Critical Infrastructure: Energy and Transportation Resilience

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What Can Local Decision Makers Do?

Chris Lotspeich

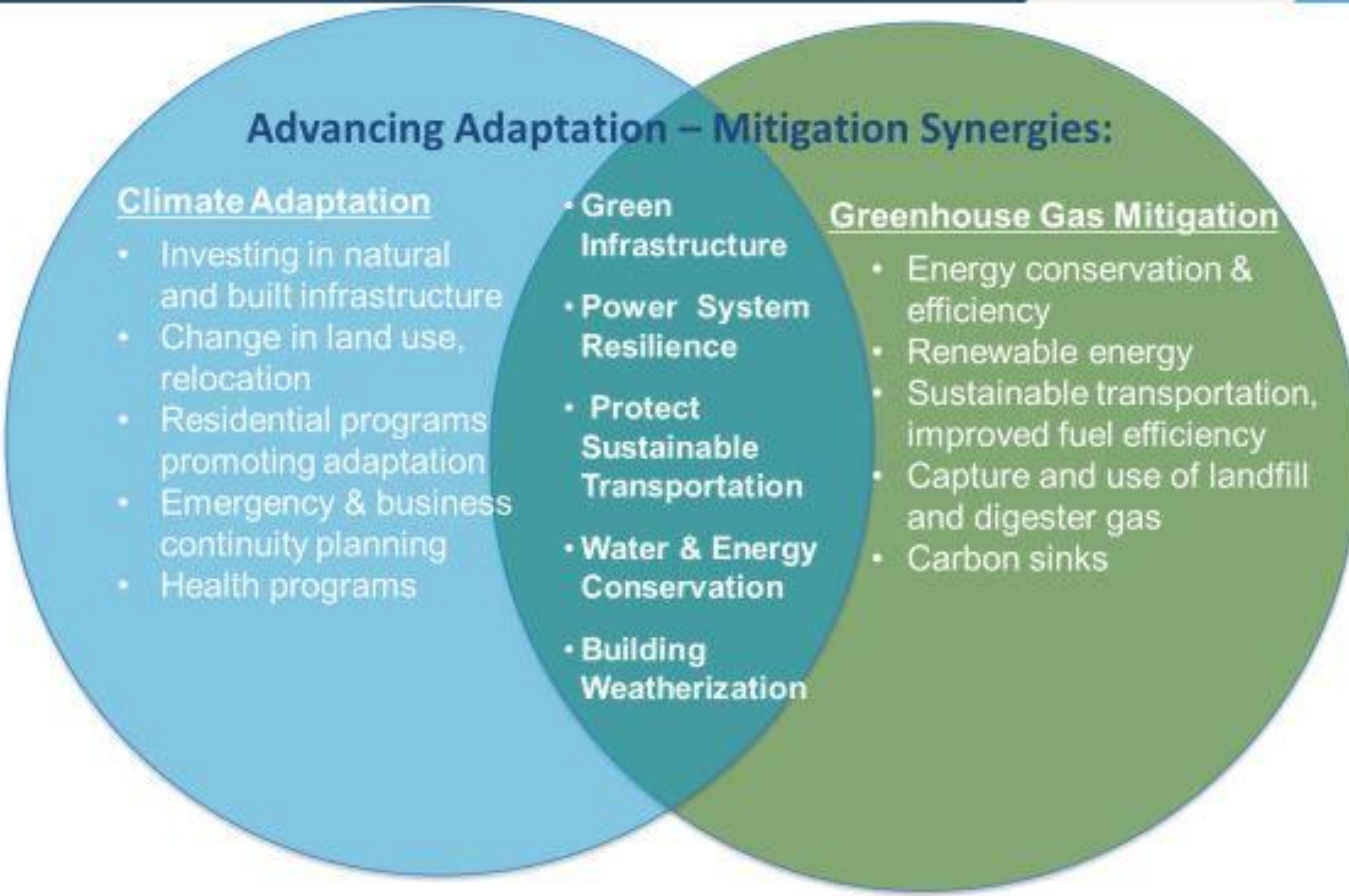
Celtic Energy Inc.

Local Solutions: Eastern Regional Climate Preparedness Conference

April 4th, 2016

Celtic Energy

PURSUE ADAPTATION / MITIGATION SYNERGIES



ARUP

What is your design basis threat?

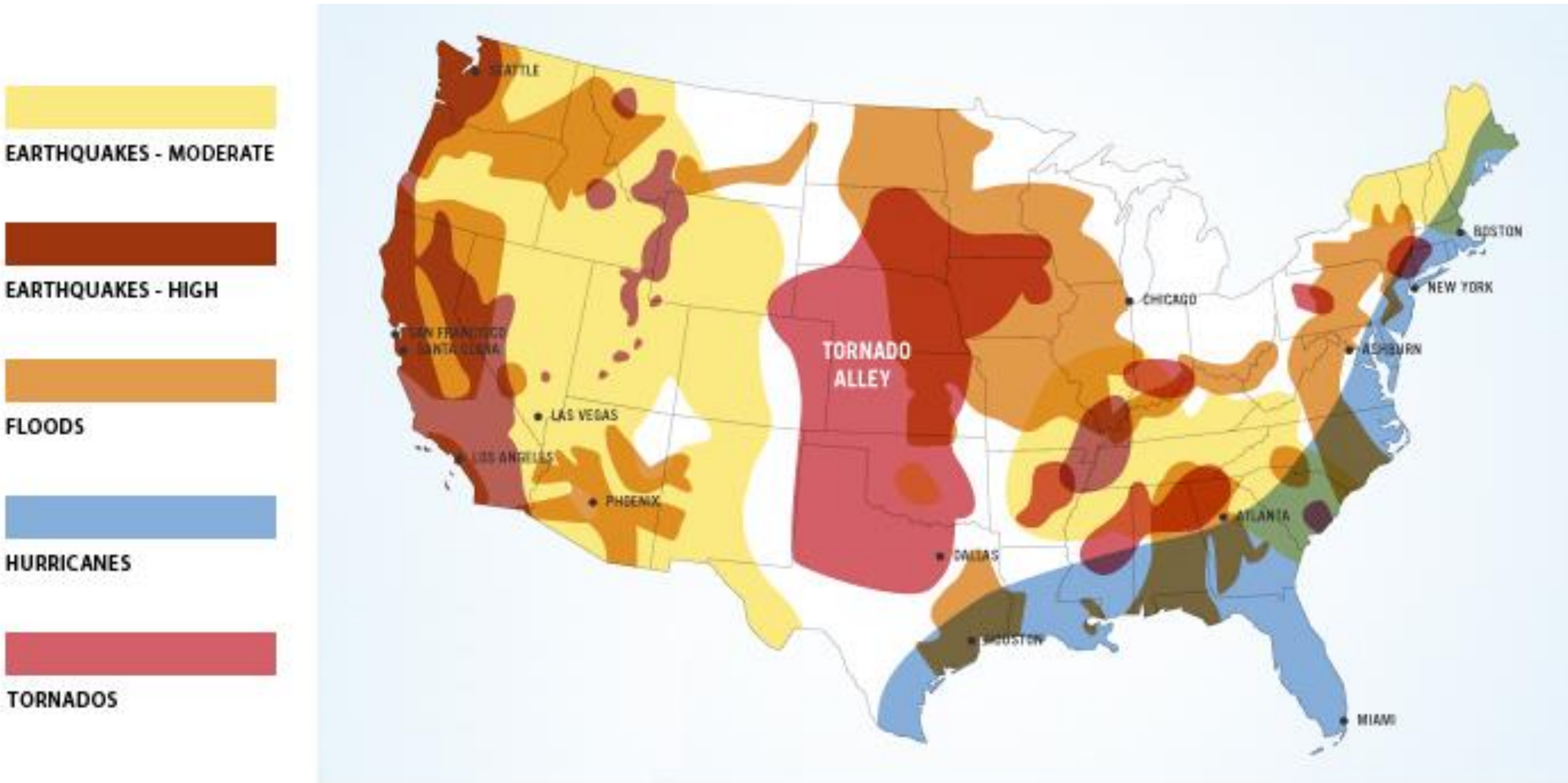


Image Credit: http://www.crisishq.com/

Slide courtesy of Arup

Critical facility energy surety planning considerations

- What are your mission critical loads?
- How long do you want to operate off grid?
- Energy resources location, capacity, fuel?
- What procurement “business model”?
- Options: Efficiency, PV, storage, CHP, gensets

Distributed energy resources

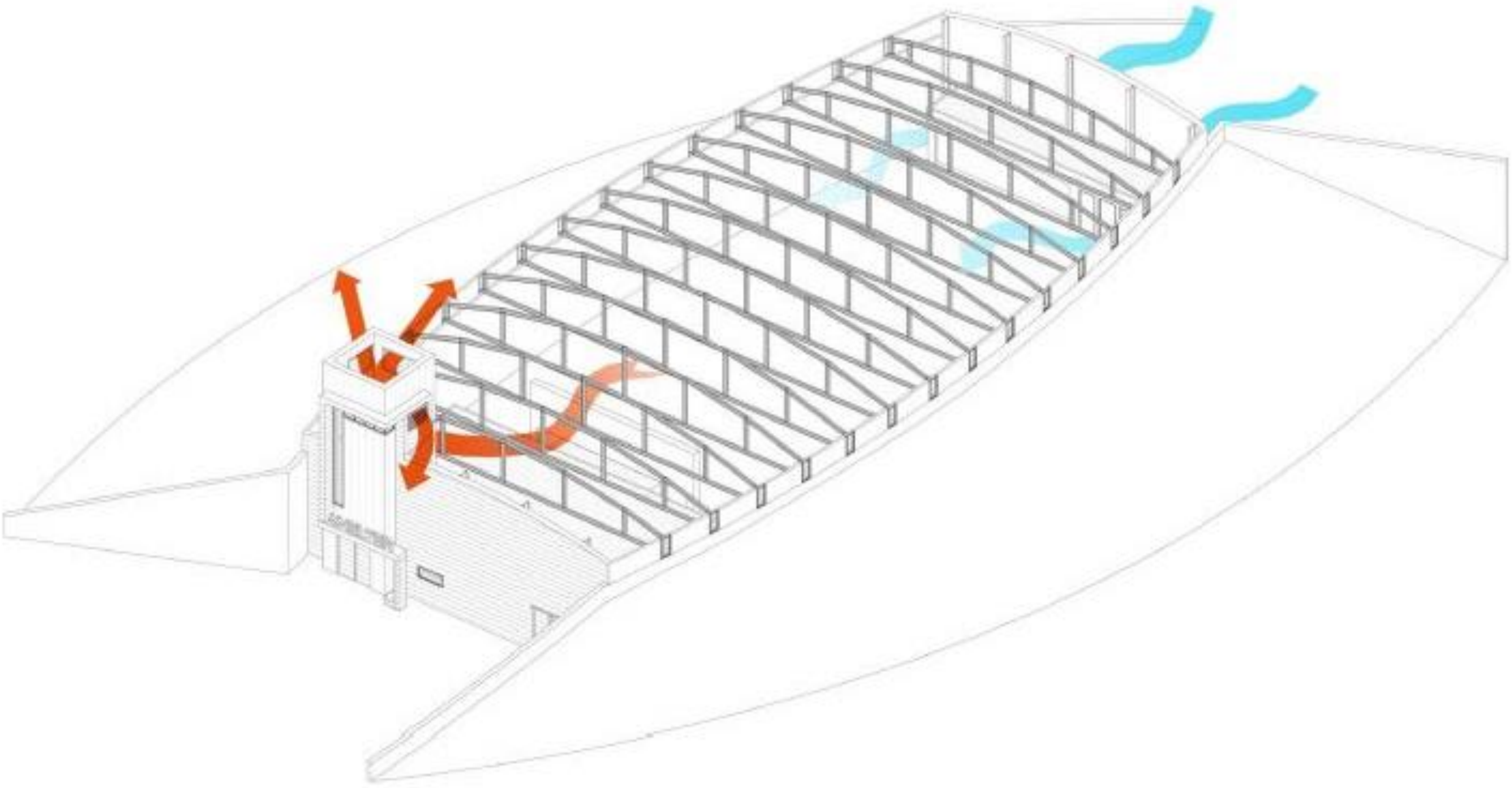
- Passive design and end-use efficiency first!
- Emergency generation
- Combined heat & power (CHP), district energy
  - Reciprocating engines, microturbines, fuel cells
- Solar power, wind power, solar thermal
- Heat pumps
- Energy storage

