BOSTON REDEVELOPMENT AUTHORITY

GREENOVATE BOSTON

COMMUNITY ENERGY PLANNING STRATEGY OVERVIEW

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SENIOR INFRASTRUCTURE ADVISOR

Boston Redevelopment Authority

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GREENOVATE BOSTON

PRESENTATION OVERVIEW

CHALLENGES → STRATEGY → LESSONS → NEXT STEPS

CA 2013: CHALLENGES TO MARKET DEVELOPMENT

- Lacks business model
- Perceived threat to utility business model
- No regulatory / statutory support
- Real estate developers unaware of opportunity
- City government involvement not the norm in energy planning

Photo credit: http://de.memory-alpha.wikia.com/wiki/Der_Fall_Charly

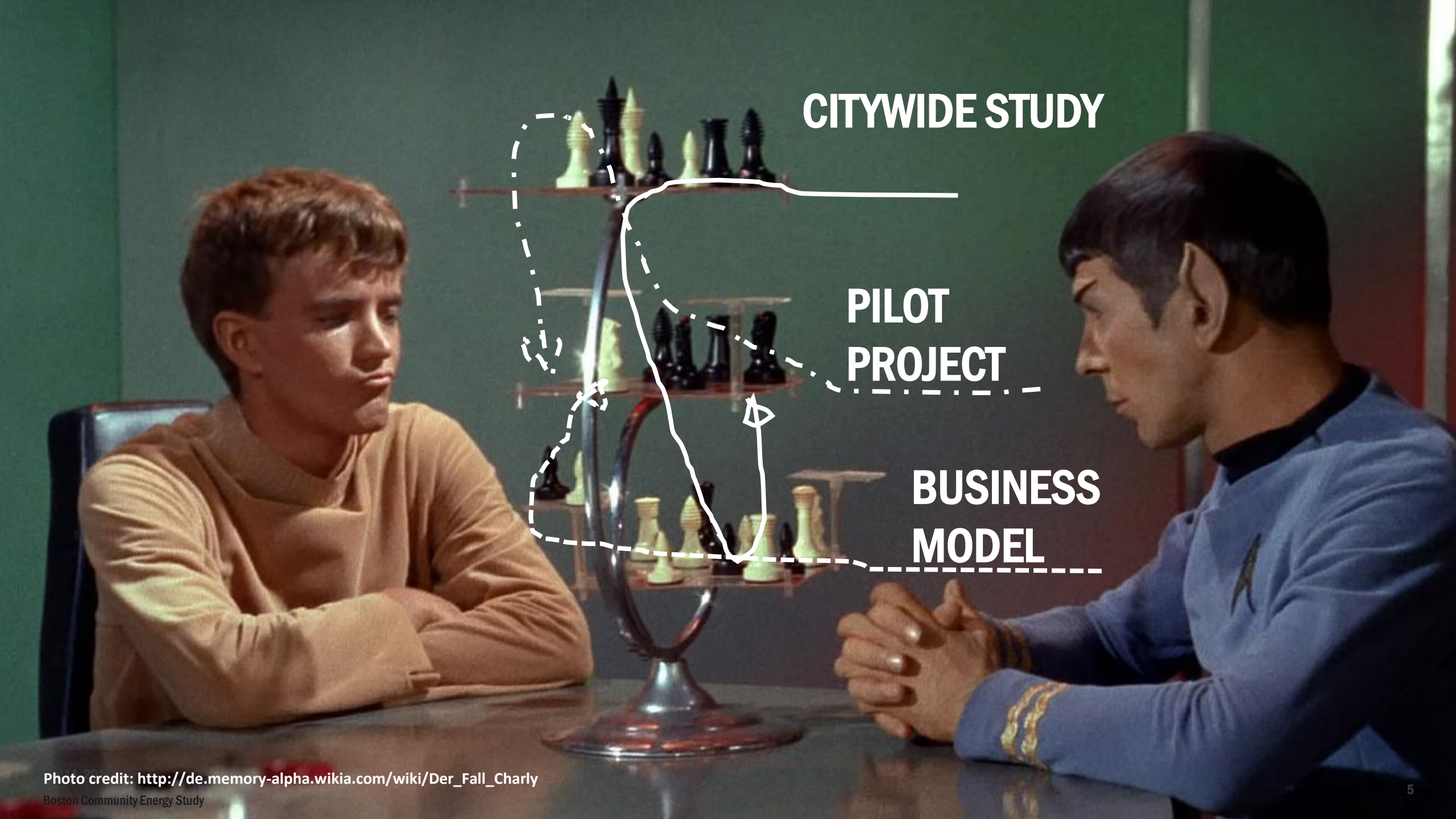

Photo credit: http://de.memory-alpha.wikia.com/wiki/Der_Fall_Charly

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SUSTAINABLE DESIGN LAB

LINCOLN LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Funded by and in Partnership with :

MASSACHUSETTS CLEAN ENERGY CENTER

BOSTON COMMUNITY ENERGY STUDY

Exploring the Potential for Local Energy Generation, District Energy, and Microgrids

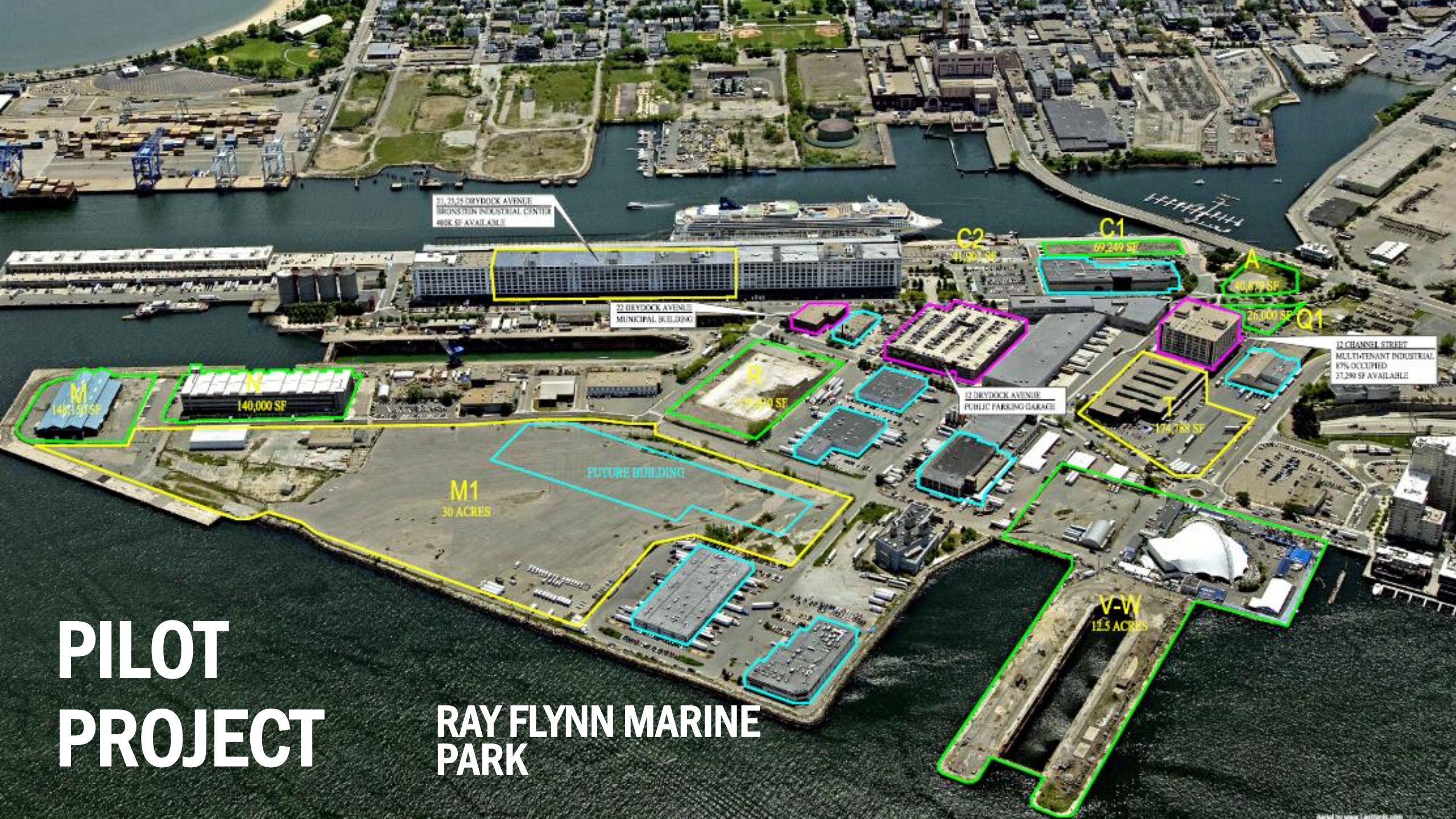
2016

BOSTON COMMUNITY ENERGY STUDY

Exploring the Potential for Local Energy Generation, District Energy, and Microgrids

