 20% of unmet funding need may be available as a loan that may be forgiven based on performance-based standards
	Loan:	**60% of unmet funding need**
Terms		▪ **Interest rate:** – 2%, fixed interest rate for bond rating of BBB- or higher at the time of approval – 3% fixed interest rate for applicants with bond rating lower than BBB- or which are not rated at time of approval ▪ **Collateral:** No collateral required ▪ **Term:** Up to 20-year term, based on useful life of majority of assets ▪ **Principal Moratorium:** Up to 2 years' principal moratorium

The ERB can cover a range of costs for both new and retrofit systems

Eligible costs

New resilient systems

- Core equipment
- Piping & wiring
- Islanding equipment
- Interconnection
- Fuel pre-treatment (e.g., biogas treatment, or gas compression)
- Installation
- Site work
- Engineering and project management
- Hardening of resilient energy system (e.g., elevation)

Resilient retrofits

- Additional core equipment (e.g., battery storage for existing solar system, biogas storage equipment)
- Islanding equipment
- Interconnection
- Installation
- Engineering and project management
- Hardening of resilient energy system (e.g., elevation)

Non-eligible costs

Backup Generators

- Emergency backup generators
- Onsite fossil fuel storage for emergency generators
- Transfer switches to support backup emergency generators

Other non-energy hardening

- Flood walls
- Elevation

Other

- Used, refurbished equipment
- Solar PV panels

Projects that do not qualify for ERB funding may be eligible for other state programs offered by the state, or could seek private funding

	NJ Energy Resilience Bank	NJ Energy Development Authority	NJ Clean Energy Program	NJ Environmental Infrastructure Trust	NJ Healthcare Facilities Financing Authority
Mission	▪ Increase resiliency of critical facilities to extreme events	▪ Finance small and mid-sized businesses, administer tax incentives, redevelopment initiative	▪ Promote energy efficiency and use of clean energy	▪ Provide financing for environmental infrastructure projects to protect water sources and safety	▪ Provide healthcare providers with low cost capital
Target sectors	▪ Critical facilities e.g. hospital, WWTP, education	▪ NJ-based businesses and communities	▪ NJ residents, businesses and local governments	▪ Drinking water, wastewater, equipment purchase, storm water, landfill etc.	▪ Hospitals, nursing homes, assisted living etc.
Products offered	▪ Partial grants, loan forgiveness and discounted loan	▪ Low interest lending, training, mentoring	▪ Partial rebates for installation of energy efficient equipment	▪ Loans with some principal forgiveness	▪ Municipal bond issuance ▪ Direct lending
Eligibility requirements	▪ Public facilities ▪ Damage from specific storms ▪ Other	▪ Size of business ▪ Number of employees ▪ Business location ▪ Other	▪ Varies – based on location, building type, fuel source	▪ Various – projects must fall in list of eligible sectors	▪ Health care related service in NJ
Funds disbursed to date	▪ $200M available	▪ ~$23B in assistance; ~$52B in public/private investment	▪ TBD	▪ >$4.3B to local and county government and some private facilities	▪ >$16B in bonds to ~150 organizations in NJ

Resilient Energy System

Who Funds Housing and Storm Recovery - HUD in CDBG

There is a better way –

HUD provides funding for LMI Housing thru CDBG
Basically Multifamily Buildings including EE/RE

After FEMA HMGP HUD provides
Recovery Funding through CDBG including EE/RE

DER is an efficient and effective way to power a multi-family building both thermal and electric

A DER system can be resilient through islanding/blackstart

HUD provided DER funding under ARRA

Super Storm Sandy October 29, 2012

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Building support for Resiliency Planning in Boston

Prepared for Better Buildings Summit, Washington DC, May 2015

Travis Sheehan
Energy Fellow at Boston Redevelopment Authority

Why is the City of Boston engaging in the resiliency conversation?