Aggressive passive

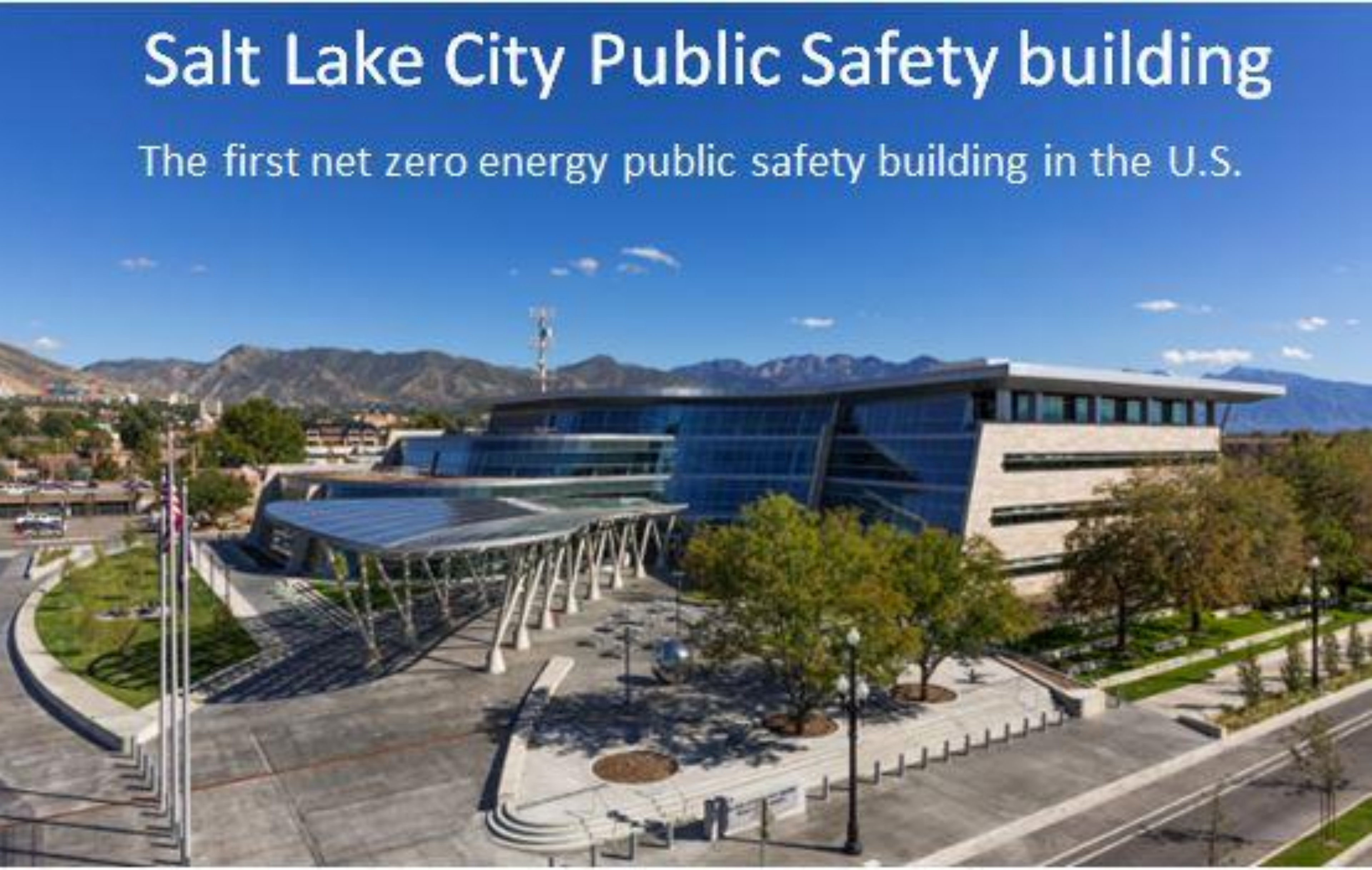
Hancock County, MS Emergency Operations Center & community safe room

design inspired by nature
EarthRise

Hancock County Mississippi Emergency Operations Center and Community Safe Room includes passive ventilation strategies.



SOURCE: Dean Sakamoto HURRIPLAN
Image Courtesy of Unabridged Architects



320,000 SF, $80 million facility completed in 2013

Image by Jeff Goldberg/Esto. From EDC magazine, 12/16/13.

- Designed to withstand 7.5 Richter scale seismic event
- Critical facility sustained operations during power outages
- 350 kW rooftop solar power array, solar thermal hot water
- 35 kW PV canopy is public device charging station

Image by Jeff Goldberg/Esto. From EDC magazine, 12/16/13.


Need to plug in? Tap into a
renewable energy source
using the outlet (below) to
power your laptop, mobile
phone or tablet. Use re-
sponsibly and share with
others in the plaza.


Need to plug in? Tap into a
renewable energy source
using the outlet (below) to
your laptop, mobile

Photo: Rus

Photo: Russell Carr


Photo: Russell Carr

Photo: Russell Carr

FL SunSmart Schools E-Shelters program

- FL Energy Office, FL Solar Energy Center, DOE
  - 2009 ARRA funds to expand shelter program
  - Goals: save energy costs, shelter, educational tool
- 115 schools totaling ~1 MW PV
  - Goals: save energy costs, shelter, educational tool
  - Total shelter capacity of 10,000–50,000 people
- Teachers, school facilities staff training

FL SunSmart Schools E-Shelter program

- 10 kW PV, 48 kW / 25 kWh lead acid batteries
  - 150 mph wind loading requirement
  - $74,000–$90,000 installed, savings $1,500+/yr
- 1 kW critical loads defined by local committee
  - American Red Cross, Emergency Management, school facility personnel and FSEC
- Lighting, plug loads for device charging
  - Enhanced Hurricane Protected Area in each school
  - Typically gyms, cafeterias, classrooms

Sun
Smart
E-Shelter

Stafford Hill, Rutland, VT

Photo: Green Mountain Power

Stafford Hill, Rutland, VT

- Green Mountain Power with Dynapower, GroSolar, DOE, ESTAP, State of VT

- 1st 100% solar microgrid,1st on brownfield
  - ES provides ancillary services to the grid
  - Island mode energy support for HS shelter

- 2.5 MW PV panels, 4 MW ES
  - 2 MW / 1 MWh Lithium ion
  - 2 MW / 2.4 MWh lead acid batteries

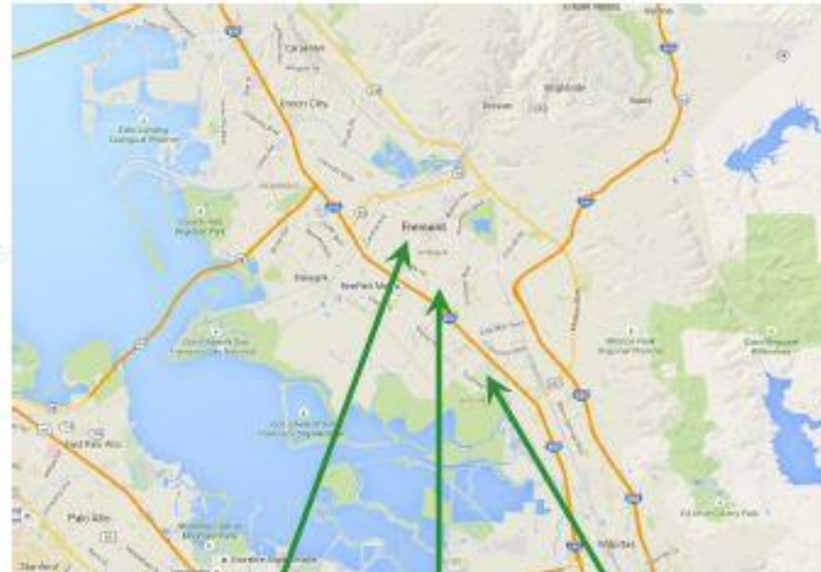
- ~$10.8 million cost, ~ 10 year payback

CEC Microgrid Award

- Total Award
  - $2.4M
- Proposed Sites
  - Three Critical Facilities – Fire Stations in the City of Fremont
- Benefits to State and City
  - 3 hour Renewable Energy Islanding in case of disasters
  - 25%-50% of Net Energy Cost Savings
  - Clean & Sustainable Energy
- Partners:

City of Fremont GRIDSCAPE DELTA SAMSUNG IDEAL POWER Microgrid Solar

- Project Details
  - 25-60KW Solar Canopy System
  - *50-80 kWhr Energy Storage System*
  - *Microgrid Controller*
  - *Cloud-based Predictive Energy Management Software*



Slide courtesy of Gridscape

Project Design (cont.)

GRIDSCAPE

Slide courtesy of Gridscape

Project Design (cont.)