2016

BCES – WHAT IT DID (AND DIDN'T) DO WELL



PILOT PROJECT

RAY FLYNN MARINE PARK

PROJECT TIMELINE

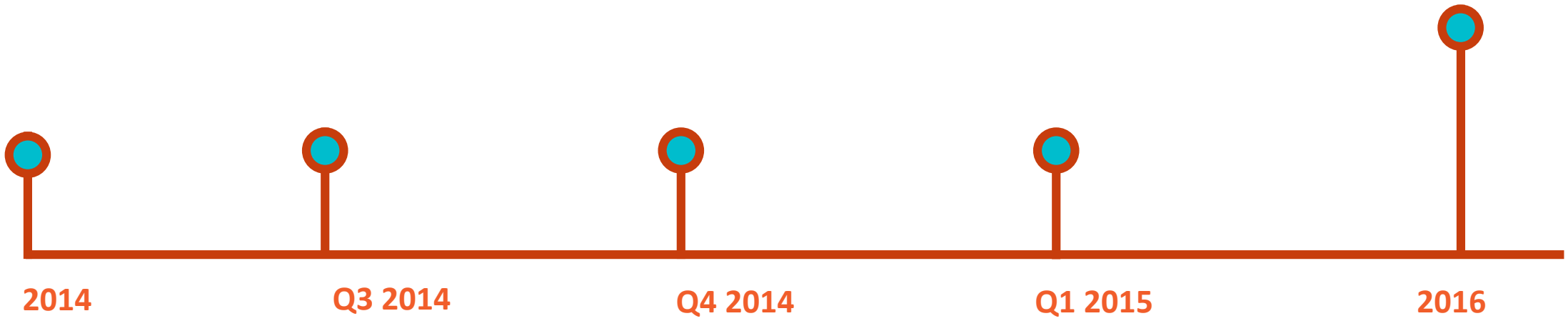
- Partnership Development
- Boston Microgrids Workshops

- Tenant engagement on Combined Heat and Power, District Energy and Microgrids

- DOE Screening for CHP potential
- Recommended Efficiency Projects + 3 MW Cogeneration Plant

- Walk-through with Eversource in 12 BMIP facilities
- Energy developer recommended phased, 7 MW Cogeneration Plant

- **Framework Agreements**
- **Procurement Method**

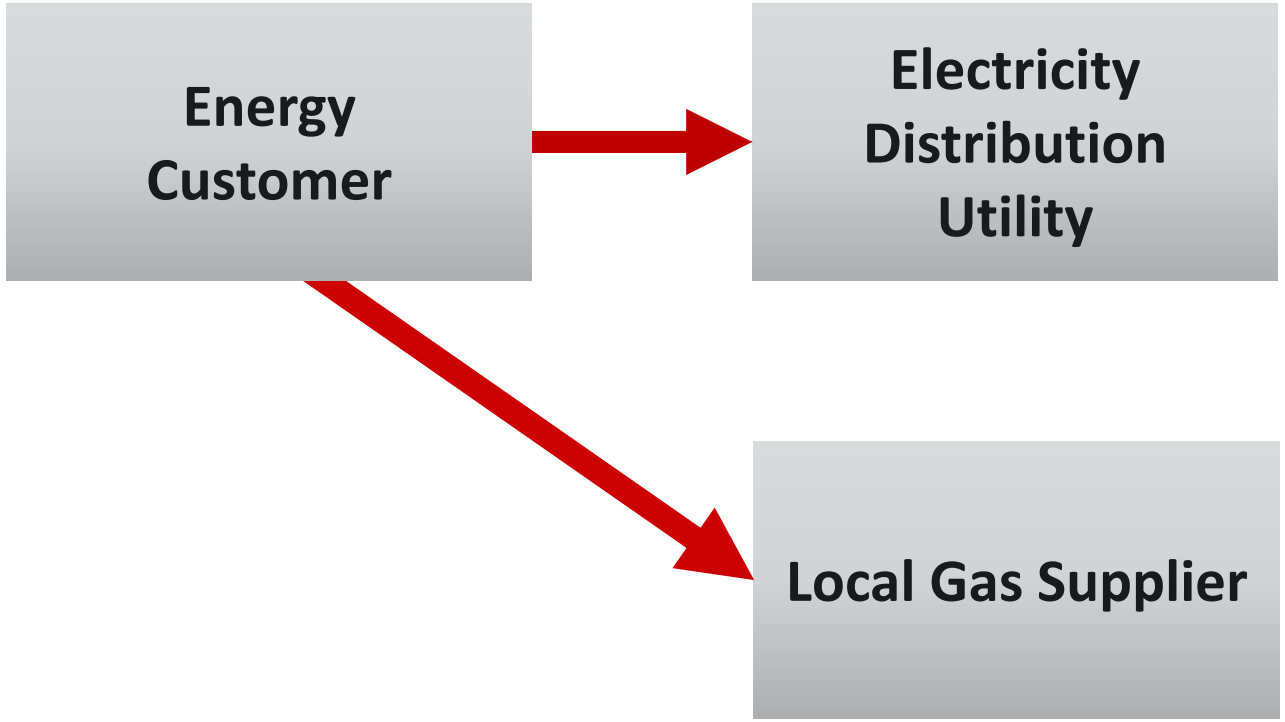


MAKING THE CASE FOR MICROGRIDS

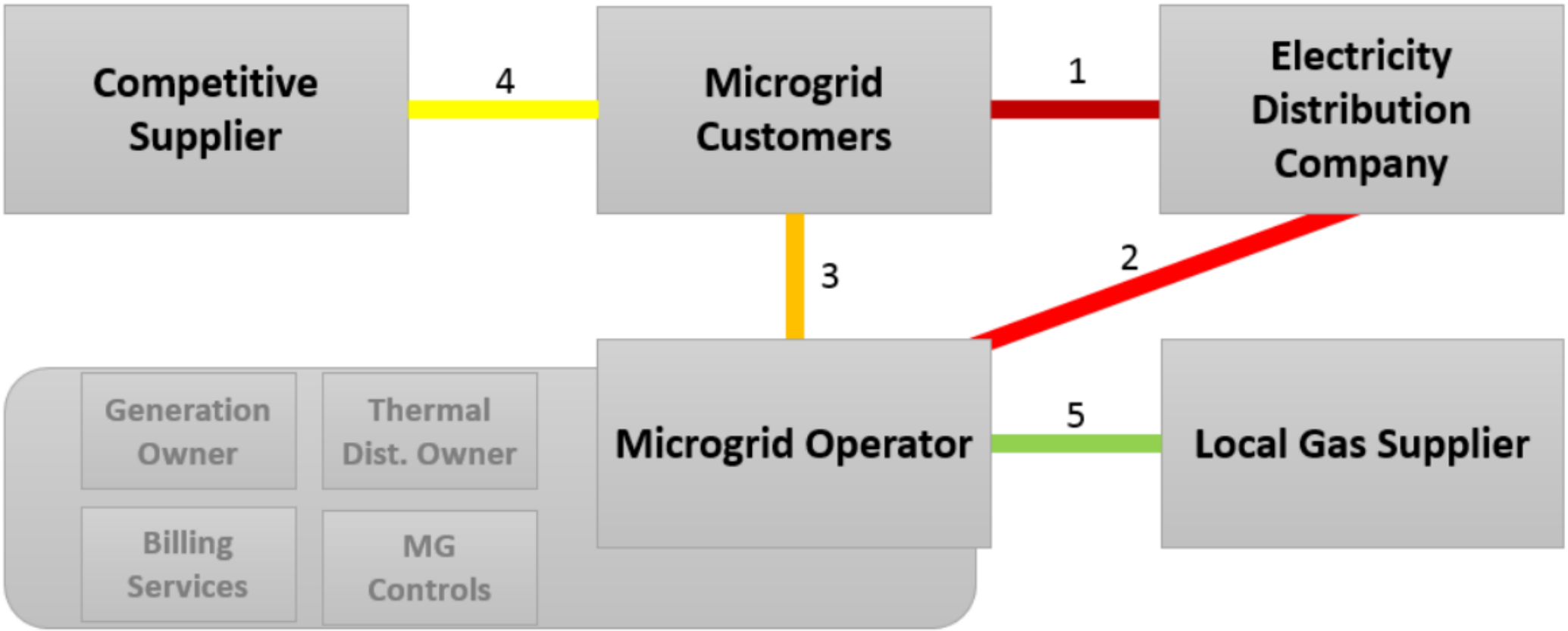
- **Central energy plant in the RFMP can:**
  - Cut energy costs by smarter management and higher efficiency equipment
  - Increase control over power quality for sensitive users
  - Add resiliency to the local power supply
  - Utilize source fuel more efficiently
- **Potential customers include…**
- ***Site control and obligation to tenants***

