PV+ES for Resilience

Solar Power and Energy Storage for Critical Facility Energy Surety

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NESEA Building Energy 16

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Celtic Energy

PV+ES planning considerations

- What are your mission critical loads?
- How long do you want to operate off grid?
- Location and capacity of onsite systems?
- What role for backup generation (if any)?
- What procurement “business model”?

What is your design basis threat?

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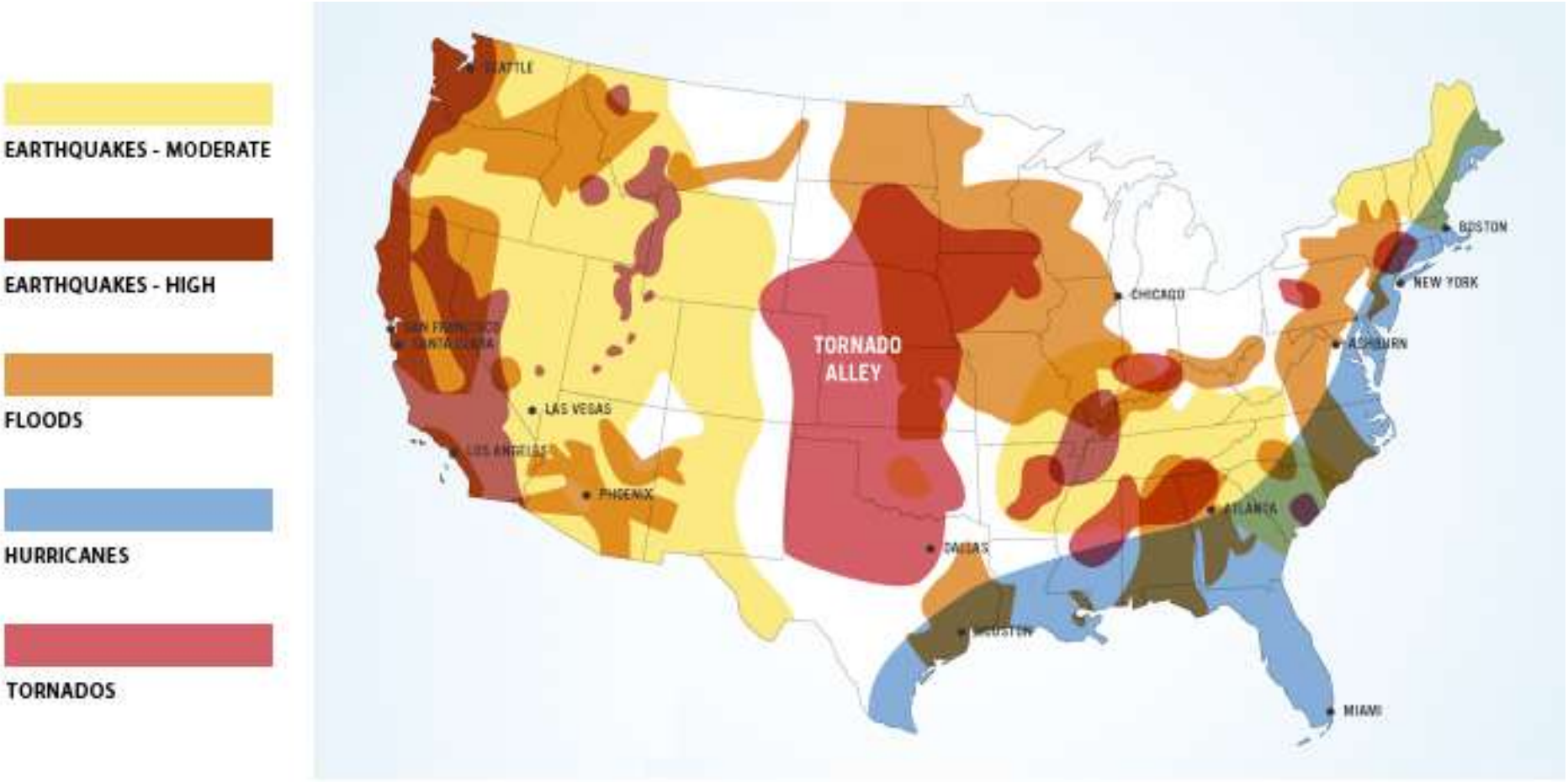

Image Credit: http://www.crisishq.com/

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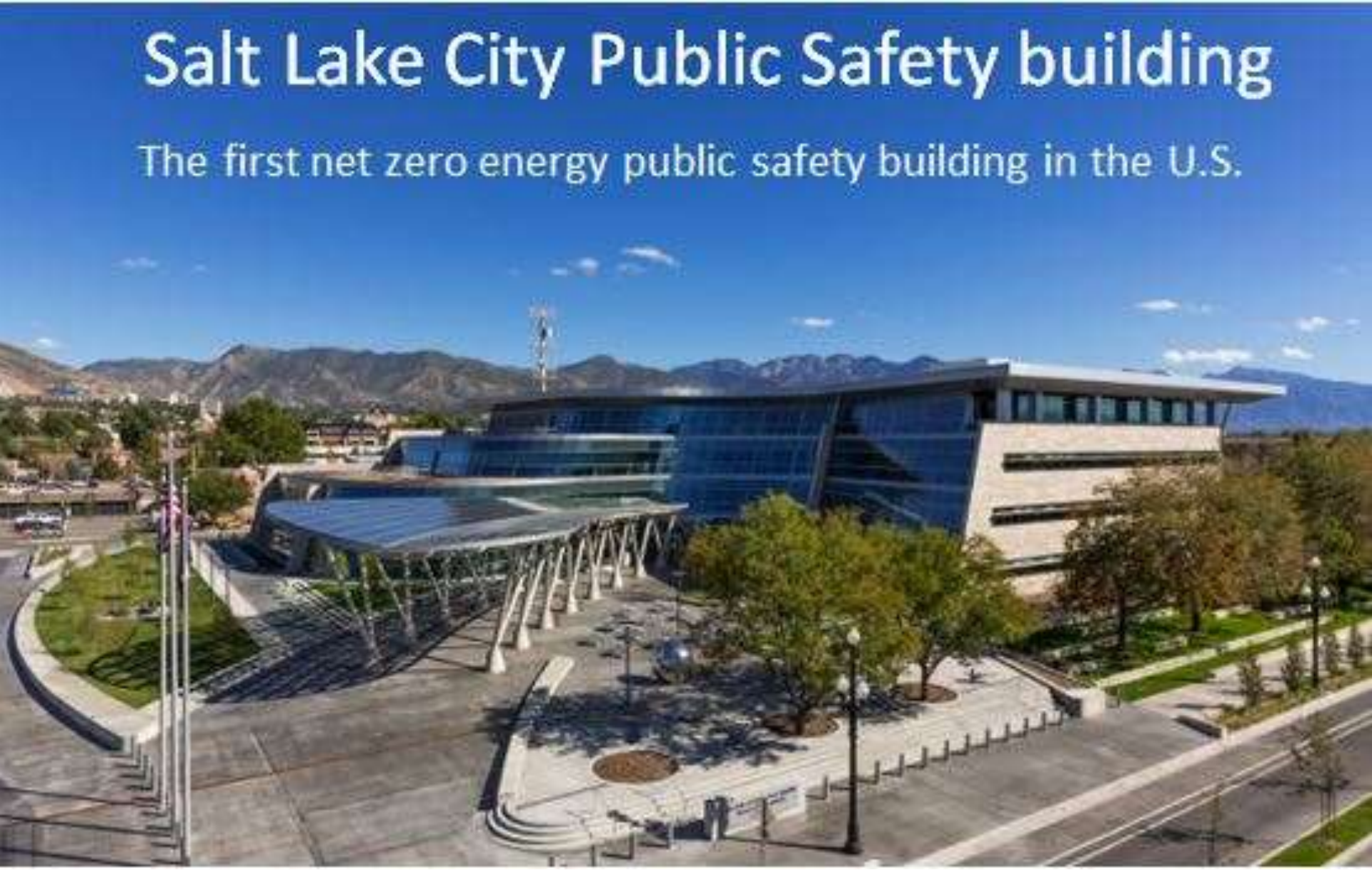
Salt Lake City Public Safety building

The first net zero energy public safety building in the U.S.