Fire Station #6

Fire Station #7

Fire Station #8

Solar Market Pathways

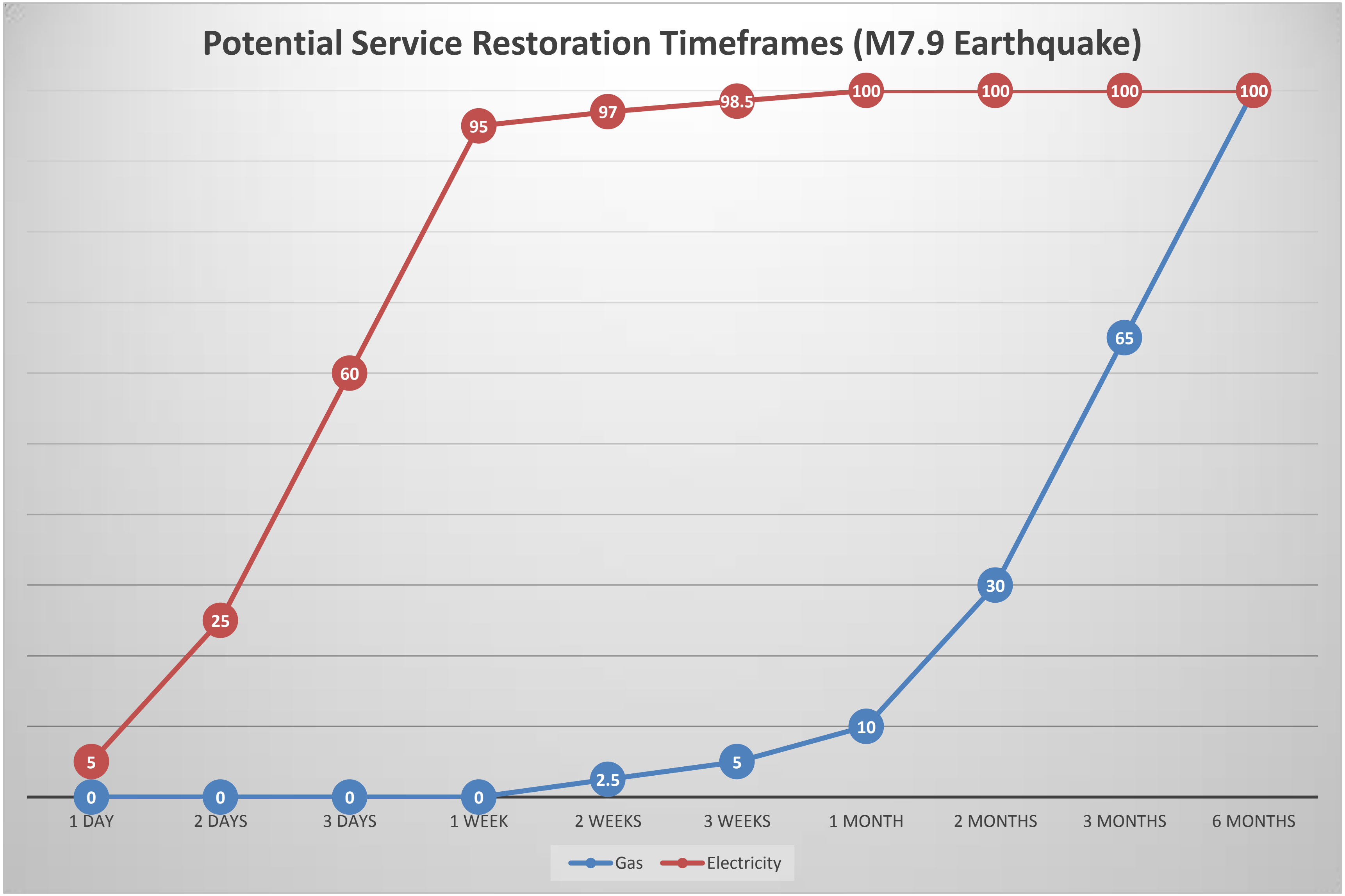
ARUP

Solar+Storage for Resilience

SunShot
U.S. Department of Energy

Slide courtesy of Arup

The Issue



Data Credit: Lifelines Council

Slide courtesy of Arup

PV+ES Technologies

ARUP

Slide courtesy of Arup

PV+ES … + Generators

Adapted from slide courtesy of Arup

SF Critical Facilities

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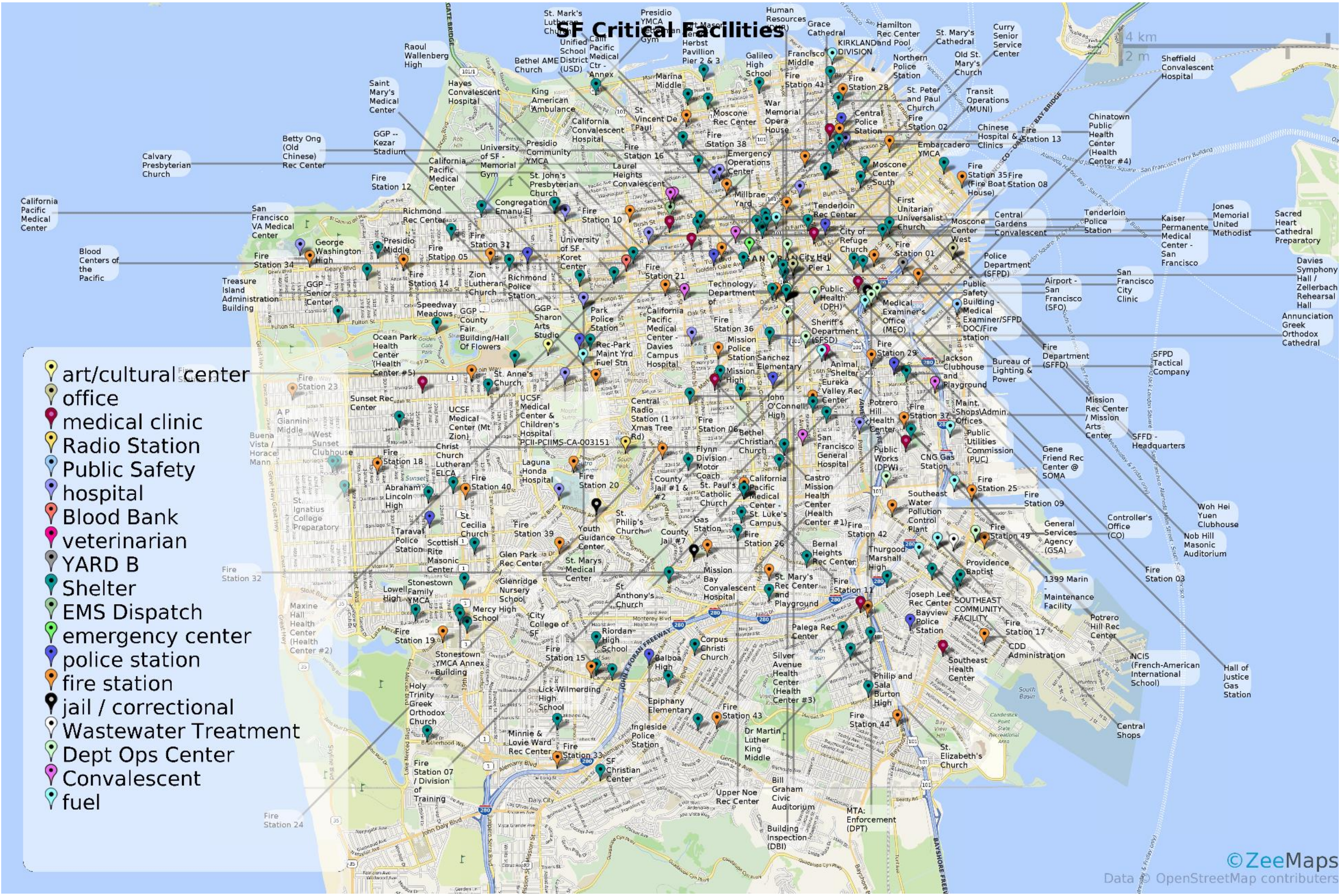
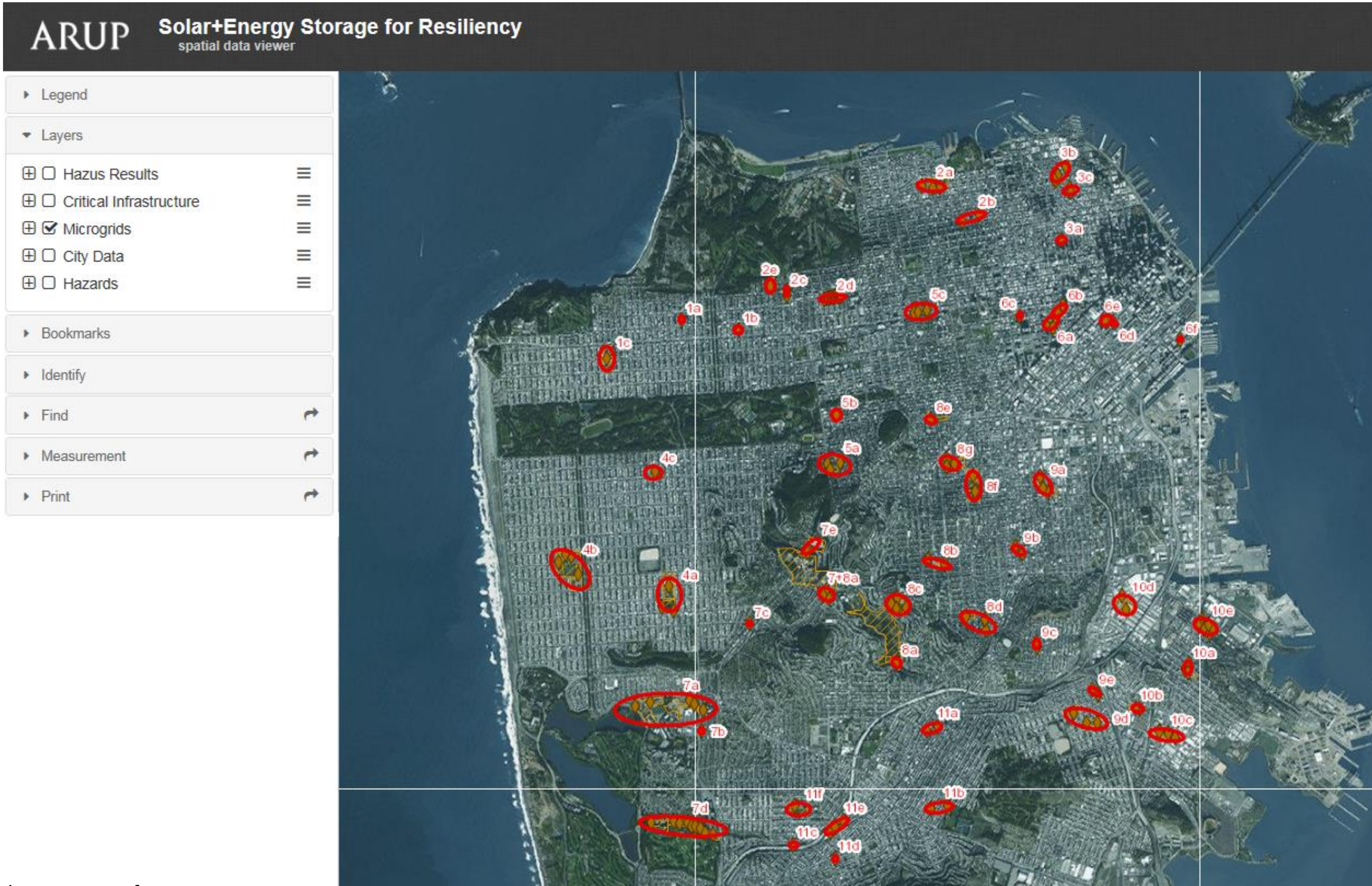