BUSINESS MODEL

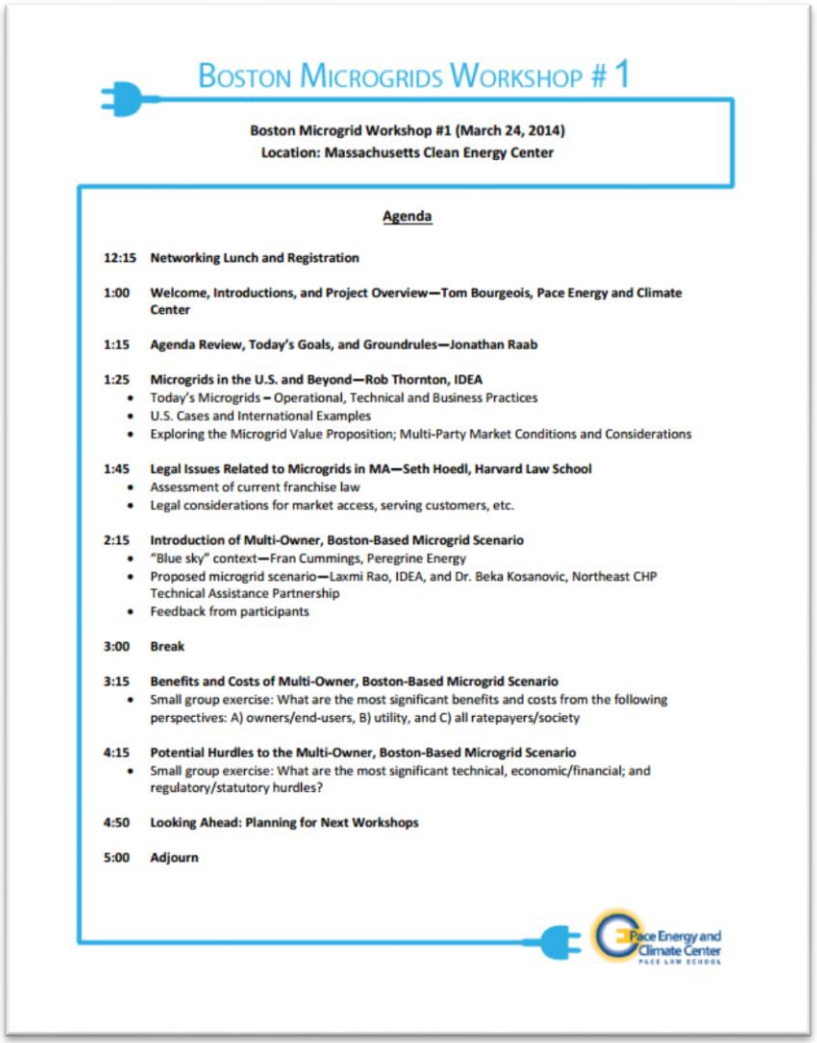
BOSTON MICROGRID WORKSHOPS
USDN MICROGRID WORKSHOPS


Energy Customer
Electricity Distribution Utility
Local Gas Supplier

6.1.1 Scenario 1 Contractual agreements diagram



Content found on page 82 on USDN Microgrids Workshops Final Report



Boston Microgrids Workshop # 1

Boston Microgrid Workshop #1 (March 24, 2014)
Location: Massachusetts Clean Energy Center

Agenda

12:15 Networking Lunch and Registration

1:00 Welcome, Introductions, and Project Overview—Tom Bourgeois, Pace Energy and Climate Center

1:15 Agenda Review, Today's Goals, and Groundrules—Jonathan Raab

1:25 Microgrids in the U.S. and Beyond—Rob Thornton, IDEA
- Today's Microgrids – Operational, Technical and Business Practices
- U.S. Cases and International Examples
- Exploring the Microgrid Value Proposition; Multi-Party Market Conditions and Considerations

1:45 Legal Issues Related to Microgrids in MA—Seth Hoedl, Harvard Law School
- Assessment of current franchise law
- Legal considerations for market access, serving customers, etc.

2:15 Introduction of Multi-Owner, Boston-Based Microgrid Scenario
- "Blue sky" context—Fran Cummings, Peregrine Energy
- Proposed microgrid scenario—Laxmi Rao, IDEA, and Dr. Beka Kosanovic, Northeast CHP Technical Assistance Partnership
- Feedback from participants

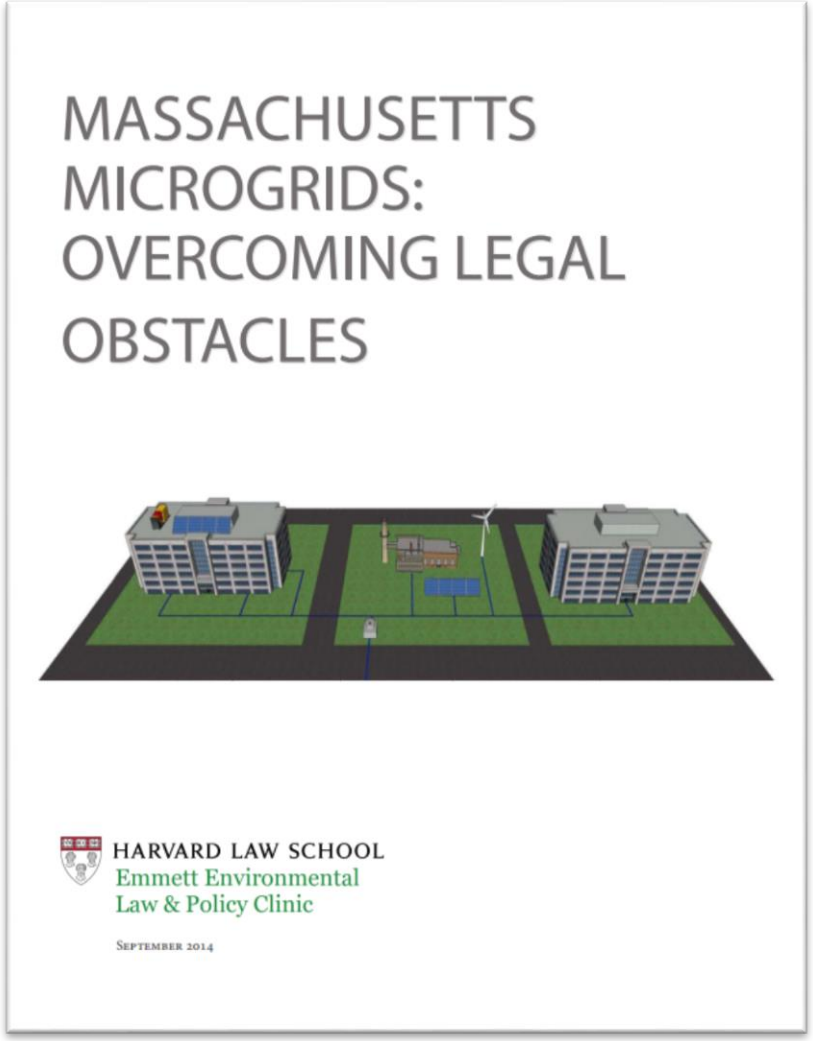
3:00 Break

3:15 Benefits and Costs of Multi-Owner, Boston-Based Microgrid Scenario
- Small group exercise: What are the most significant benefits and costs from the following perspectives: A) owners/end-users, B) utility, and C) all ratepayers/society

4:15 Potential Hurdles to the Multi-Owner, Boston-Based Microgrid Scenario
- Small group exercise: What are the most significant technical, economic/financial; and regulatory/statutory hurdles?

4:50 Looking Ahead: Planning for Next Workshops

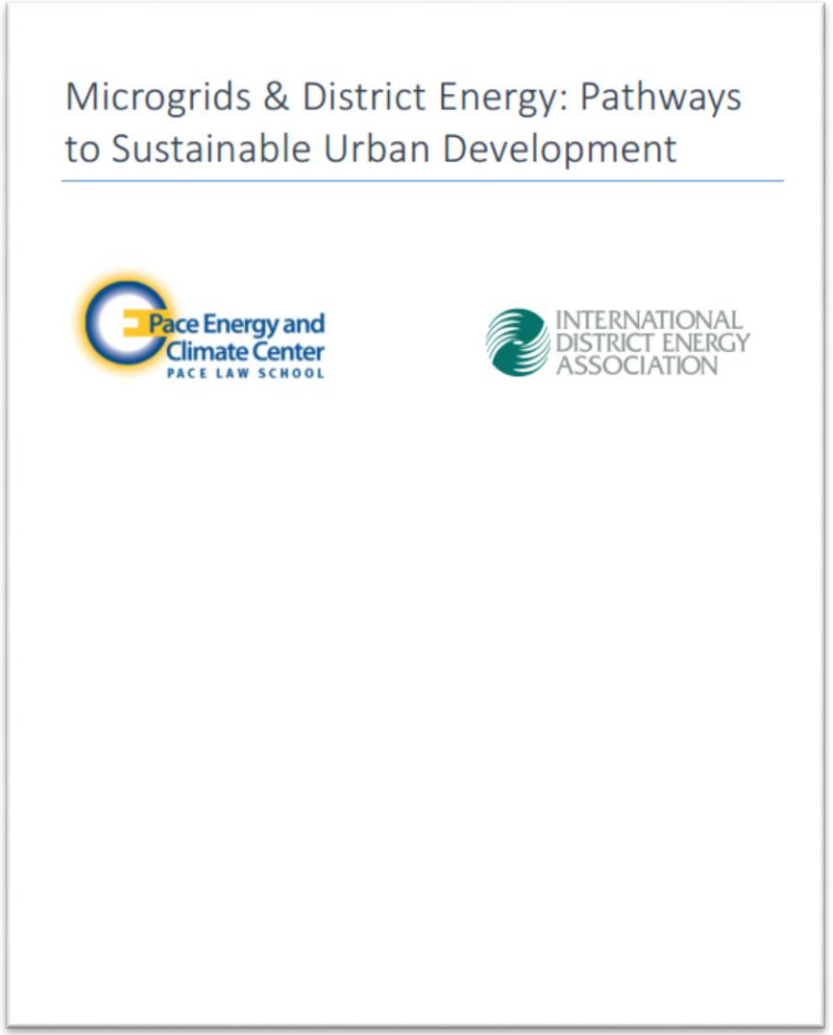
5:00 Adjourn



MASSACHUSETTS MICROGRIDS: OVERCOMING LEGAL OBSTACLES

HARVARD LAW SCHOOL
Emmett Environmental Law & Policy Clinic

SEPTEMBER 2014



Microgrids & District Energy: Pathways to Sustainable Urban Development

Pace Energy and Climate Center
PACE LAW SCHOOL

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

http://www.bostonredevelopmentauthority.org/planning/planning-initiatives/community-energy-planning