Waterfront city, Climate Action Plan

Energy Prices, Economic Development

Statewide EE Programs, Renew Boston, GridMod Order

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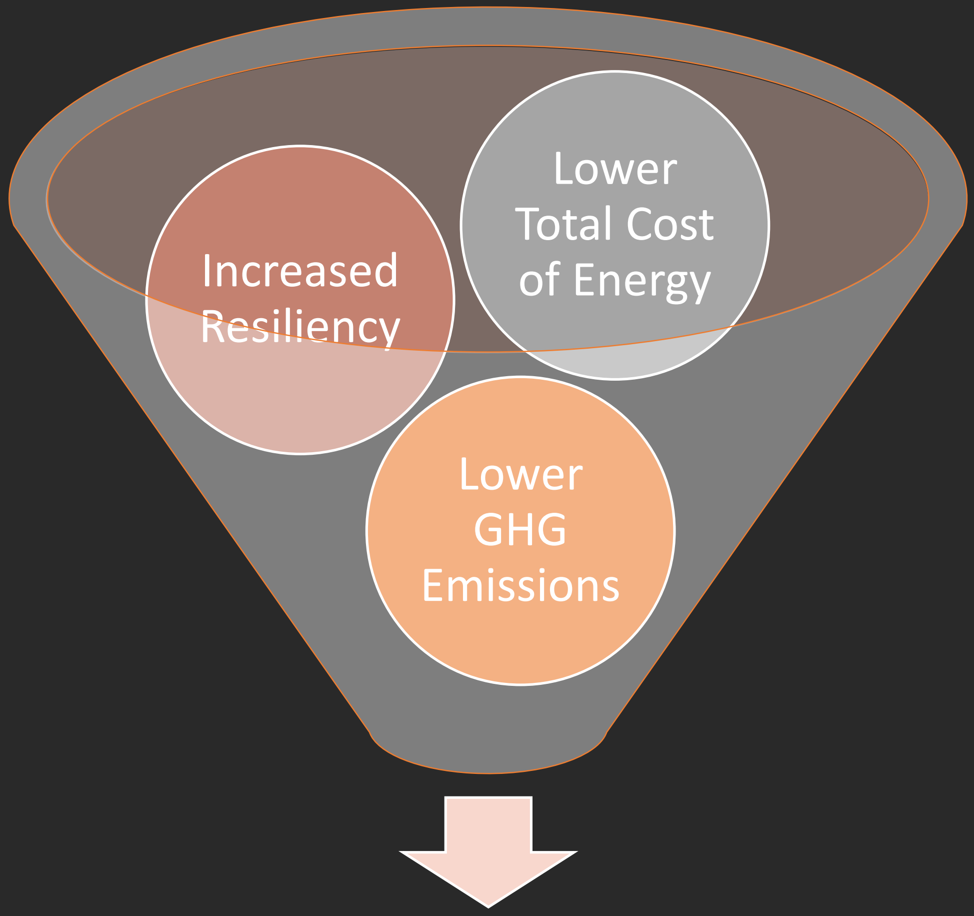

Energy Investments

Resiliency for vulnerable populations and business continuity

Lower Total Cost of Energy makes the state attractive to all firms and residents

Energy Security make the state more attractive to hi-tech/ clean tech/ bio tech / advanced manufacturing

Local generation revenues keep capital local, investment potential to spark local industries

