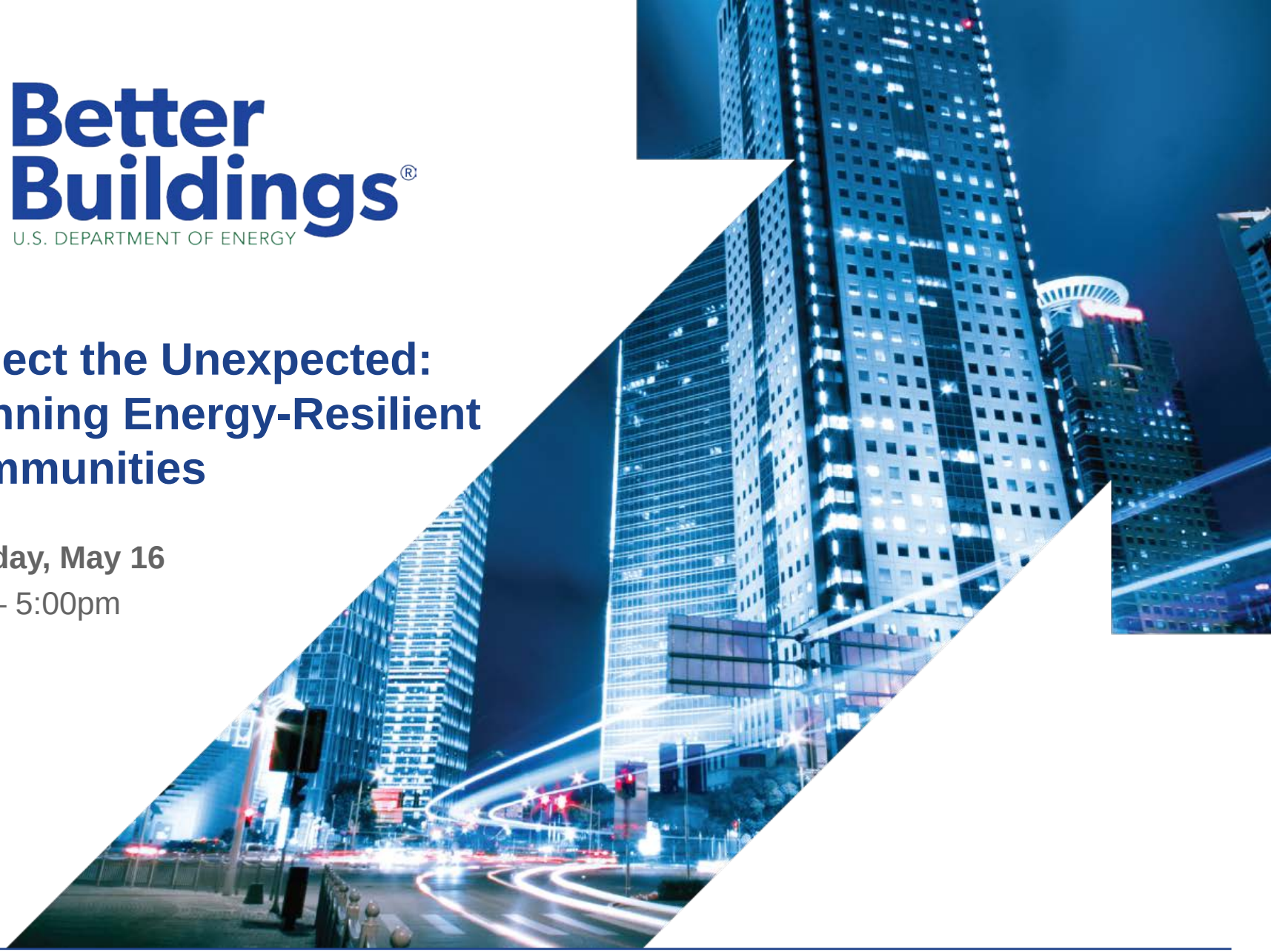
Better Buildings®
U.S. DEPARTMENT OF ENERGY



Expect the Unexpected: Planning Energy-Resilient Communities

Tuesday, May 16

2:00 – 5:00pm

U.S. DEPARTMENT OF ENERGY

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

U.S. DEPARTMENT OF
ENERGY

NREL
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

National Renewable Energy Laboratory

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

Resilience Defined

What is resilience and why are we talking about it?

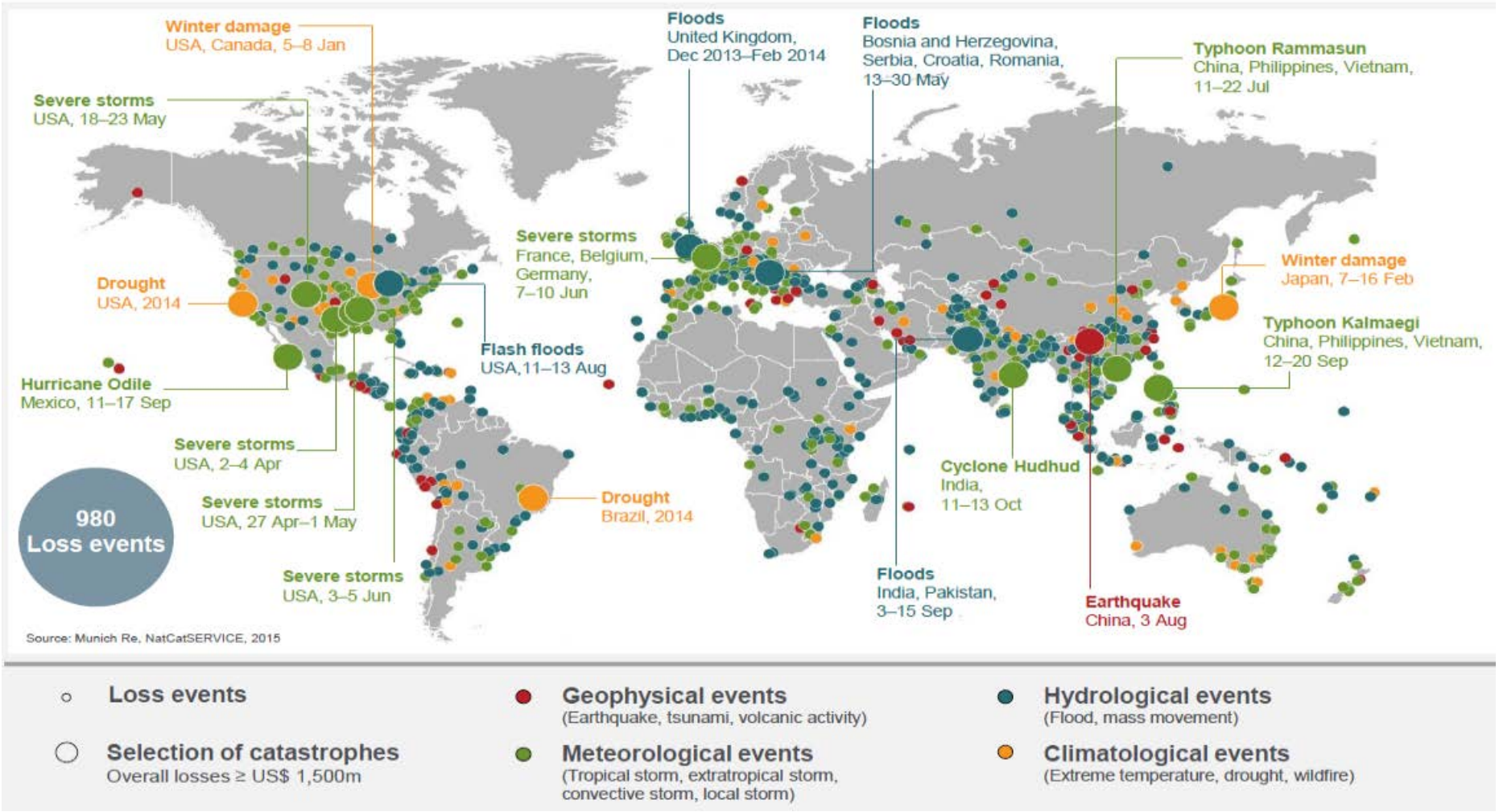
- Executive Order 13693 defines resilience as "the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions".

- 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."