Photo credit: http://de.memory-alpha.wikia.com/wiki/Der_Fall_Charly

NEXT STEPS

- EDF Climate Corps Summer Fellow
- Framework Agreements with IOU's
- Renew Boston Trust: energy efficiency procurement that can unlock microgrid market

APPENDIX SLIDES

TRENDS IN URBAN ENERGY INFRASTRUCTURE

Superstorm Sandy

- NYU serves as safe haven, Hudson Yards

Energy Efficiency and Economics in Boston

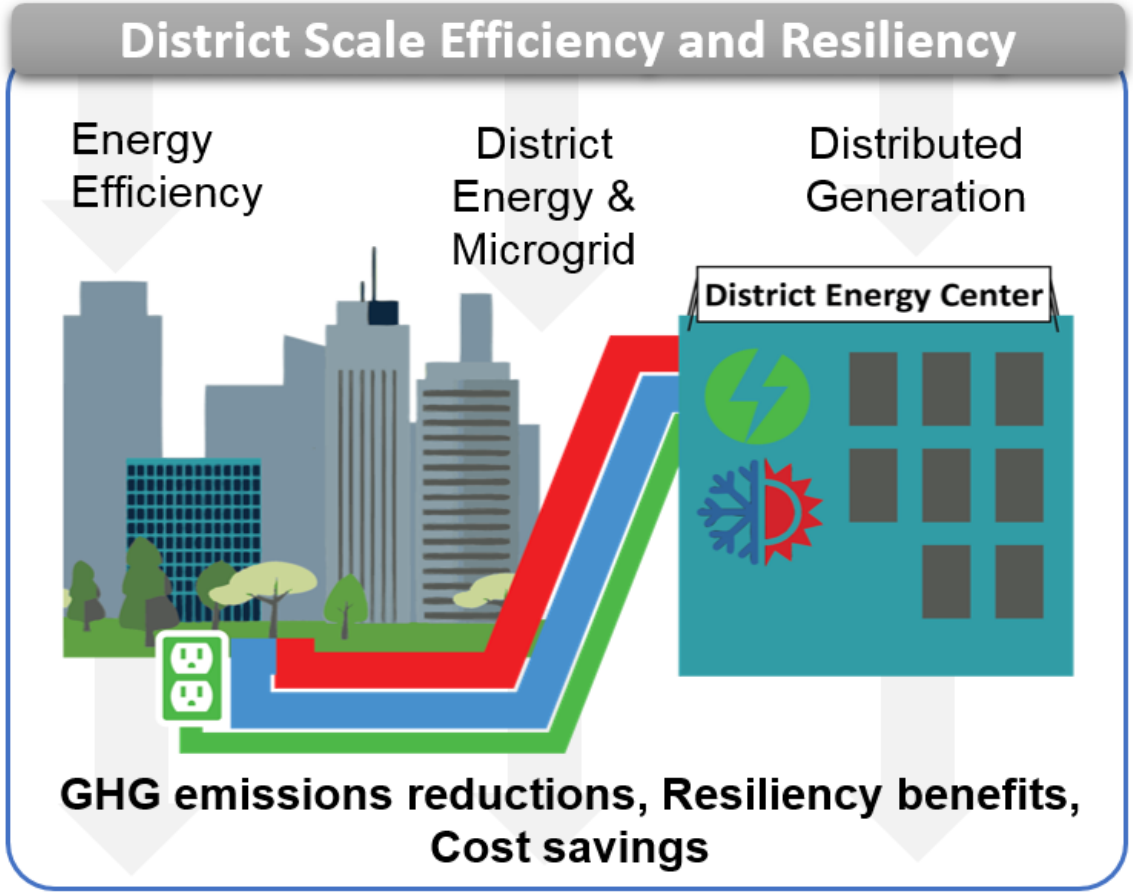
- Biogen Energy System- CHP Driven

City of "Meds and Eds" as case examples

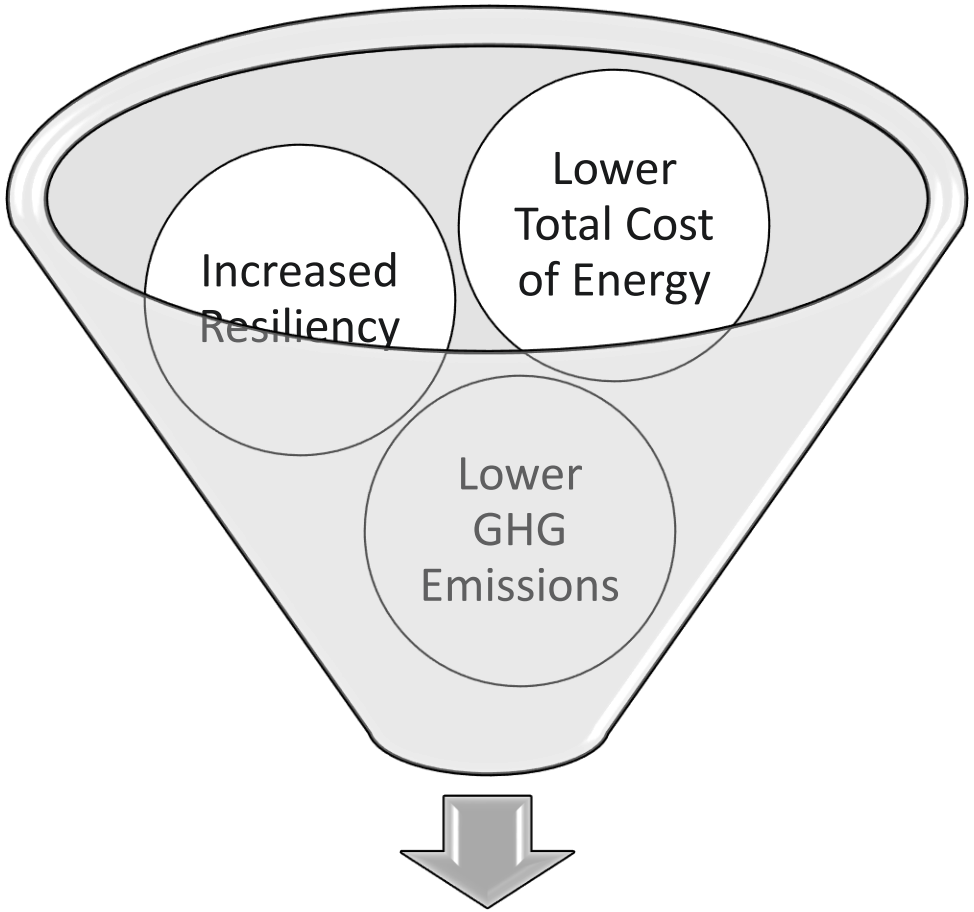
- Harvard, MIT, MATEP- CHP Driven

CHP for Resilience:

- Seeking to transfer institutional models to commercial (multi user microgrids)
- Partnering with DOE TAP to perform community scale CHP assessments
- Partnering with Eversource Energy to promote CHP via Article 37 and Article 80



