BOSTON SMART UTILITIES

CITY OF BOSTON
Martin J. Walsh, Mayor
Brian P. Golden, Director

bpda

CONTENTS

Thank you to the Barr Foundation for their generous support of Boston's Smart Utilities Vision

And a special thanks to our facilitators:

Alistair Pim, Anne Schwieger, Bryan Glascock, Frank Curran,
Galen Nelson, Katrina Lewis, Maeghan Lefebvre, Suzanne Findlen

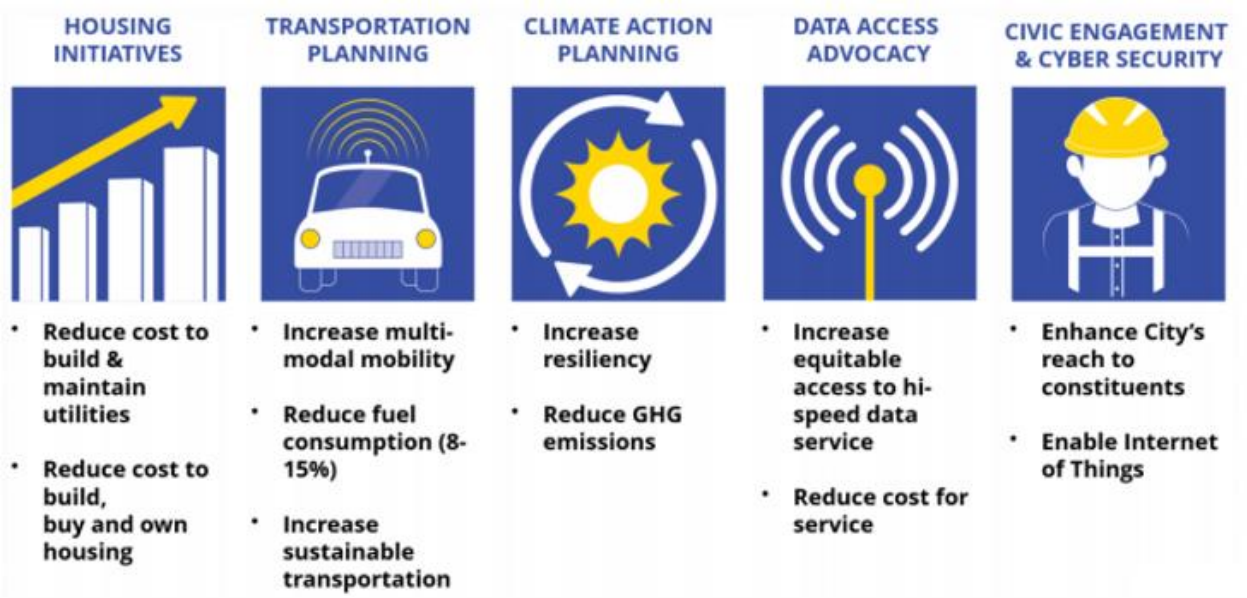
Thanks to our project partners:
The Boston University Initiative on Cities, the Smart Cities Council, and the Northeast Clean Energy Council

For more information, please contact the Project Leads of the Smart Utilities Vision:
Travis Sheehan, Senior Infrastructure Advisor, *Travis.Sheehan@boston.gov*
Colin Curzi, Smart Utilities Fellow, *Colin.Curzi@boston.gov*

INTRODUCTION

This document provides a summary of the Boston Smart Utilities whiteboarding session ("session") convened by the Boston Planning & Development Agency (BPDA) at Boston University on January 25th, 2017.

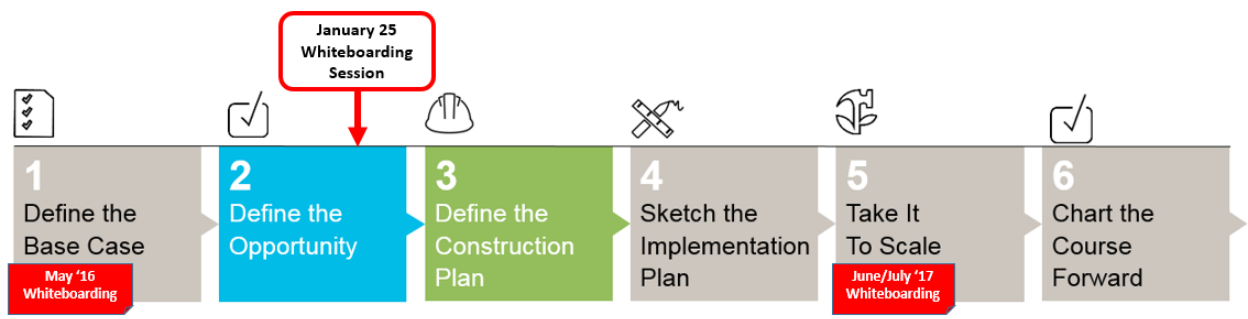
The Smart Utilities Vision (SUV) is a collaborative study between city government and Boston's utility companies that will offer a new model for integrated planning among energy, transit, water, and communications utilities. By improving coordination among utilities, the Vision aims to make urban districts more equitable, resilient, connected, and sustainable.



BACKGROUND

Phases of the Smart Utilities Vision

The Smart Utilities Vision (SUV) is a planning study of utility infrastructure in the 144-acre PLAN: South Boston Dorchester Avenue planning district ("Study Area"). The challenge of smart utility planning will be addressed in six phases during the year-long duration of the SUV.



The first phase, *Define the Base Case* began with an assessment of "business-as-usual" utility installation costs and processes. That information was used to shape the second phase, *Define the Opportunity*, where a preliminary estimation of the benefits and savings offered by Smart Utility Technologies was modeled.