Slide courtesy of Arup

Potential Microgrids



Slide courtesy of Arup

Potential "West Side" Microgrid

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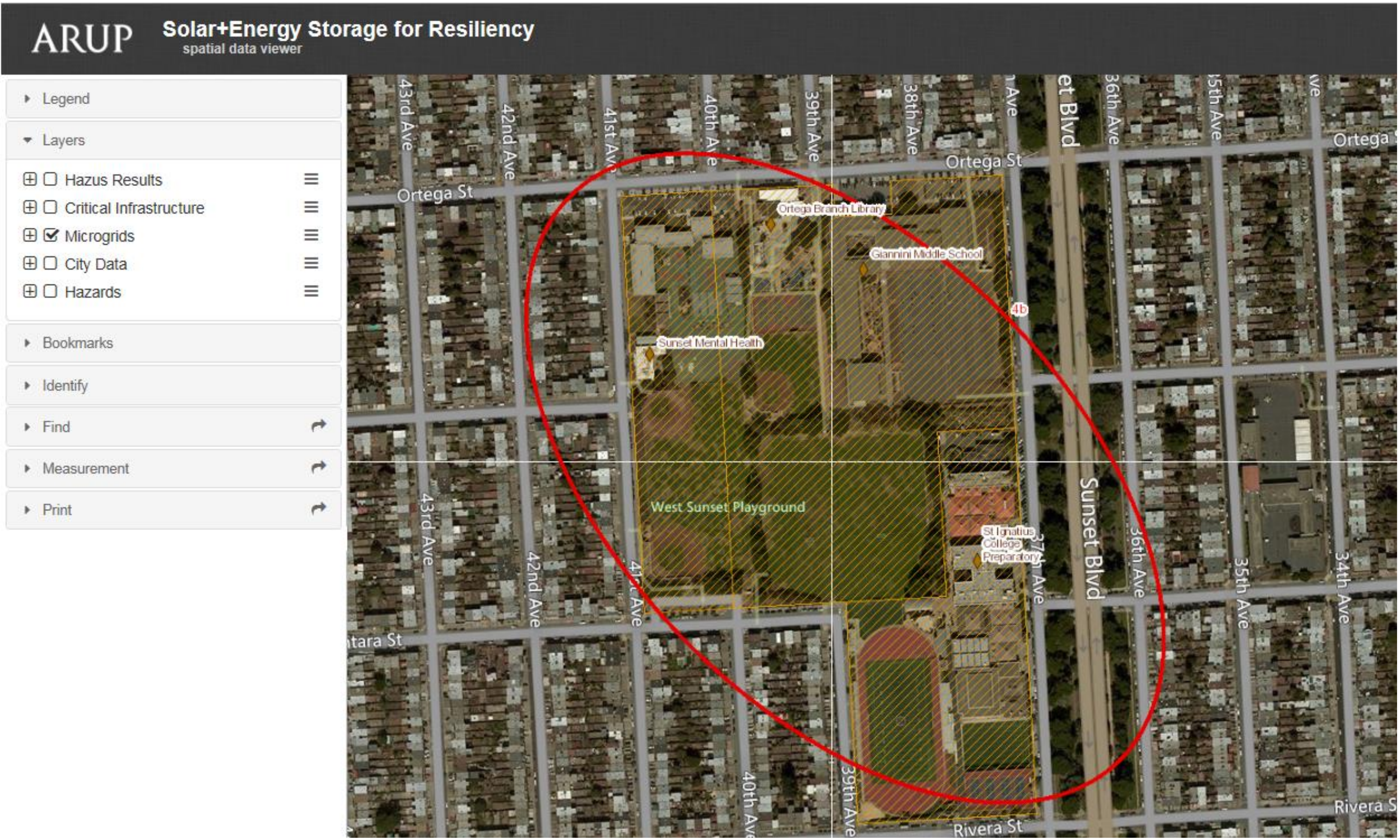
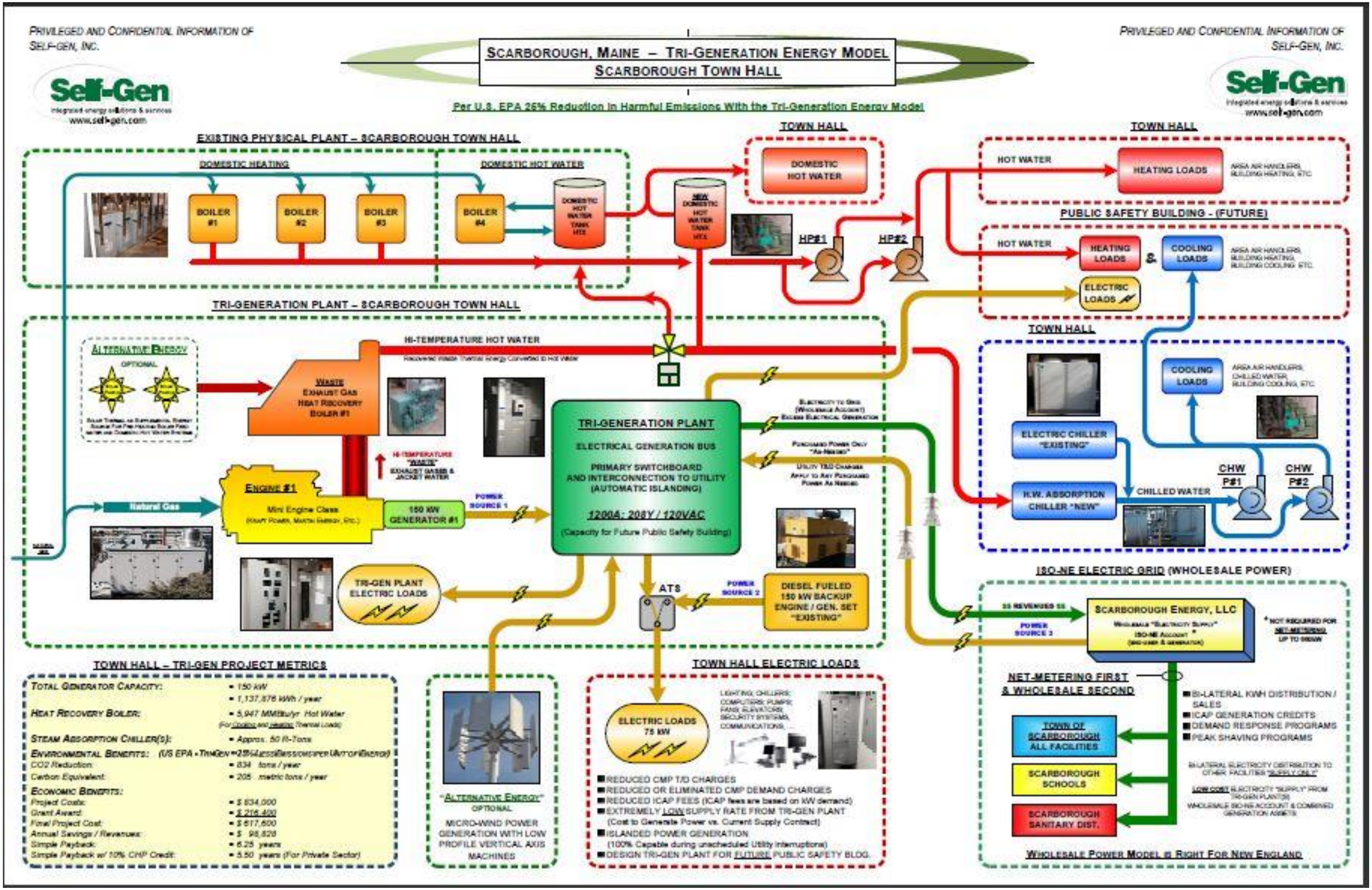


Slide courtesy of Arup

Scarborough, ME Town CHP

- CHP for resilience at Town Hall and planned Public Safety Building (PSB)
- Power, heat and cooling for both buildings
- $830,000 project, $220,000 Efficiency Maine grant, ~6.5 yr SPB
- Project cost more than it had to just to serve Town Hall alone (~5 yr SPB)
- $300,000-$400,000 in avoided cost at planned Public Safety Building
  - Avoided / downsized electrical & HVAC infrastructure



Slide courtesy of Paul Aubrey / Self-Gen

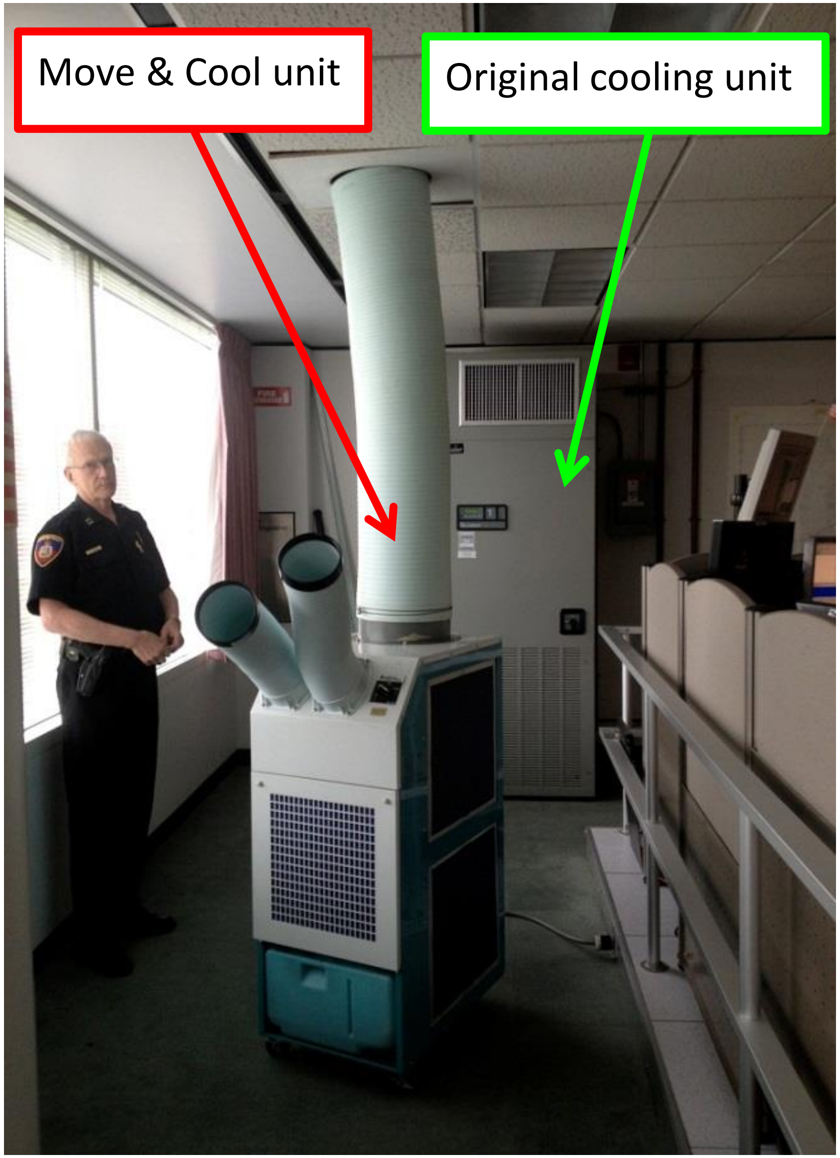

BAC


GÜNTNER

Stamford's Government Center (SGC)