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.


Photo: Russell Carr


Photo: Russell Carr


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

Photo: Rus

Photo: Russell Carr

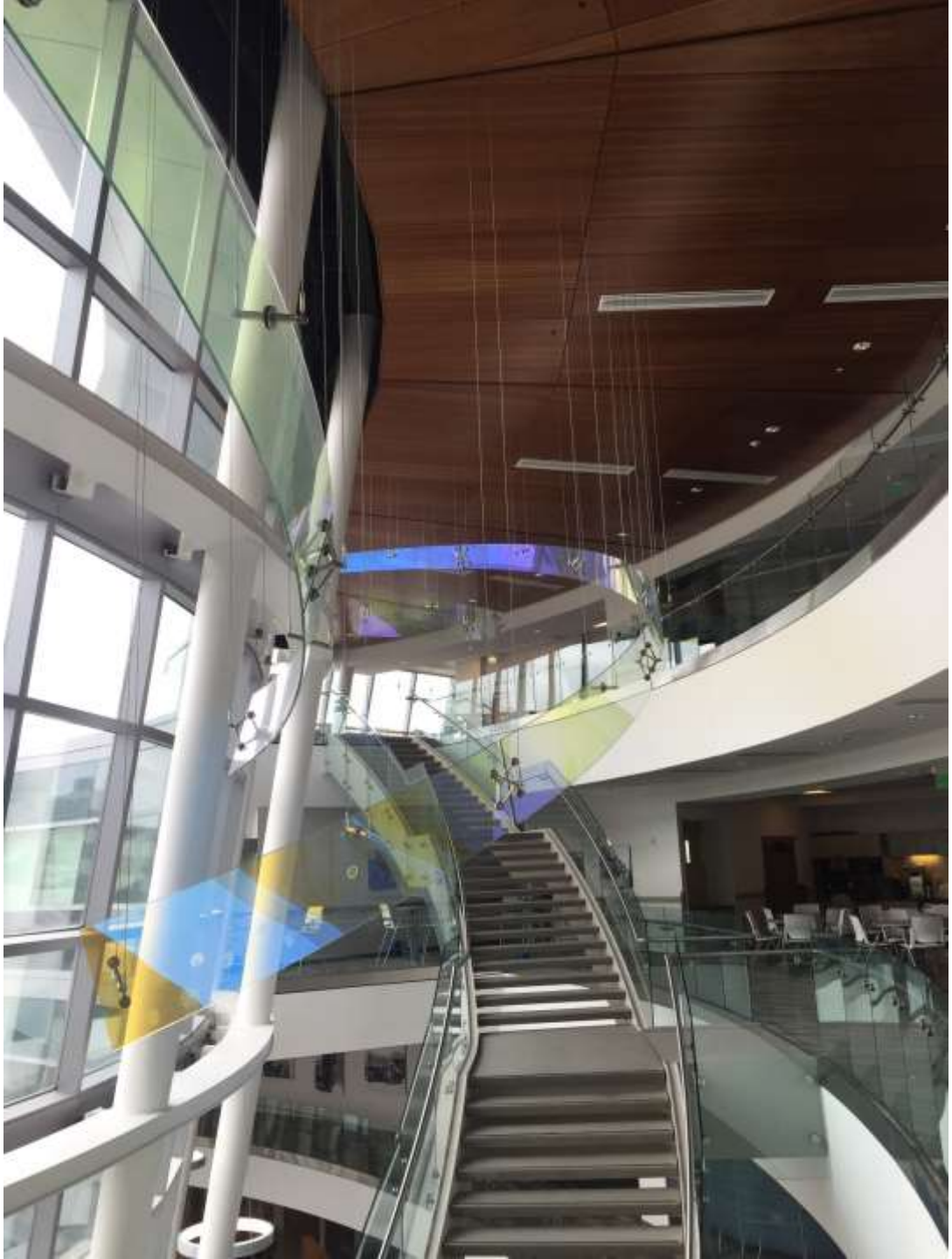


Photo: Russell Carr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FL SunSmart Schools E-Shelters program

- 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, outlets for device charging; no HVAC
  - Enhanced Hurricane Protected Area in each school
  - Typically gyms, cafeterias, classrooms

Solar Market Pathways

ARUP

Solar+Storage for Resilience

SunShot
U.S. Department of Energy

Slide courtesy of Arup

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Partners

SFDEM
SAN FRANCISCO DEPARTMENT OF EMERGENCY MANAGEMENT

nen

San Francisco Water Power Sewer
Services of the San Francisco Public Utilities Commission

SFFD NERT
NEIGHBORHOOD EMERGENCY RESPONSE TEAM

San Francisco Department of Public Health

ROCKY MOUNTAIN INSTITUTE®

RENEWABLE FUNDING

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COUNTY OF ALAMEDA CALIFORNIA