The information collected in Phases 1 and 2 was presented to Whiteboarding Session attendees in the draft Engineering Report. The Engineering Report first defines the "business-as-usual" cost of utilities at full build-out in the PLAN: Dot Ave development. The Report then identifies a set of Smart Utility Technologies (SUTs), defines the cost of installing SUTs throughout the lifetime of the project, and calculates the impacts of SUTs on environmental factors in the Study Area.

The draft "Engineering Report" that was provided to participants is available here.

The feedback provided by stakeholders will be used to shape the SUV's final phases.

Recap: May 2016 Workshop and Findings

The primary purpose of the first Whiteboarding Session held on May 25, 2016 was to solicit feedback from multiple stakeholder groups on a draft Request for Proposals (RFP) for consultant services to initiate the Smart Utilities Vision. The May Whiteboarding Session explored the risks and rewards of coordinated utility planning and implementation, and began the process of mapping value drivers to stakeholders.

The BPDA compiled the insights from the session and issued an RFP in July 2016 for a "Smart Utilities Vision" that would yield engineering and policy recommendations for utility infrastructure in the 144 acre PLAN: South Boston Dorchester Avenue planning district.

On September 15th, 2016, the BPDA board approved the selection of the AECOM consulting team for consulting services to execute the project.

JANUARY 25TH WHITEBOARDING SESSION OVERVIEW

Executive Summary

The January 25, 2017 Whiteboarding Session for was conducted in three parts:

- An overview of the work to date
- A series of Tabletop Exercises regarding Smart Utility Technologies
- A panel discussion with City Chiefs

The Boston Planning & Development Agency (BPDA) presented the preliminary financial and engineering model developed by the AECOM consulting team and its partners.

The BPDA asked Boston's leading industry, government, academic, and utility professionals to evaluate the initial assessment of Smart Utility Technologies [See *Appendix B*].

Stakeholders participated in a series of tabletop exercises to evaluate and refine the engineering methodology, the Smart Utility Technologies proposed, and the potential solutions for implementing new types of utilities. The 70+ attendees submitted roughly 335 comments during the Tabletop Exercises.

The exercises were followed by a conversation with Chris Osgood, the Chief of the Streets, Transportation, and Sanitation, Jascha Franklin-Hodge, the Chief Information Officer, and Sara Myerson, the Director of Planning for the BPDA. The senior officials discussed the City's role as a catalyst for making Boston a "Smart City" that better serves its citizens.

The day concluded with a discussion of the synergies and governance structures needed to realize the Smart Utilities Vision.

Morning Presentation

Travis Sheehan, the BPDA's Senior Infrastructure Advisor, began the day with a presentation of Boston's unprecedented urban growth and the opportunities offered by coordinated utility construction in the PLAN: South Boston Dorchester Avenue project area.

The BPDA presented a simulation of the future buildout of real estate in the Study Area that anticipated two scenarios, each defined by a unique mix of land uses. Scenario 1 reflected a high penetration of residential buildings while Scenario 2 reflected a high penetration of Office/Lab buildings. The unique Scenarios were developed to test the variability of energy and resource demands in the Study Area. Furthermore, the BPDA presented a map of the Study Area that approximates the sporadic, non-linear sequence of private real estate development in a large district.

The BPDA and its consulting team from AECOM presented the findings the Phase 1 and Phase 2 studies using the following materials:

- A summary table of the total cost to build and maintain utilities in the study area over a 20-year construction period
- A synopsis of the team's methodology and assumptions
- An overview of the technical characteristics, costs, and benefits of Smart Utilities Technologies
- An analysis comparing the "business as usual" buildout to the Smart Utilities Vision

Tabletop Exercises

Attendees were organized into 8-10 person teams and collaborated in three tabletop exercises. In the first, participants provided feedback on the "Base Case" and discussed new modeling outputs. Participants were then presented with ten Smart Utility Technologies and challenged to find ways to enable the installation of each by identifying policy needs, new business practices, or engineering solutions. Lastly, participants identified which newly-contemplated implementation solutions would be most proficient in putting their ideas into practice.

EXERCISE 1 RECAP: DISCUSS THE BASE CASE RESULTS

The BPDA Asked:
What additional modeling outputs would benefit your organization?

What comments do you have on the methodology?

Prior to the Whiteboarding Session, the AECOM team analyzed the need for future infrastructure in the study area. This analysis is referred to as the "Base Case". The BPDA sought feedback on Base Case from the attendees following a presentation of AECOM's results and methodology. Attendees identified a number of additional modeling outputs that would clarify both the costs of, and their role in, future development:

Additional Modeling Outputs	
Connection Costs	*Sample Feedback from Participant:* Model the cost of connecting to BWSC pipes to the zones east and west of the project area
Comparative Scales of Demand	*Sample Feedback from Participant:* Examine a similar district such as the Boston Seaport/Innovation District
Onsite vs. Offsite Costs	*Sample Feedback from Participant:* Model the costs of increasing infrastructure outside of the project area to meet the anticipated load growth
Impact of Sporadic Development	*Sample Feedback from Participant:* Examine how costs are allocated to the first real estate developers versus the last developers to build in the district
Size of "Future Proof" Underground Allotments	*Sample Feedback from Participant:* Model how much space (in concrete dimensions) is anticipated for the fiber conduit required in the area.