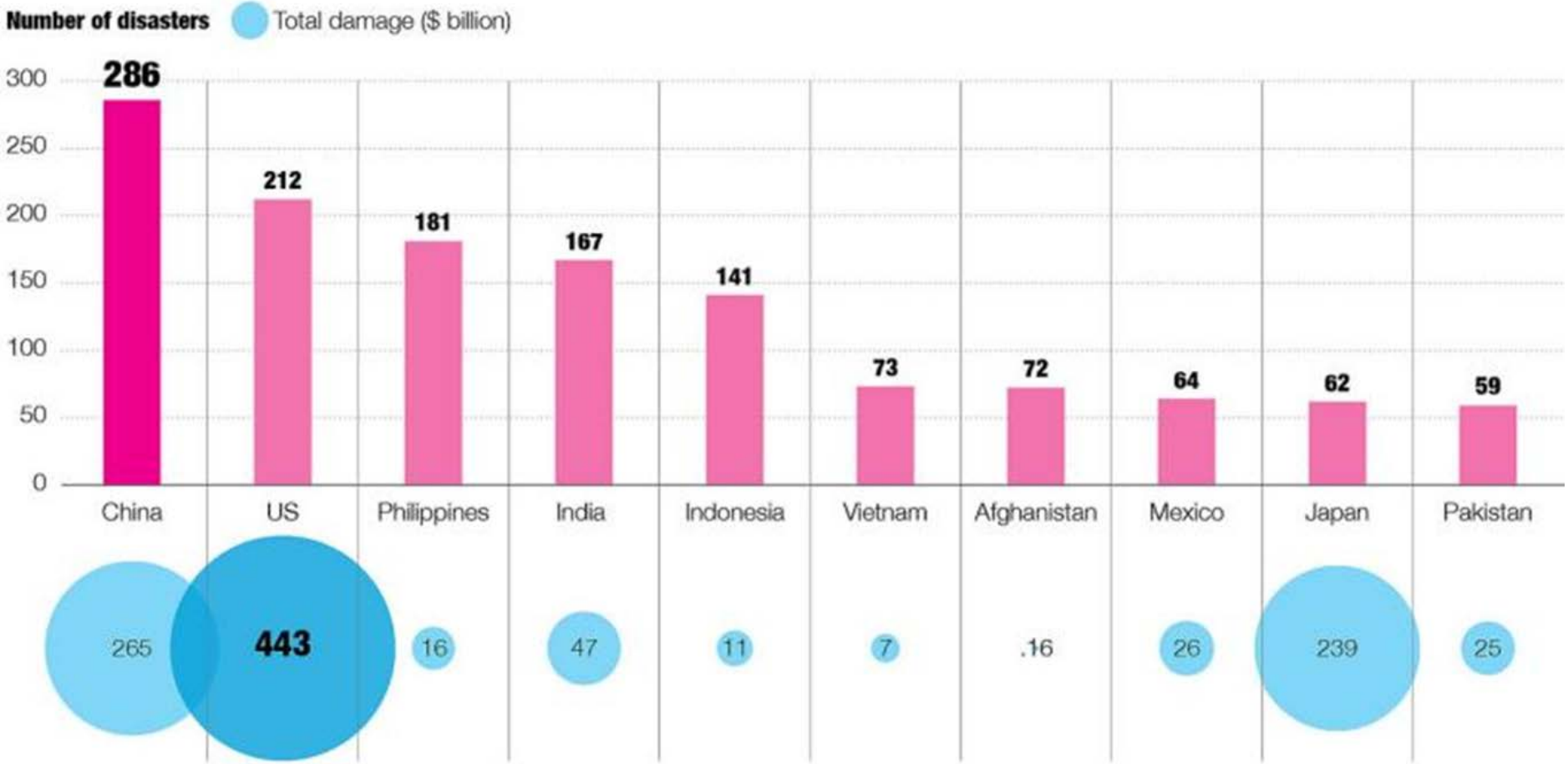
Loss events worldwide 2014

Geographical overview



Source: Munich RE

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

http://www.cnn.com/2016/08/18/us/louisiana-flooding/

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

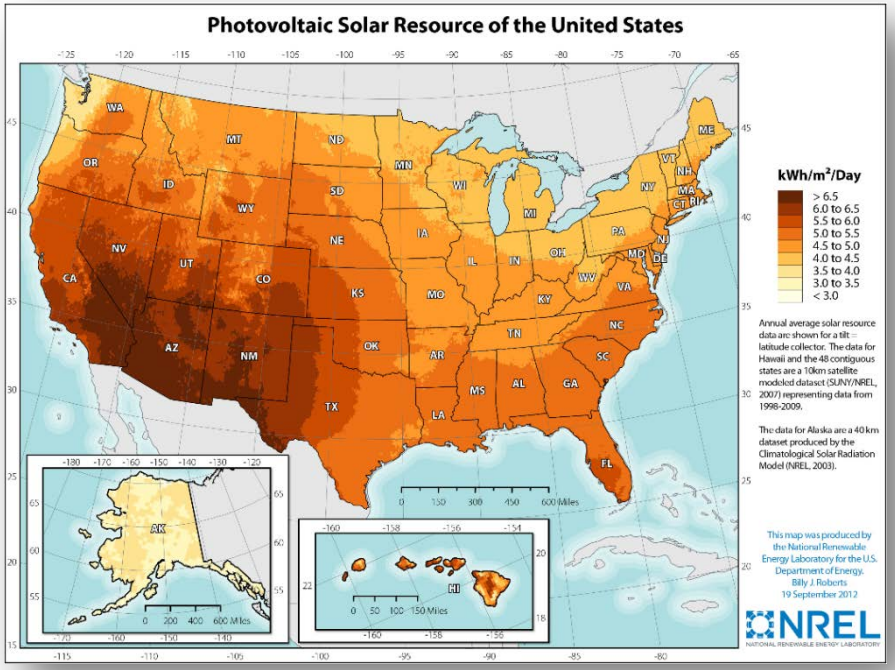


Image Sources:
http://www.reuters.com/article/us-storm-sandy-hurricane-idUSBRE89N16J20121030
http://www.serve.gov/site-page/sandy
Camden County MUA: http://www.ccmua.org/
Eliza Hotchkiss, NREL

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

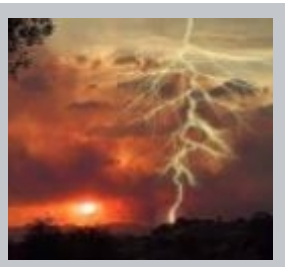
www.nrel.gov/tech_deployment/resilience-planning-roadmap/

Risk and Vulnerabilities Assessment



Vulnerabilities

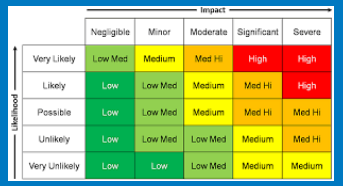
+


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

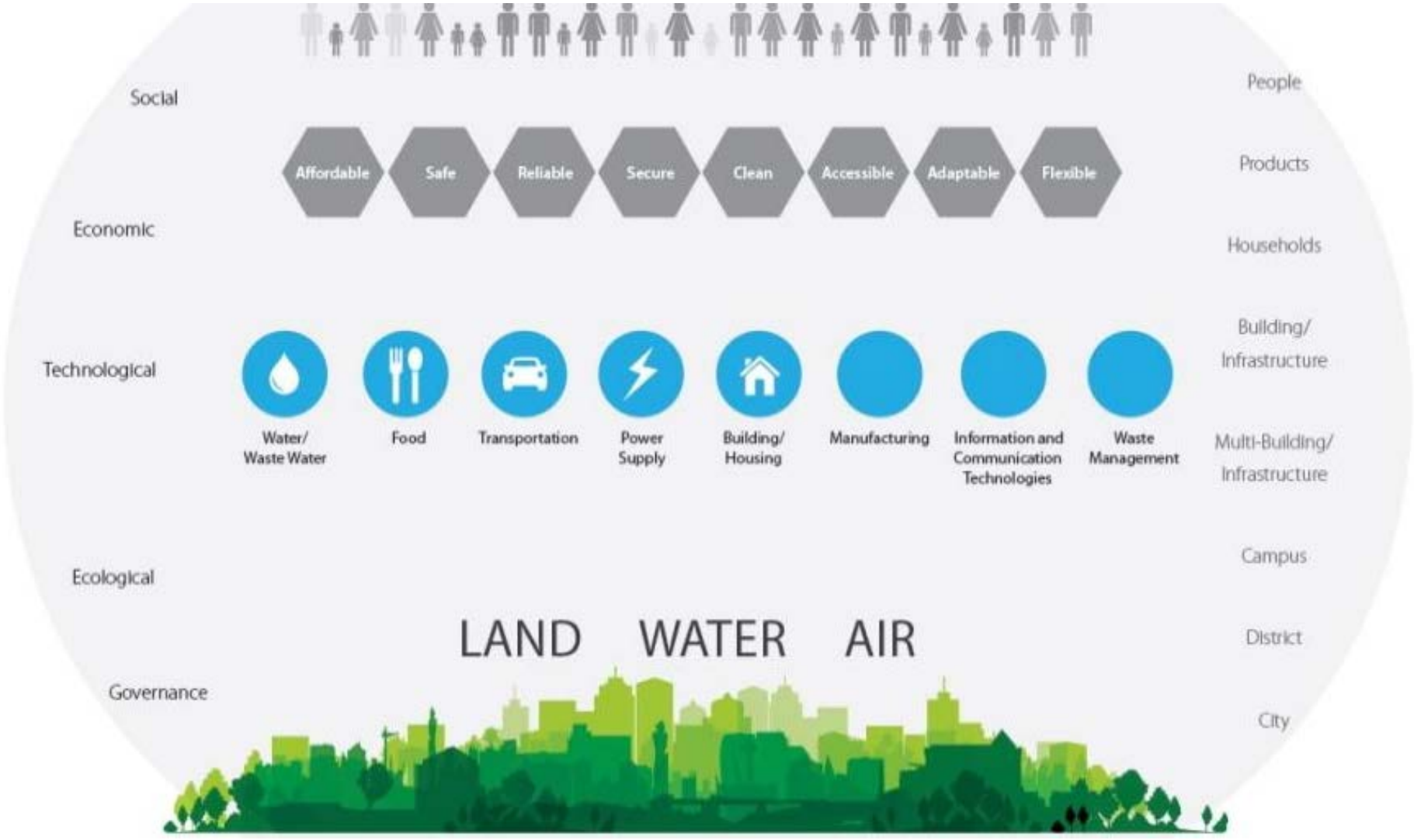
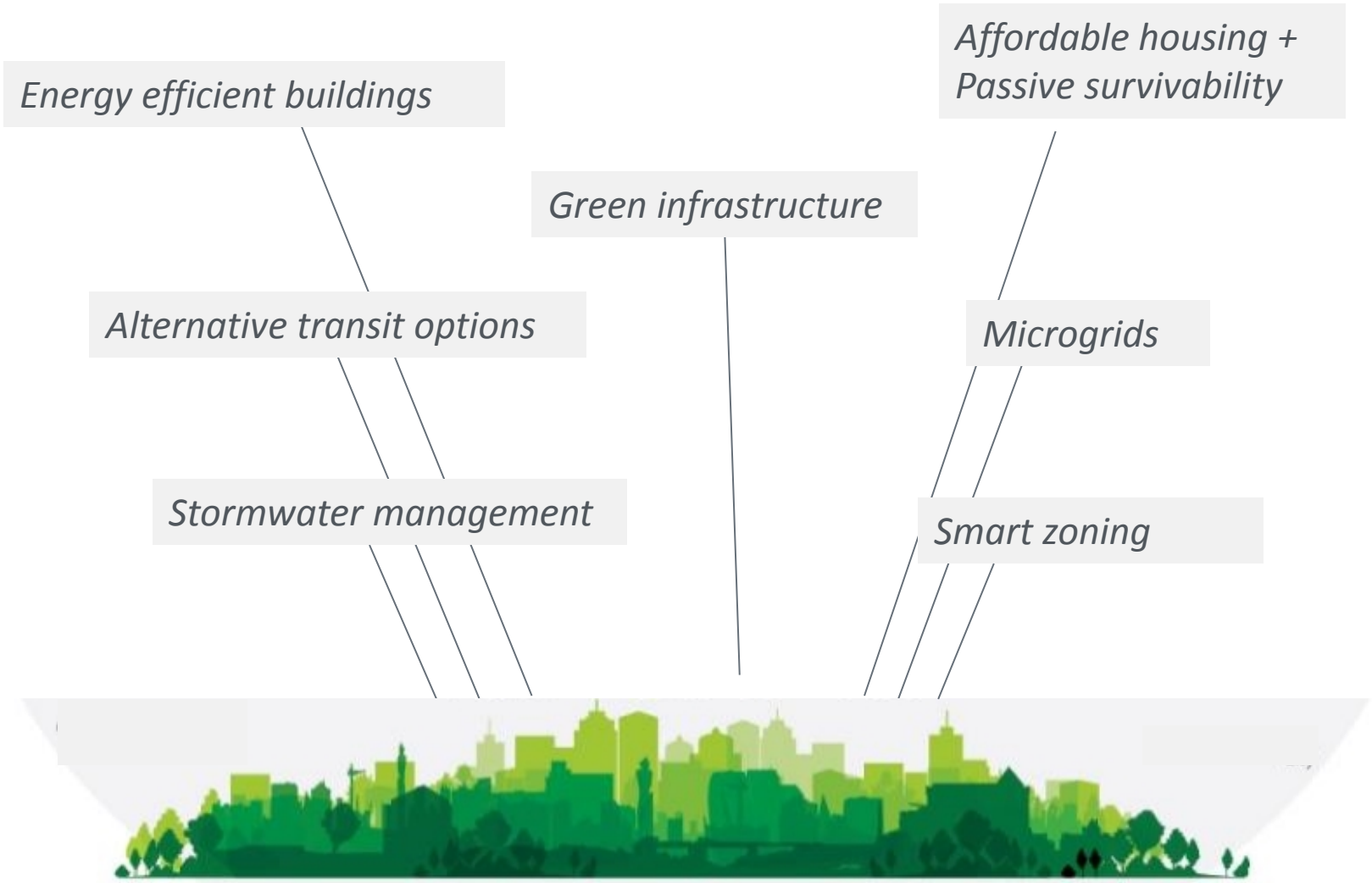
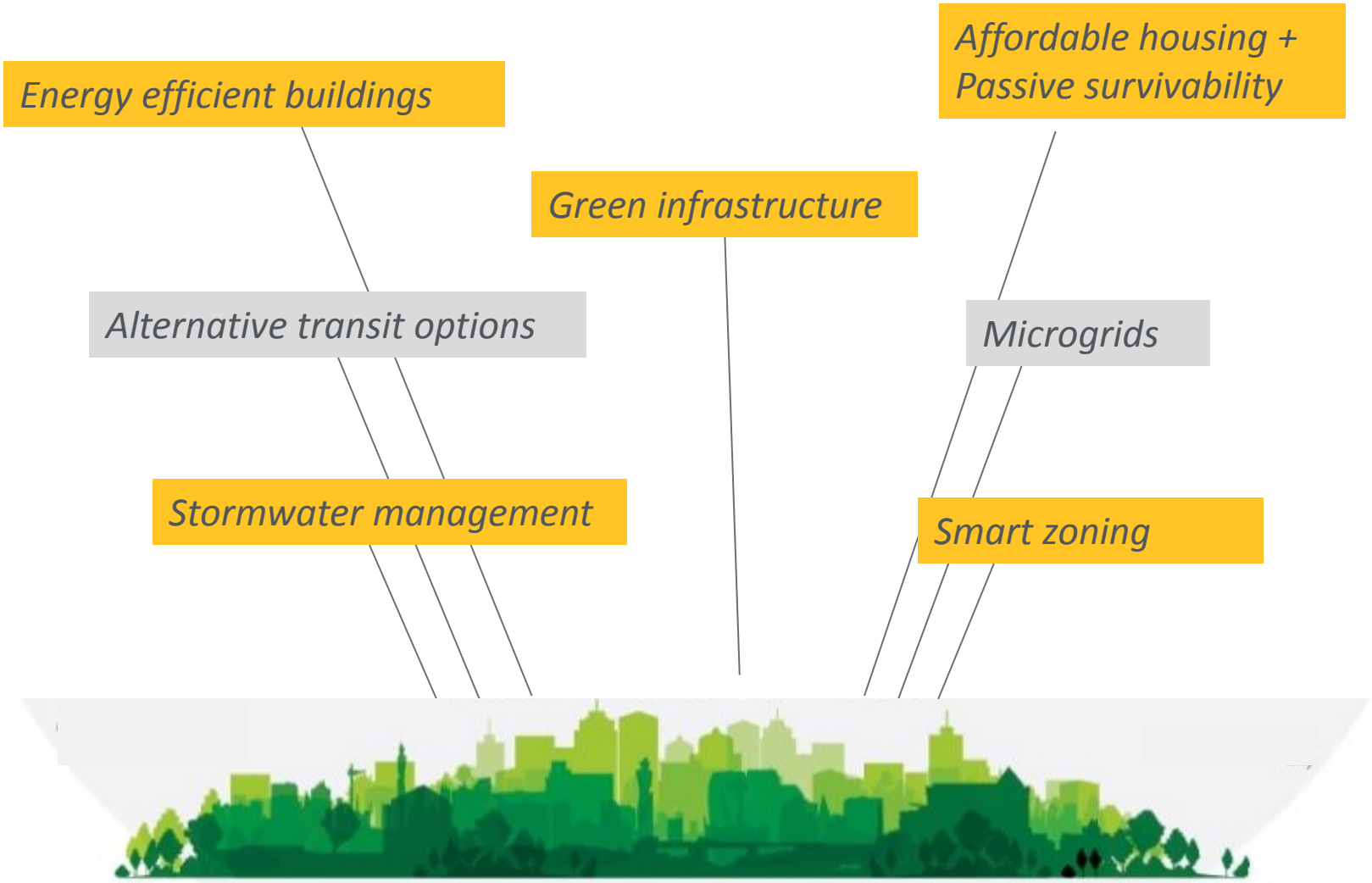