Celtic Energy

STRATEGEN
STRATEGIES FOR CLEAN ENERGY

Sandia National Laboratories

BERKELEY LAB
Lawrence Berkeley National Laboratory

USDN urban sustainability directors network

Slide courtesy of Arup

The Issue

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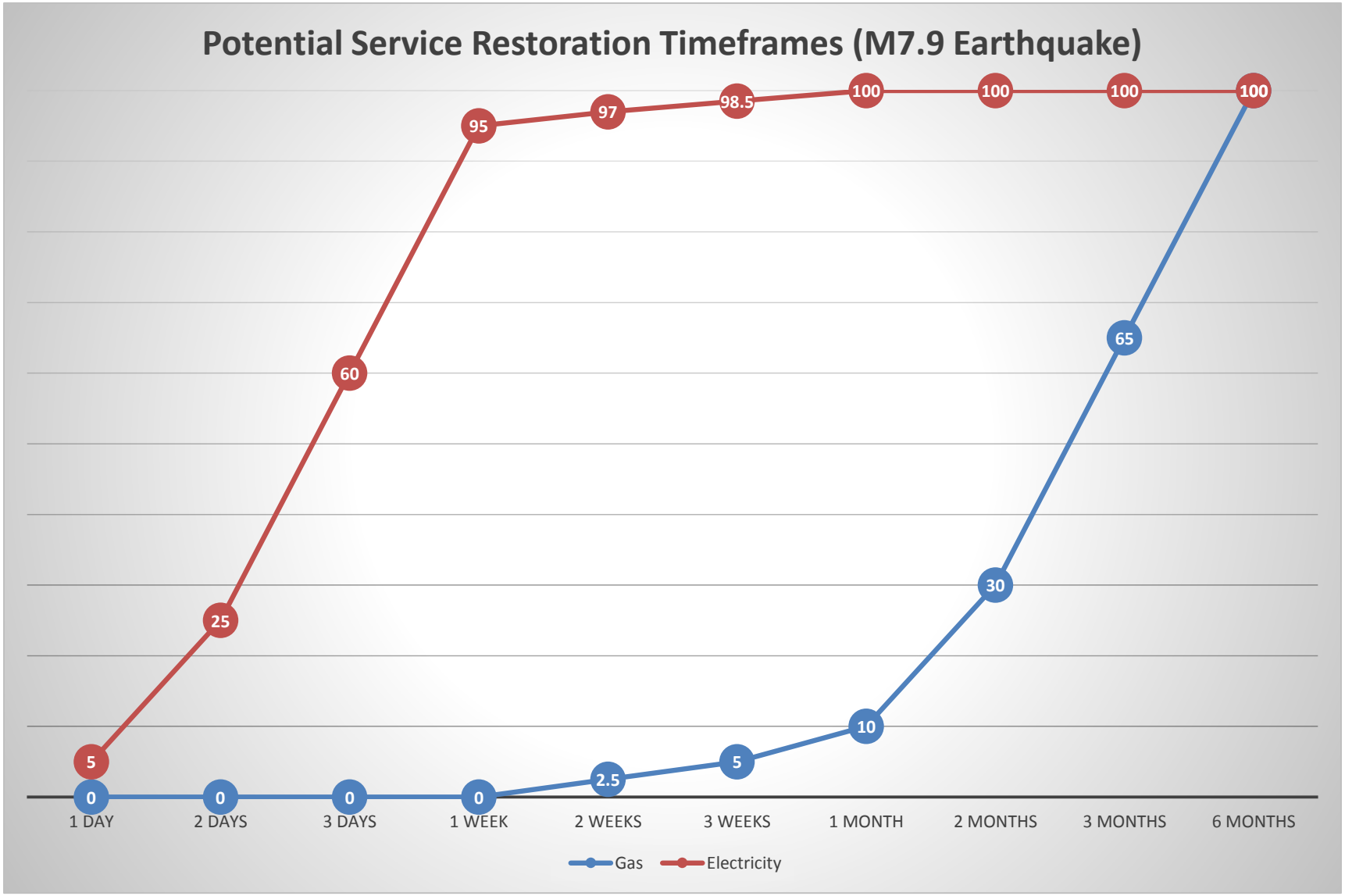

Data Credit: Lifelines Council

Slide courtesy of Arup

PV+ES Technologies

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Slide courtesy of Arup

PV+ES … + Generators

Adapted from slide courtesy of Arup

Design Decision Tree

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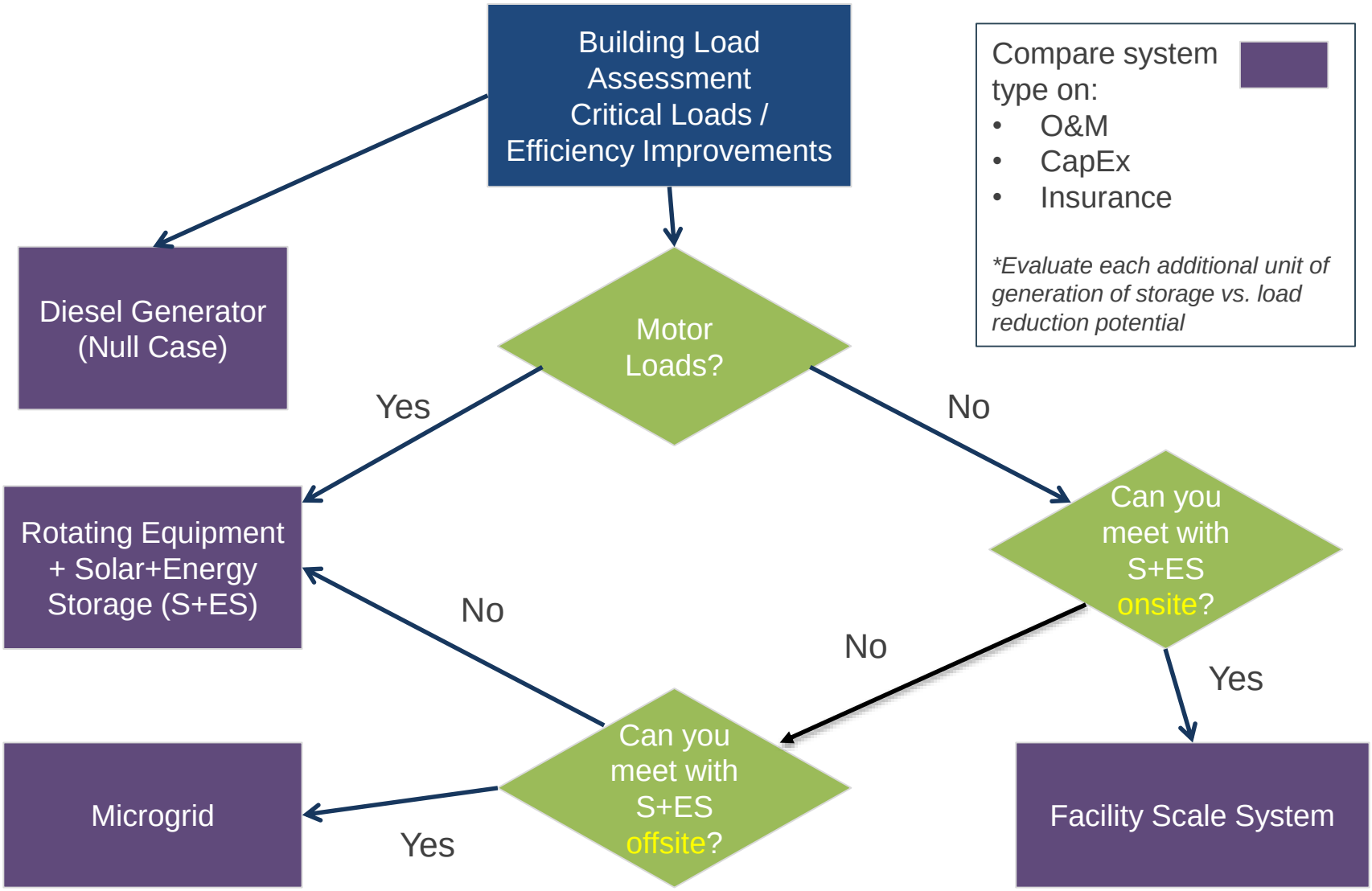