Participants also offered a number of suggestions to improve and clarify the modeling methodology of the "business as usual" cost estimation:

Comments on Modeling Methodology
Incorporate **Climate Change** & **Climate Event** Scenarios
Add considerations for **Net Zero Buildings**
Produce a quantitative assessment of **Quality of Life**
Include a robust description of **Assumptions & Margin of Error**

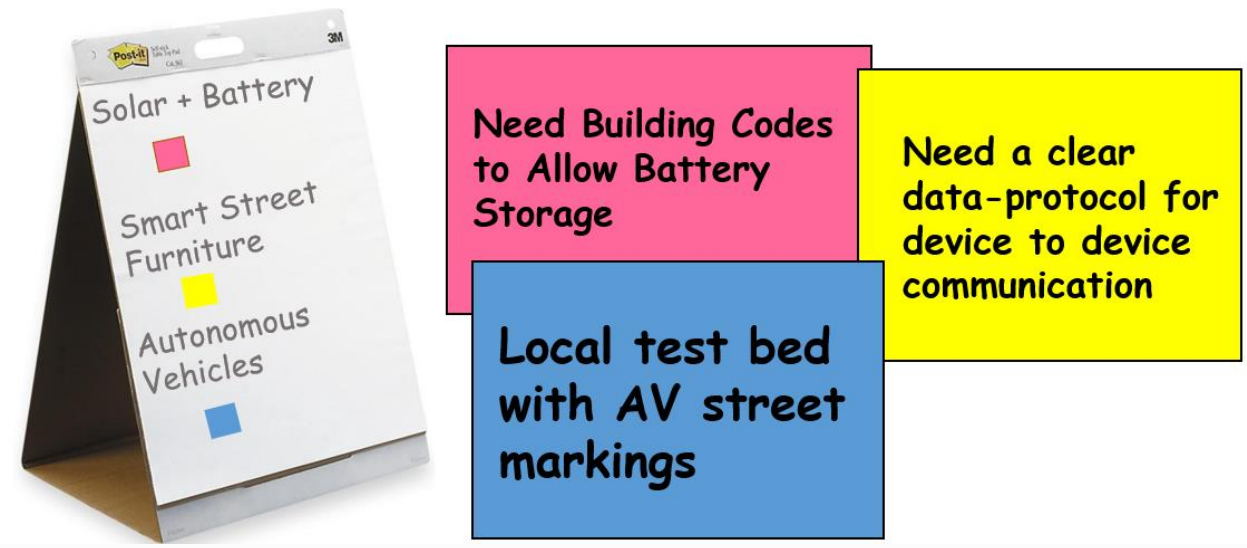
EXERCISE 2 RECAP: ENABLERS FOR SMART UTILITY TECHNOLOGIES

The BPDA Asked:

Smart Energy	District Energy, Distributed Generation, Microgrids
Smart Water & Wastewater	On-Site Water Reuse, Green Infrastructure
Smart Transit	Electric Vehicles, Autonomous Vehicles, Smart Traffic Management
Smart Telecom	Public WiFi, Fiber Optics Loop

What would you need to enable these technologies?

The BPDA presented participants with ten demonstrative, but not comprehensive, SUTs across Energy, Water, Transit, and Telecommunication utilities. They worked to identify what they would need to enable those technologies.



Feedback from Exercise 2 fell into two categories. Enablers that are specific to the implementation of a single smart utility technology (e.g. "Microgrids") were categorized as relevant to ***Engineering/Construction*** considerations. Enablers that would benefit the deployment of all SUTs within a category (ex. "Energy") were categorized as relevant to **Regulatory/Governance** considerations. The compilation of enablers is presented in the following tables.

Energy: Engineering/Construction		
District Energy	**Distributed Generation**	**Microgrids**
Building and Fire Codes related to District Energy heat and waste	Smart Meters (possibly down to the unit-level in apartments)	Estimate for the cost of interruptible service
Thermal standards for pipes (ex. Conversion of plastic to steel)	Regulation requirements to register a generation source	Additional natural gas capacity for the contemplated turbines
Regulations for heat extract to and from the building(s)	Simpler (inter)connection to the grid	A tiered management and control approach: 1. Building Controls 2. Neighboring Buildings 3. District Controls
Separate route for heating and cooling lines	Reliable energy storage	Assessment of the legal feasibility Ex. Eversource prohibits "islanding" capabilities on select areas of their grid
Agreement on "islanding" protocols and essential operations	Assessment of the comparative value of green versus solar roofs	Quantification of the value of resiliency
Leveraged public-private partnerships	Assessment of the solar generation capacity of the project area	Incentive structures for renters with bundled costs
Accessible infrastructure for ease-of-maintenance	Access to low-income users (Community Solar Farms)	Virtual simulation of technology's implementation
Franchise law that contemplates DE ownership	Ownership of solar rights as it relates to shadows from phased construction	An electric co-op in larger utility locations
	Pilots for integrating and transmitting power from DG sources	Controller and protection (physical security) equipment
	Methods to leverage the location of interconnection points with other/existing infrastructure	Design for a central station/generation center

Energy: Regulatory/Governance
A multi-owner operator framework
Accessible infrastructure easy to maintain and support
A coordinated approach to implementation
Virtual controls for remote system and device management
Rate structures to incentivize mechanisms for distribution
Contemplation of franchise law
Understanding of available or contemplated public private partnerships
Capacity for future technology
Clarification of future ownership
Understanding of risk management for the city, utility, and property owners

Water: Engineering/Construction	
On-Site Water Reuse	**Green Infrastructure**
Regulations for irrigation standards	Quantification on how much water needs to be removed from the area
Regulations for potable rainwater	Fees for storm water management; incentives for green infrastructure
Clarification on the placement and ownership of water collection systems (roof top storage, cisterns, etc.)	Requirements for stormwater discharge into the harbor
Business case for BWSC as centralized usage declines	Hyper-localized incentives for water quality
Incentives for grey water use	Alignment of parks plan and water management plan
Zoning considerations that allow for on-site water reuse	Assessment of flood plan impacts on train lines
Additional pipes for each building (grey and blackwater systems can double the number of pipes needed)	Monitoring of water quality leaving buildings
Sub-meters and smart meters	Industry advancements to maintain green water infrastructure