Image Credit: Bill Gillies, NREL

Individual Projects



Holistic Approaches



Holistic Approaches

Green infrastructure

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.

Stormwater management

Smart zoning

Holistic Approaches

Energy efficient buildings

Affordable housing + Passive survivability

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.

Travis Sheehan

Senior Infrastructure Advisor,
Boston Planning and Development Agency

U.S. DEPARTMENT OF
ENERGY

RESILIENCY & COMMUNITY ENERGY PLANNING IN BOSTON

Travis Sheehan, Senior Infrastructure Advisor

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Supporting Plans

Climate Ready Boston

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

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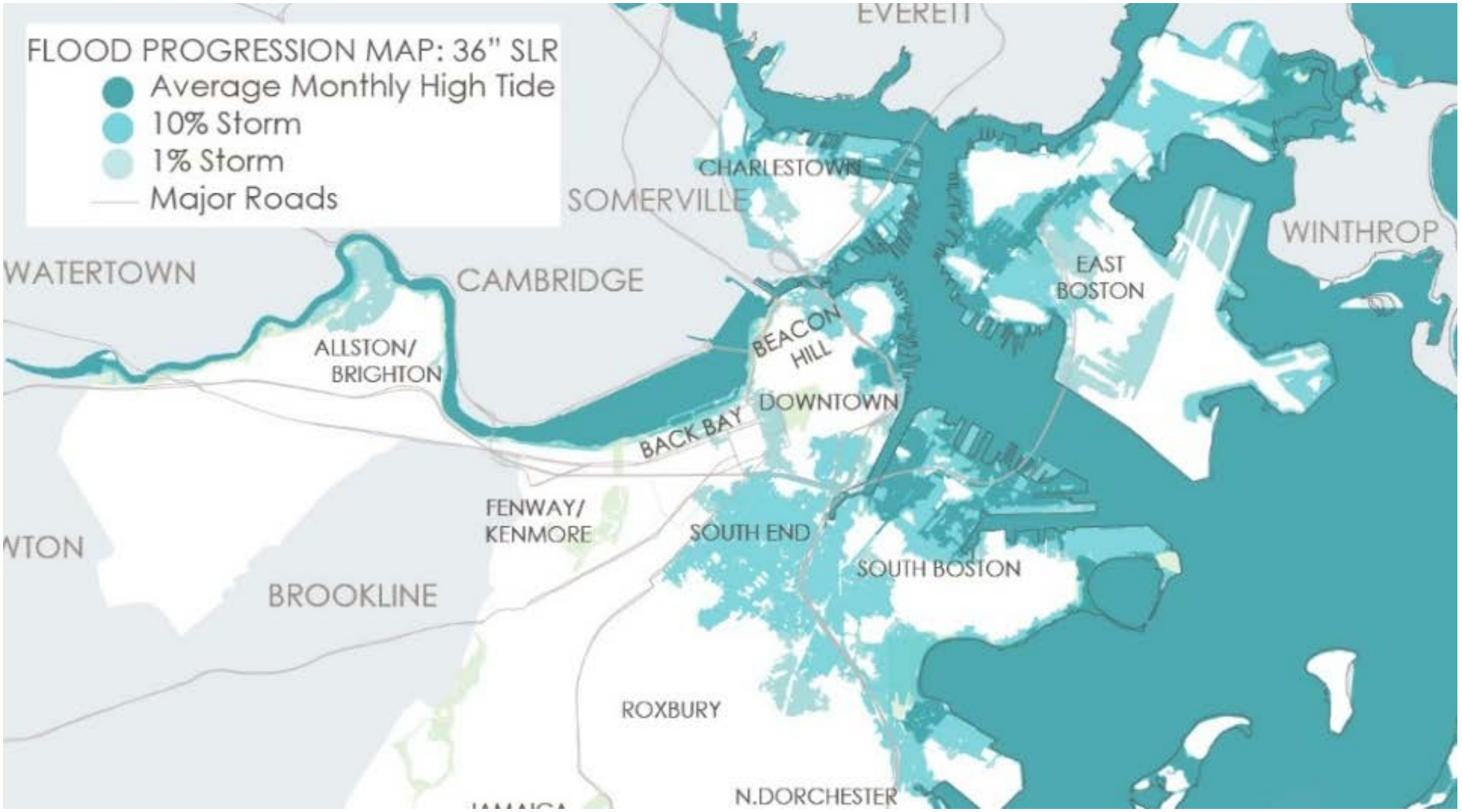
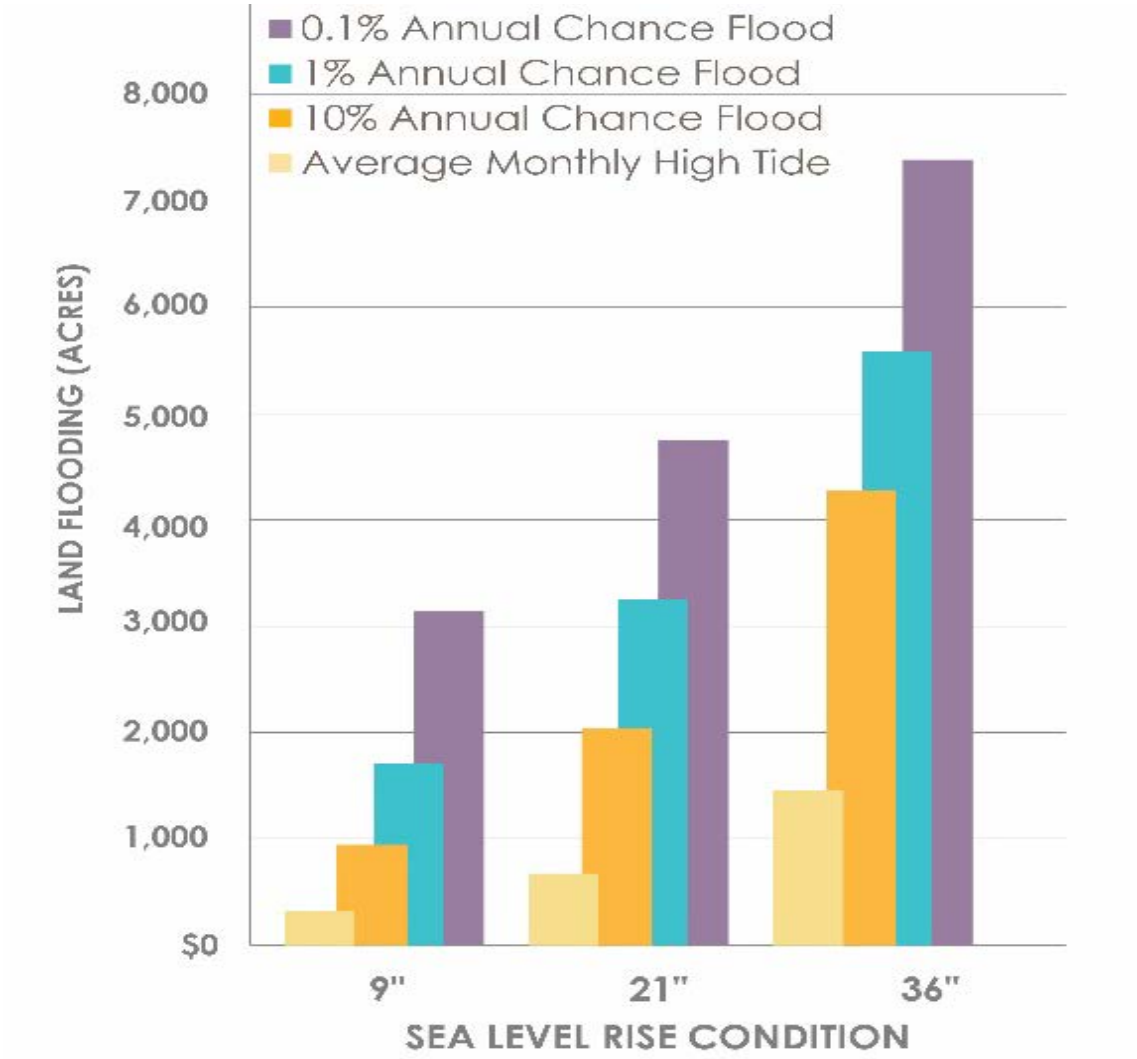
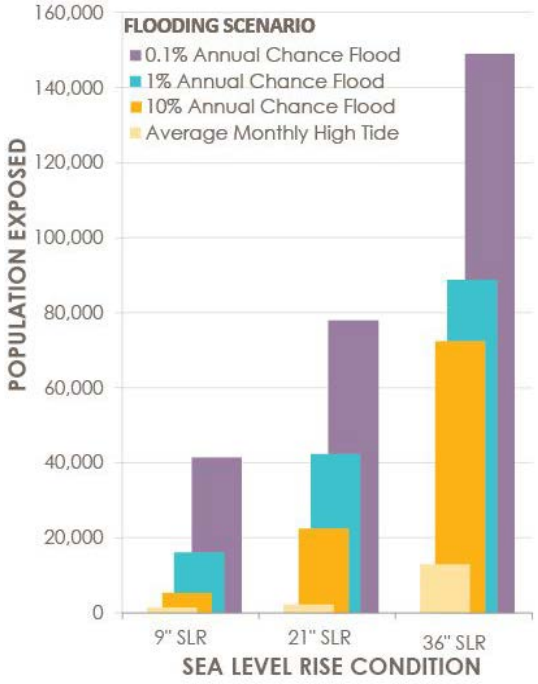
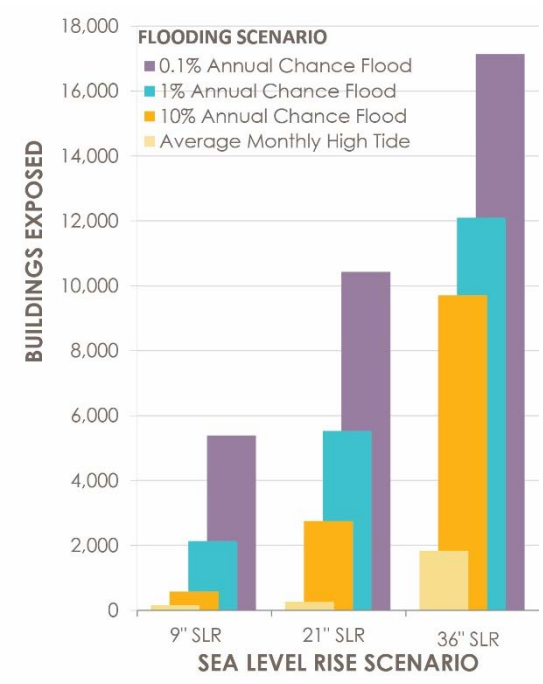