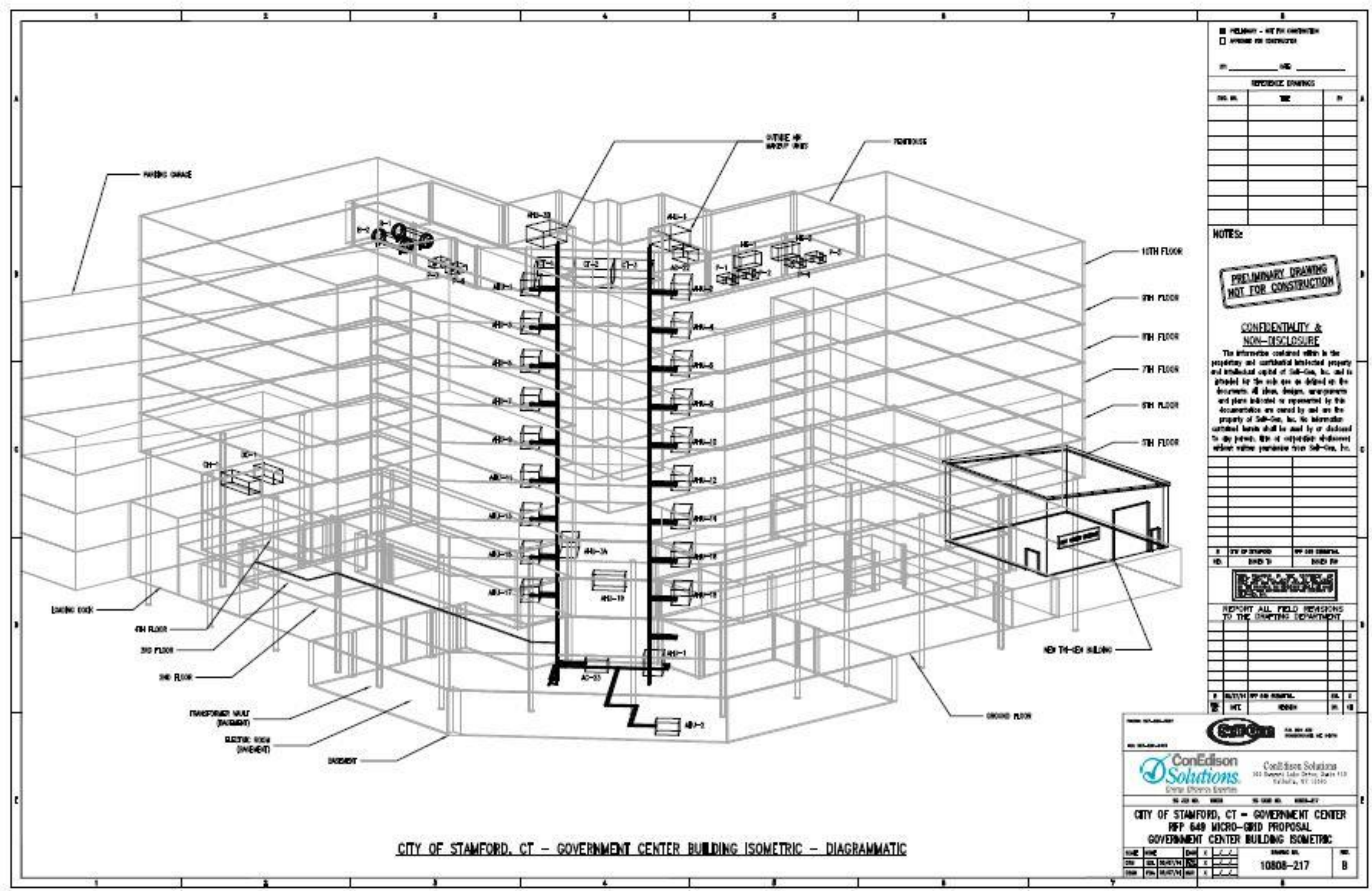
- 10 stories, 272,000 SF, built in 1985
- 1.2–1.4 MW summer peak, ~800 kW winter peak demand

SGC energy challenges



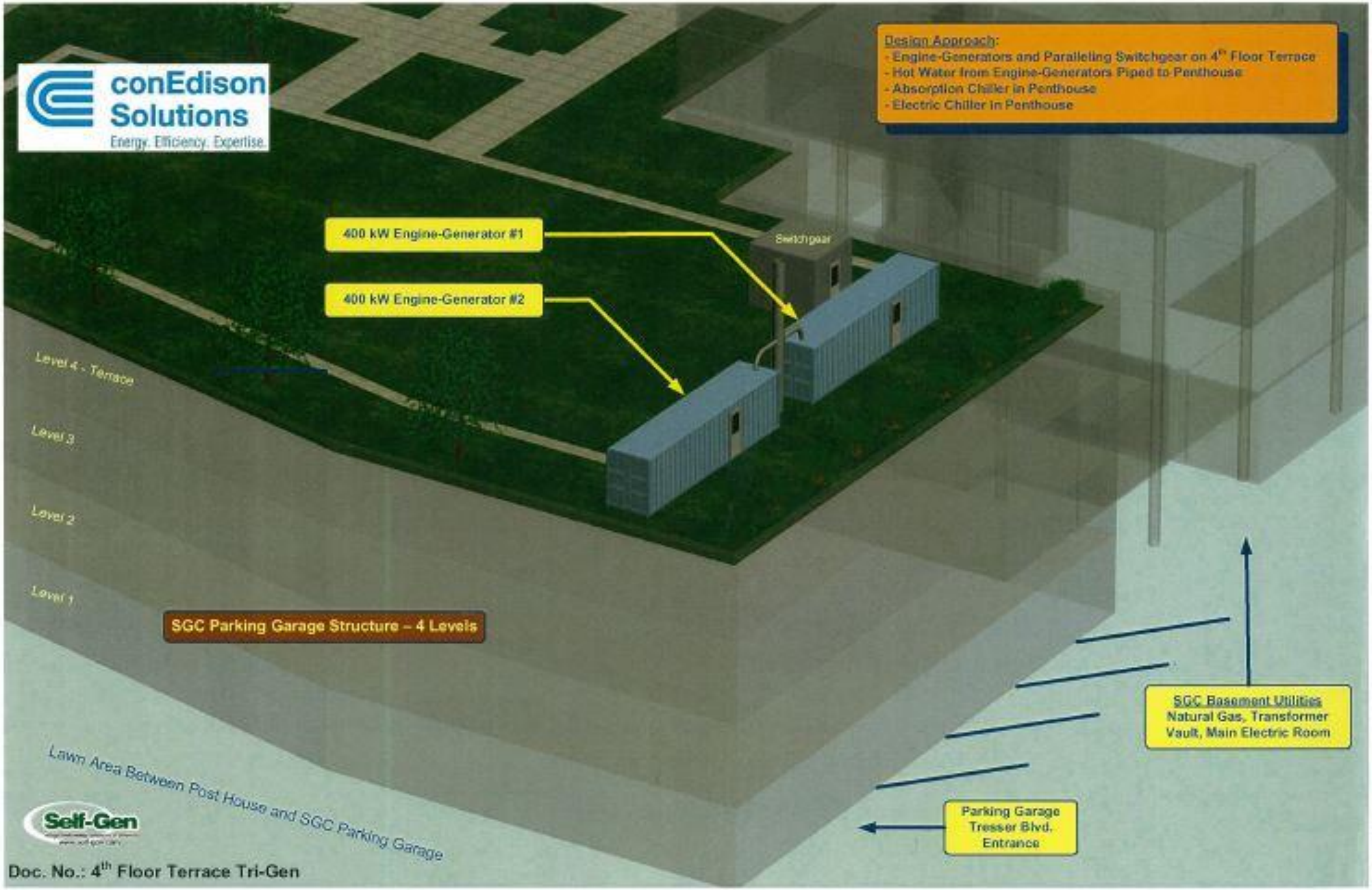
- Designed as corporate HQ, not critical facility
- Aging HVAC, cooling maxed out
- Power & cooling challenges interfere with 911 emergency communications
- No efficiency upgrades
- Diesel backup generators
- Resilience improvements

SGC HVAC systems

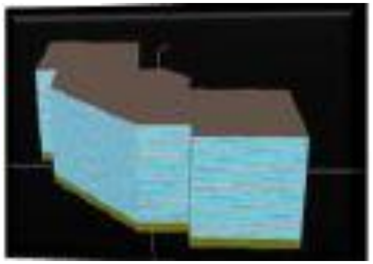


Graphic courtesy of ConEdison Solutions

SGC combined heat and power plan



Graphic courtesy of ConEdison Solutions



SGC annual electric load profile: existing conditions

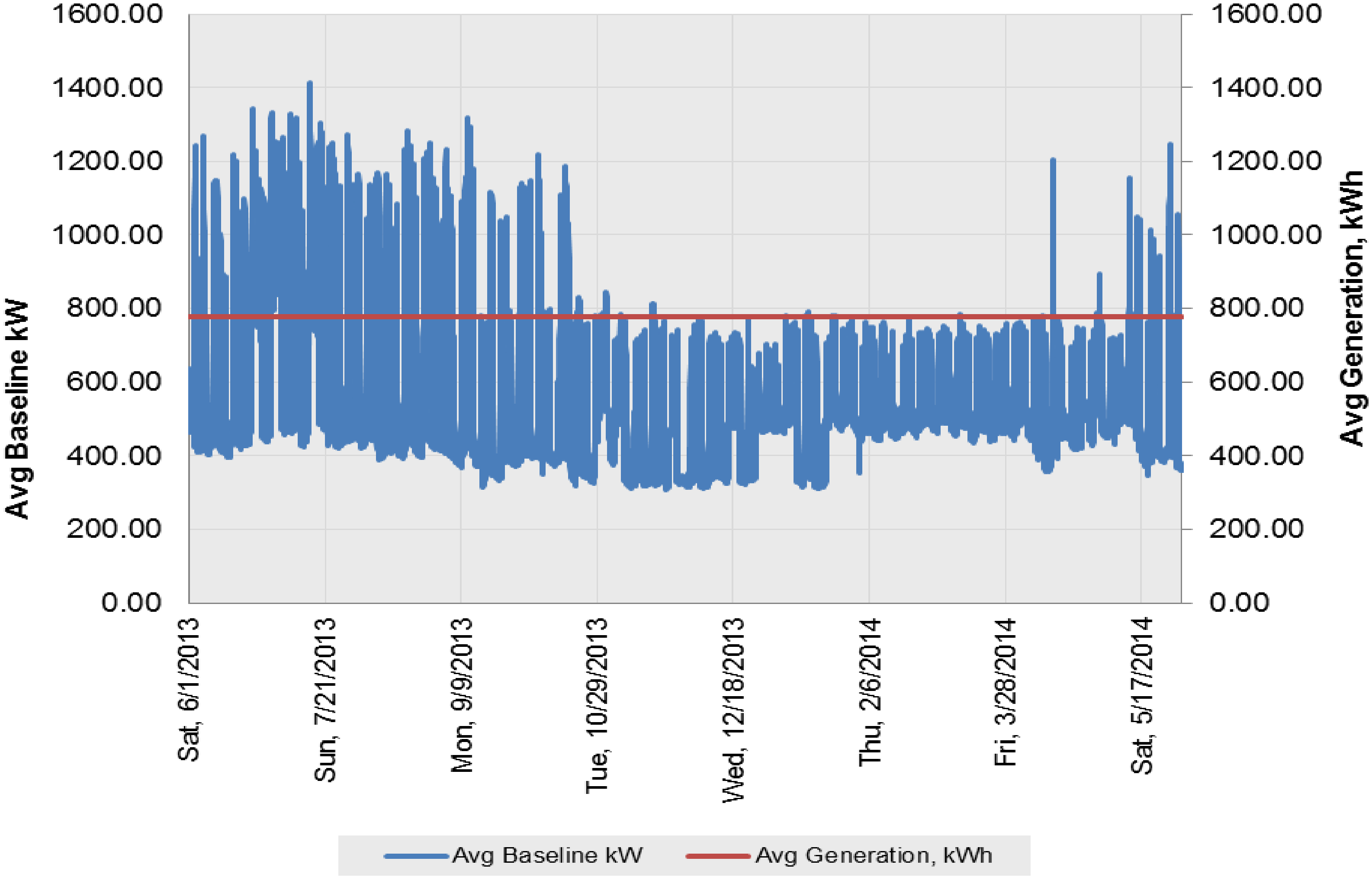
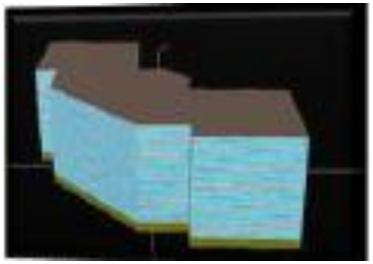