Water: Regulatory/Governance
Regulations for water reuse at the source
Education on water use and the associated public health issues
Workforce development for the maintenance of complicated and holistically-designed water infrastructure
Consideration of water displacement and flooding effects on areas surrounding Dot Ave
Understanding of the ownership of flood water utility
Coordination of top-down and bottom-up strategies
Description of the topology of the land to assess where pumps and/or gravity will need to be utilized
Explicit considerations for sea level rise
Holistic development plans
Contemplation of advanced water management in zoning and building efficiency codes
A market-based approach to water infrastructure management

Transit: Engineering/Construction		
Electric Vehicles	**Autonomous Vehicles**	**Smart Traffic Management**
Understanding of the demand EV's will place on the electric grid	Vehicle-friendly "curbs" that accommodate an AV fleet's dropping-off and picking-up	Pilots to understand how AV fleets will impact traffic
Staging and location of connection points	Regulatory oversight of the technology	Explicit performance measures of "ease of transport" (i.e. within 1KM of a hub)
Plan for providing power to charging stations/parking spots	Autonomous vehicle pilot programs and test beds	Limit of vertical obstructions in the street and right-of-way
Understanding of the viability of electric vehicles as an energy storage infrastructure	Storage for shared fleets of idle vehicles	Design and planning for multi-purpose transit hubs
Plan to incrementally add charging capacity in public and private space	Transition plan for a phased integration of autonomous and human-operated vehicles	Evacuation route considerations at the system level
Coordinated plan with the City on the location of charging assets	Maintenance of road striping that cannot be deferred	Coordination with state-owned roads
Vehicle-to-Grid charging and storing regulations	Understanding of human demographics to accommodate for types of users (AV's with car seats for families)	Coordination plan that incorporates all support and sensor infrastructure
Understanding of standards and protocols for demand response of power to and from EV's	Additional cell coverage and communications bandwidth for sensor, GPS, and vehicle-to-vehicle communications	Capability to utilize smart sensors and inter-vehicle communication
Charging infrastructure that preempts the arrival of EV's		Understanding of the effects on traffic as it enters and exits this "smart traffic" zone
EV-ready building codes		Reliable communications feedback look about state of traffic and traffic infrastructure

Transit: Regulatory/Governance
Future technology capacity
Data access and availability
Integration of smarter transit with rail and mass transit
Clear ownership of assets and infrastructure
Distribution of the cost burden for infrastructure installation and management (i.e. Drivers vs. Riders vs. Walkers vs. Bikers)
Regulatory oversight of new technologies
Clear inventory of transit technology and assets from a City standpoint
Incentives for developers to integrate transit technology, flexible curbs, and charging stations
Regulatory oversight that tracks with evolving technologies
Shared information systems and standards
Public education on new transit technologies
Rate structure/regulation for charging (Treat an electric charge as a gas fill-up)

Telecom: Engineering/Construction	
Public WiFi	**Fiber Optics Loop**
Availability of Smart Street Furniture	Design that leverages the role of existing partners
Redundancy in fiber optics	Shared access to fiber
Coordination of private investment in antennae infrastructure	Capacity to electrify the additional fiber-dependent technologies
Quantifiable justification for the social and City-services enabled by public access	Design for above-ground installation options
Equitable access to Wi-Fi in public spaces	Monetized business model for redundancy and resiliency

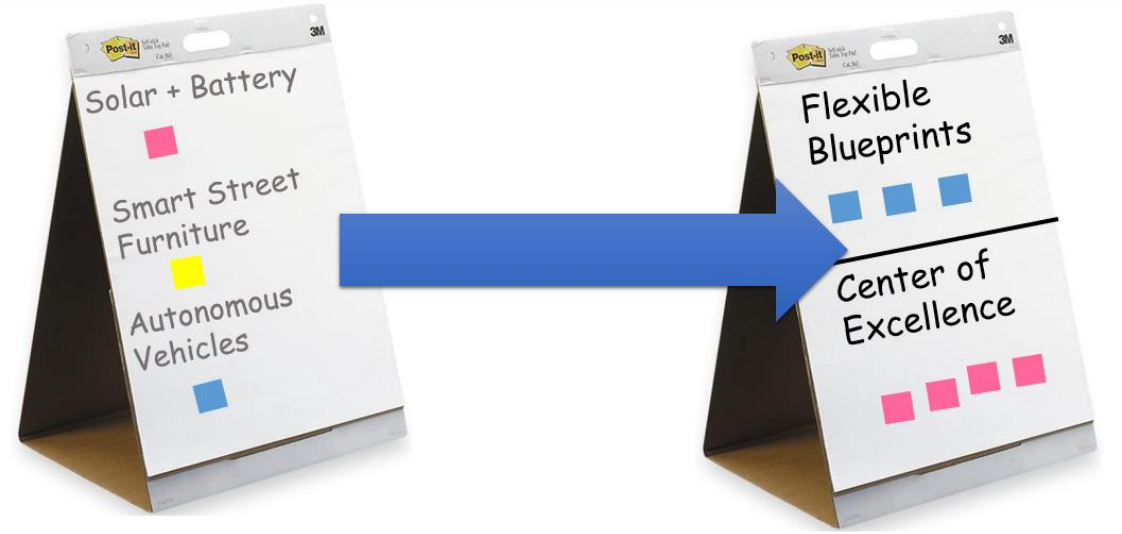
Telecom: Regulatory/Governance
Standardized requirement for carrier neutrality
Availability of accessible conduits and fiber
Public or private procurement legislation for connecting to different systems
Regulatory considerations for above-ground installations
Considerations for public ownership and leasing of shadow conduit
Capacity for future technology

EXERCISE 3 RECAP: SOLUTIONS TO IMPLEMENTATION

The BPDA Asked Participants To Answer:
Where do the enablers fit within the Implementation Solutions?