FLOOD PROGRESSION MAP: 36" SLR
Average Monthly High Tide
10% Storm
1% Storm
Major Roads
EVERETT
CHARLESTOWN
SOMERVILLE
WINTHROP
WATERTOWN
CAMBRIDGE
EAST BOSTON
BEACON HILL
ALLSTON/ BRIGHTON
DOWNTOWN
BACK BAY
FENWAY/ KENMORE
SOUTH END
SOUTH BOSTON
BROOKLINE
ROXBURY
N.DORCHESTER


0.1% Annual Chance Flood
1% Annual Chance Flood
10% Annual Chance Flood
Average Monthly High Tide
LAND FLOODING (ACRES)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
$0
9"
21"
36"
SEA LEVEL RISE CONDITION

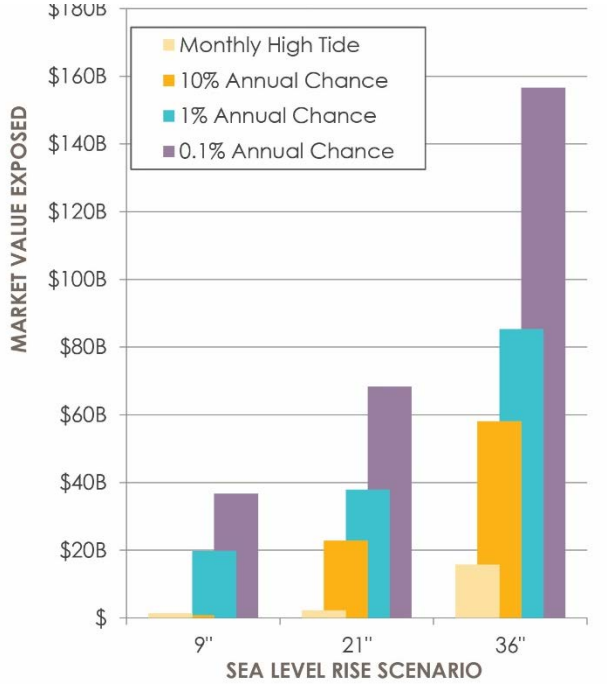
POPULATION



BUILDINGS

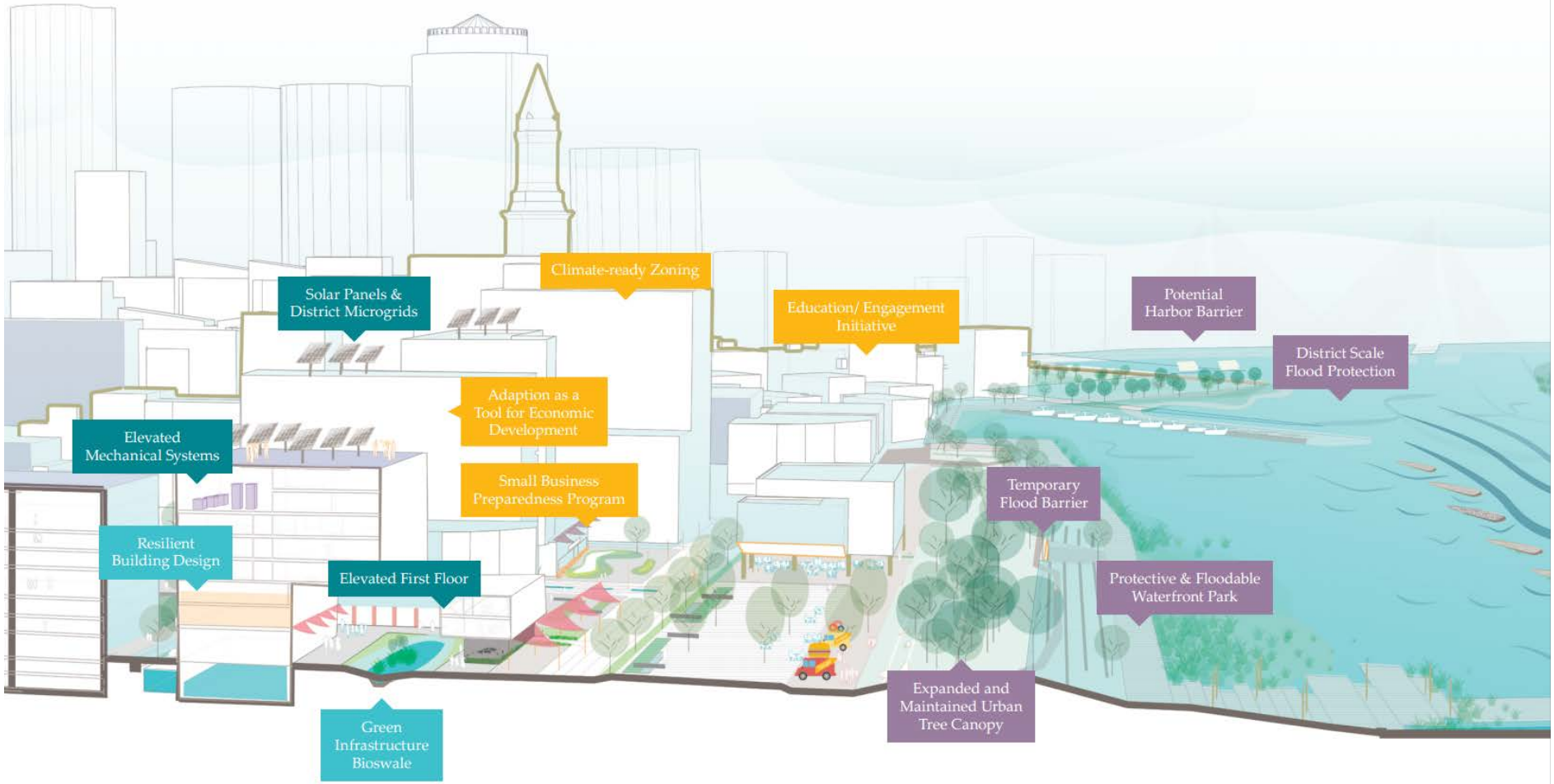