Image: ConEdison Solutions



SGC annual electric load profile: Post-retrofit estimate

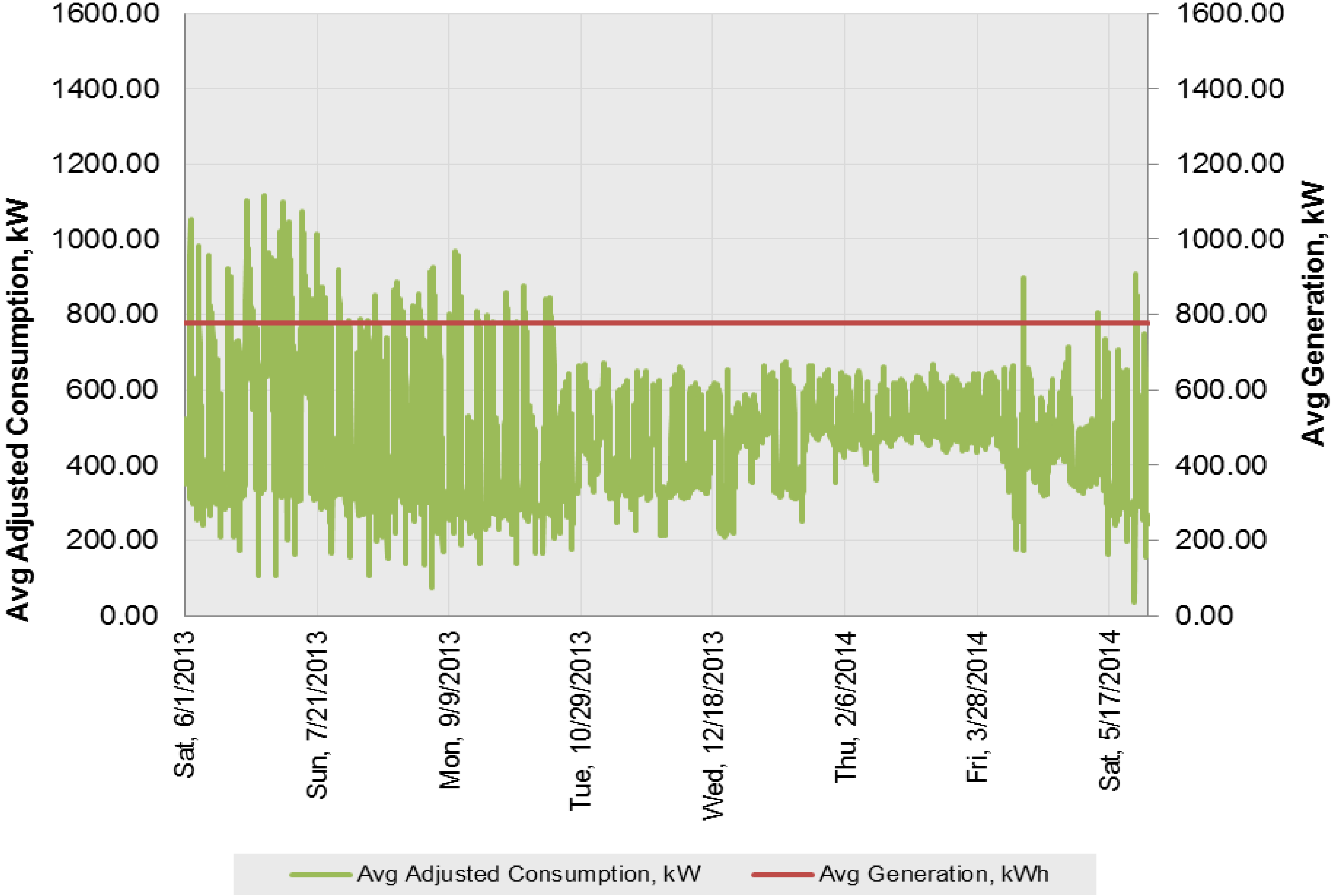
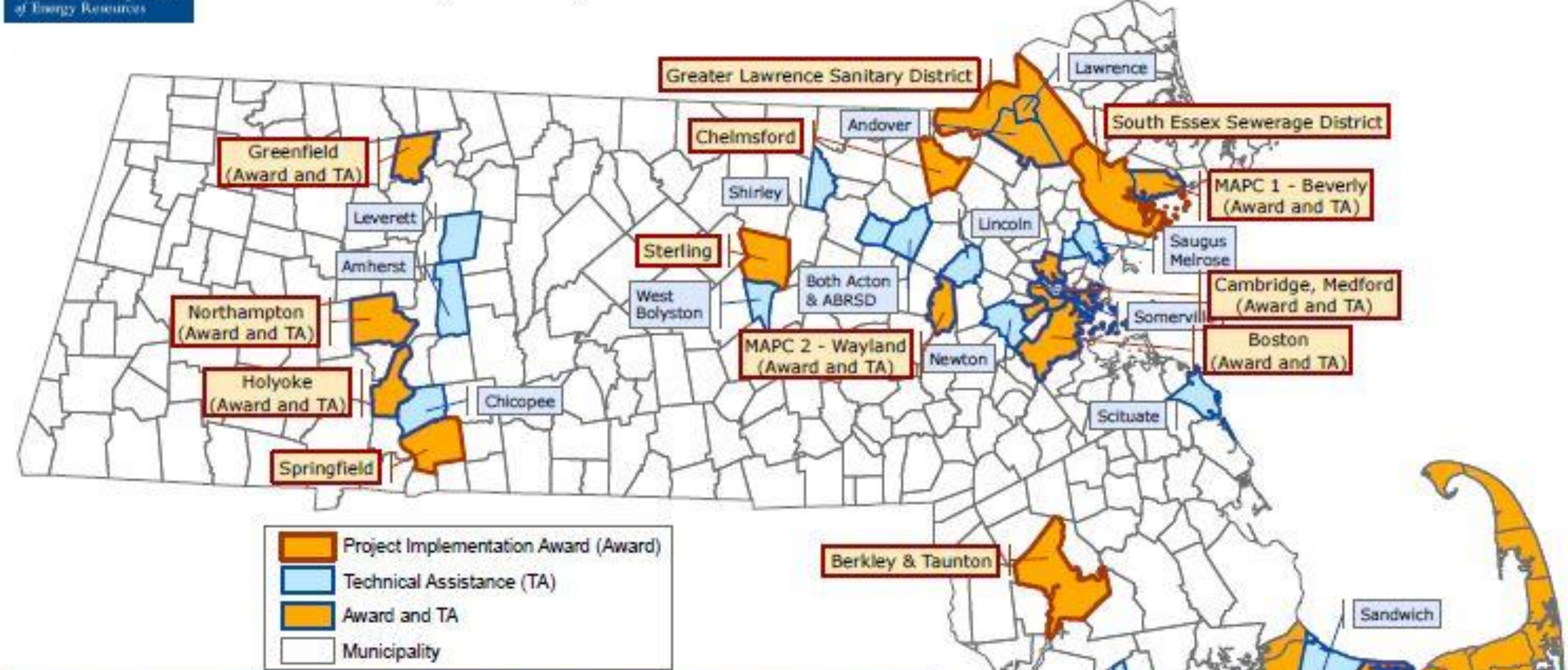
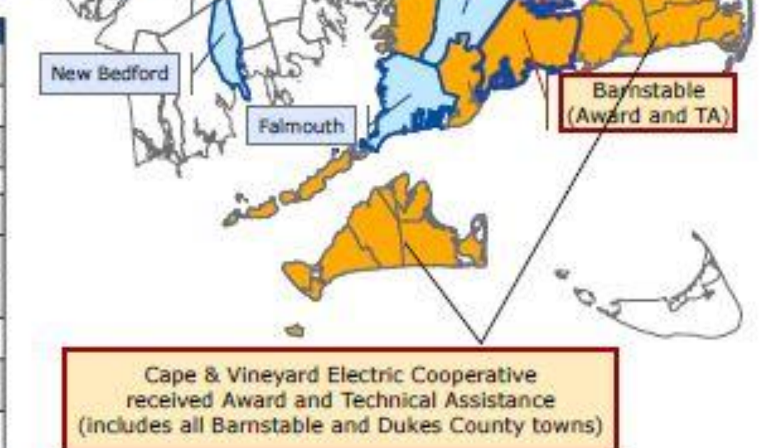


Image: ConEdison Solutions

DOER Massachusetts Department of Energy Resources

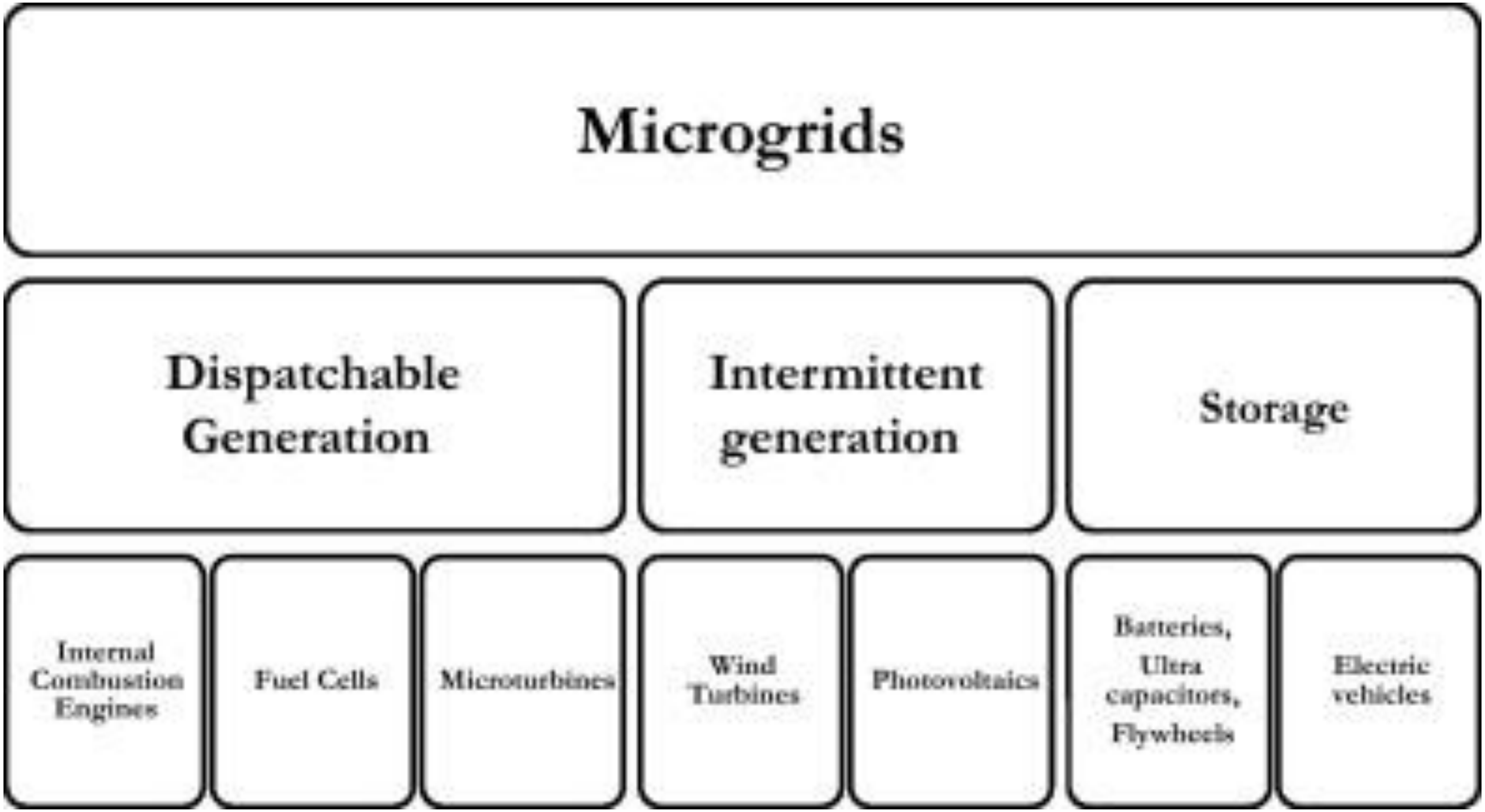
Community Clean Energy Resiliency Initiative
Project Implementation and Technical Assistance