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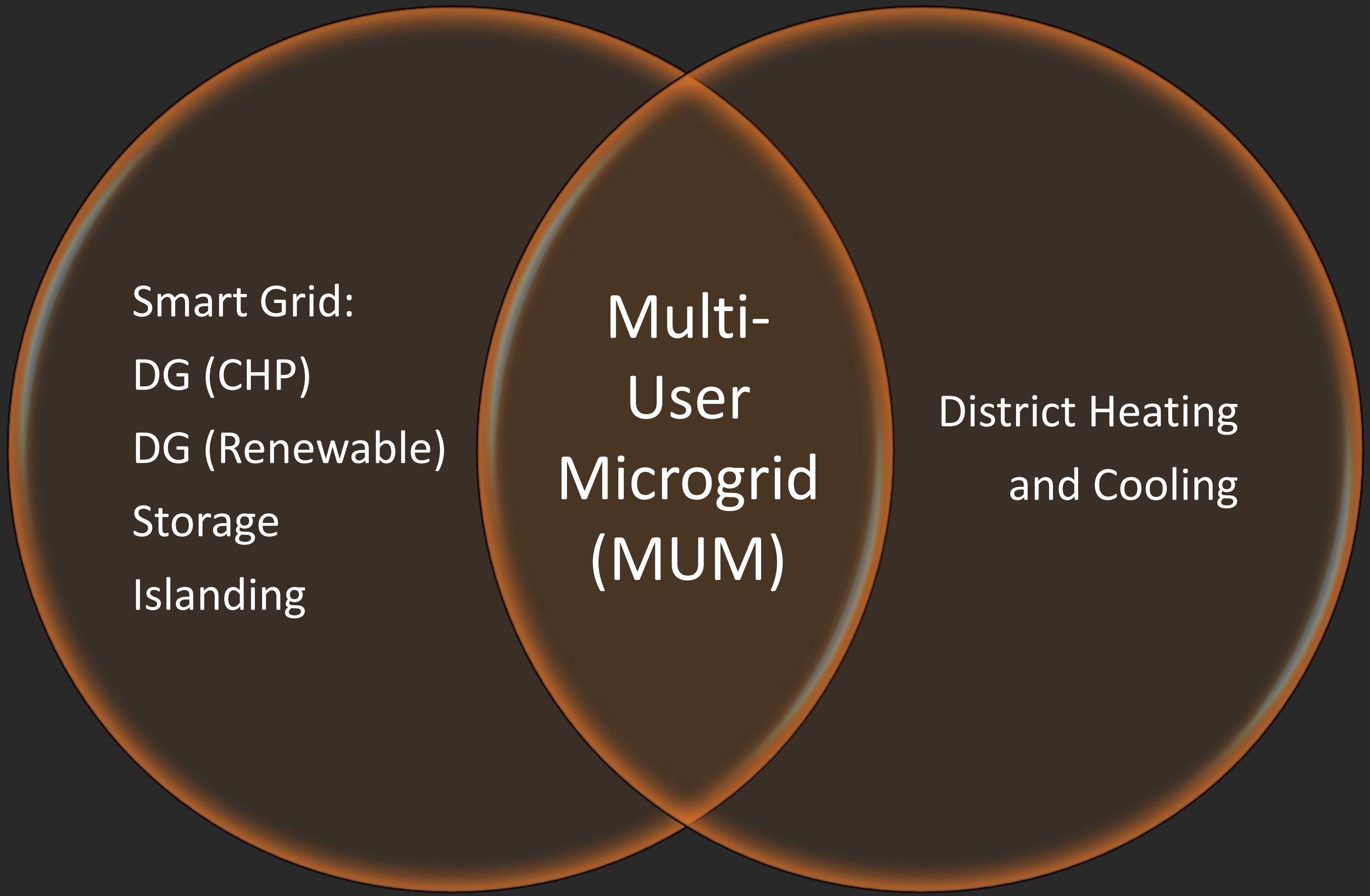

Business Model for MUM

- DISCO owns the microgrid
- Comes from an innovative and evolving utility partnership
- Potential pathway to respond to the Grid Modernization order
- Technology includes generation and distribution for thermal and electric