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SF Critical Facilities

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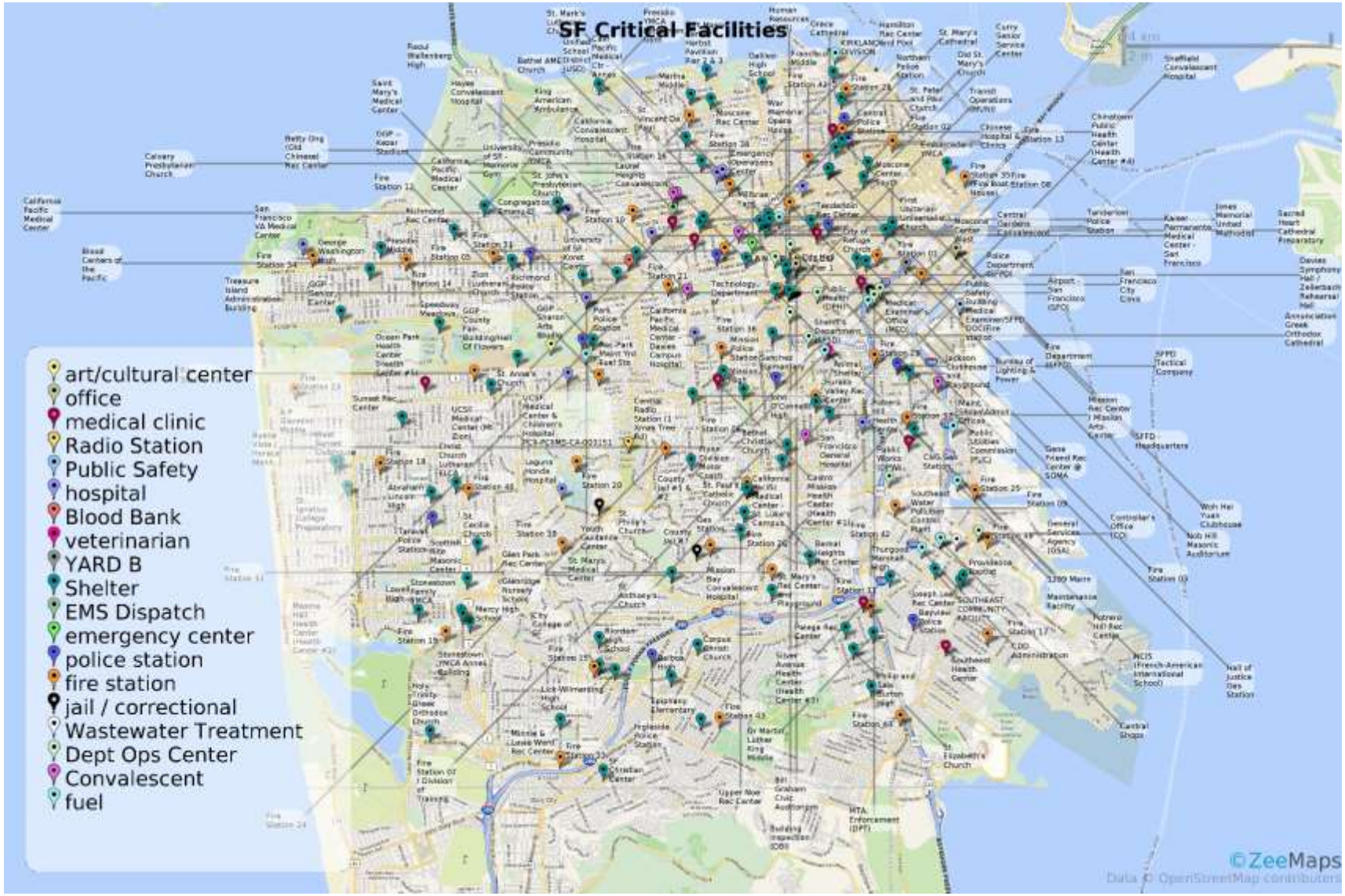

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Potential Microgrids

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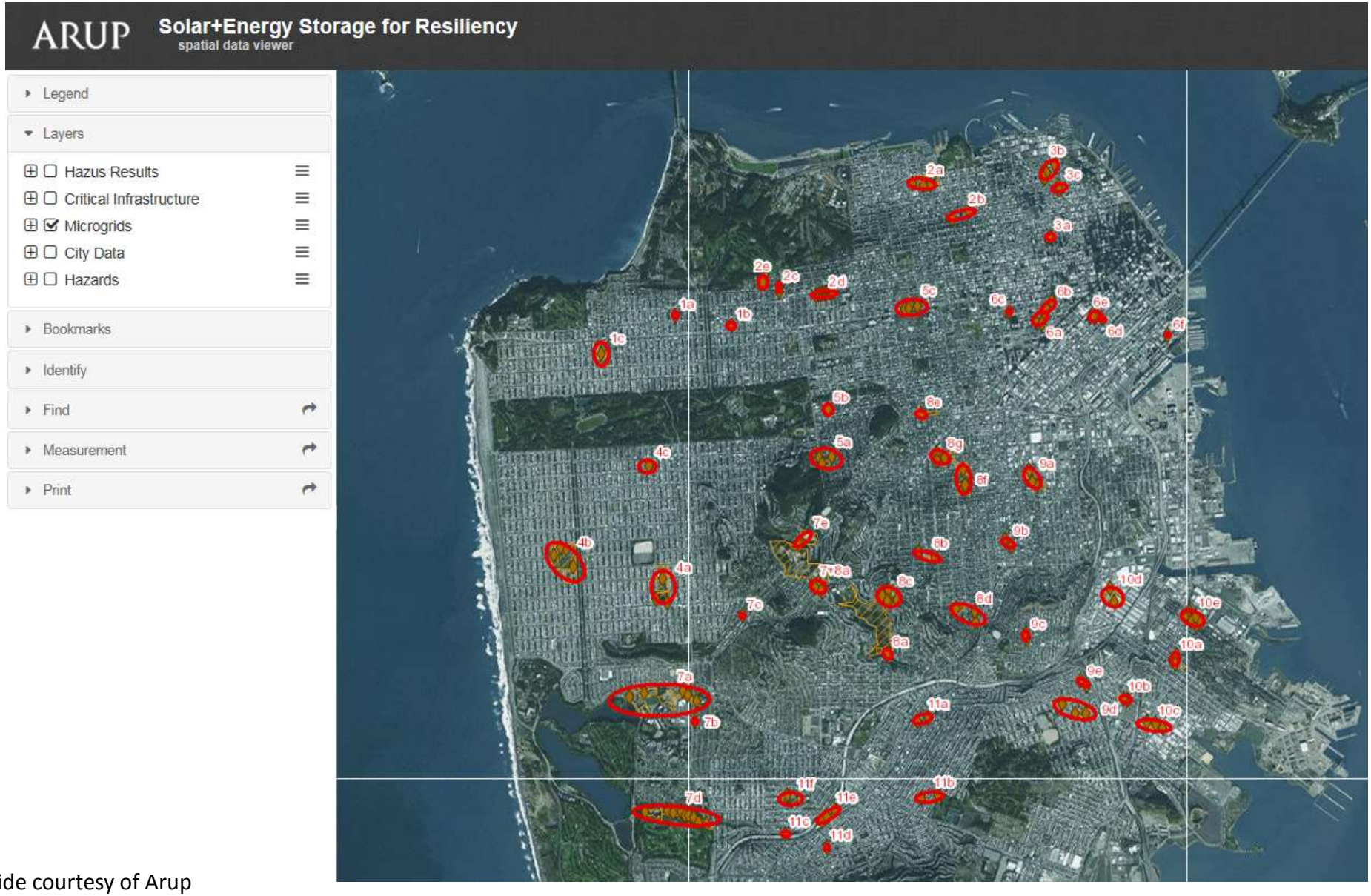
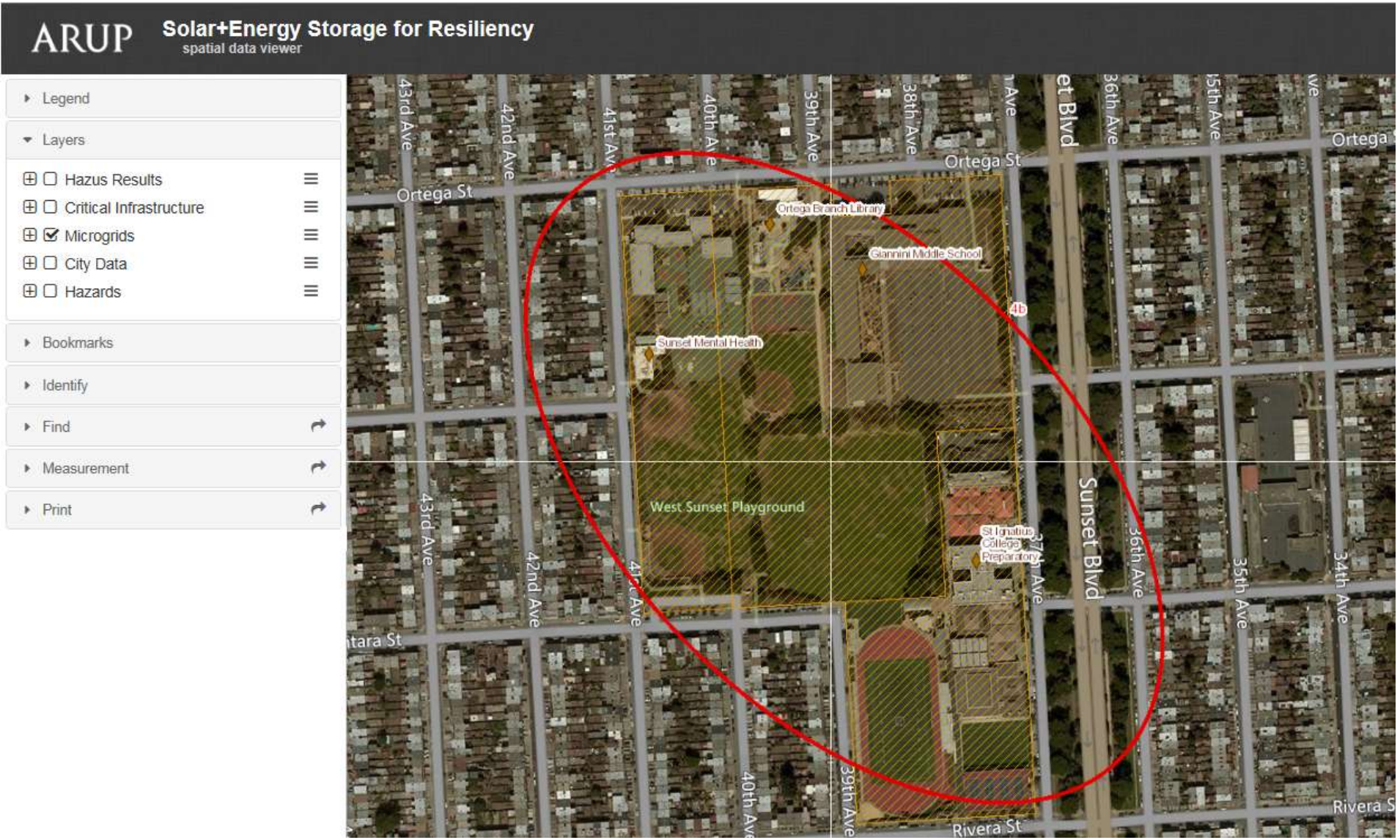