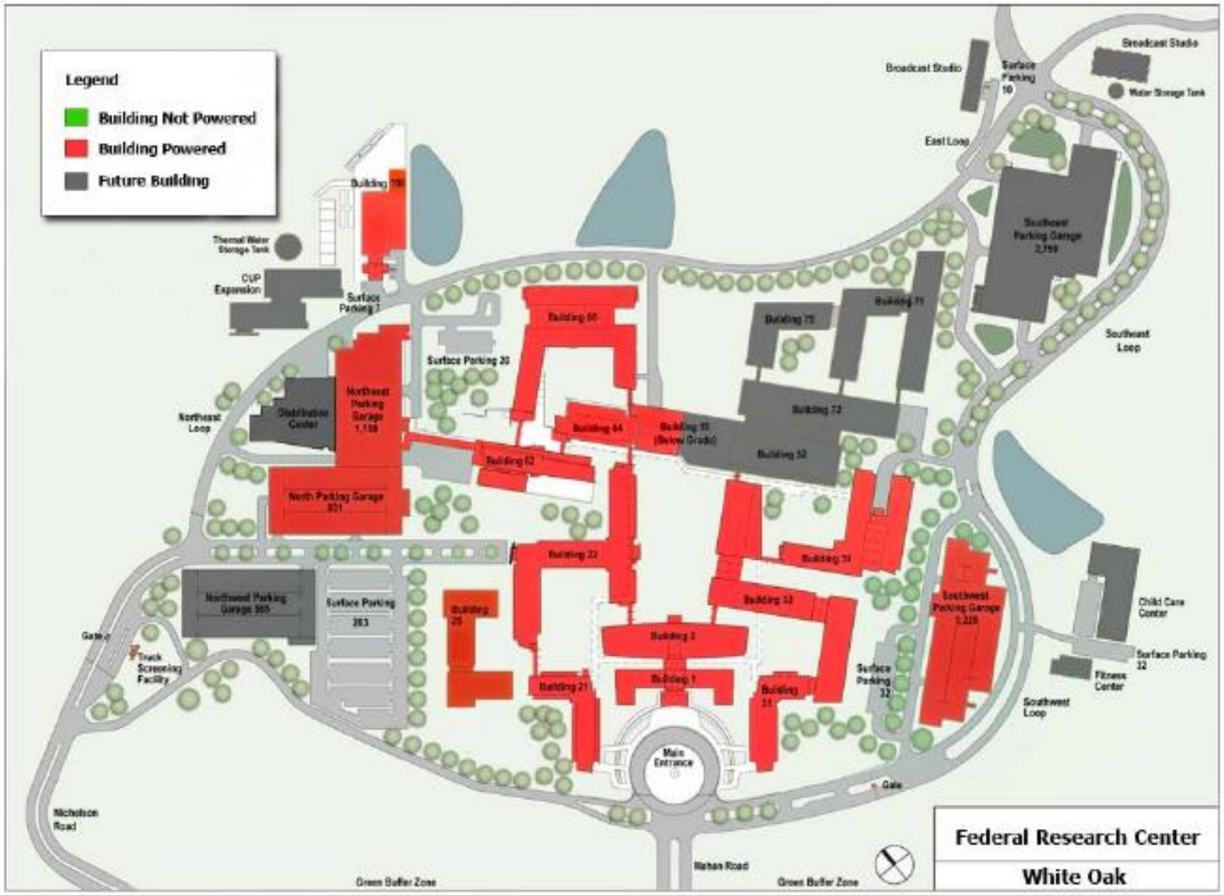
Applicant	Project Title	Grant Amount
Barnstable	Cogeneration Plant at Barnstable Intermediate School	$ 406,000
Berkley and Taunton	Berkley/Taunton Community Microgrid	$ 1,455,000
Boston	Solar PV with Battery Storage for select Boston Community Centers	$ 1,320,000
	BMC Menino Campus CHP Plant	$ 3,680,000
Cambridge	Cambridge Water Supply Resilience	$ 851,868
Chelmsford	McCarthy Middle School, Emergency Power Generation	$ 74,941
Cape & Vineyard Electric Cooperative	Dennis-Yarmouth High School Regional Shelter	$ 1,479,193
Greater Lawrence Sanitary District	Organics to Energy Upgrade Project	$ 5,000,000
Greenfield	Greenfield Resiliency Plan for High School	$ 367,310
Holyoke	Resiliency at Holyoke Facilities - Fire HQ, Mt. Tom Tower, Dean School	$ 1,013,794
MAPC - Beverly	Energy Resiliency at Beverly Regional Cache Site	$ 526,180
MAPC - Wayland	The MAPC Solar Resiliency Project	$ 264,627
Medford	Medford Resiliency Project	$ 833,366
Northampton	Batteries and PV Islanding Capability for Fire HQ	$ 525,401
	Microgrid with Islan d-able PV at Smith Vocational and Agricultural High School, Northampton DPW and Cooley Dickinson Hospital	$ 3,078,960
South Essex Sewerage District	Combined Heat and Power Facility	$ 700,000
Springfield	Baystate Health Cogeneration Project	$ 2,790,099
Sterling	Implementing a Resiliency Plan through Clean Storage for a Municipal Microgrid	$ 1,463,194
Total		$ 25,829,933

DOER, JPfister, 3-24-16


Microgrids
Dispatchable Generation
Intermittent generation
Storage
Internal Combustion Engines
Fuel Cells
Microturbines
Wind Turbines
Photovoltaics
Batteries, Ultra capacitors, Flywheels
Electric vehicles

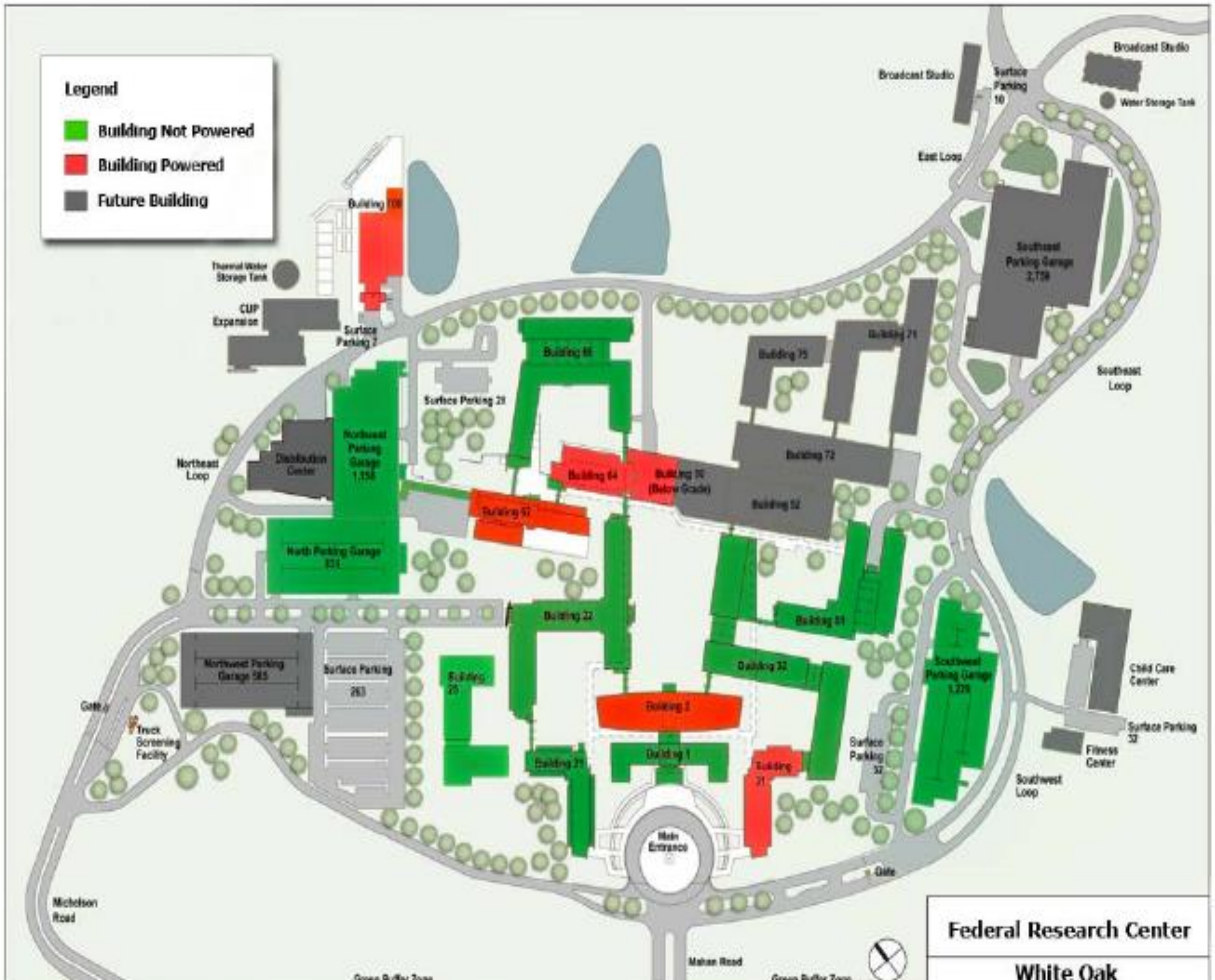
FDA White Oak campus microgrid

Capabilities – Emergency Preparedness
Black-Start Power Restoration: 20 Minutes – 60 Minutes



Capabilities – Emergency Preparedness

Black-Start Power Restoration: 30 Seconds – 20 Minutes

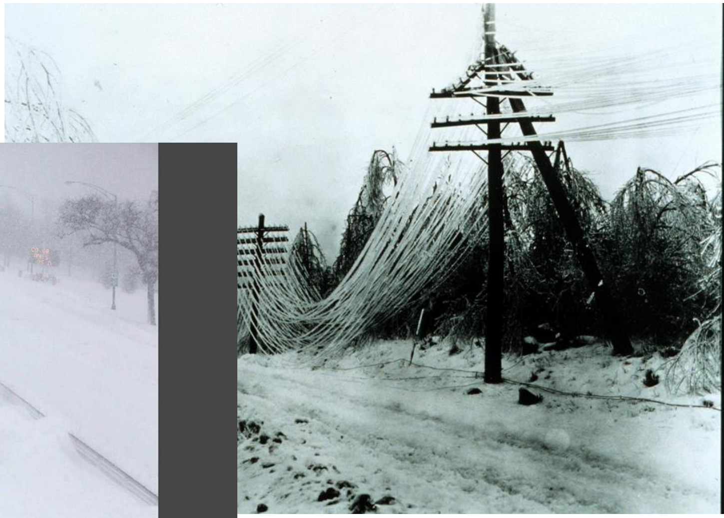


Multi-user community microgrids are coming…

Planes, trains and automobiles: Transportation resilience

- Roads, rails, runways, boats, bridges, tunnels, …
- Hazards
- Systems interdependencies
- Can you get people out and get help in?
- Mitigate, adapt, sustain, shut down, retreat

Fire or ice?