Source: City of Boston, Mayor's Office of Environment Energy and Open Space



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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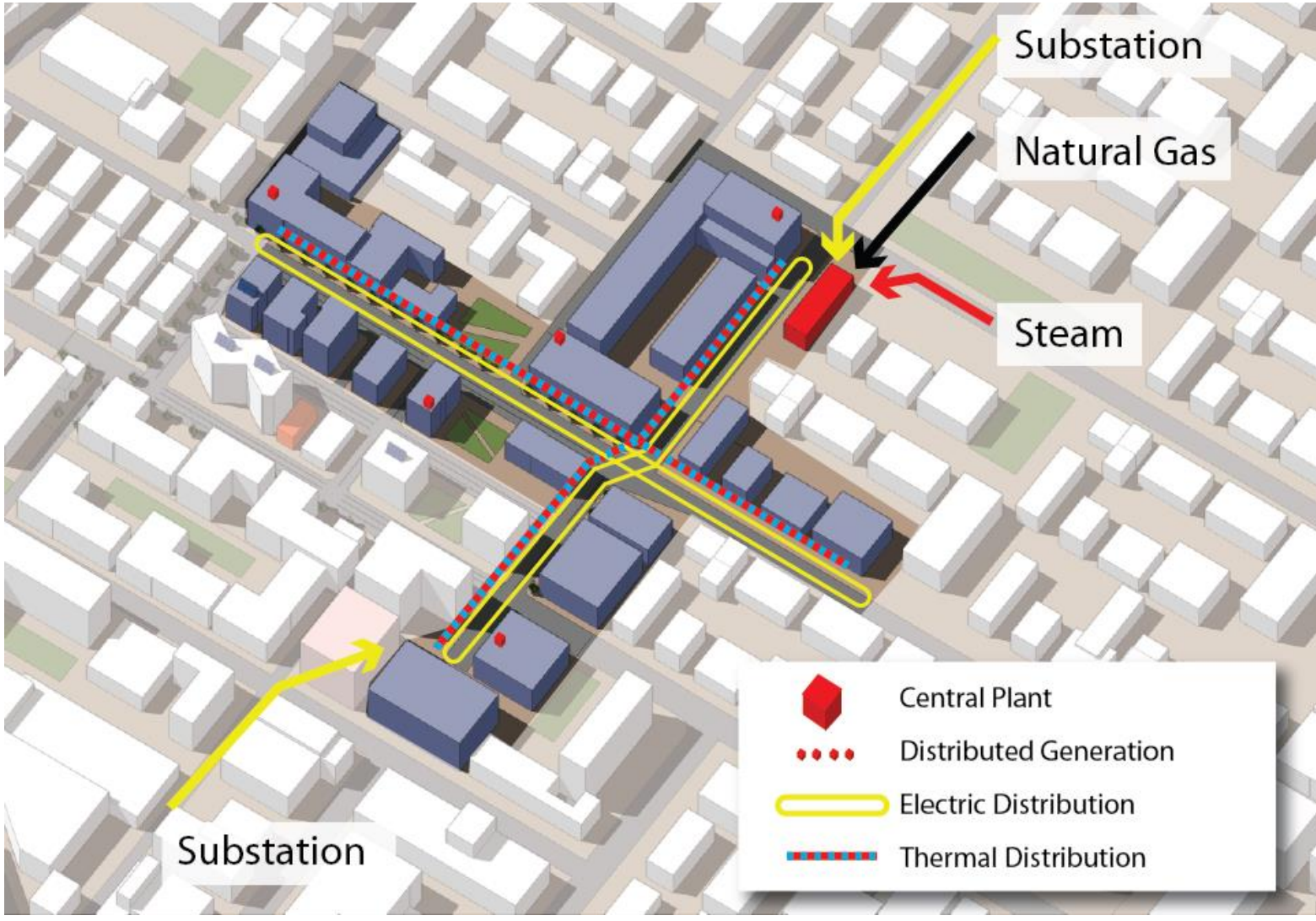
MULTI USER MICROGRIDS

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

Illustration of a Multiuser Microgrid



ENERGY SYSTEM PLANNING

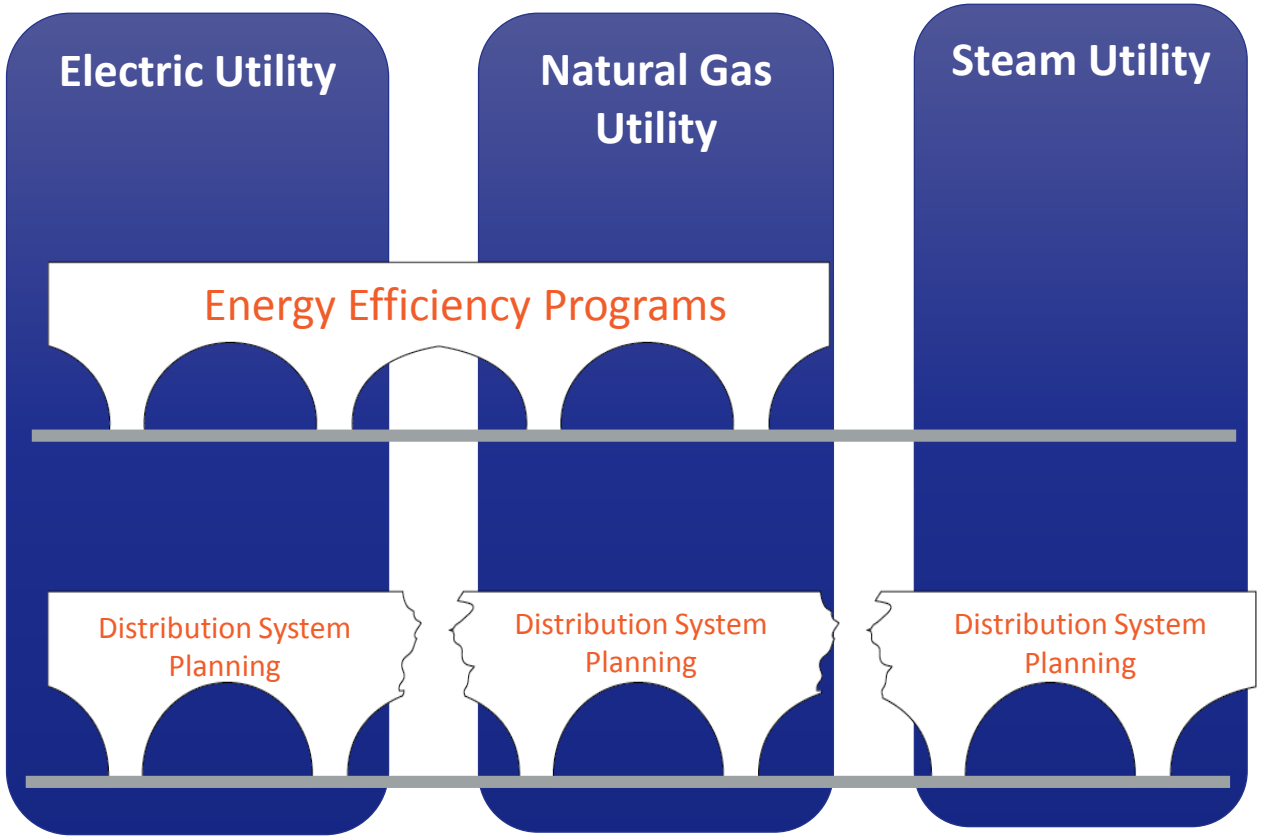
Why involve city government?

A policy of the Climate Action Plan

- Increased cogeneration, district energy, solar installation
- Lower total cost of energy, reduced GHG emissions, increased resiliency

Challenges

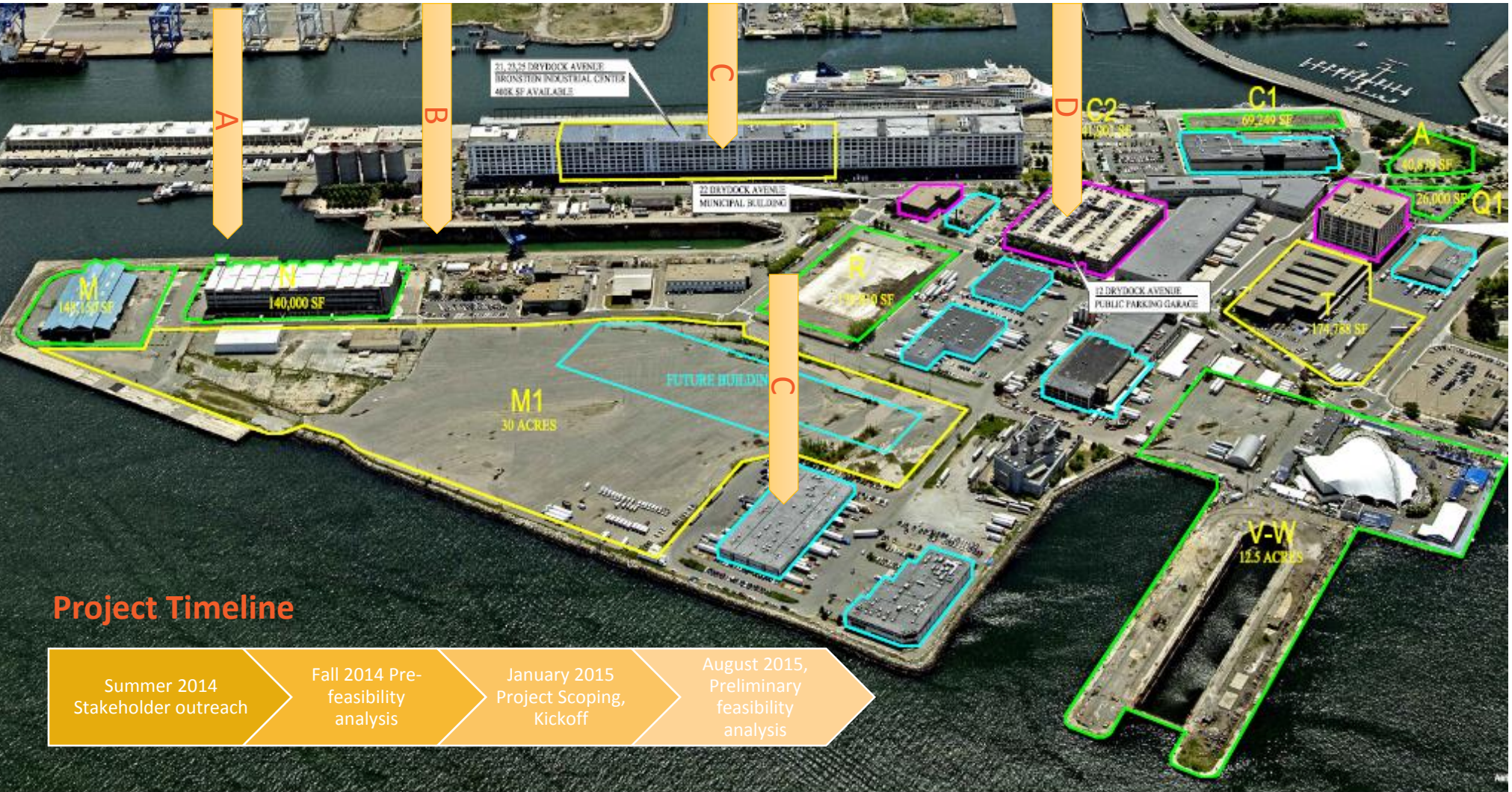
- Boston has many DE systems because campuses
- Vision: Campus-like technology in commercial buildings
- No business model