Flexible Blueprints	**Legislative Authority & Financing Vehicles**
One Big Pipe	**Master Services Agreement**
Data Hub	**Center of Excellence**

The BPDA presented six "Implementation Solutions" that were developed by attendees during the May 2016 whiteboarding session. The Solutions sought to address challenges of governance, ownership, and design standards that would allow for a successful implementation of SUTs and to overcome basic operational challenges in public works. Participants were tasked with sorting the enabler from Exercise 2 into the most relevant Implementation Solution. The following pages offer a summary of the participants' results.



1. **Flexible Blueprints [Complete Streets for Underground Utilities] include:**

    - Design guidelines for utilities in various types of public right-of-way
    - Accommodate future installations without re-digging street
    - Remain flexible for future technology changes, accommodates legacy utilities

The concept of "Flexible Blueprints" as outlined above was redefined during the course of the whiteboarding session to incorporate the underground utilities with Boston's concept of *Complete Streets*. "Flexible Blueprints" has been tentatively rebranded as "Complete Streets for Underground Utilities" and the participants' feedback included the following:

- Produce standards for constructing new streets and reconstructing major roadways that provide sufficient underground space and organization guidelines for:
    - Increased needs of fiber, water, and electric connections to SUTs
    - Redundancy of critical systems
    - Storage of water and electricity (centralized batteries, water cisterns, etc.)
    - Excess capacity to buildings
    - Future technology
- Provide guidelines for above-ground SUTs that allows for future capacity/technological improvements
- Direct the staging and location of connection points that accounts for:
    - The accessibility for utilities
    - The interruption of traffic (be it vehicle or pedestrian)
    - The effect of sea level rise on the resiliency of underground spaces
    - The displacement of existing utilities

2. One Big Pipe [Telecom Utilidor] includes:

- Underground tunnel containing all utility assets
- Reduces surface-street disruptions
- Respects physical security guidelines for each utility

The discussion of the "One Big Pipe" solution highlighted a number of logistical difficulties for the inclusion of multiple separate utilities in a single tunnel at this time. However, significant interest was expressed in the creation of a single, shared telecommunications "utilidor" that would allow multiple providers to access and lay fiber conduit without requiring intermittent road construction. The participants' feedback included the following:

- The "Utilidor" should provide an conduits to:
  - Meet future demand
  - Allow equitable access for providers and technologies
  - Reduce roadway disruptions and reconstruction costs
  - Provide options for remote maintenance
  - Provide resilient, redundant fiber
- Produce a business model for ownership of the asset that considers:
  - Ownership of the utilidor and conduit
  - Revenue and leasing structures for conduit use
  - Physical security requirements
  - Cyber security requirements
  - Logistics for connecting the conduit to buildings and furniture without reconstruction
  - The modular development of the project area
  - The uninterruptible existing conduits, vaults, and piping

3. Data Hub includes:

- Storage and governance of maps for underground utilities
- Storage and governance of big-data collected in public realm
- Framework for the monetization of various data sources

The “Data Hub” solution was identified as a necessary means of governing, securing, and monetizing the data collected in the public realm. The participants’ feedback included the following:

- Produce a model for data governance that considers:
  - A clear and accountable owner of the data
  - Enhanced cybersecurity of the data and the SUT assets
  - A balance between accessibility and privacy
  - Transparency into the data’s usage
  - Limitations of what should and should not be collected
- Develop a business model for sharing the windfall of monetized data
- Develop an inventory of assets and that allows for 3D mapping of:
  - Wi-Fi enabled assets (particularly those owned by the city)
  - Underground utilities
  - Simulated scenarios
- Collect a range of sensor data on the area to quantify the quality of life:
  - Energy & Gas usage
  - Air quality
  - Water quality
  - Noise pollution

4. Legislative Authority & Financing Vehicles include:

- New "Special Purpose Entities" for utility construction and operation of utilities
- Risk and reward sharing agreements among public/private actors
- New rate-structures for utilities to fund projects

The "Legislative Authority & Financing Vehicles" solution solicited ideas for the creation of broader legislative pathways that can track with technology and allow for the faster installation of emerging (or uncontemplated) technology. The regulatory and financial institutions would best serve Boston's citizens and businesses by producing standards for piloting technologies and coordinating the efforts of multiple stakeholders involved in the process. The participants' feedback included the following:

- Modernize the building, zoning, and fire code to contemplate:
  - Shared utility services
  - On-site generation and use of water and electricity
  - Storage of water and electricity
  - Irrigation standards for rainwater
  - Green and solar roofs
- Monetize the business model for:
  - Shared public-private risk and investment in SUT developments
  - Rate structure that incentivizes mechanisms for distribution
  - Rate structure change agreements and standby rates
    - Solve the "freeloader" problem for using electrified and WiFi-enabled street furniture and charging infrastructure
  - Maintenance approaches that consider public budget pressures
- Determine the ownership of each SUT and the underlying utility connection
  - If it is third party owned, identify the funding structure
  - If it is City-owned, identify the access and use rates
- Develop incentive structures for:
  - Tenants with fixed utility prices to monitor and conserve energy
  - Legacy utilities to facilitate new SUT technologies
  - Developers to incorporate and pay operations and maintenance for SUTs
  - Residential Buildings to utilize variable rates
- Produce a guideline for demand response that identifies which assets are considered "critical" or at least a definition of "critical"
  - Ex. Smart traffic vs. Digital Signage in an emergency situation
- Produce regulation requirements to register a power generation source
- Design a pathway and timeline for net carrier neutrality within the City
  - Low-income and low-development areas' access to SUT benefits
- Define the role of natural gas in the Mayor's "carbon neutral 2050" commitment

