Expect the Unexpected: Planning Energy-Resilient Communities

Tuesday, May 16
2:00 – 5:00pm
Speakers

- **Moderator**
  - Adam Guzzo, U.S. Department of Energy

- **Speakers**
  - Eliza Hotchkiss, National Renewable Energy Laboratory
  - Travis Sheehan, Boston Planning and Development Agency
  - Mark Feasel, Schneider Electric
  - Jessie Denver, City and County of San Francisco, Department of the Environment
  - Tracy R. Babbage, Connecticut Department of Energy and Environmental Protection
Eliza Hotchkiss

Disaster Recovery and Resilience Lead, National Renewable Energy Laboratory
Building Resiliency into State and Local Planning and Technical Solutions

Eliza Hotchkiss, NREL

May 16, 2017
Workshop Framework:

- Workshop Part I: Building Resiliency into State and Local Planning
- Workshop Part II: Technology Solutions
Broad Range of Clean Energy Solutions

Energy Efficiency
Vehicle Technologies
Building Technologies

Renewable Resources
Wind and Water
Solar
Biomass
Hydrogen
Geothermal

Systems Integration
Grid Infrastructure
– SmartGrid and RE Grid
Battery and Thermal Storage

International, Tribal, Federal Agencies, States, Local Communities

Foundational and Applied Science
**What is resilience and why are we talking about it?**

- **Executive Order 13693** defines resilience as "the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions".

- The **Rockefeller Foundation’s 100 Resilient Cities** defines urban resilience as “the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience.”

- **CRRO** defines resiliency as “the ability of communities to rebound and positively adapt to or thrive amidst changing conditions or challenges -- including disasters and changes in climate -- and maintain quality of life, healthy growth, economic vitality, durable systems and conservation of resources for present and future generations.”
Loss events worldwide 2014

Geographical overview

- Winter damage: USA, Canada, 5–8 Jan
- Severe storms: USA, 18–23 May
- Drought: USA, 2014
- Hurricane Odile: Mexico, 11–17 Sep
- Severe storms: USA, 2–4 Apr
- Severe storms: USA, 27 Apr–1 May
- Severe storms: USA, 3–5 Jun
- Flash floods: USA, 11–13 Aug
- Drought: Brazil, 2014
- Severe storms: France, Belgium, Germany, 7–10 Jun
- Floods: United Kingdom, Dec 2013–Feb 2014
- Floods: Bosnia and Herzegovina, Serbia, Croatia, Romania, 13–30 May
- Typhoon Rammasun: China, Philippines, Vietnam, 11–22 Jul
- Winter damage: Japan, 7–16 Feb
- Typhoon Kamae: China, Philippines, Vietnam, 12–20 Sep
- Cyclone Hudhud: India, 11–13 Oct
- Earthquake: China, 3 Aug
- Floods: India, Pakistan, 3–15 Sep

980 Loss events

- Loss events
- Geophysical events: (Earthquake, tsunami, volcanic activity)
- Meteorological events: (Tropical storm, extratropical storm, convective storm, local storm)
- Hydrological events: (Flood, mass movement)
- Climatological events: (Extreme temperature, drought, wildfire)

Source: Munich Re, NatCatSERVICE, 2015
Top 10 countries with most disasters, 2005-2014

Source: United Nations International Strategy for Disaster Reduction
Louisiana flood: Worst US disaster since Hurricane Sandy, Red Cross says

By Holly Yan and Rosa Flores, CNN

Updated 12:32 PM ET, Fri August 19, 2016

Lessons Learned: Be Proactive by Doing Resilience Planning

- New York and New Jersey (2012)
- Greensburg, Kansas (2007)
- Galena, Alaska (2013)
- New Orleans (2005)
Technology Alone ≠ Resilience

Effective Strategies

- Resource
- Appropriate technology
- Controls
- Policies and agreements
- Co-benefits

Image Sources:
http://www.serve.gov/site-page/sandy
Camden County MUA: http://www.ccmua.org/
Eliza Hotchkiss, NREL

Photovoltaic Solar Resource of the United States

Image Sources:
http://www.serve.gov/site-page/sandy
Camden County MUA: http://www.ccmua.org/
Eliza Hotchkiss, NREL
Stakeholder Driven and Participatory Process

“A system’s ability to anticipate, prepare for, and adapt to long-term changing conditions and withstand, respond to, and recover rapidly from disruptions through **sustainable, adaptable, and holistic planning and technical solutions**.”