BOSTON REDEVELOPMENT AUTHORITY

GREENOVATE BOSTON

RAY FLYNN MARINE PARK



Project Timeline

- Summer 2014 Stakeholder outreach
- Fall 2014 Pre-feasibility analysis
- January 2015 Project Scoping, Kickoff
- August 2015, Preliminary feasibility analysis

Opportunities

A. Economic development

B. Cost sensitivity

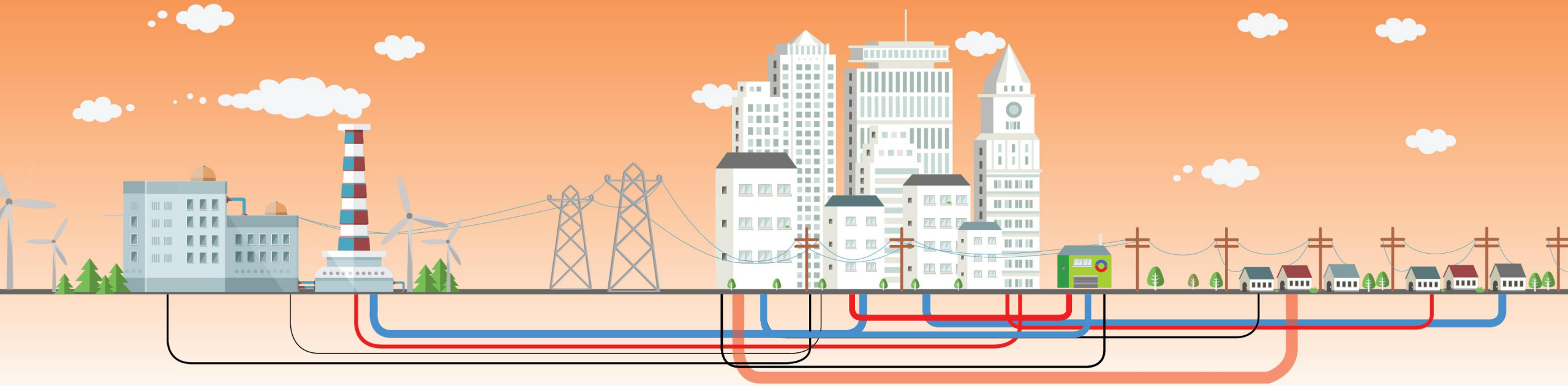
C. Security & business continuity

D. Clean power

Challenges

1. Lacks business model
2. Perceived threat to utility business model
3. No regulatory / statutory support
4. Real estate developers unaware of opportunity
5. City government involvement not the norm in energy planning

INTRODUCTION



Boston's Climate Action Commitment

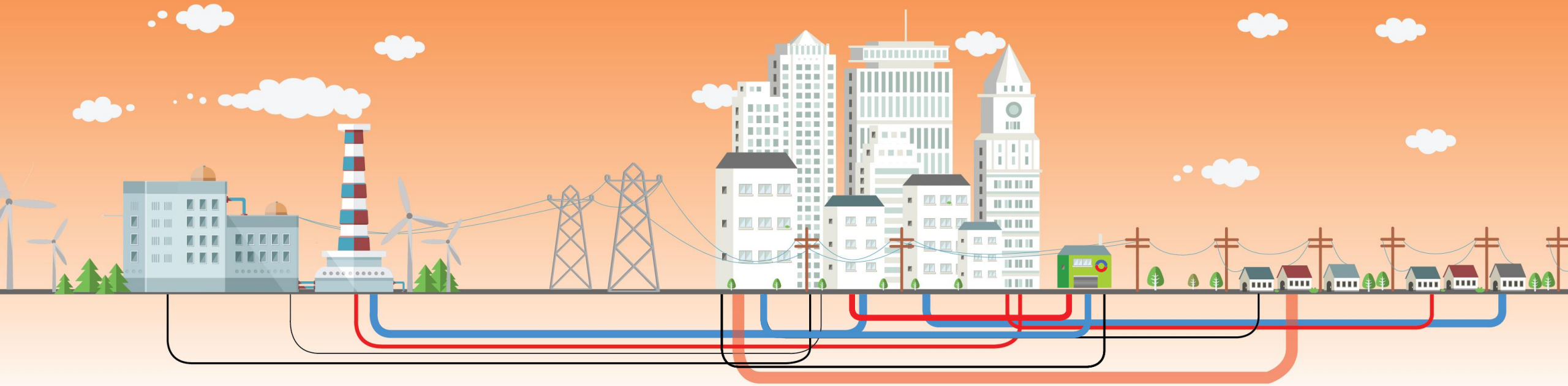
- Goals in 2014 Climate Action Plan Update
- Promote onsite CHP, renewables, district energy
- 2020 Supply Targets: 15 % energy use from cogeneration, 10 MW of commercial solar generation

Purpose of the Study

- identify districts where these technologies are most feasible,
- provide hypothetical engineering solutions as a starting point for community conversation, and
- quantify the overall benefits of Community Scale energy systems in Boston.

Image credit: Tajunique Thompson, Boston Redevelopment Authority, 2016

INTRODUCTION- COMMUNITY ENERGY SOLUTIONS



Local Generation and Storage

Photovoltaic / Solar Panels, Solar Thermal Panels, Combined Heat and Power (CHP) , Heat Storage, Cold Storage, Battery Storage, Absorption Chiller, Refrigeration, Air Source Heat Pump, Ground Source Heat Pump

Building owners use local generation and energy storage to reduce peak loads, energy costs , greenhouse gas emissions and to increase resiliency to power outages.

District Thermal Systems

A network of underground pipes that deliver, heating and cooling directly to buildings from low carbon, local energy source via steam, hot water and/or cold water.

Availability of low-carbon heating/cooling sources, outsourcing boiler and chiller operations to a central energy plant, reducing upfront capital expenditures on boiler and chiller equipment.

Microgrids

An electrical grid that can isolate a group of buildings and self-power with local generation.

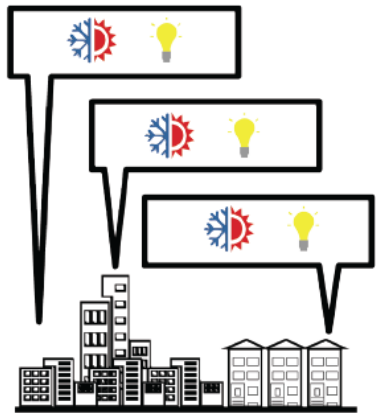
Protection against long-durations of grid outage, controls help balance energy demand and supply among co-located buildings.

Image credit: Tajunique Thompson, Boston Redevelopment Authority, 2016

STEP ONE

ENERGY-USE MAPPING

An hourly simulation of energy use for every building in the City of Boston shows electricity, heating and cooling demand data. The foundation of this Study, this map encompasses over 85,000 structures, 12 different energy use profiles, and Gigabytes of data.



STEP TWO

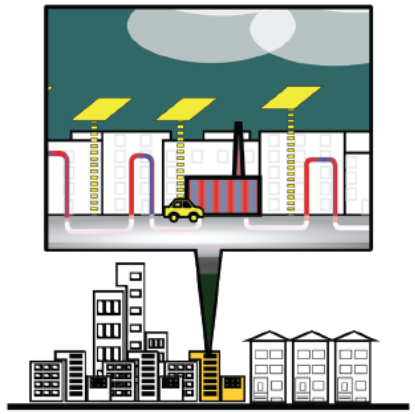
LOCATING SUITABLE DISTRICTS

The study identifies districts where local, clean and renewable energy supply is feasible at the community scale- based on population, critical facilities, and energy use. This analysis yields co-located buildings which are then grouped together to form a single energy demand district profile.