5. Master Services Agreement includes:

- Contracts among property owners to coordinate improvements of the public realm
- Proposals for the distribution of costs and benefits of utility solutions among property owners
- Guidelines for upkeep of common utility assets after transfer of property

The "Master Services Agreement" solution represents an enhancement to the style of "condo agreements" currently upheld between the Boston Public Improvement Commission and the developers in the Seaport District to include the operation and maintenance of underground utilities and various Smart Utility Technologies. The participants' feedback included the following:

- Develop a replicable agreement that shares investment and risk among these stakeholders:
  - The City
  - Utilities
  - Developers
  - Customers
  - Vendors
- Develop the agreement around a business model that shares the following among stakeholders:
  - Costs and benefits from SUTs
  - Payback periods for installation, operation, and management of utilities
- Produce standards for the accessibility of infrastructure in the area
- Design a "Grant of Location" to install utilities or smart street furniture in the ground
- Understand the ownership of the integrated infrastructure components

6. Center of Excellence includes:

- Formal organization with private and public partners
- Functions include utility research and development, pilot project funding, and data security
- Legal due diligence functions for Data Hub, Condo Agreement, One Big Pipe

The "Center of Excellence (COE)" was imagined as a non-partisan body tasked with devising structures to coordinate the technology, finance, and infrastructure systems applicable to the public right-of-way. The COE would own the thought leadership for Boston's utility stakeholders and educate the community on the changing utility and IoT landscape. The participants' feedback included the following:

- Implement funding strategies for the COE's operations that consider:
  - Sharing the construction savings from coordination
  - Monetizing the SUT data collected
  - Applying for public or private grant funding
  - Quantifying the:
    - Cost of Interruptible Service
    - Value of resilience and sustainability
- Create a "Knowledge Management" base for Boston that documents:
  - Process for piloting SUTs and coordination strategies in the City
  - Tracking of and progress reports on performance measures
    - Ex. Ease of transport, environmental impact, etc.
  - Inventory of accessible/leasable smart street furniture
  - Case studies and thought leadership to and from innovative cities
  - Transparent and accessible mappings of the legal authority, regulations, and ownership of infrastructure by city, state, and utility partners
- Plan public education and community engagement programs on:
  - Workforce development
  - Water use and reuse
  - Energy generation and system design
  - Safety/risk of autonomous vehicles

DISCUSSION WITH THE CHIEFS

Travis Sheehan, Senior Infrastructure Advisor for the BPDA, moderated an open discussion about Boston's plans for a "Smart City" future with members of the Mayor's Cabinet:

- Chris Osgood, the Chief of the Streets, Transportation, and Sanitation
- Jascha Franklin-Hodge, the Chief Information Officer
- Sara Myerson, the Director of Planning for the BPDA

The dialogue with participants highlighted Boston's collaborative advantage with universities, private partners, and engaged communities. As planning processes becomes better integrated across divisions of government, the City will further improve its strategic planning capabilities.

The Chiefs emphasized the City's role as a as a catalyst in creating pathways for beneficial new technologies. The Smart Utilities Vision was lauded alongside the other ongoing studies contributing to innovative infrastructure solutions in Boston, including Climate Ready Boston, Imagine Boston 2030, and the Resilience and Racial Equity Blueprint.

APPENDIX A: TIMELINE OF THE BOSTON SMART UTILITIES VISION

1. Describe the Base Case (September 2016 - December 2016)

Conventional Approach: What will the demand be for new utility services in the Pilot Project area? Using conventional approaches and technologies, what are the future costs to build and maintain streets, and underground and overhead utilities? How resilient would the conventional approach be?

2. Define the Opportunity (October 2016 - December 2016)

Smart Approach: To meet our goals, what infrastructure should be built in the Pilot Project area? What Smart Utility Technologies and road construction methods are most appropriate? What data sharing platforms and data protocol are needed?

★ January Whiteboarding Session ★

3. Define the Construction Plan (December 2016 - April 2017)

To take the "Smart Approach", how would we sequence the development of roads, utilities, and data management in the Pilot Project area?

4. Sketch an Implementation Plan (February 2017 - June 2017)

To implement this plan in the Pilot Project area, what data frameworks, engineering plans, financing vehicles and governance structures will the BPDA and the City of Boston need?

5. Take it to Scale (April 2017 - July 2017)

How can the BPDA and the City of Boston implement this plan in other areas of the city that are not part of a comprehensive rezoning effort like the Pilot Project area?

6. Chart the Course Forward (July 2017)

How can the BPDA and the City of Boston sustain the relevance of this work and stakeholder relationships going forward? What would the consultant recommended as next steps?

For more information please contact:
Travis Sheehan, Senior Infrastructure Advisor, at travis.sheehan@boston.gov
Colin Curzi, Smart Utilities Fellow, at colin.curzi@boston.gov

APPENDIX B: SMART UTILITIES TECHNOLOGIES

Smart Utilities Technologies ("SUT") are the hardware and software solutions that are central to enhancing social equity, resource efficiency, community resilience, and economic competitiveness. The City is taking a leading role to promote SUTs for various reasons. Some technologies do not have a good market presence. Some SUTs require years of pre-planning to implement. Some technologies increase first costs while reducing lifecycle costs. SUTs include:

District Energy + Microgrids

- Hot and cold water distribution infrastructure
- Resilient, local, low carbon energy generation
- Electrical distribution infrastructure that can 'island' during grid outage

Smart Transportation

- Autonomous vehicles: hardware and software to enable the burgeoning market
- Smart Traffic Management: hardware (such as adaptive traffic signals) and software (such as mobile apps) to help make the flow of people safer and more reliable
- Electric Vehicles: hardware and software to enable market