- Resilience Roadmap, NREL

www.nrel.gov/tech_deployment/resilience-planning-roadmap/
Risk and Vulnerabilities Assessment

Vulnerabilities + Threats

Risk Assessment:
likelihood + impacts

Ranking of Climate Change Vulnerabilities
High, Medium, Low

Resilience Options Evaluation:
Cost, effectiveness, feasibility

Resilience Strategies
Do Now, Additional Analysis Needed, Remove from Consideration
Competing Demands, Limited Resources

Image Credit: Bill Gillies, NREL
Individual Projects

- Energy efficient buildings
- Green infrastructure
- Alternative transit options
- Stormwater management
- Affordable housing + Passive survivability
- Microgrids
- Smart zoning
Holistic Approaches

- Energy efficient buildings
- Green infrastructure
- Alternative transit options
- Stormwater management
- Affordable housing + Passive survivability
- Microgrids
- Smart zoning
Green infrastructure mimics the natural water cycle, is effective, economical and enhances community safety and quality of life. It can be an effective way to manage stormwater, reduce the urban heat island effect and, when incorporated with zoning practices can be a resilient community strategy.
Energy efficiency reduces annual energy spending, can help vulnerable populations and, when paired with passive survivability and microgrid principles, could allow populations who may not have the means to own vehicles to shelter in place.
RESILIENCY & COMMUNITY ENERGY PLANNING IN BOSTON

Travis Sheehan, Senior Infrastructure Advisor

boston planning & development agency
Supporting Plans

- 100 Resilient Cities
- Climate Ready Boston
- Waterfront Planning Process
- Go Boston 2030
- BuildBPS
- Boston Creates
- Greenovate Boston
- Open Space Plan
- Strategic Planning Areas
- Strong Schools, Strong Boston
- Age-Friendly Boston
- Housing a Changing City
- Boston’s Way Home
- Economic Inclusion + Equity Agenda
- Vision Zero
- Small Business Plan
- Boston’s Workforce
- Health in all Policies
- Capital Plan
Climate Ready Boston

Phases

- Update Climate Projections
- Map buildings and critical assets and assess damage
- Develop Strategies
- Implement Strategies

Involved Parties

- Project Partners: Green Ribbon Commission

INFRASTRUCTURE ADVISORY COMMITTEE

City
- Boston Housing Authority
- Boston Redevelopment Authority
- Boston Transportation Department
- Boston Water and Sewer Commission
- Boston Public Schools
- Boston Conservation Commission
- Boston Department of Public Works
- Boston Inspectional Services Department
- Boston Landmarks Commission
- Boston Office of Emergency Management
- Boston Parks and Recreation Department
- City of Cambridge

State and Regional
- MA Department of Conservation and Recreation
- MA Department of Public Utilities
- MA Department of Transportation
- Metropolitan Area Planning Council
- Massachusetts Bay Transportation Authority
- Massachusetts Port Authority
- Massachusetts Water Resources Authority
- National Park Service (Harbor Islands)

Utilities
- Comcast
- Eversource Energy
- National Grid
- Veolia
- Verizon Communications

Nonprofit
- Medical Academic and Scientific Community Organization
- A Better City
- Partners Health Care
- The Trust for Public Land
- The Trustees of Reservations
- Boston University
- Harvard University
- Green Ribbon Commission Climate Preparedness Working Group
STRATEGY 4: IMPLEMENT CLIMATE ADAPTATION THROUGH RESILIENCE AREA PLANS
STRATEGY 6: ESTABLISH INFRASTRUCTURE COORDINATION COMMITTEE (ICC) TO FACILITATE CLIMATE ADAPTATION
INFRASTRUCTURE

INTERDEPENDENCE AND POWER OUTAGE VULNERABILITY

POWER OUTAGE MAP
- Short Duration - Partial
- Short Duration - All
- Medium Duration - All
- Long Duration - Partial
- Long Duration - All

POWER OUTAGE LATE CENTURY SEVERE STORM
STRATEGY 7: DEVELOP DISTRICT-LEVEL ENERGY SOLUTIONS TO INCREASE DECENTRALIZATION AND REDUNDANCY
Existing District Energy Microgrids

1) Veolia Steam System
2) MATEP
3) Boston Medical Center
4) MIT
5) Biogen
6) Harvard

[Map showing locations of existing district energy microgrids in Boston and Cambridge.]
Resilient Energy Services for Commercial Properties

Campus “MUSH Market”
• easy to generate power,
• distribute benefits to one meter,
• simple to finance

Multi User Microgrid
• not easy to distribute benefits,
• hard to develop user base,
• difficult to finance,
• no business model
Microgrid Workshops *Engagement*

**Developed 3-part microgrid workshop**
- 12 hours of scenario planning to align interests of key stakeholders
- Chief Regulators of State, Chief Strategy and Distribution Planners from Utilities, Technology providers, Real estate community

**Convened Urban Sustainability Directors Network workshop 2015**
- New York City, Washington DC, MA Communities: Somerville, Cambridge, Northampton
- Housed by International District Energy Association Conference with 950+ Attendees
- Technology and Policy innovations replicable
Microgrid Workshops Engagement

1) A session which describes the microgrid including engineering market interactions.