STEP THREE

ENGINEERING ANALYSIS

The engineering analyses simulates energy technologies in action. By custom tailoring local generation and storage technologies to fit the aggregate energy demand of the district, the analysis shows how the hypothetical technologies would lead to cost savings and carbon emissions reductions.



STEP FOUR

SUSTAINABLE RETURN ON INVESTMENT ANALYSIS

The Sustainable Return on Investment Analysis quantifies the benefits of this hypothetical infrastructure, if it were implemented. This economic model quantifies the monetary value of the infrastructure in operation over 25 years.

Image credit: Boston Redevelopment Authority, 2016

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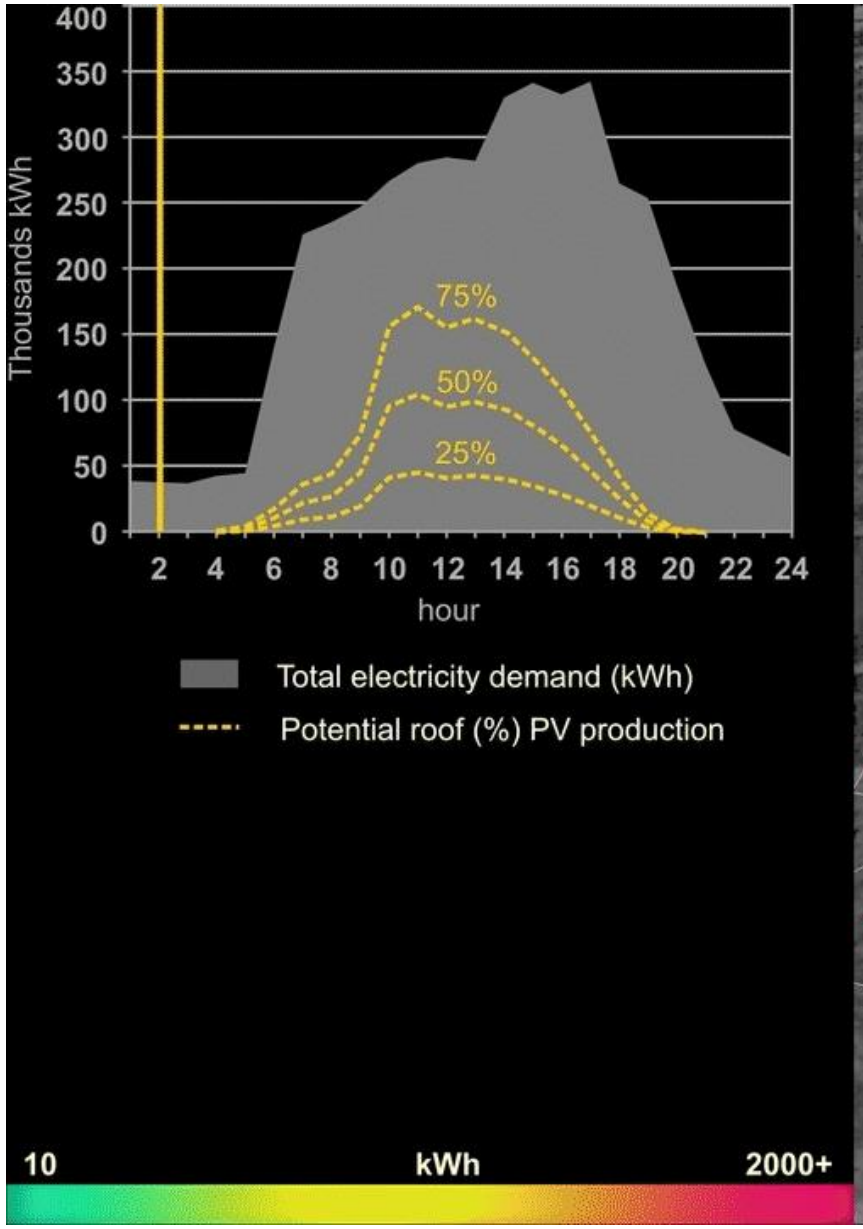
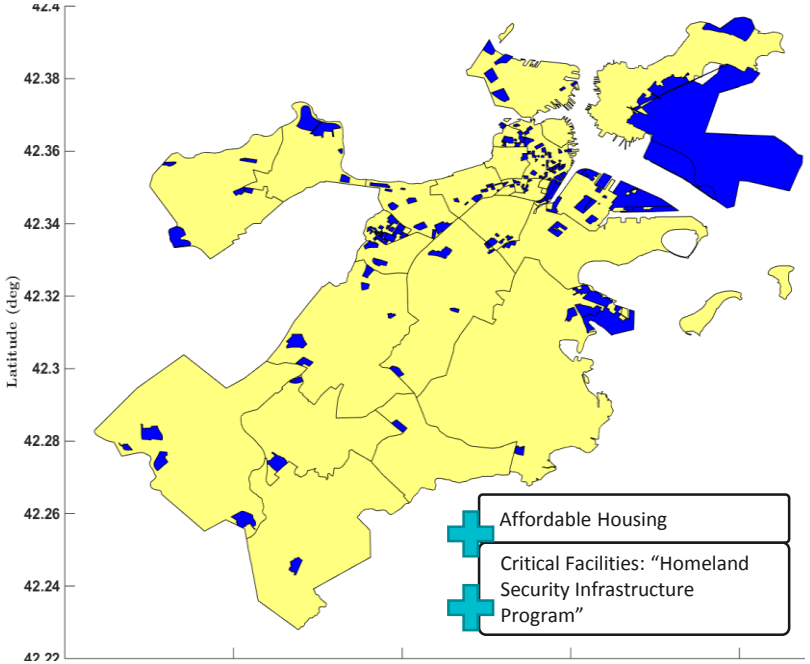
MIT SUSTAINABLE DESIGN LAB

LINCOLN LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY



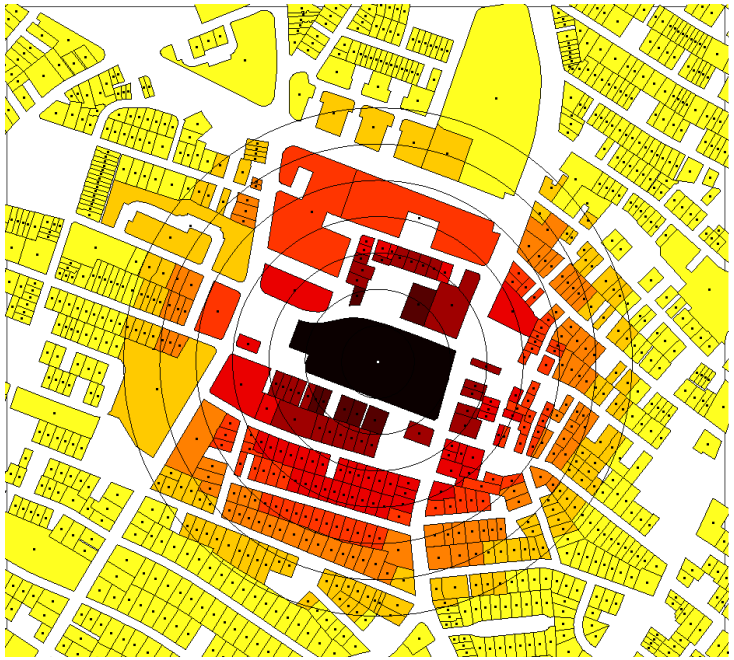
DISTRICT SUITABILITY ANALYSIS

Step 1: High energy use parcels



HSIP compiles geospatial data from federal agencies, commercial vendors, state, and local partners for common use by the Homeland Security; Homeland Defense; and Emergency Preparedness, Response, and Recovery communities. These datasets allow for nationwide infrastructure information access to assist decision makers in analyzing threats (whether natural or manmade) and modeling for emergencies and other missions.