Water + Wastewater

- Water re-use technologies: infrastructure to support building or district scale water recapture and re-use
- Space-heating generation: using sewage waste-heat recovery to feed low-cost, no carbon heating to buildings
- Green infrastructure: hardware to reduce loads on stormwater infrastructure

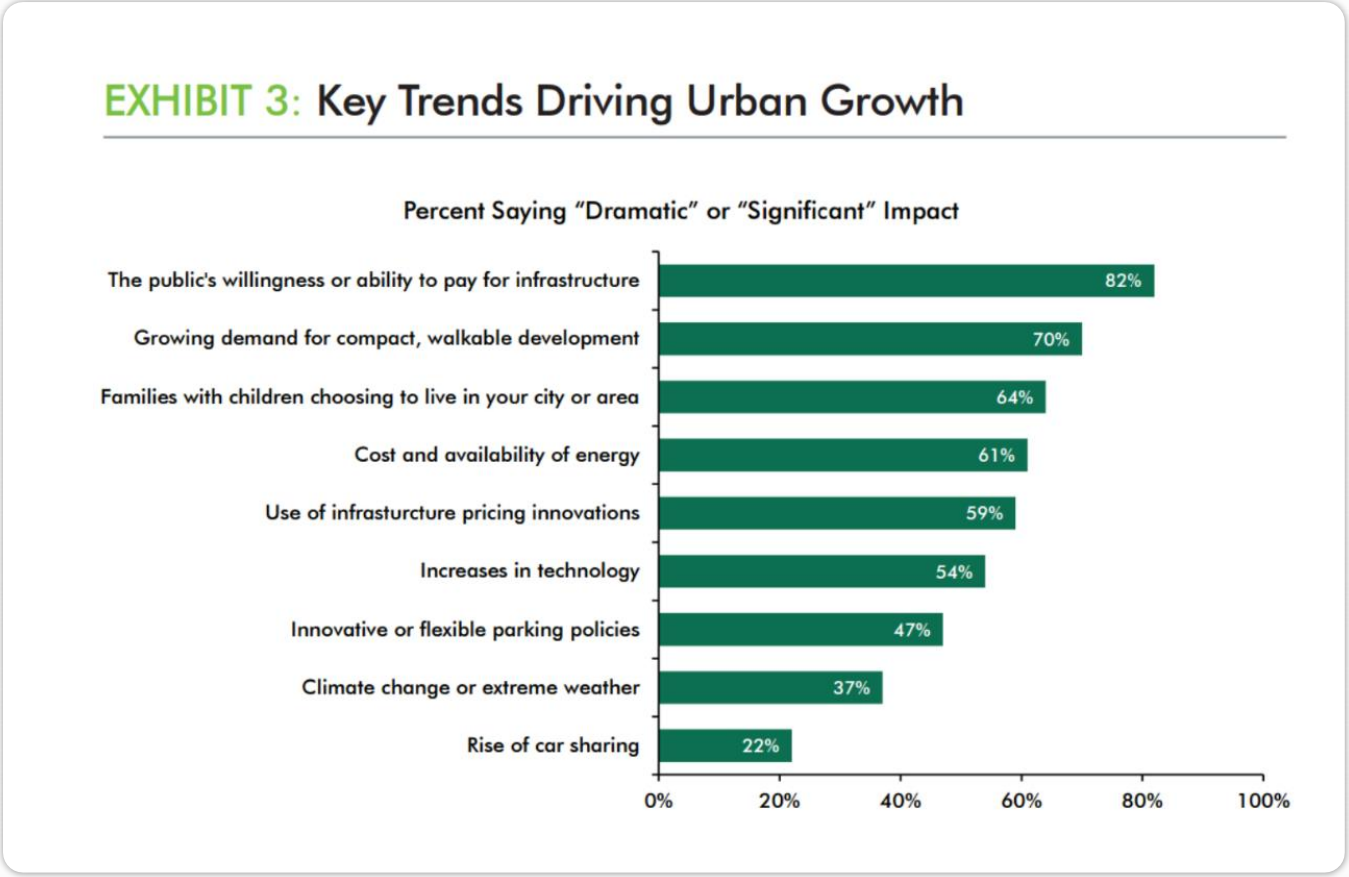
Gigabit + High Speed Communications

- Conduit and Fiber: to increase competition in the marketplace and lower end-user costs
- Wireless hardware: to support Internet of Things for utilities and personal devices
- Communications Protocols: software and standards solutions that enable secure communications for utilities and personal devices

APPENDIX C: SUPPLEMENTAL INFORMATION FOR ATTENDEES

CONTEXT- URBAN INFRASTRUCTURE SPENDING IN US CITIES

- $416 BN spent on US Transportation + Water Infrastructure in 2014 [1]
- $582 BN projected spending on electric distribution (non-transmission) from 2010-2030 [2]
- $2.2 BN average municipal budget for top 100 US Cities with 62% Growth in Infrastructure spending for municipalities [3]



Source: CBRE US Urbanization Trends and Investment Implications for Commercial Real Estate

[1] Congressional Budget Office, based on data from the Office of Management and Budget and the Census Bureau
[2] Stifel Nicolaus, ASCE, EEI, and IIR
[3]"Analysis of spending in America's largest cities", The Encyclopedia of American Politics, Ballotpedia, 2014

CONTEXT- BOSTON GROWTH CONDITIONS

- Boston is experiencing major urban growth spurred by strategic planning for housing, transportation, and overall comprehensive growth strategy.
- The Mayoral initiative Imagine Boston 2030 has identified "investment in infrastructure, open space, and culture" as a key priority.
- The Boston Community Energy Study demonstrates national thought leadership on innovative solutions to energy infrastructure.
- Other Boston indicators for growth and spending:
    - A Booming Real Estate market- $4.71 Billion in construction activity in 2014 , 37% increase in building permit revenues
    - Boston allocated $90 million dollars for Public Works and Transit in 2016 [1]
    - Boston aims to grow housing stock by 50,000 units by 2030 [2]