MARKET VALUE



ADAPTING TO CLIMATE CHANGE

PROTECTED SHORES | PREPARED AND CONNECTED COMMUNITIES | RESILIENT INFRASTRUCTURE | ADAPTED BUILDINGS



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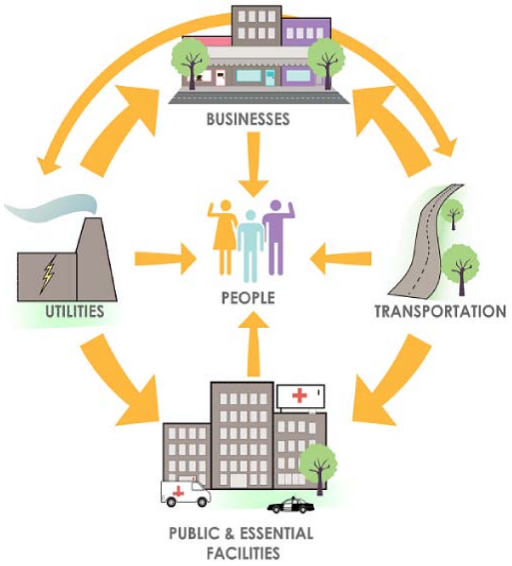
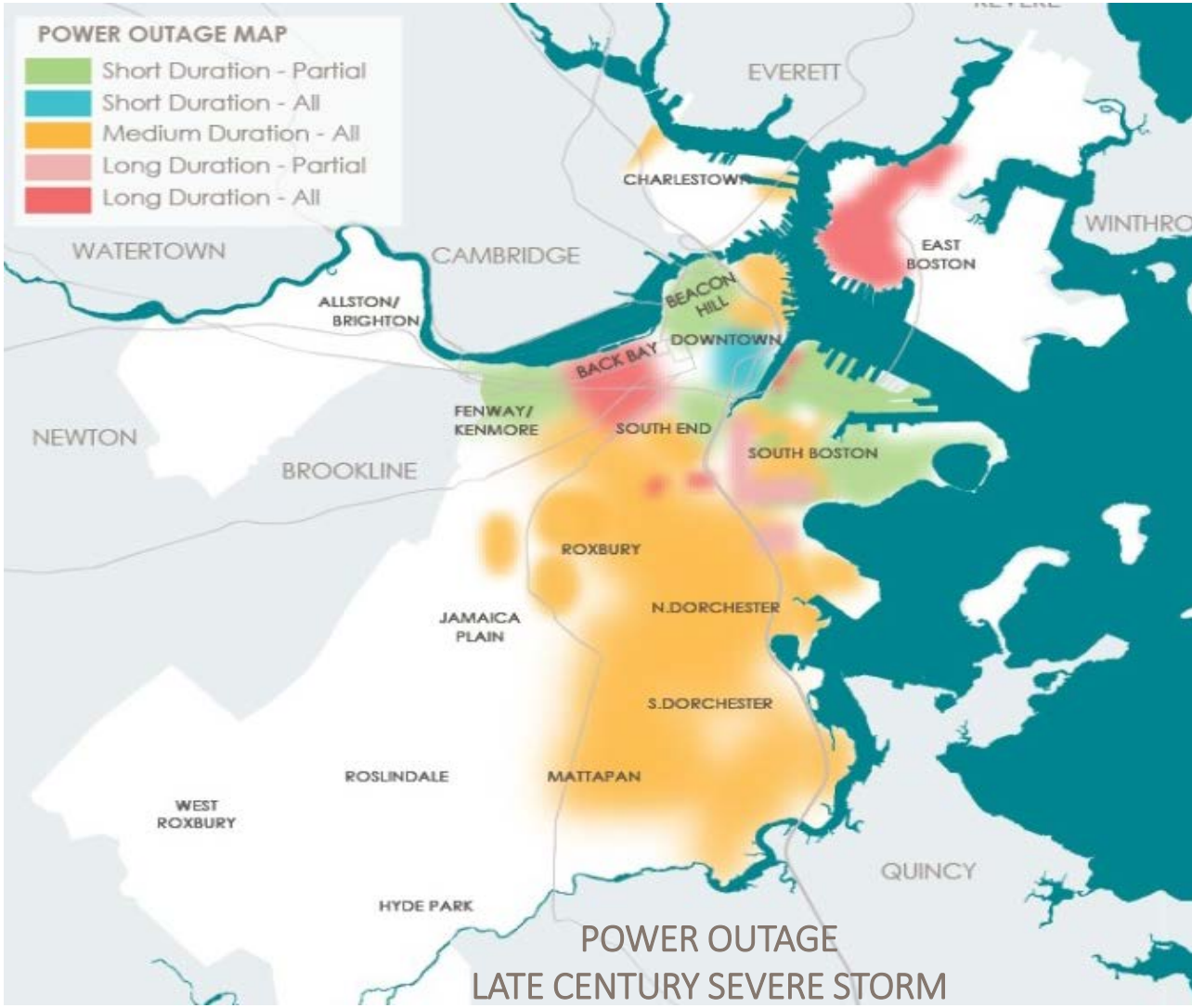
STRATEGY 4: IMPLEMENT CLIMATE ADAPTATION THROUGH RESILIENCE AREA PLANS

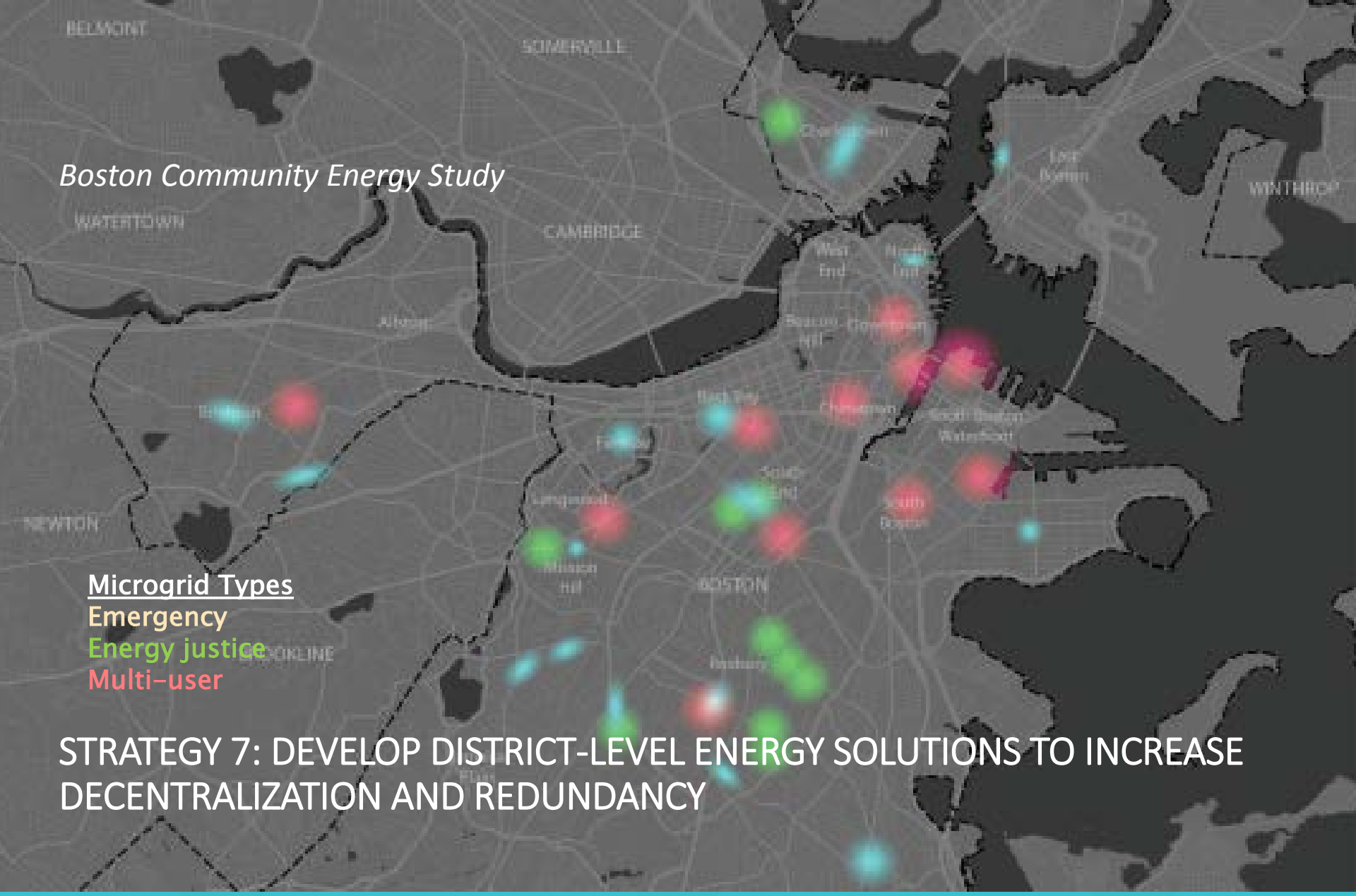
STRATEGY 6: ESTABLISH INFRASTRUCTURE COORDINATION COMMITTEE (ICC) TO FACILITATE CLIMATE ADAPTATION

INFRASTRUCTURE

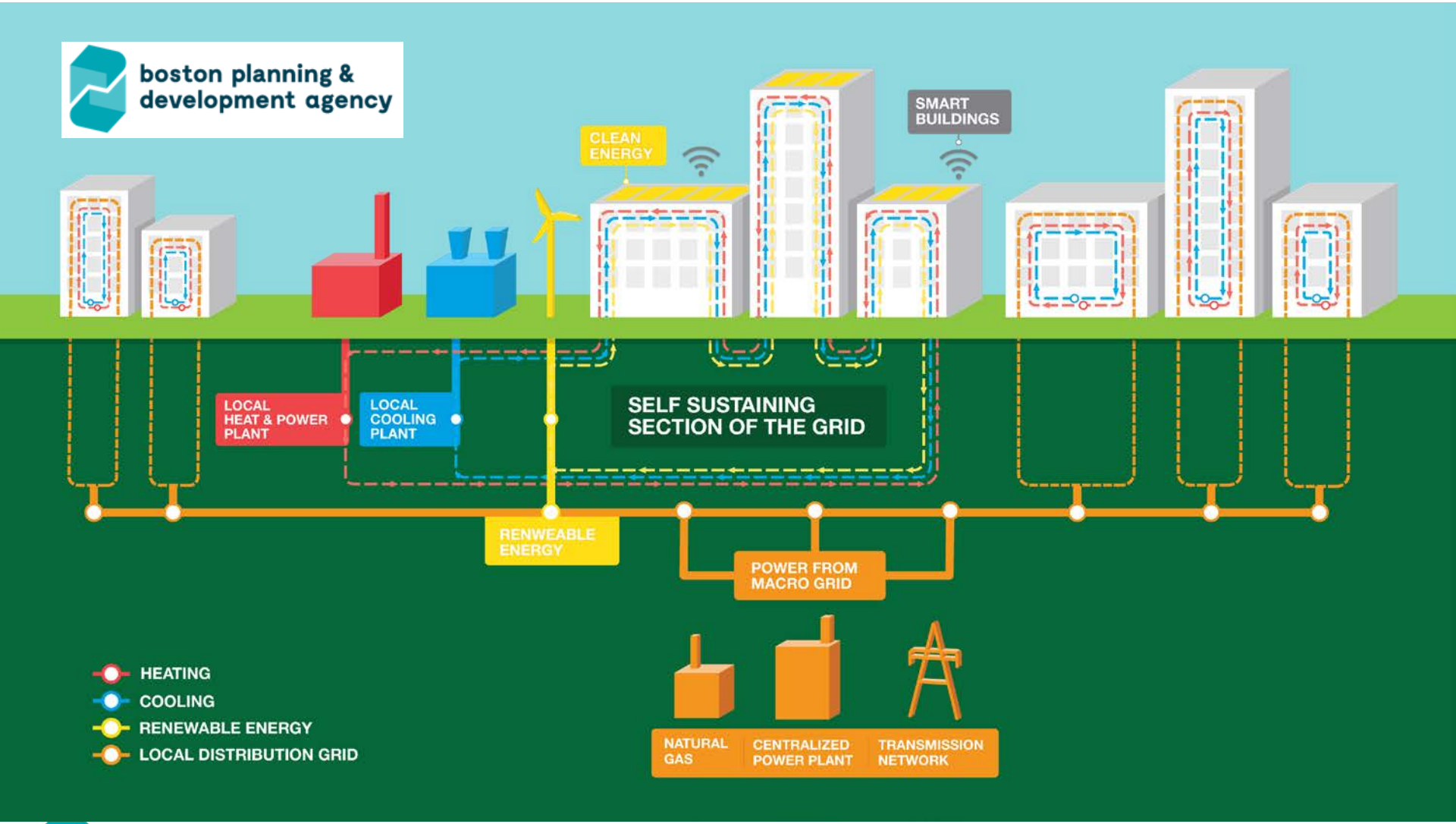
INTERDEPENDENCE AND POWER OUTAGE VULNERABILITY