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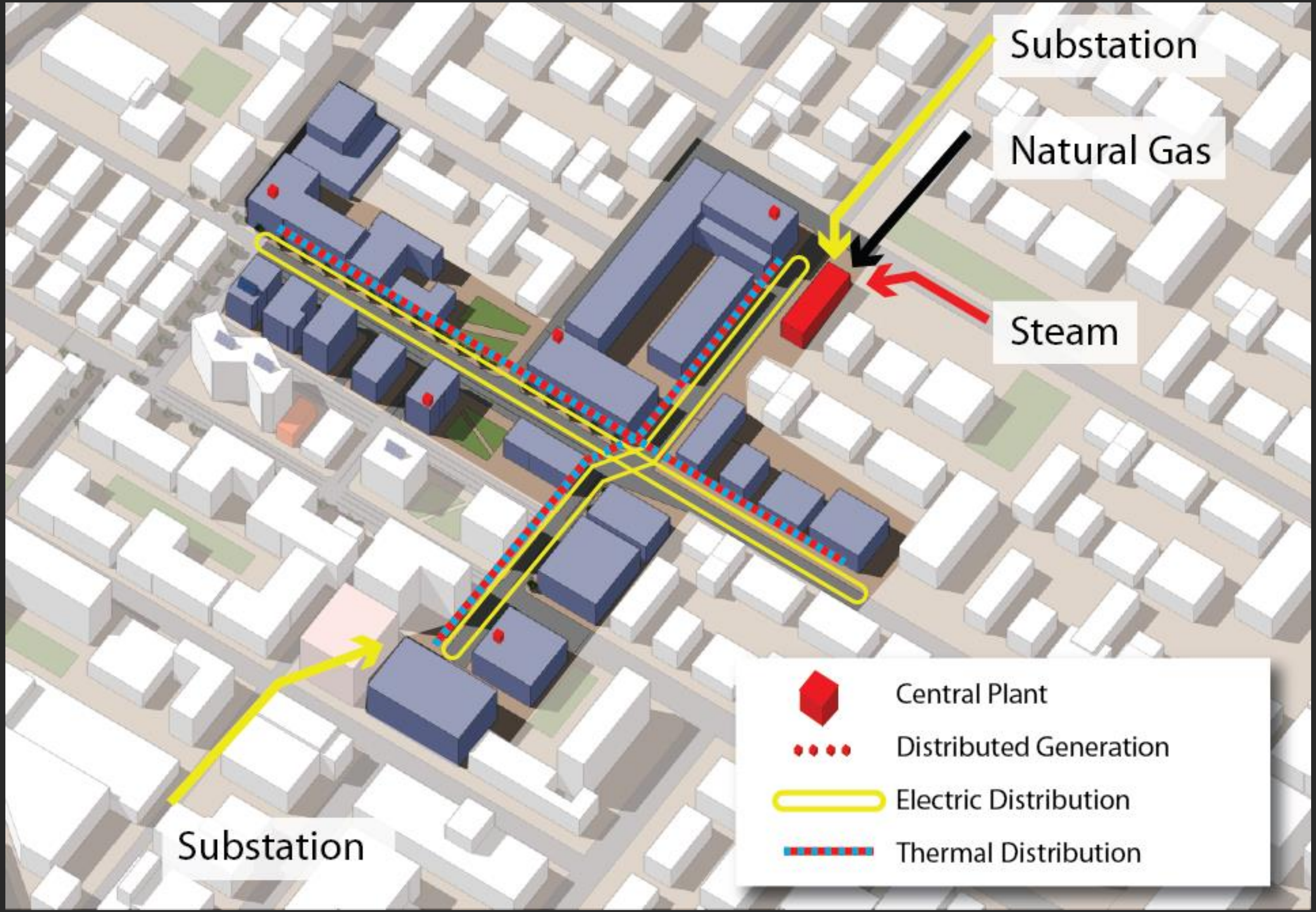
Boston's MUM model

- Deploy local generation and storage
- Replace building boilers and chillers with central CHP (applied to new and old districts of the City)
- Develop hot and cold water loops
- Deploy Smart Grid and smart building technologies
- Create islanding capability for local loads



Boston municipal government shaped the conversation….

BOSTON REDEVELOPMENT AUTHORITY

Business Model

March 2014- June 2014

- "Boston Microgrids Workshops"
- 12 Hours of scenario planning
- Utility Corporate Strategy / Gov. Relations, Real Estate Developers, Infrastructure investors, Muni-finance Advisors, Energy Developers, DPU staff and Commissioners,
- **Outcomes: Straw proposal outlines business plan**

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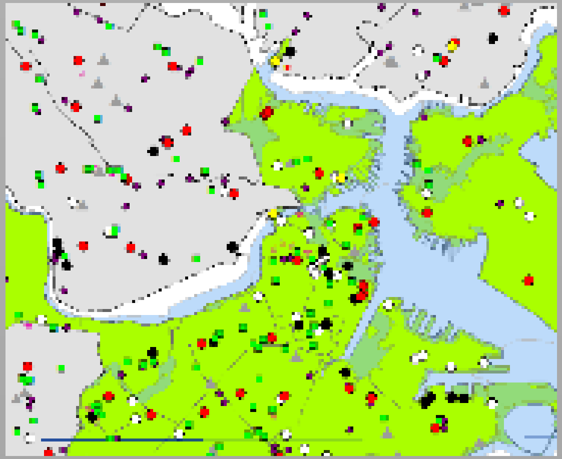
City Planning

