Piloting Boston's Smart Utilities Policy: Exchange South End

June 25, 2019

Agenda

- Background
- Approach
- Process
  - *Building a business-as-usual case*
  - *Constraints and opportunities*
  - *Preliminary screening assessment*
  - *Scenario development and analysis*
- Results
  - *Optimization and technical description*
- Challenges
- Lessons Learned

Boston Smart Utility Policy adopted June 2018 amid increasing power outages and flooding

Rains cause flooding, road closures in region

Laurel J. Sweet, Jordan Frias Sunday, August 12, 2018

Over 100 Require Assistance Following North Shore Flooding

August 12, 2018 at 12:36 pm Filed Under: Boston, Flooding, Local TV, Storrow Drive

Weather

MA Bomb Cyclone: 130K+ Without Power, Residents Saved From Floods

Massachusetts storm latest: power outages surpassed 100,000 as high winds and flooding hit much of the eastern part of the state.

By Alex Newman, Patch Staff | Mar 2, 2018 7:29 am ET | Updated Mar 2, 2018 4:39 pm ET

Storm blasts New England, leaving 1.5 million without power

Blizzard knocks out power to 60,000 customers across Massachusetts in Winter Storm Stella

Updated Mar 14, 2017; Posted Mar 14, 2017

More than 25,000 Bay State households without power (live link to outage maps)

Brian Dowling Thursday, January 04, 2018

Roads flooded throughout Boston area after heavy rain

'Days If Not A Week' Before Power Fully Restored In Mass.

March 3, 2018 at 5:15 pm Filed Under: Local TV, March Nor'Easter, Power Outages

Policy incorporates smart utility technology in the city's permitting process for new development

TECHNOLOGY	SIZE THRESHOLD	SPECIFICATIONS
District Energy Microgrid	>1.5 million SF	*Feasibility Assessment; if feasible, then Master Plan & District Energy Microgrid-Ready design*
Green Infrastructure	>100,000 SF	*Install Green Infrastructure to retain 1.25'' rainfall on impervious areas (Increase from 1" currently required by BWSC)*
Adaptive Signal Technology	All projects requiring signal installation or improvements	*Install AST & related components into the traffic signal system network*
Smart Street Lights	All Projects requiring street light installation or improvements	*Install additional electrical connection & fiber optics at pole*
Telecom Utilidor	>1.5 million SF of development, or >0.5 miles of roadway	*Install Telecom Utilidor: underground duct bank to consolidate the wires and fiber optics installed for cable, internet, and other telecom services.*

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Exchange South End redevelopment was the first project to respond to the policy

Project Specifications:

— *4 high/mid-rise buildings in South Boston*

— *1.6M sf lab and office space*

— *Construction starting EOY 2019*

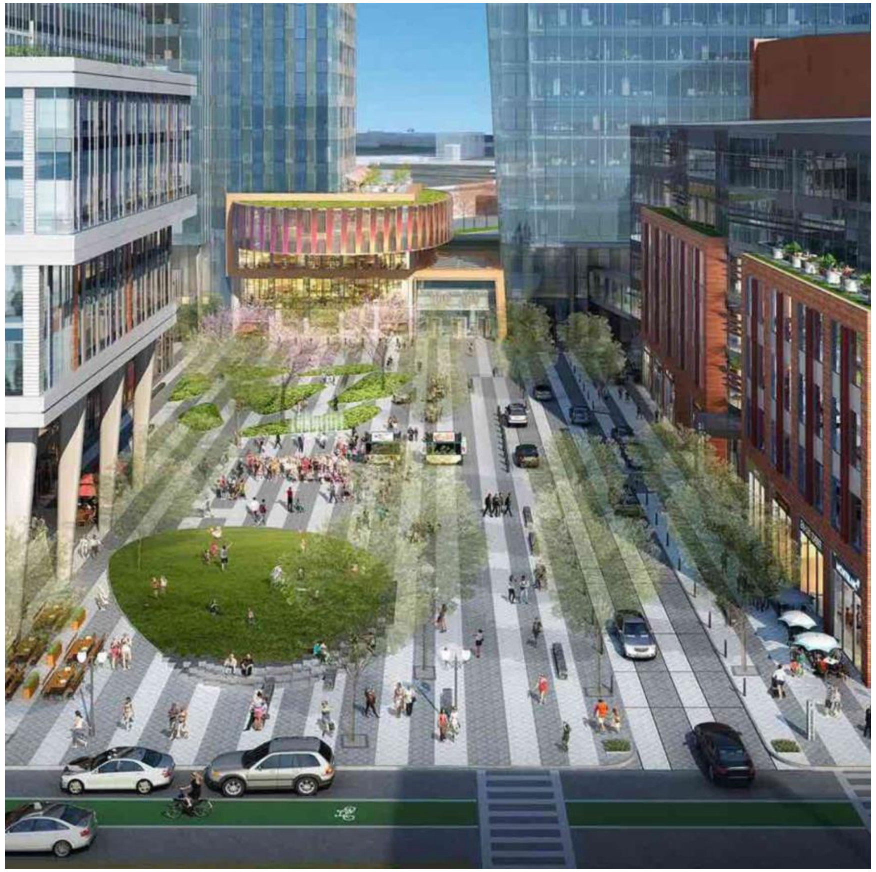
— *Phase 1 includes construction of two office/lab buildings*