Step 2: Local Analysis



Critical Facility Types:
AFFORDABLE HOUSING | EMERGENCY SHELTERS | GAS/ELECTRIC ASSETS (SUBSTATIONS, GAS STATIONS) | PHARMACIES | SUPERMARKETS | BOSTON CENTER FOR YOUTH AND FAMILIES FACILITIES HOTELS / MOTELS | LIBRARIES | MALLS | MUSEUMS | PUBLIC SCHOOLS | PUBLIC GOOD SHELTERS | HOMELESS SHELTERS, ETC) | FIRE STATIONS | POLICE STATIONS

Step 3: Final Identification

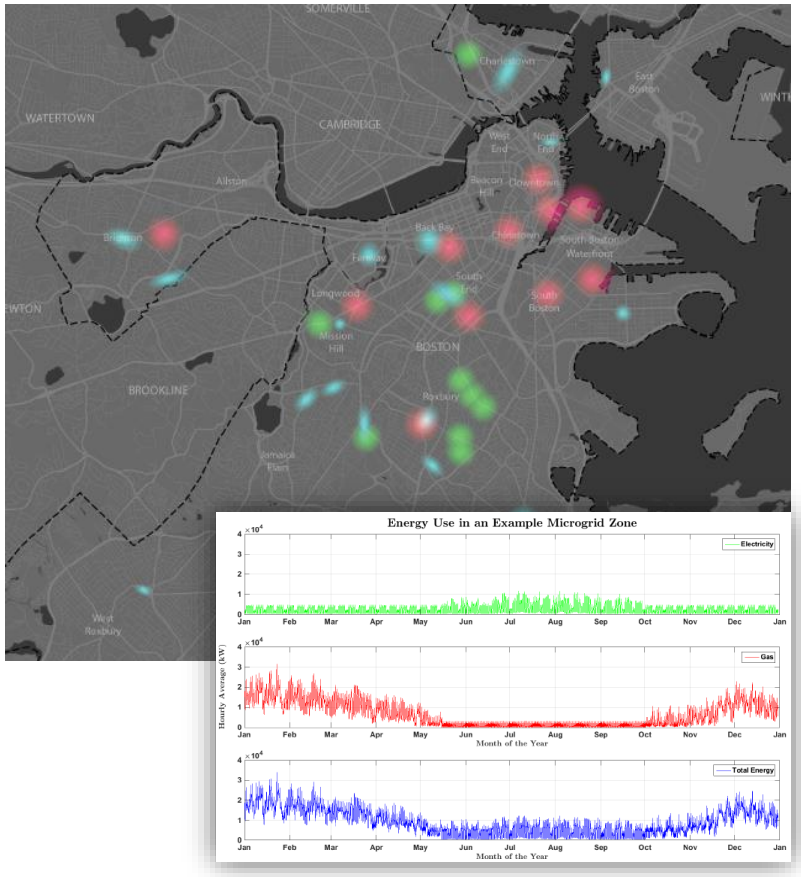
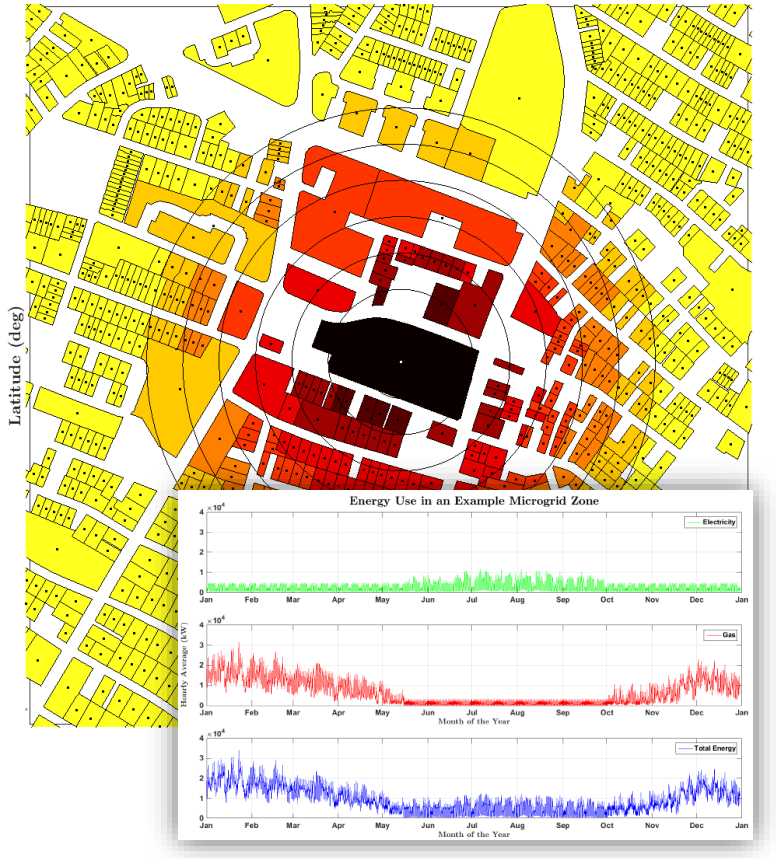


Image credits: "High Energy Use Parcels" and "Local Analysis" by Lincoln Laboratory. "Final Identification" by Boston Redevelopment Authority, 2016

ENGINEERING A DISTRICT SYSTEM

Step 1: Input Base Data



Step 2: Run DER-CAM

- Inputs: Local electric and gas prices
- Inputs: Weather normalization
- Operations: Can decide how and when to dispatch technologies
- Existing data: Capital costs for technologies

Step 3: Engineering Solution

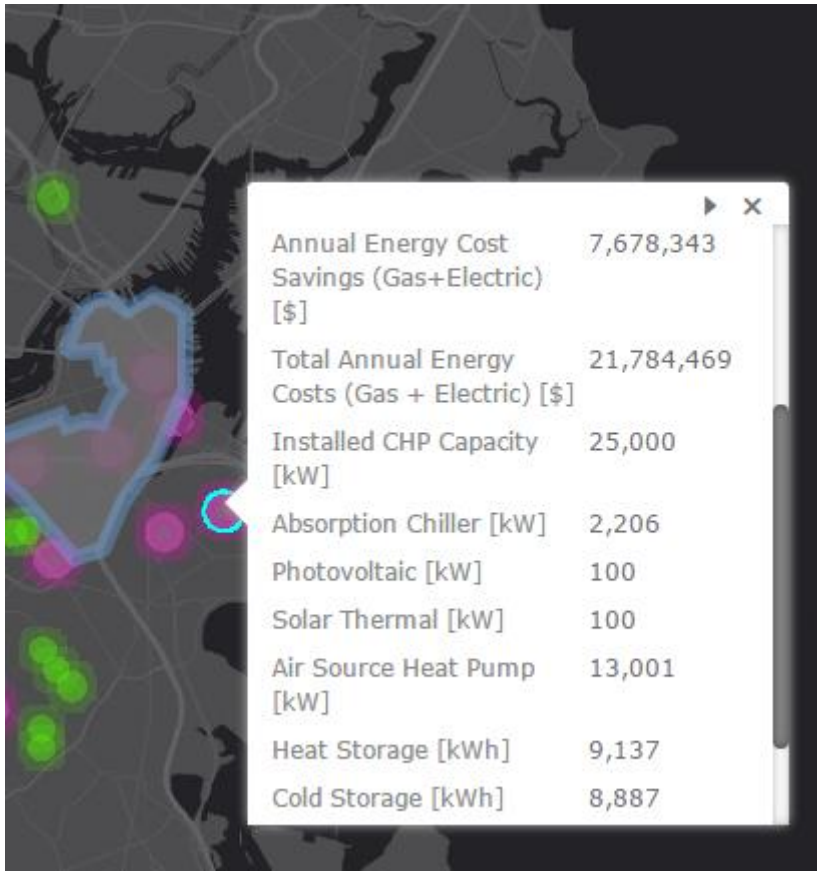


Image credits: (left) Lincoln Laboratory, 2015, (right) Boston Redevelopment Authority 2016

SUSTAINABLE RETURN ON INVESTMENT

MODEL INPUTS

The direct inputs for each scenario are as follows:

- Capital Costs ($): total installation cost distributed over 3 years (2018 to 2020)
- Operations and Maintenance Costs ($): $0.01 per kWh of electricity produced
- Total CO_2e Reductions (tons)
- Utility Electric Costs Savings ($)
- Natural Gas Costs Savings ($)

SUSTAINABLE RETURN ON INVESTMENT

COMPARISON OF FINANCIAL SAVINGS AND MONETIZED ENVIRONMENTAL BENEFITS

Analysis by Boston Redevelopment Authority, Research Division
2015

SCENARIO	TOTAL ELECTRICITY UTILITY COST SAVINGS OVER 25 YEARS	TOTAL NATURAL GAS UTILITY COST SAVINGS OVER 25 YEARS	TOTAL GHG EMISSIONS SOCIAL COST SAVINGS OVER 25 YEARS	TOTAL BENEFITS OVER 25 YEARS
COST OPTIMIZATION	$2,980.7 million	$ -1,266.8 million**	$30.0 million	$1,743.8 million
CO_2 OPTIMIZATION	$237.1 million	$272.2 million	$119.2 million	$628.5 million

***The Cost Optimization Scenario uses more natural gas each year than the base scenario, meaning the cost "savings" are negative.*

NEXT STEPS

City of Boston

- Engage area residents and businesses.
- Partner with key stakeholders including our local utilities and the regional energy system operators.
- Recognize and expand existing and planned microgrids and Community Energy Solutions.
- Identify resources to expand and deepen feasibility analysis of Community Energy Solutions.
- Refine and upgrade the Boston Energy Model as new and better data become available including BERDO, local energy supply information, and the emissions savings from the existing steam system.
- Investigate public right-of-way infrastructure solutions and develop modeling tools to include costs.
- Identify existing building retro-fits costs and develop strategies to phase-in Community Energy Solutions.
- Develop pilot projects in new and existing areas to demonstrate feasibility and benefits of Community Energy Solutions.

Photo Courtesy of Medical Area Total Energy Plant (MATEP, LLC)