2) A session which analyzes legal context, opportunities, and challenges for microgrids each jurisdiction.

3) A session which describes the USDN microgrids whitepaper and ‘straw proposal’ business case for multi user microgrids.

4) A scenario planning exercise allows each stakeholder to identify merits and challenges to project deployment. This exercise will conclude with a revision of the straw proposal.
BCES Planning

Boston Community Energy Study (2016)

- Study identified 42 potential CES
- Conducted with MIT, Lincoln Labs, and Funding from DOE and DHS
- $1.7 Bn USD in End User and Environmental Savings
- Community Engagement: Online Video, Interactive Map, Report
- U.S. Department of Energy TA – Feasibility Screening of 8 sites

Pilot Project Coordination

2014–2016

- Engaging 50 businesses and property owners
- DOE CHP TAP Feasibility Study
- MOU with Eversource Energy
- Procurement & Legislative Action
- Public–Private Partnerships
Challenge

Developing a procurement, or a multi-party agreement, to develop a single ESCO relationship for multiple building owners—public and private.

Aggregating Energy Performance Contracts for small structures while reducing fixed ESCO costs.
Resources


Microgrids Workshops Recap [Urban Sustainability Director’s Network Multi-City Engagement]: http://www.bostonplans.org/getattachment/fa993b9a-d3ab-43a2-8981-94a7a49b8a33
### CRB Timelines

#### Resilient Infrastructure

**STRATEGY 6**

**6.1** Establish an Infrastructure Coordination Committee (ICC).
- ICC is launched.

**6.2** Continue to collect important asset and hazard data for planning purposes.
- Data-sharing protocol is established.

**6.3** Provide guidance on priority evacuation and service road infrastructure to the ICC.
- Priority evacuation and service roads are identified.

#### Implementation Period

<table>
<thead>
<tr>
<th>#</th>
<th>Initiative</th>
<th>Within 2 Years</th>
<th>Within 5 Years</th>
<th>Long-Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Conduct feasibility studies for community energy solutions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1</td>
<td>Develop a green infrastructure location plan for public land and rights-of-way.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.2</td>
<td>Develop a sustainable operating model for green infrastructure on public land and rights-of-way.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.3</td>
<td>Evaluate incentives and other tools to support green infrastructure.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.4</td>
<td>Develop design guidelines for green infrastructure on private property to support co-benefits.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.5</td>
<td>Develop an action plan to expand Boston's urban tree canopy.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.6</td>
<td>Prepare outdoor facilities for climate change.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.7</td>
<td>Conduct a comprehensive wetlands inventory and develop a wetlands protection action plan.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**STRATEGY 7**

Resilient Infrastructure

Develop district-level energy solutions to increase decentralization and redundancy.

**STRATEGY 8**

Expand the use of green infrastructure and other natural systems to manage stormwater, mitigate heat, and provide additional benefits.
Themes

- 2014 Climate Action Plan Update: planning, engagement, green infrastructure, buildings and energy
- Coordination between city, state, and regional (Metropolitan Mayor’s Preparedness Taskforce)

Initiatives

- Climate Ready Boston: multi-stakeholder development of climate change consensus, vulnerability assessment, and roadmap for resiliency including protected shorelines, resilient infrastructure, adapted buildings, and prepared communities.
  - [climateready.boston.gov](http://climateready.boston.gov)
- Rockefeller 100 Resilient Cities: Summer 2016 release of “Preliminary Resiliency Assessment” and forthcoming “Resilience Strategy” which targets social cohesion and racial equity, including a critical infrastructure focus area
- Boston Community Energy Study: roadmap for local, resilient, clean energy generation, microgrids and district energy with MIT Sustainable Design Labs, MIT Lincoln Labs

CHP Accelerator

- Continue partnership with DOE TAPs feasibility studies on major Boston private, public and non-profit institutions
- Complete Marine Industrial Park microgrid agreements with Investor Owned Utilities
Energy Megatrends – More E +3D

More ELECTRIC

2X faster growth of electricity demand compared to energy demand by 2040

Source: IEA WEO 2014

DIGITIZATION

10X more incremental connected devices than connected people by 2020

Source: Cisco, Internet World Statistics

DECARBONIZATION

82% of the economic potential of energy efficiency in buildings and more than half in industry, remains untapped

Source: World Energy Outlook 2012, Internal Analysis

DECENTRALIZATION

70% of new capacity additions will be in Renewables by 2040

Source: BNEF
Energy Consumers Have New Expectations

<table>
<thead>
<tr>
<th>Efficiency</th>
<th>Supply</th>
<th>Sustainability</th>
<th>Resiliency</th>
</tr>
</thead>
</table>
| ● Reduce energy consumption  
  ● Improve and monetize flexibility  
  ● Energy / Fuel source arbitrage | ● Innovative Product and Hedge Structures  
  ● Global Program  
  ● Real-time-price forecasting  
  ● Portfolio Risk Management | ● Reduce Greenhouse Gasses  
  ● Minimize carbon footprint  
  ● Improve LEED | ● Service site loads during times of grid instability  
  ● Protect assets against harmful effects of poor power quality |