STRATEGY 7: DEVELOP DISTRICT-LEVEL ENERGY SOLUTIONS TO INCREASE DECENTRALIZATION AND REDUNDANCY



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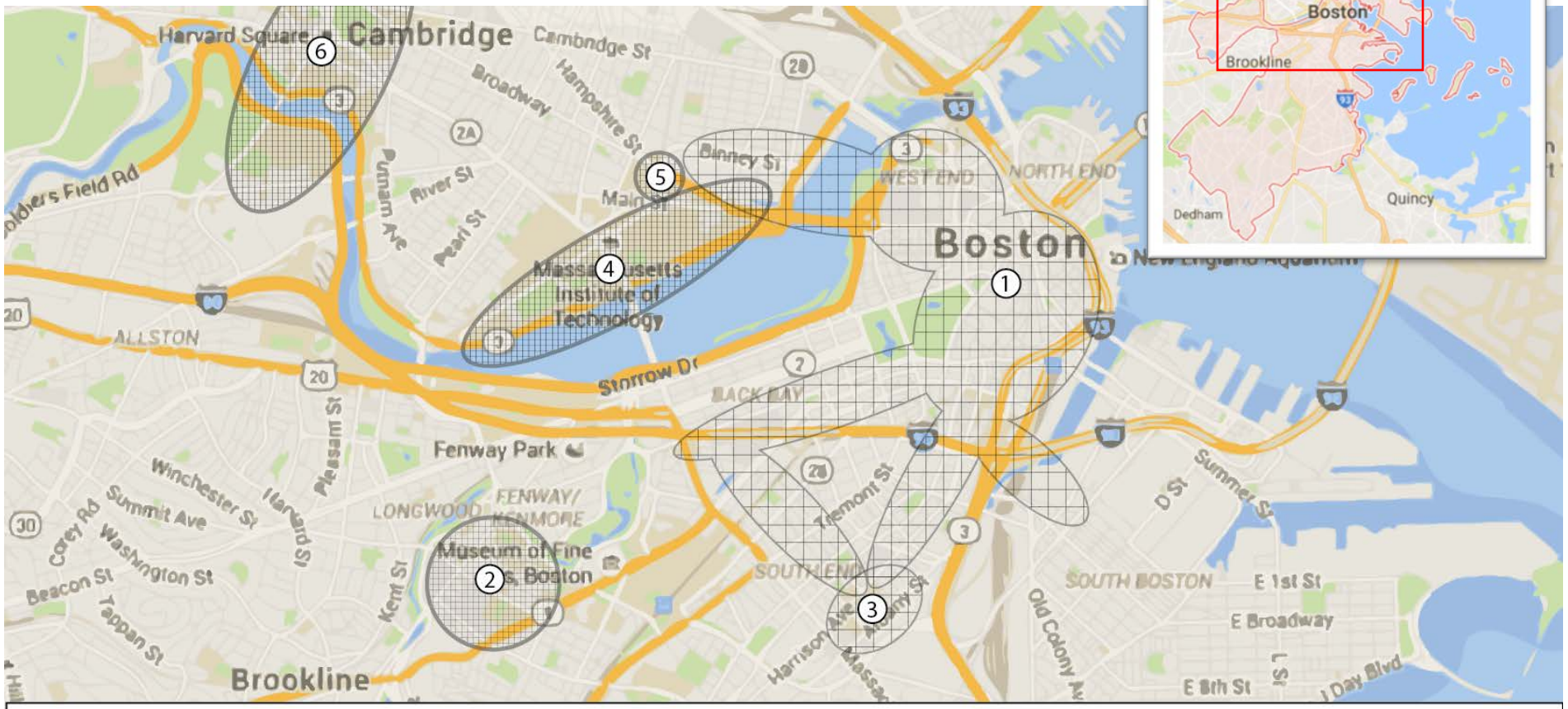
Existing District Energy Microgrids



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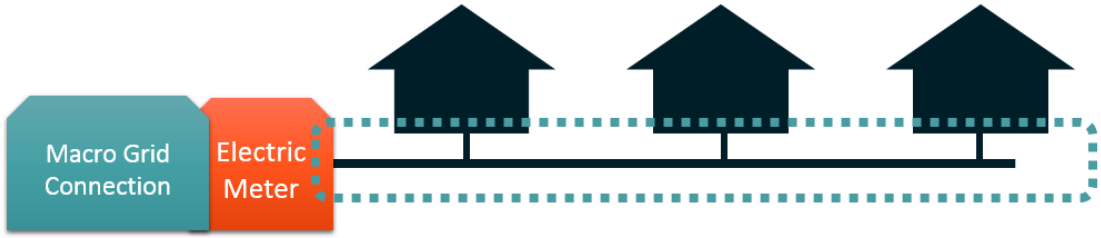
Resilient Energy Services for Commercial Properties

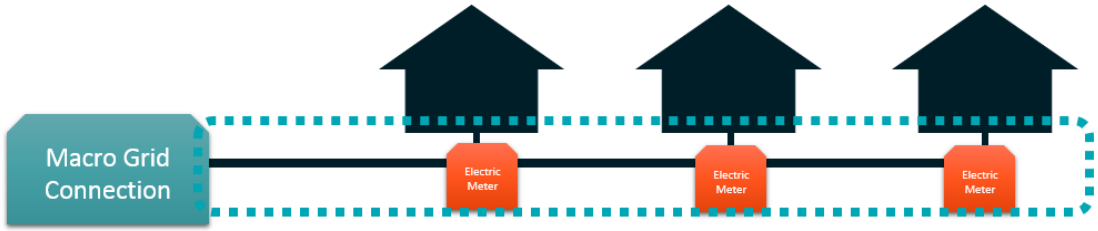
Campus “MUSH Market”

- 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



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Microgrid Workshops *Engagement*

Developed 3-part microgrid workshop

- 12 hours of scenario planning to align interests of key stakeholder
- 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

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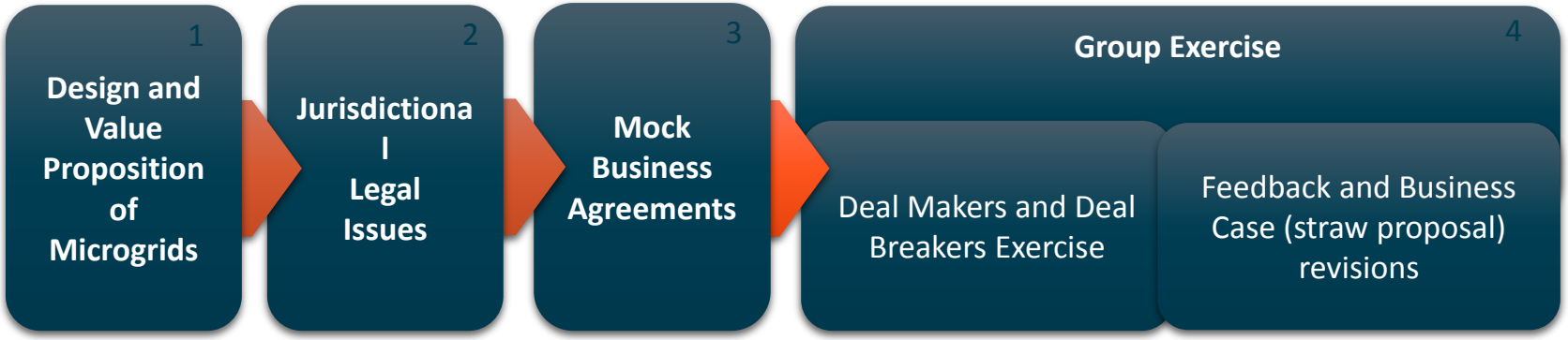
Microgrid Workshops Engagement