June 2014- June 2015

- “Citywide Energy Study”
- Planning Study to identify Microgirds Districts
- Energy model of every building in Boston
- **Economic impact analysis** will show City-wide benefits: lower total cost of energy, avoided business downtime, local environmental impact

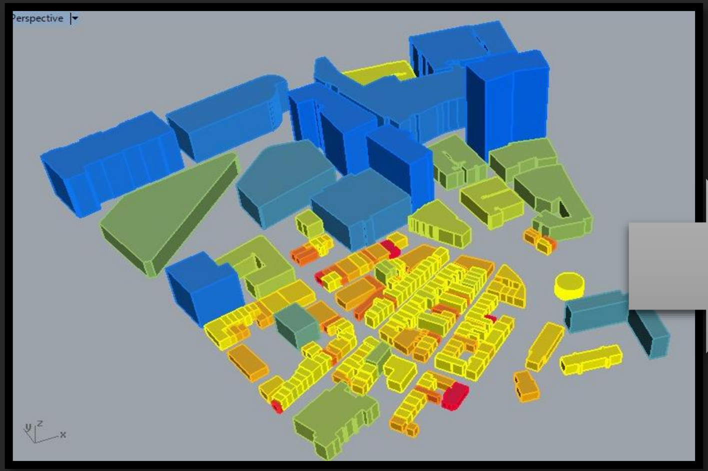
SUITABILITY ANALYSIS



Analysis of Critical Assets and Vulnerable Populations

Building-specific energy models (8760 Data)

MICROGRID IDENTIFICATION



SAMPLE: Microgrid (1 of 5) Model Outputs			
		Base Case	**Microgrid**
Demand	*Source fuel*	40 GJ	33 GJ
Supply	*CHP Size*	0	5 mw
	PV	0	350kw
	Storage- E	0	1mwh
	Storage- T	0	19mbtu
Performance	*Cost*	$19/sf/yr	$20/sf/yr
	Emissions	200 tons	10 tons
	Resiliency	$-1M	$0

CITYWIDE BENEFITS ANALYSIS

SAMPLE: Citywide Microgrid Capacity			
	Supply	**Emissions**	**Resiliency**
MG1	10 MW	-40000 tCO2e	$25.0 M USD
MG2	12 MW	-30000 tCO2e	$1.0 M USD
MG3	2 MW	-2000 tCO2e	$1.2 M USD
MG4	13.1 MW	-320000 tCO2e	$0.1 M USD
MG5	5.4 MW	-10000 tCO2e	$0.6 M USD
Total	42.5 MW	-402000 tCO2e	$27.9 M USD

SAMPLE: SROI	Boston	Massachusetts
Over project span of 4 years:		
Total Jobs (Direct, Indirect, and Induced)	2,126	2,861
Gross State Product (2009 dollars)	$ 174,253,457	$ 245,947,611
Personal Income (2009 dollars)	$ 66,111,927	$ 199,150,693
Personal Consumption Expenditures (2009 dollars)	$ 39,043,480	$ 115,863,657
Total State Tax Revenue over 4 years (2009 dollars)	$ 3,439,645	$ 10,334,019

Boston municipal government shaped the conversation….

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Pilot Project

- "Microgrid Pilot"
- Local planning to reduce costs for manufacturing hub of Boston (Marine Industrial Park)
- Developing MOU with Eversource
- **Engineering study to be completed August 2015**, investors ready