Slide courtesy of Arup

Potential “West Side” Microgrid

ARUP



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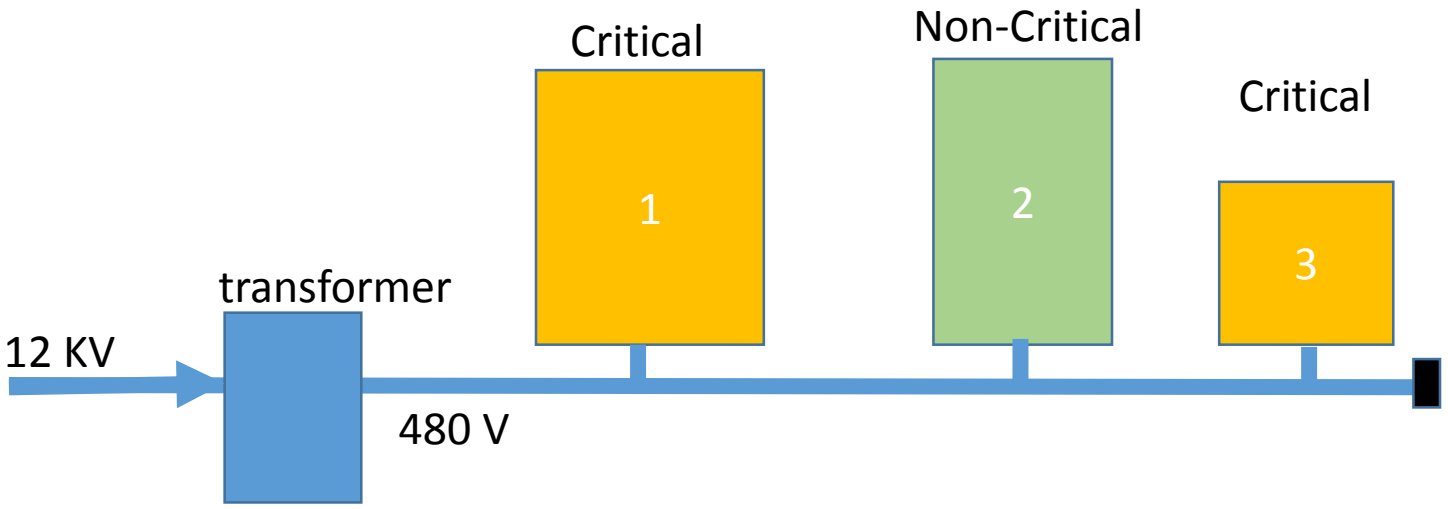
Microgrid Considerations