USDN urban sustainability directors network



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

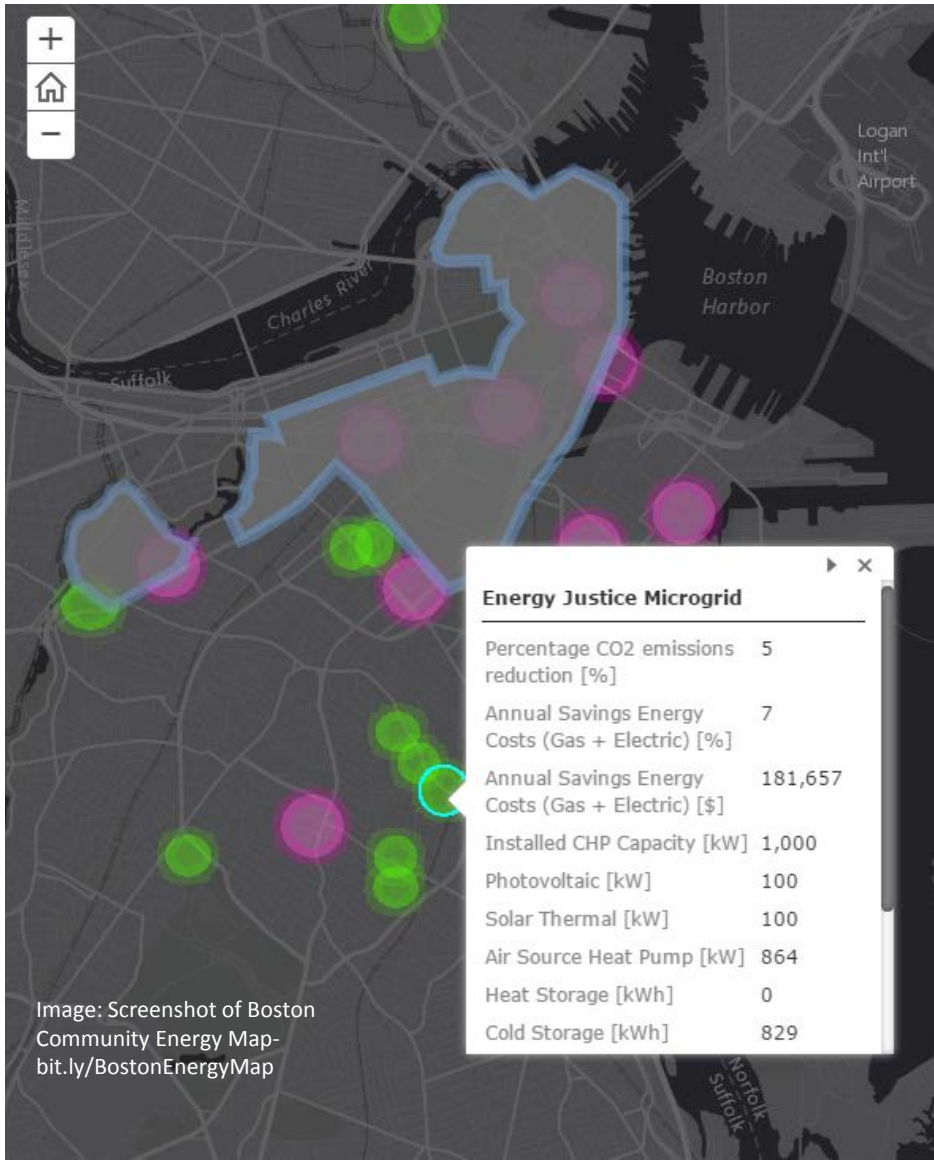


Image: Screenshot of Boston Community Energy Map- bit.ly/BostonEnergyMap

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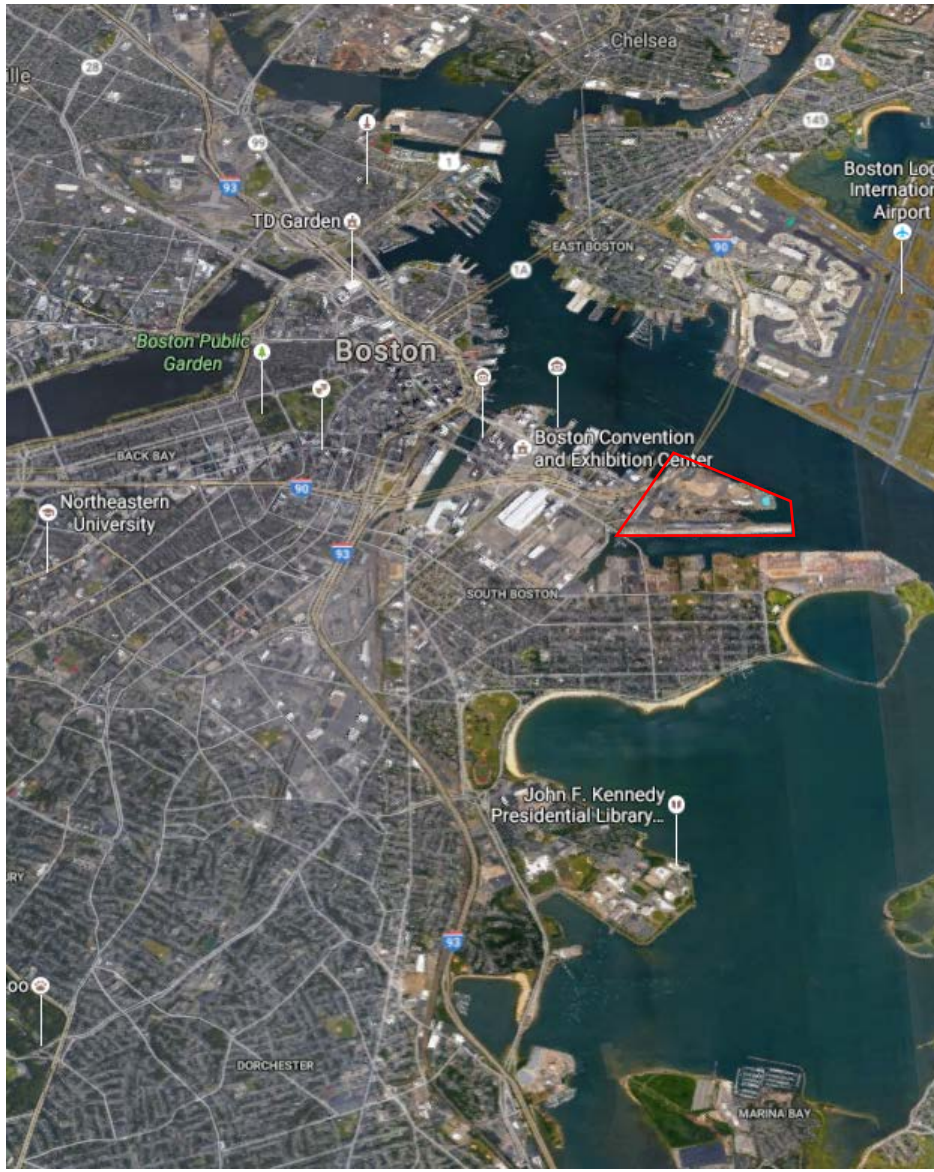
Pilot Project *Coordination*

2014–2016

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



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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.

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Resources

Climate Ready Boston:
https://www.boston.gov/sites/default/files/20161207_climate_ready_boston_digital2.pdf

Boston Community Energy Study: bit.ly/BostonEnergyStudy

Boston Community Energy Map: bit.ly/BostonEnergyMap

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

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Appendix Slides

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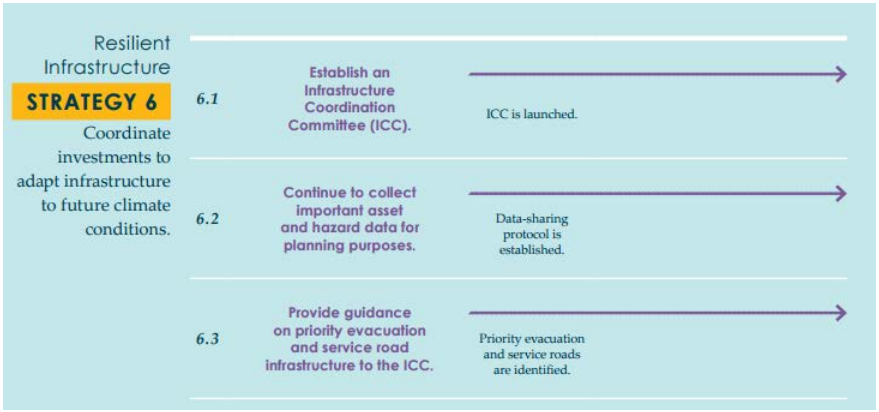
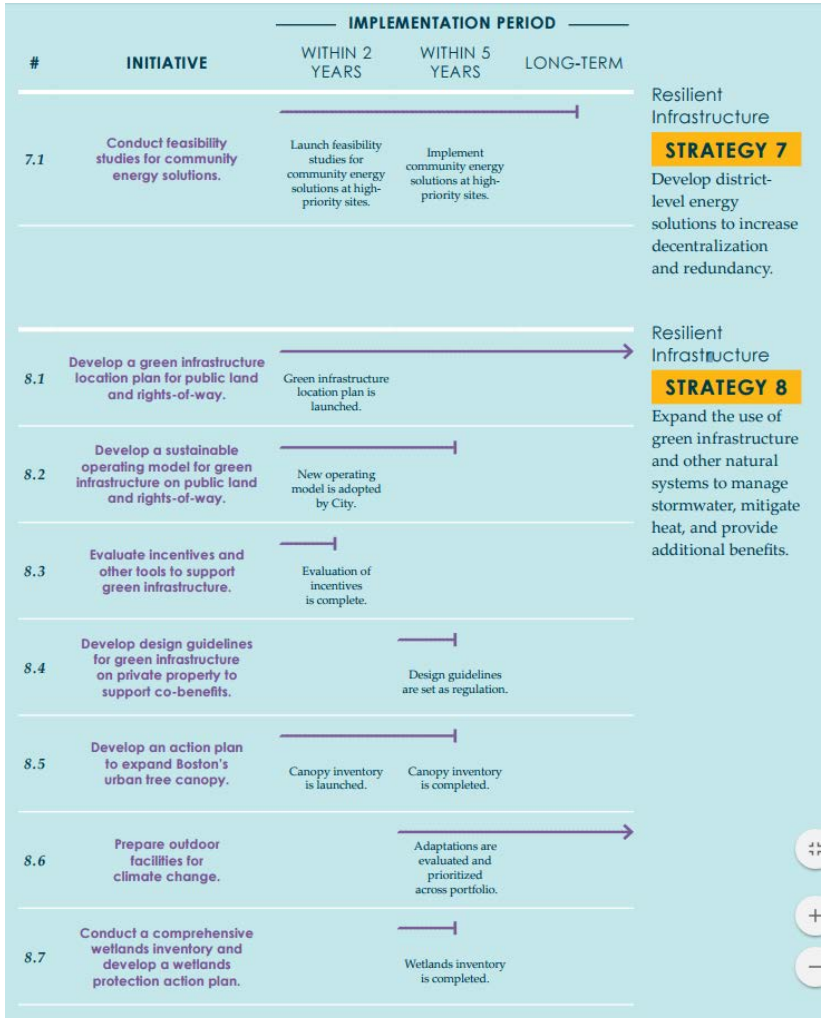
CRB Timelines





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- 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
  - 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

Mark Feasel

Vice President,
Electric Utility Segment & Smart Grid,
Schneider Electric

U.S. DEPARTMENT OF
ENERGY

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

Life Is On | Schneider Electric

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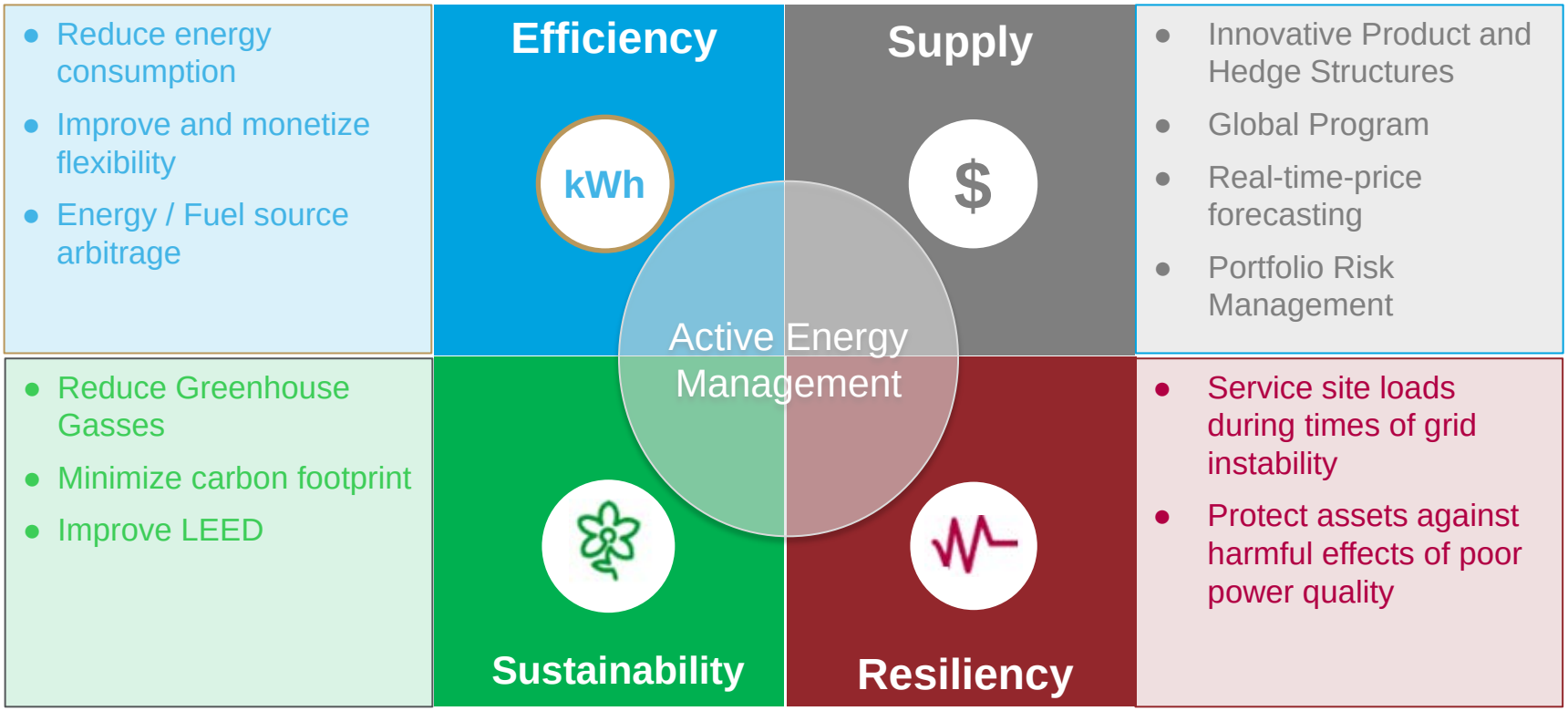
U.S. DEPARTMENT OF ENERGY

Energy Consumers Have New Expectations



and are taking control of their Energy

Demand Energy Brings Pioneering Solar Plus Storage Microgrid to New York City

April 12, 2017 By Elisa Wood Leave a Comment

93 | 83 | 10 | 2 | 188 SHARES

Demand Energy is set to begin operating a pioneering solar plus storage microgrid that achieves several firsts for the New York City power grid.

News of the project milestone comes just three months after Italian utility giant Enel acquired Demand Energy, a move that made a splash in the microgrid industry and significantly changed the fortunes of the small company.