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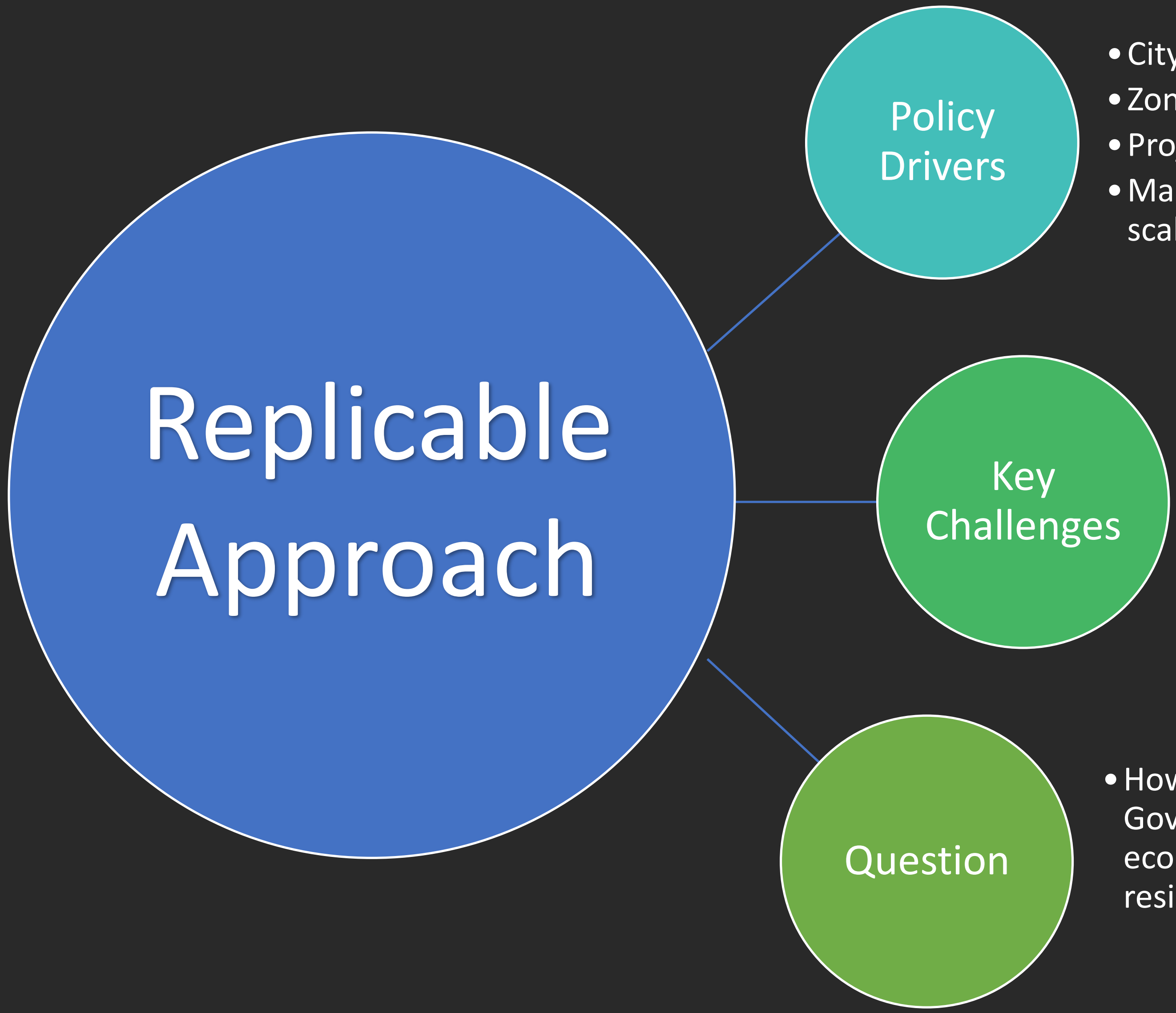

Policy Drivers

- Citywide Energy Study
- Zoning - Harvard Analysis
- Project finance
- Mass CEC sponsorship and scalability

Key Challenges

- Planning district infrastructure amidst single parcel development
- Providing space for municipal leaders to prioritize district energy policy and planning

Question

- How does the Municipal Government marry economic development with resiliency?

Appendix Slides

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The Statewide Implications of Boston's MG

- Collaborations and statewide strategy
  - Plans to export method
  - Potentially export business model
- Department of Homeland Security interactions

Conclusion

- Energy regulatory frameworks are under major transformation
- New investments require new reg. frameworks
- We've partnered with IOU to explore this

- **Asking for support: a pilot that explores new project finance**
  - **Support for exploring revenue streams: frequency regulation, DR, MRAs**
- **Give Eversource exploration of mixed approach: efficiency and distribution planning**
- **Support seeking outside assistance to study the 'scaling up' from pilot**