ARUP

End of the same feed branch



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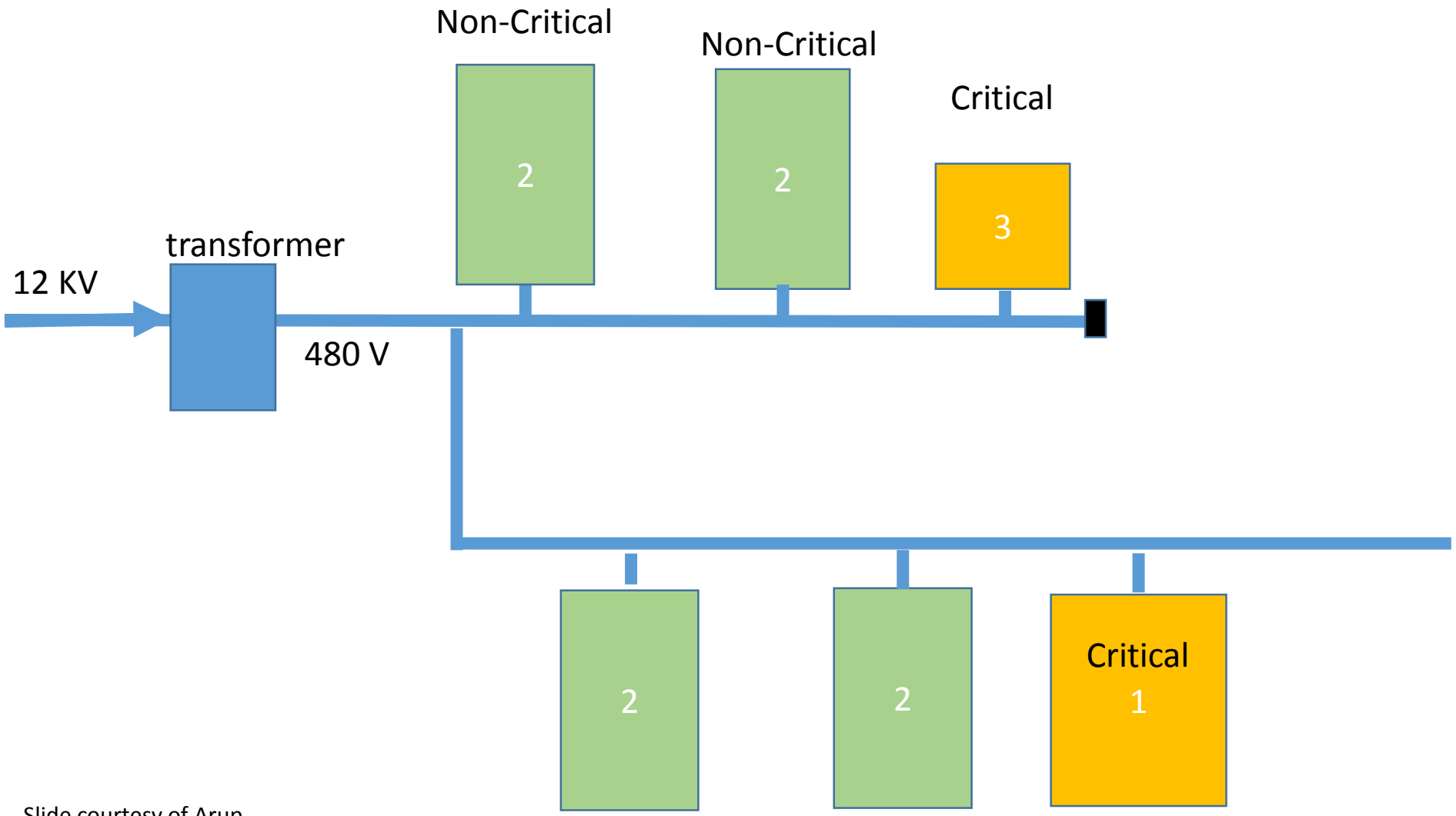
Microgrid Considerations

ARUP

Same feed, different feed branch



Slide courtesy of Arup

Microgrid Considerations

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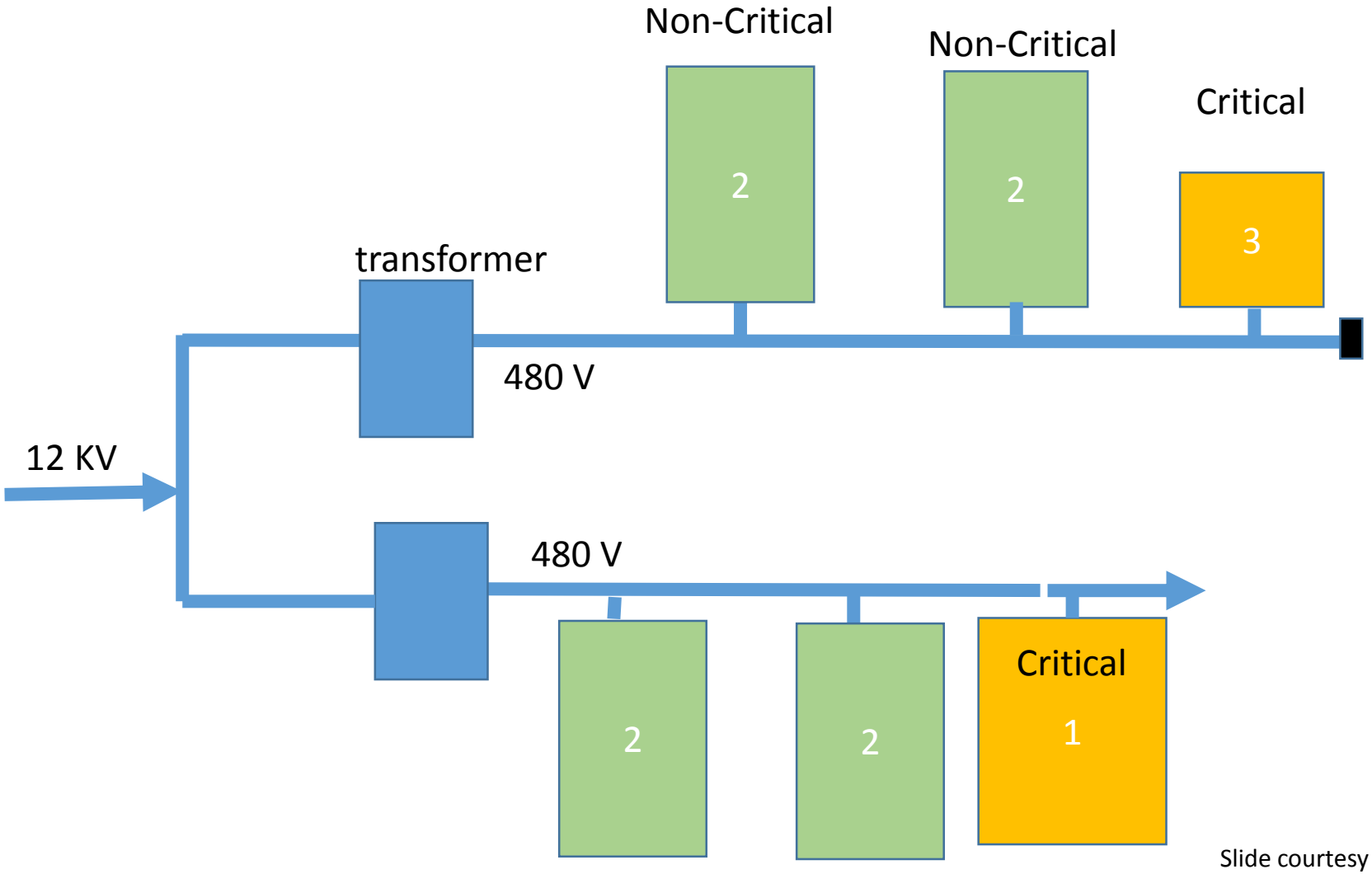
On a different feed



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GRIDSCAPE

Microgrid Demonstration Project for the City of Fremont Fire Department Stations 6, 7 and 11

CEC PON-14-301

Demonstration of Low Carbon-Based Microgrids for Critical Facilities

Slide courtesy of Gridscape

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

Equipment to be Installed:

Location	Solar	Energy Storage
Fire Station #11: 47200 Lakeview Blvd	22.3 kW parking canopy	Samsung Lithium-ion Battery (~80 kWhr)
Fire Station #6: 4355 Central Ave	37.1 KW parking canopy	Samsung Lithium-ion Battery (~80 kWhr)
Fire Station #7: 43600 S. Grimmer Ave	43.4 kW parking canopy	Samsung Lithium-ion Battery or IMERGY vanadium based flow battery (~80 kWhr)

Slide courtesy of Gridscape

Project Design (cont.)

GRIDSCAPE

9/24/15

Slide courtesy of Gridscape

Project Design (cont.)