The microgrid will serve the Marcus Garvey Village, a 625-unit mixed-income apartment complex. It will be the first microgrid on the city's power grid to:

- Win approval to use lithium-i
  city's strict fire safety rules
- Serve an affordable housing c
- Participate in Consolidated Ed
  Program, designed to use non
  construction of a substation.

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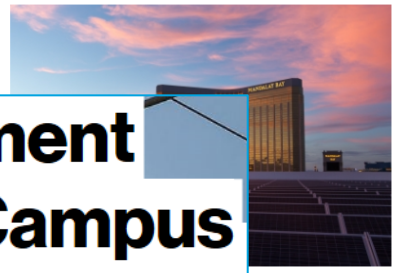
UTILITIES

How MGM Prepared Itself to Leave Nevada's Biggest Utility



The casino conglomerate expects to double its use of renewable energy and earn payback within 7 years.

by Julian Spector
September 16, 2016

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

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

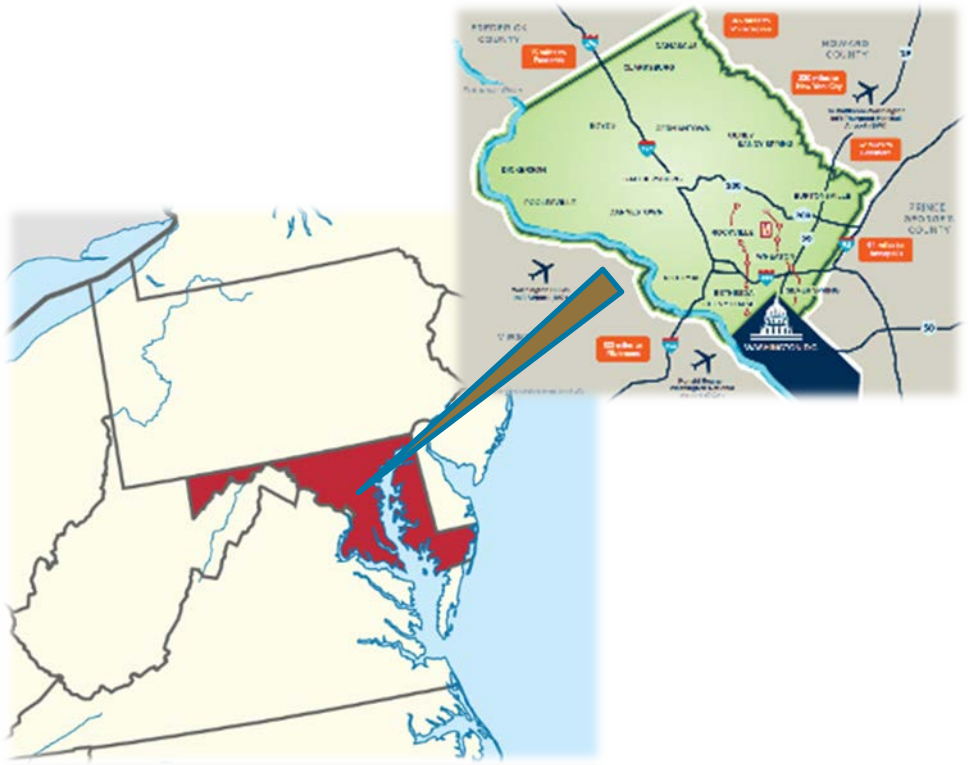
- Engie SA, Axium to manage school's energy assets for 50 years
- Board of trustees approved public-private partnership

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

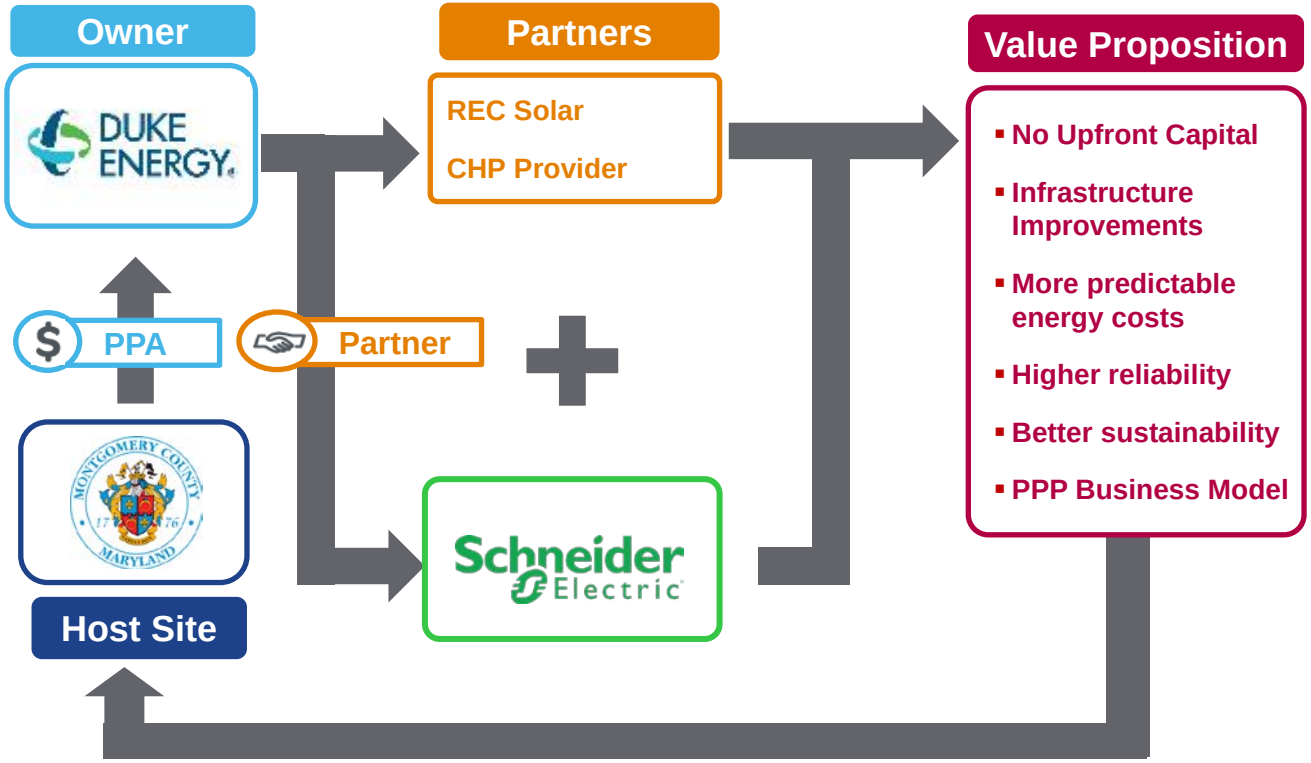
Correctional Facility

- 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



Thank you!

Microgrid Resources

E-Learning and White Papers

http://www.schneider-electric.us/en/work/solutions/microgrid-solutions/learning-center/

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.
http://www.schneider-electric.com/us/en/download/document/3070AC1506

Bear Creek Mountain Resort: Microgrid keeps power flowing at remote ski resort
http://www.schneider-electric.com/us/en/download/document/0104AC1501

US Coast Guard Puerto Rico: Reduce cost of power at remote island locations while improving reliability and complying with federal energy efficiency mandates.
http://www.schneider-electric.com/us/en/download/document/998-1218937_US

Panel Questions

Q&A

First Breakout

Eliza Hotchkiss

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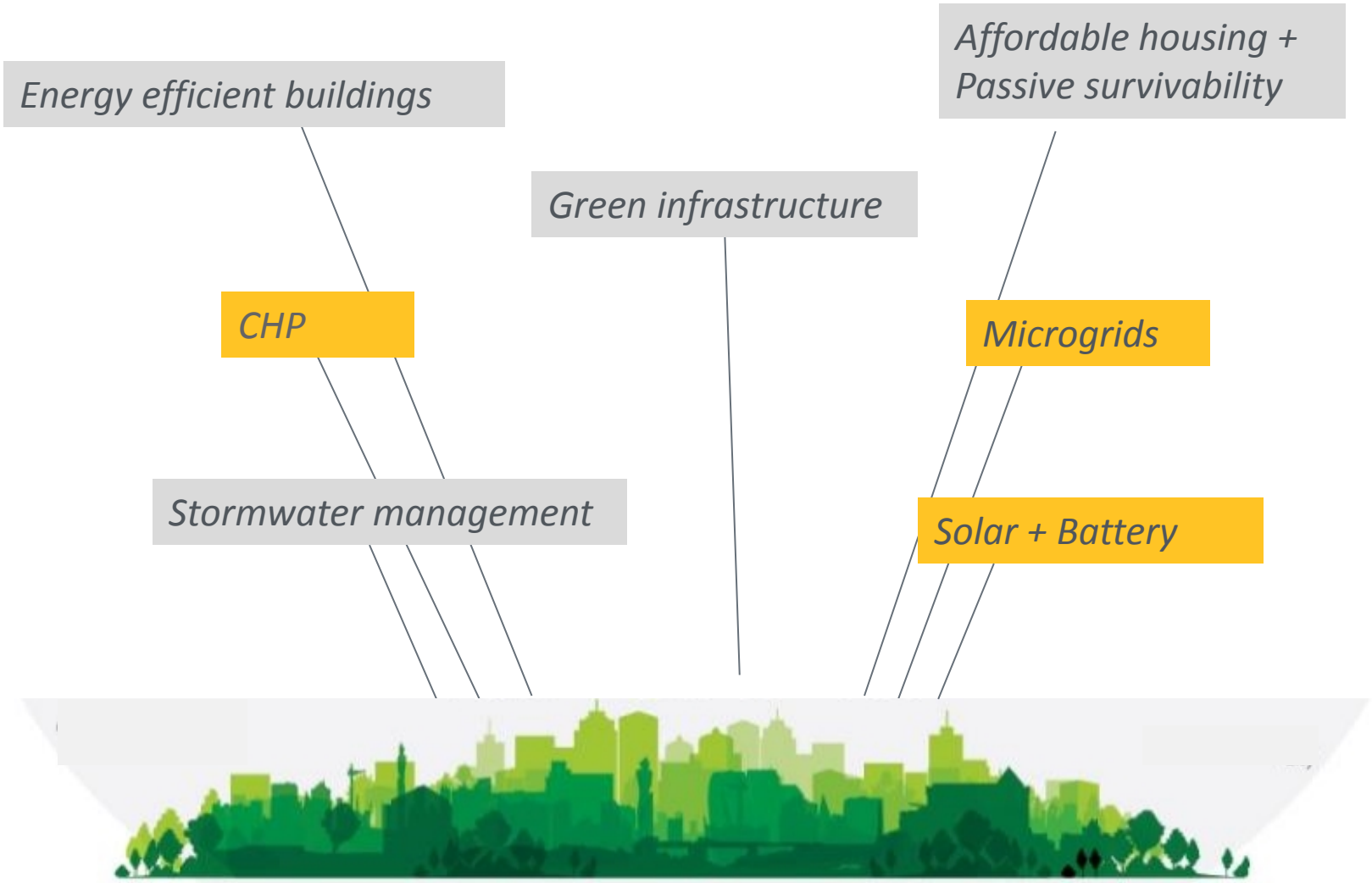
U.S. DEPARTMENT OF
ENERGY

Workshop Framework:

- Workshop Part I: Building Resiliency into State and Local Planning
- **Workshop Part II: Technology Solutions**

Holistic Approaches



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!

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