Boilers and chillers are at end of useful life, windows are from 1915
Freezer buildings: low margin businesses, high energy prices are impediment
Drydock: high energy prices are impediment to bidding in a small market
PARCEL AREA
A = 40,879 SF
C-1 = 69,249 SF
C-2 = 41,901 SF
M = 148,150 SF
N = 140,000 SF
Q-1 = 26,000 SF
R = 179,810 SF
T = 174,788 SF
V-W = 12.5 ACRES
21, 23,25 DRYDOCK AVENUE
BRONSTEIN INDUSTRIAL CENTER
400K SF AVAILABLE
22 DRYDOCK AVENUE
MUNICIPAL BUILDING
12 DRYDOCK AVENUE
PUBLIC PARKING GARAGE
12 CHANNEL STREET
MULTI-TENANT INDUSTRIAL
87% OCCUPIED
37,290 SF AVAILABLE
C2
C1
69,249 SF
A
40,879 SF
26,000 SF
Q1
M
N
140,000 SF
R
T
174,788 SF
FUTURE BUILDING
M1
30 ACRES
V-W
12.5 ACRES
Boston's Marine Industrial Park
Located in the Innovation District
City of Boston
Mayor Martin J. Walsh
www.BostonRedevelopmentAuthority.org

Pilot MUM Study

Technical

System Design: Generation, Storage, Islandability, Thermal Distribution

Financial

Base Case Costs

Scenario Costs

Delta: Total Cost of Energy

Ownership

Scenario 1-3: Basic Disco involvement, muni or third party ownership

Scenario 4: Energy Efficiency?

- **Total Cost of Energy**
- **Resiliency Metrics**
- **Environmental Metrics**

- Key questions
  - Will Eversource be allowed to rate base aspects of the pilot?
  - Will "Retail Choice" / "Obligation to Serve" be affected ?
  - Will the "district efficiency" project enable local generation ownership?

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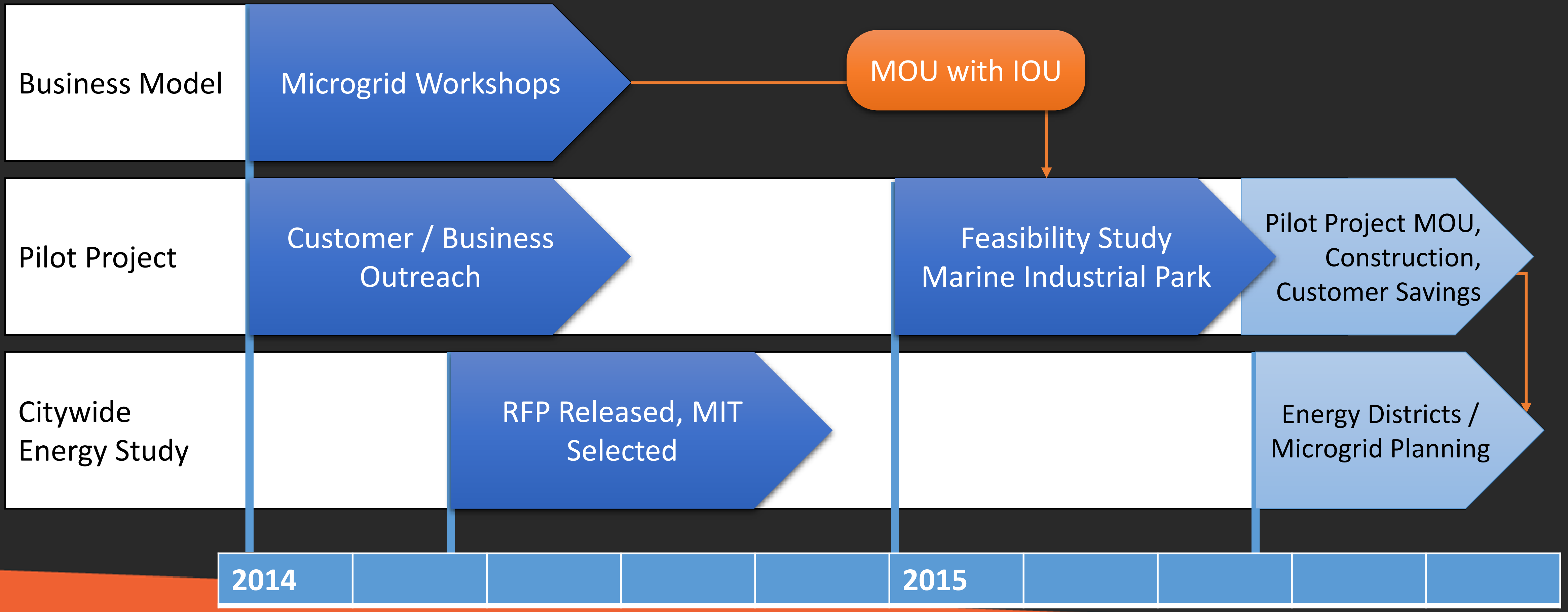
The Background on Microgrids in Boston/MA