Active Energy Management

- kWh

- $
and are taking control of their Energy

Ohio State's Endowment Gets $1 Billion With Campus Energy Deal

by Janet Lorin and Brian Eckhouse
April 07, 2017 11:58 AM

Engie SA, Axium to manage school's energy assets for 50 years
Board of trustees approved public-private partnership

Ohio State University's endowment will jump 25 percent in size with a $1 billion payment from two companies that will lease the school's energy assets for 50 years.
Montgomery County Maryland

About Montgomery County

- Approximately 1 million people
- High tech knowledge based economy
- 400+ facilities
- Leader in Advanced Energy
  - 11 megawatts of solar across 18 sites
  - Procure 100% clean energy for County facilities
  - Inaugural Partner in the U.S. DOE’s Combined Heat and Power for Resiliency Accelerator
  - First CHP system installed in 2016
Project Objectives

- Improve resiliency of county operations
  - Upgrade existing aging electrical distribution infrastructure
  - Ability to island operations for >7 days without grid support
- Mitigate risk of escalating energy price over 15 years.
- Upgrade infrastructure without capex
- Reduce greenhouse gas and other emissions
- Create replicable models for other facilities and governments

Public Safety Headquarters
- Large electrical upgrades
- New 2 MW Solar
- Load management with BAS
- New Cogen
- Integrate Existing gas generator

Correctional Facility
- Minor Electrical Upgrades
- New 250 kW Cogen
- Integrate existing Diesel
Challenges

- Capital procurement not an option
- Some aspects of the solution can be tied to a volumetric charge, others cannot.
- Competitive Bid Process Required
- Multi-Site
- Multi DER type
- Required assets have varying economic useful lives
- Rebate & Incentives in flux
- Relatively small (<$25M)
Solution: Microgrid as a Service

Value Proposition:
- No Upfront Capital
- Infrastructure Improvements
- More predictable energy costs
- Higher reliability
- Better sustainability
- PPP Business Model

Diagram:
- Owner: Duke Energy
- Partner: REC Solar, CHP Provider
- Host Site: Montgomery County, Maryland
- Partner: Schneider Electric
Thank you!
Microgrid Resources

E-Learning and White Papers

Case Studies

Oncor: Innovative microgrid improves utility’s reliability and optimizes distributed energy resources.
https://go.schneider-electric.com/NAM_EBU_US_201602_Oncor_Microgrid_Case_Study_01-Oncor-Microgrid-Case-Study-LP.html

City of Fairfield, CT: Fairfield: a Connecticut town on the vanguard of microgrid development.

Bear Creek Mountain Resort: Microgrid keeps power flowing at remote ski resort

US Coast Guard Puerto Rico: Reduce cost of power at remote island locations while improving reliability and complying with federal energy efficiency mandates.
Panel Questions

Q&A
First Breakout
Eliza Hotchkiss

Disaster Recovery and Resilience Lead, National Renewable Energy Laboratory
Workshop Framework:

• Workshop Part I: Building Resiliency into State and Local Planning

• Workshop Part II: Technology Solutions
Holistic Approaches

- Energy efficient buildings
- Green infrastructure
- CHP
- Stormwater management
- Affordable housing + Passive survivability
- Microgrids
- Solar + Battery
Evaluating Needs and Resilience Opportunities

**Policies**
- What policies hinder progress?
- What policies support progress?

**Technology**
- What energy efficiency and renewable energy technologies or solutions are most appropriate?
- What’s needed for implementation?

**Partners and Synergy**
- What partnerships exist to further projects?
- What projects are being planned that could integrate co-benefits?
Resources

How Solar PV Can Support Disaster Resiliency
www.nrel.gov/tech_deployment/state_local_governments/blog/how-solar-pv-can-support-disaster-resiliency

Resilience Roadmap: Planning Process
www.nrel.gov/tech_deployment/resilience-planning-roadmap/

Solar PV and Resilience Policies
www.nrel.gov/docs/fy15osti/62631.pdf

Alternative Energy Generation for Critical Infrastructure Study
www.nrel.gov/docs/fy14osti/60631.pdf

Economic Impacts of Resilience
www.nrel.gov/docs/fy16osti/66617.pdf

Resilience and Disaster Recovery Lessons Learned
http://www.nrel.gov/tech_deployment/tech_assistance_disaster_resilience.html
Thank you!

Eliza.Hotchkiss@nrel.gov