Fire Station #6

Fire Station #7

Fire Station #8

GRIDSCAPE

Slide courtesy of Gridscape

Project References
Duke Energy McAlpine Substation & Fire Station

DUKE ENERGY®

ABB solution
- Implement microgrid control system to manage transition from grid to island mode
- Manage solar PV and battery while islanded

System Specifications
- 1 x 50kW Solar PV Farm
- 1 x 200kW/250kWh Battery System
- 1 x back up diesel generator in fire station

Key objectives
- Test and prove seamless 'islanding' capabilities
- Validate battery and PV power to provide reliable power upon main grid loss of power

ABB

Slide courtesy of ABB

MCALPINE SITE LAYOUT

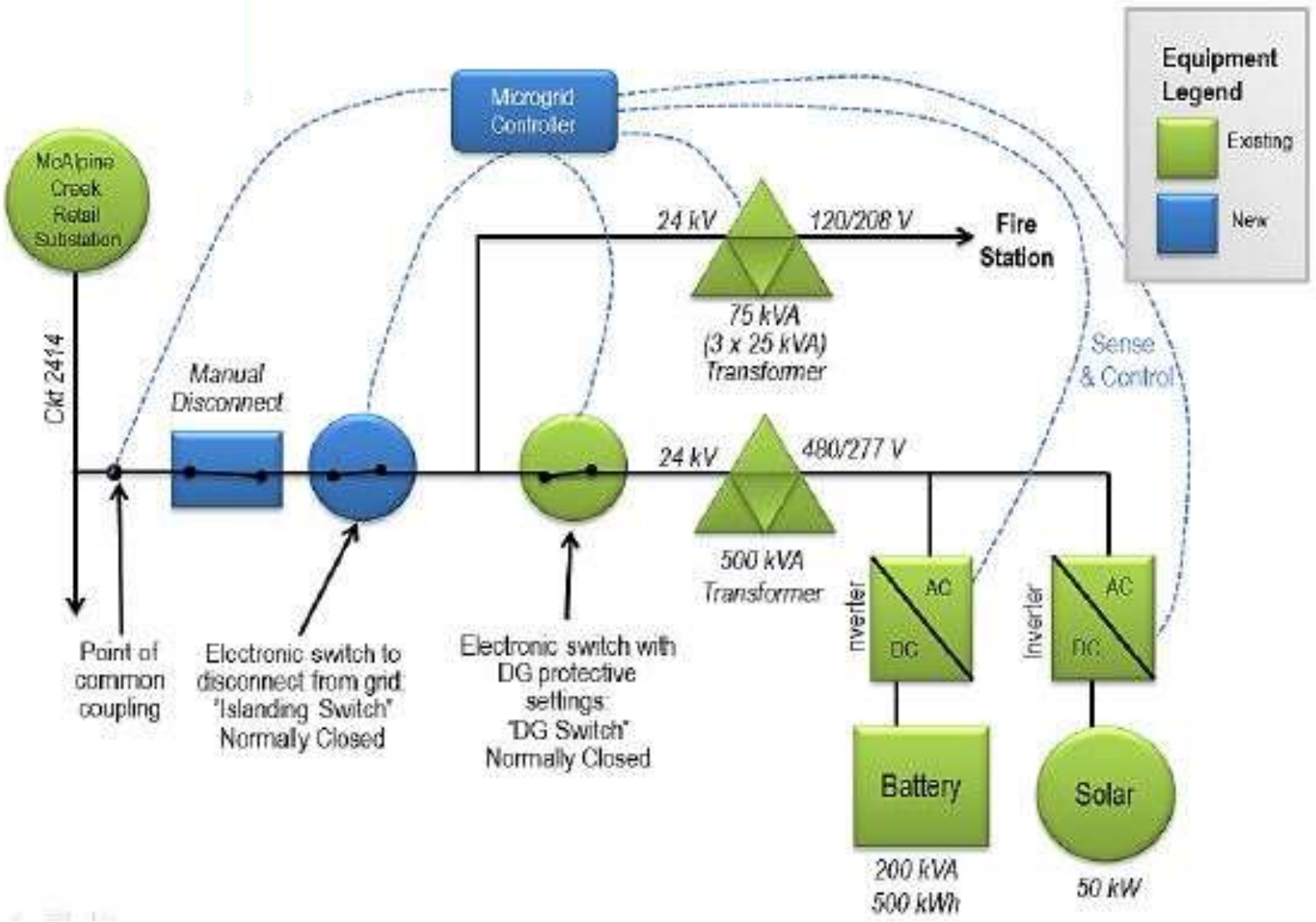
	EQUIPMENT	DESCRIPTION
1	Substation	McAlpine Creek Retail Substation
Microgrid Controls		
2	Islanding Switch	Electronic switch to disconnect from grid
3	DER Recloser	Electronic switch with interconnection protection
4	DER Transformer	500kVA 24kV/480V three-phase transformer
Distributed Energy Resources		
5	Solar Inverter	50kW three-phase 480V inverter
6	Battery, Inverter & Control House	200kW/500kW Lithium-Iron-Phosphate
7	Solar Array	50kW array; 207 monocrystalline panels (230 w/panel)
Customer Application		
8	Customer Transformer	75kVA; 120/208V transformer
9	Customer Generator	50kVA generator with open transition transfer switch

McAlpine Substation | 7132 South Pineville-Mathews Road | Charlotte, NC 28226

DUKE ENERGY.

www.duke-energy.com

Graphic: Duke Energy (Accessed March 2016 at http://aee-ncpc.org/docs/mcalpine_fact_sheet.pdf)



Graphic: Duke Energy (Accessed March 2016 at http://aee-ncpc.org/docs/mcalpine_fact_sheet.pdf)

Scripps Ranch, CA

Graphic: Resilient Power Project

Scripps Ranch Community Rec Center

- Support from CPUC, DOE, CA Solar Initiative
- Existing 30 kW PV, added ES to empower EOC
  - Grid-tied 100 kW inverter
- Add 100-kW/100-kWh lithium-ion battery
  - 2 grid-tied 100 kW inverters
  - Island via Princeton Power Systems Site Controller
- Energy bill fell from $2,000/mo to nearly zero
  - Shave peak for demand charge reductions
  - Revenue for grid support