FTA

Phillip Dugaw/Reddit

Images: Steven Winkelman / CCAP

Photo source: New York Daily News

Images: Steven Winkelman / CCAP

Water, Water…

…EVERYWHERE

Image: Klaus Jacob / Columbia U.

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Image: Susanne DesRoches / Port Authrority

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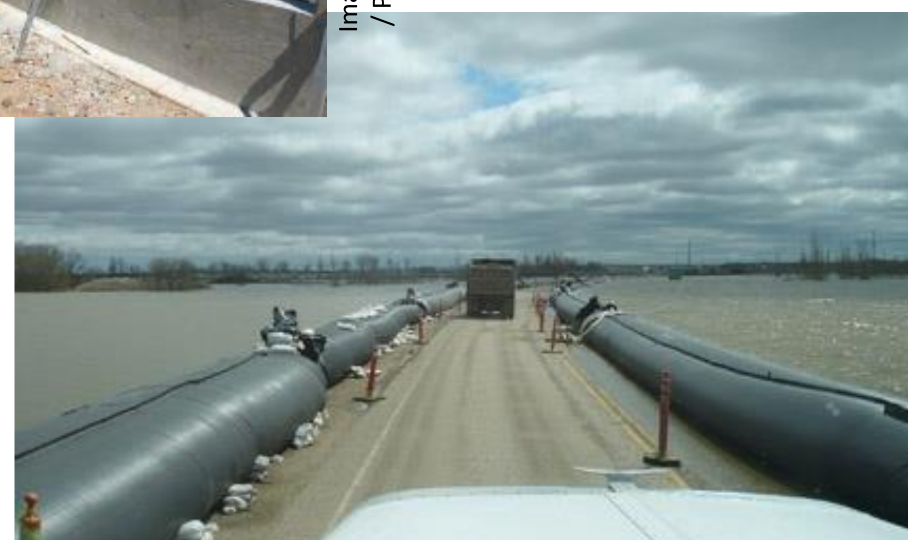
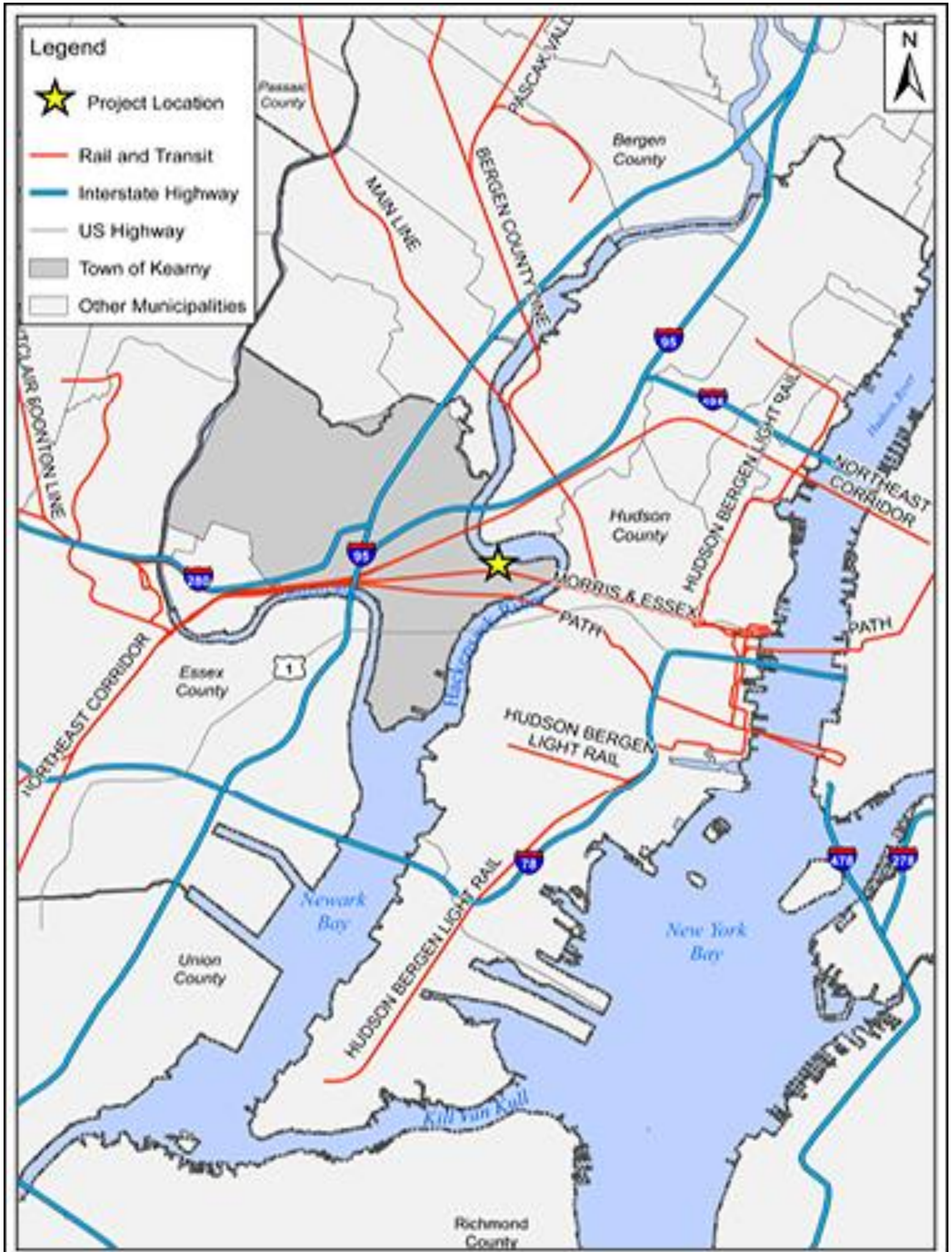


VERMONT: CULVERT REDESIGN, RIVERS & ROAD TRAINING

FEMA initially denied reimbursement for larger culvert. Ongoing challenge with site-specific design flexibility vs. uniform application of a law. Georgetown Climate Center is preparing a case study (and provided these photos).

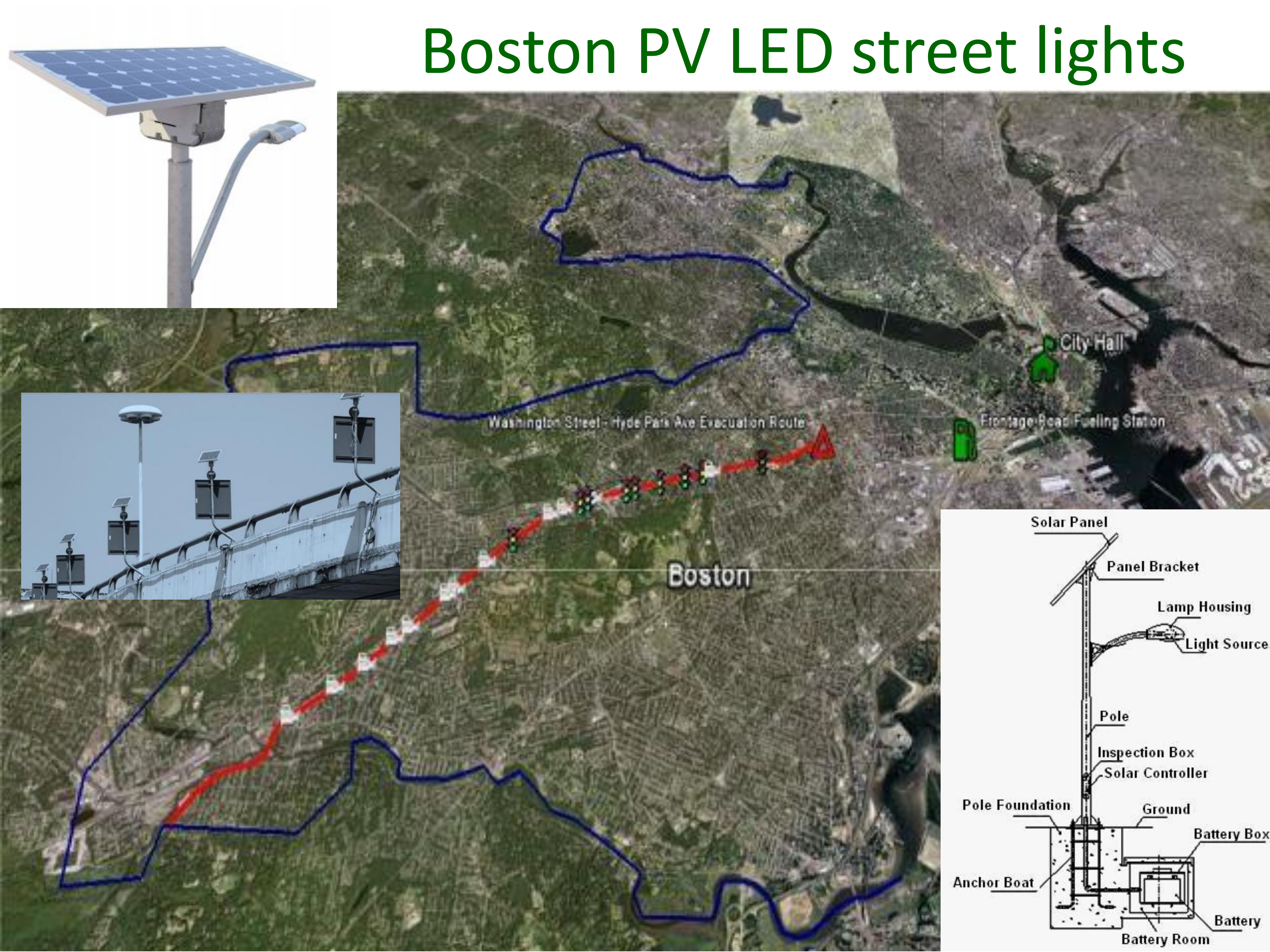
VTRANS: Rivers & Roads Training
Design, maintain, operate with the rivers foremost in mind.



New Jersey Transitgrid

- FTA $410M grant, DOE support
- 100+ MW natural gas generation 24/7
- Future clean DG
- Harden substations
- Power sections of NE Corridor, lighter rail, signals, buildings
- Resilient storage for 444 rail cars

Boston PV LED street lights



PLANNING NOW SAVES MONEY LATER.

We tend to spend more cleaning up after disasters than planning ahead to prevent future losses.

Scenario	Losses	Preventative Measure
Sandy, NYC (2012)	$19B	$20B (PlaNYC)
Katrina, New Orleans	$150B	$30B (Amsterdam-style flood controls)
1.4m Sea Level Rise, San Francisco	$62B	$5B (Flood defense)

Thank you for your time…

QUESTIONS?

Chris Lotspeich, MBA, MES, CEM (pending)

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Microgrids lessons leaned

- Barriers to implementation
  - Political, economic, organizational > technical
  - Technical complexity & immaturity
- Business model, ownership & operation
  - Public/private partnerships, incentives programs
- Bigger projects are easier to bring to marketplace
  - >1-2 MW (best 3-5+ MW); >$1 million for 3rd party BOOM
- Controls, integration, interconnection challenges
- Generation selection, load matching
- Alternative infrastructure hardening strategies
- Challenges to utility franchise rights
  - Crossing rights of way; import-only microgrids