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Project Positioning

Microgrids Workshop: DC, NYC, Chicago

USDN urban sustainability directors network

Cambridge/Somerville/Northampton (June 28, 2015)

Pace Energy and Climate Center
PACE LAW SCHOOL

JPMorgan

Raab Associates, Ltd.

U.S. DOE
CHP Technical Assistance Partnerships

VE RI TAS

MASSACHUSETTS CLEAN ENERGY CENTER

C40 CITIES
CLIMATE LEADERSHIP GROUP

MIT SUSTAINABLE DESIGN LAB

EVERSOURCE

nationalgrid

PEER
PERFORMANCE EXCELLENCE IN ELECTRICITY RENEWAL

DOE Better Buildings Conference, May 27, 2015

LINCOLN LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
U.S. DEPARTMENT OF ENERGY
Homeland Security

VEOLIA ENERGY

IDEA International Conference

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

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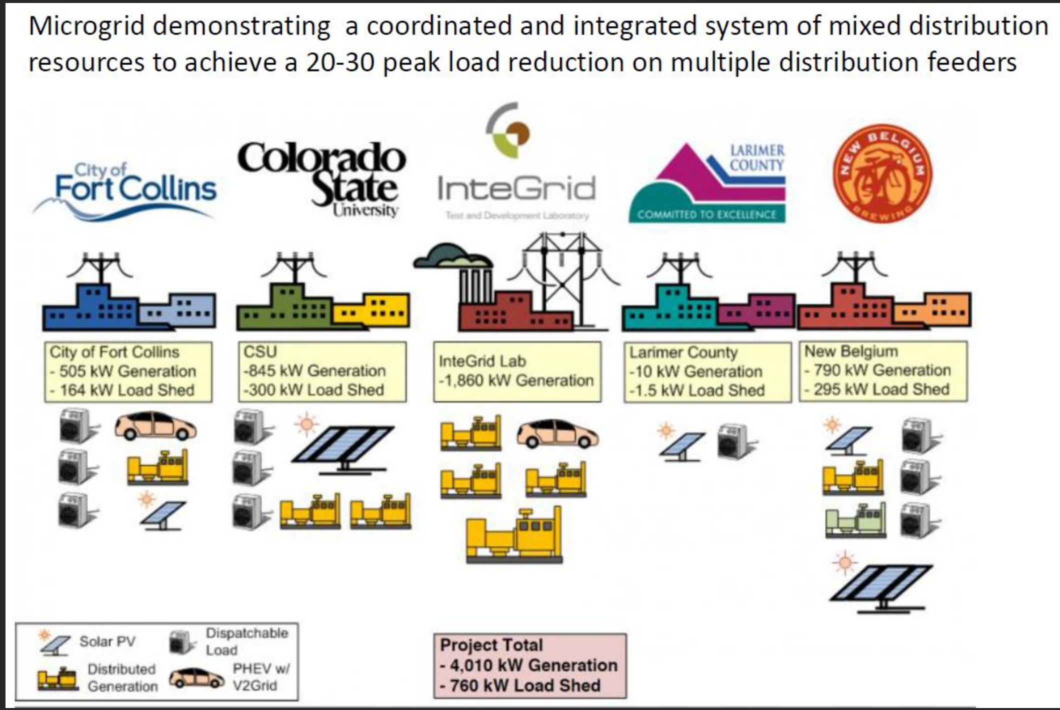
National Examples of Pilot Projects

Fort Zed
$6.3 M in Federal Funding

Borrego Springs
$5 M in Federal Funding

"Microgrid Research, Development, and System Design"FOA 2014
$7 M

REDI FOA 2015
$3.5 M



Utility executed microgrids are heavily funded through DOE , Boston's model is to leverage tech transfer and investment in pilot.