Stafford Hill, Rutland, VT

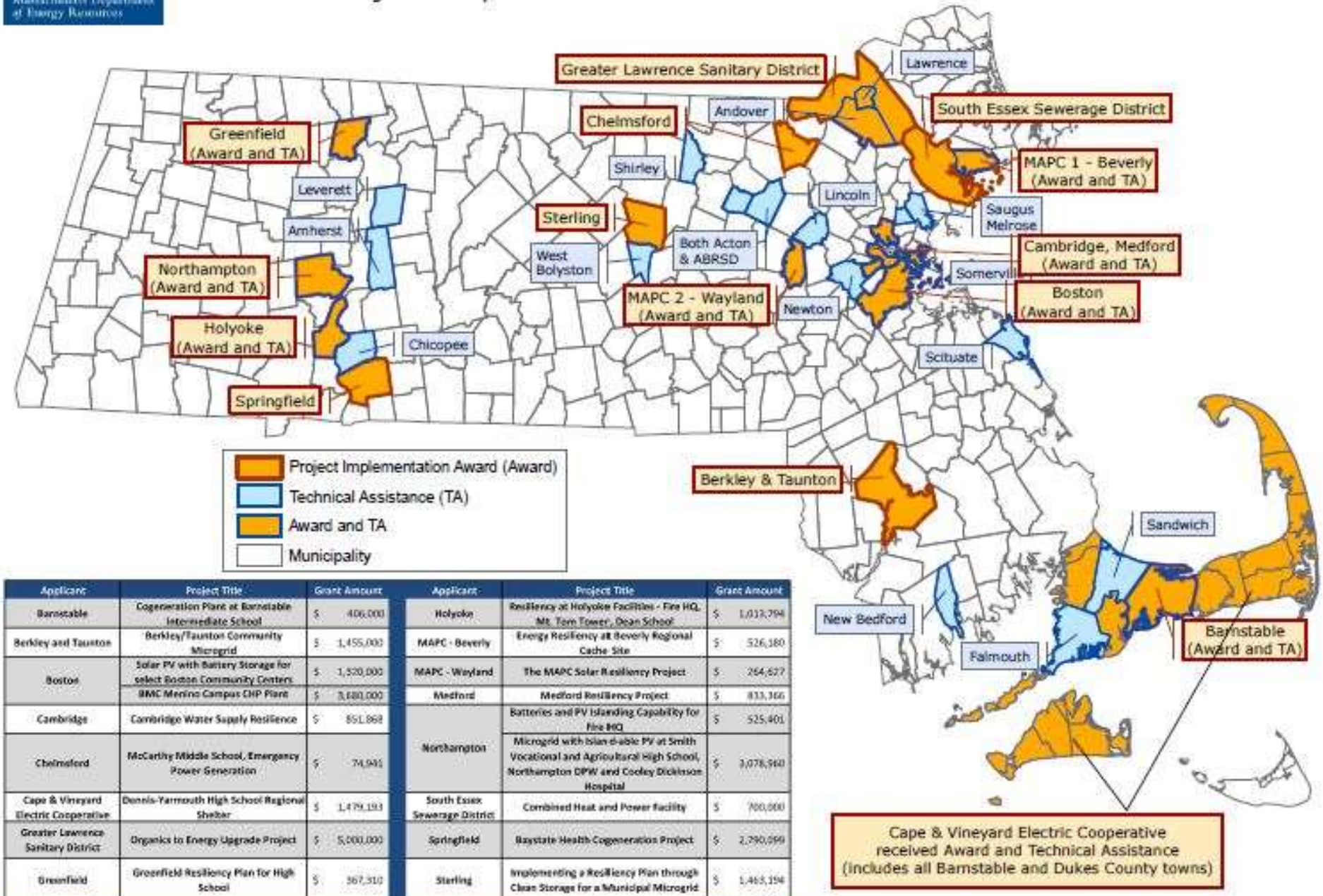
Photo: Green Mountain Power

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

Community Clean Energy Resiliency Initiative
Project Implementation and Technical Assistance

DOER
Massachusetts Department of Energy Resources



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	$ 1,520,000
	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

Applicant	Project Title	Grant Amount
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 bian-d-able PV at Smith Vocational and Agricultural High School, Northampton DPW and Cooley Dickinson Hospital	$ 3,078,560
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	$ 1,465,194
Total		$ 25,829,933

Graphic: MA DOER

DOER, JPfister, 3-24-16

MA DOER Community Clean Energy Resilience Initiative grant awards

- Technical assistance by Cadmus Group, HOMER Energy, MCFA

- Seven projects serve individual facilities
  - Boston (4 community shelters)
  - Northampton Fire Headquarters
  - Cape and Vineyard Electric Cooperative
  - Cambridge
  - Medford
  - Greenfield
  - Holyoke

- Four projects seek to install battery storage in microgrids
  - Metropolitan Area Planning Council – Beverly
  - Berkley
  - Sterling
  - Northampton

Microgrids and Single facilities

Massachusetts Department of Energy Resources -
Community Clean Energy Resiliency Initiative: Round 1 Project Implementation Awards

Applicant	Project Title	Grant Amount	Brief Description	Facility(ies)	Technology(ies)
Berkley and Taunton	Taunton/Berkley Community Microgrid	$ 1,455,000	Community microgrid	(1) Middle School - shelter (2) Emergency Services Building - Police and Fire (3) Community School - shelter (4) Municipal fueling station/pump (5) Police/fire radio repeater	- Energy management system - Lithium ion battery - Solar PV (existing) - Diesel generators (existing)
Boston	Solar PV with Battery Storage for select Boston Community Centers	$ 1,320,000	Solar and storage based islandable community shelters	(1) Shelburne Community Center - shelter (2) Roslindale Community Center - shelter (3) Tobin Community Center - shelter (4) Curtis Hall Community Center - shelter	- Solar PV - Battery storage
Greater Lawrence Sanitary District	Organics to Energy Upgrade Project	$ 611,000	Islandable and black start capable self-sustaining wastewater treatment facility	(1) Wastewater treatment facility	- Biogas storage - Combined heat and power system - Anaerobic digestion (existing)
Northampton	Batteries and PV Islanding Capability for Fire HQ	$ 525,401	Solar and storage based islandable fire station, that incorporates existing backup generation for further resiliency	(1) Northampton Fire Department	- Solar PV - Battery storage - Diesel generators (existing)
South Essex Sewerage District	Combined Heat and Power Facility	$ 700,000	Islandable and black start capable combined heat and power facility at wastewater treatment facility	(1) Wastewater treatment facility	- Combined heat and power system
Springfield	Baystate Health Cogeneration Project	$ 2,790,099	Islandable and black start capable combined heat and power facility at regional hospital	(1) Baystate Health - hospital	- Combined heat and power system
Total		$ 7,401,500			

Adapted from MA DOER graphic

Microgrids and Single facilities

Massachusetts Department of Energy Resources -
Community Clean Energy Resiliency Initiative: Round 2 Project Implementation Awards

Applicant	Project Title	Grant Amount	Brief Description	Factility(ies)	Technology(ies)
Barnstable	Cogeneration Plant at Barnstable Intermediate School	$ 406,000	Islanding equipment for a 60kW CHP system to support town's emergency shelter with both electric and thermal power.	Barnstable Intermediate School	Islandable CHP
Boston	BMC Menino Campus CHP Plant Project	$ 3,680,000	Engineering, controls, electrical switchgear and wiring required for a 2MW CHP system black start at BMC and interconnection of city emergency communications infrastructure system	BMC, Emergency communications	Islandable CHP
Cambridge	Cambridge Water Supply Resilience	$ 851,868	Battery storage to complement the planned 170kW solar PV system and other equipment to enable the system to island during an outage event.	Sullivan WTP	Islandable PV + Storage
Chelmsford	McCarthy Middle School, Emergency Power Generation	$ 74,941	Retrofit exisitng solar PV to provide emergency generation in island mode. Provide automated controls for grid and island mode.	McCarthy Middle School	Islandable PV + NG generator
Cape & Vineyard Electric Cooperative	Dennis-Yarmouth High School Regional Shelter	$ 1,479,193	Incorporation of two PV systems (641kW and 715kW, both VNM) with battery back-up, an energy management system and islanding equipment.	Dennis-Yarmouth High School	Islandable PV + storage

Adapted from MA DOER graphic

City of Northampton, MA

- FD HQ
  - 100 kW PV, 640 kWh battery (dispatch 1st)
  - Diesel emergency generator (dispatch 2nd)
- Cooley-Dickinson hospital microgrid
  - Hospital with CHP
  - School with PV+ES
  - Department of Public Works garage

City of Holyoke, MA

- FD HQ
  - 53 kW PV + 300 kWh battery bank
  - Islandable, 3 day duration
- Mt. Tom emergency communication tower
  - Small PV, small wind turbine, 200 kWh battery
  - Islandable, 3 day duration
- City of Holyoke school shelter
  - Islandable PV+ES

Thank you for your time...

QUESTIONS?

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