[1] City of Boston Office of Budget and Management, 2016
[2] "Housing a Changing Boston" report, City of Boston, 2015

SUPPLEMENTAL INFORMATION ON "PLAN: South Boston Dorchester Avenue"

The Dorchester Avenue Corridor from Andrew Square to Broadway Station is experiencing market pressures to change from its traditional manufacturing and industrial uses to residential and mixed-use. Situated between two major red line MBTA stations and bus hubs, it is a prime corridor for transit-oriented development. The goal of this study and planning process is to create new zoning that aligns the aspirations of the community with predictable, as-of-right development conditions that will enhance overall livability in the area.

CONCEPTUAL development opportunity

- 12 ~ 16 million square feet of space
  - Residential uses ~ 6-8 million square feet
  - Other (office, 21st century industrial) ~ 5-7 million square feet
  - Ground floor retail and cultural uses ~ .5 – 1 million square feet
- Public Realm
  - Roads & Sidewalks ~ 30 – 50 acres
  - Open Space ~ 8 – 12 acres
- Residential uses
  - 6,000 – 8,000 residential units
  - ~14,000 – 16,000 new residents

Boston Smart Utilities will build on the findings from the final zoning and planning work.

More information on PLAN: DOT AVE can be found here:
http://www.bostonplans.org/planning/planning-initiatives/plan-south-boston-dorchester-ave

APPENDIX D: LIST OF ATTENDEES

Name	Organization
Aladdine Joroff	Harvard Emmet Environmental Law Clinic
Alistair Pim	NECEC
Amy Cording	City of Boston
Anne Schwieger	City of Boston
April Salas	Tuck School of Business at Dartmouth
Avinash Srivastava	AECOM
Bill Abolt	AECOM
Brad Swing	City of Boston
Brennan Molina	MassCEC
Brian Phillips	Eversource
Bryan Glascock	Boston Planning & Development Agency
Carl Nylen	ESRI
Christopher Dean	Zayo
Christopher Ranahan	Eversource Energy
Colin Curzi	Boston Planning & Development Agency
Conor LeBlanc	Boston University Initiative on Cities
Dana Al-Qadi	AECOM
Daniel Gregory	Positive Energy
David Carlson	Boston Planning & Development Agency
David Rodriguez	Enel
Faye Brown	National Grid
Francis Cummings	Peregrine Energy Group
Frank Curran	CKM consulting
Gabriella Carolini	MIT
Galen Nelson	MassCEC
George Bivens	Schneider Electric
Harry Colwell	Zayo
Herb Boynton	Lightower
Hillary Flynn	National Grid
Irene McSweeney	Boston Water and Sewer Commission
James Cater	Eversource
Jeff DeInnocentis	AECOM
Jeff Winbourne	Winbourne Consulting LLC
Jennifer Ducey	Stantec
Jennifer James	Black & Veach
Jim Hanley	NetBlazr
Jim Johnson	Ecova
Jim Newman	Linnean Solutions
John "Tad" Read	Boston Planning & Development Agency

John Cleveland	Innovation for Cities
John Hoey	Eversource Energy
John Markowitz	Mass Development
Jose Escobar	Verizon
Katie Choe	City of Boston
Katrina Lewis	AECOM
Laura Melle	City of Boston
Maegan Lefebvre	Mass CEC
Marcus Quigley	Optirtc
Margaret Cherne-Hendrick	Boston University
Mark Johnson	Schneider Electric
Mary Knasas	Boston Planning & Development Agency
Mary Rose Fissinger	Bridj
Marybeth Riley-Gilbert	MBTA
Mia Goldwasser	City of Boston
Michael Hernon	Get PSPC
Michael Lynch	City of Boston
Nick Diaconis	Cisco
Patricia Cahill	Boston University
Richard Moran	Harvard University
Rob Clark	Unify/Atos
Rob Farris	Hitachi Consulting
Robert Thronton	IDEA
Sarah Slaughter	Built Environment Coalition
Scott McCarley	PTC Thingworx
Scott Turner	Nitsch Engineering
Shawn Curley	Tuck School of Business at Dartmouth
Steve Caliri	National Grid
Suchi Gopal	Boston University
Susan Nguyen	City of Boston
Suzanne Findlen	AECOM
Tim Fairchild	SAS
Timothy Enright	Crown Castle
Todd Lukesh	IES
Travis Sheehan	Boston Planning & Development Agency
Vanessa Fox	Partners in Productivity
Vijay Narula	OST Inc
Vince Pastore	Verizon
Wendy O'Malley	Mass Development
Will Agate	LEED AP
Yaxiong Ma	Boston University Student

APPENDIX E: STEERING COMMITTEE

The development of the Boston Smart Utilities Vision would not be possible without the insights of the cross-departmental Steering Committee:

Amy Cording	Public Works Department / Public Improvement Commission
Anne Schwieger	Department of Information Technology
Brad Swing	Department of Environment, Energy, and Open Space
Bryan Glascock	Zoning, Boston Planning and Development Agency
Colin Curzi	Planning, Boston Planning and Development Agency
Chris Osgood	Chief of Streets, Transportation and Sanitation
Irene McSweeney	Boston Water and Sewer Commission
John "Tad" Read	Planning, Boston Planning and Development Agency
Katie Choe	Public Works Department
Mark Cardarelli	Public Works Department
Mary Knasas	Planning, Boston Planning and Development Agency
Travis Sheehan	Planning, Boston Planning and Development Agency