— *Phase 2 will complete build-out of remaining two buildings to reflect market demand*

EXCHANGE SOUTH END

THE ABBEY GROUP

Stantec



wsp

Feasibility study includes technical, regulatory, financial, resiliency & GHG emissions

TECHNICAL

- Load profile evaluation
- Equipment sizing optimization and selection
- System basis-of-design
- Solar shading analysis

REGULATORY

- Electricity sellback considerations
- Interconnection requirements
- Federal and state incentives
- NO_x requirements
- Inverter vs synchronous interconnection

FINANCIAL

- Rate structure evaluation
- Capital cost estimates for all equipment
- O&M full service contract costs
- Interconnection costs
- Impact of incentives

RESILIENCY & GHG EMISSIONS

- Optional standby load evaluation
- Islandable design considerations
- GHG emissions evaluation

SMART Utility District Energy Microgrid Approach

SMART Utility Policy Requirements

Part A:

A.1. Data Collection and Site Investigation
A.2. Utility Load Profiles
A.3. Physical System Constraints
A.4. Regulatory Constraints

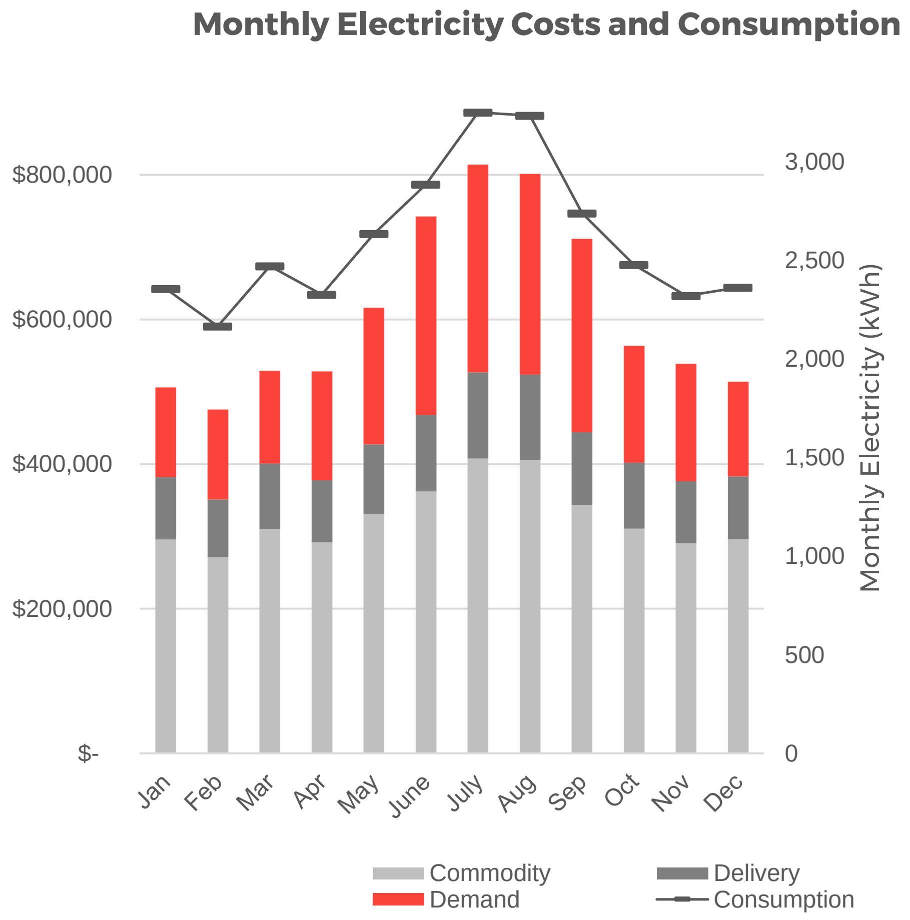
Part B:

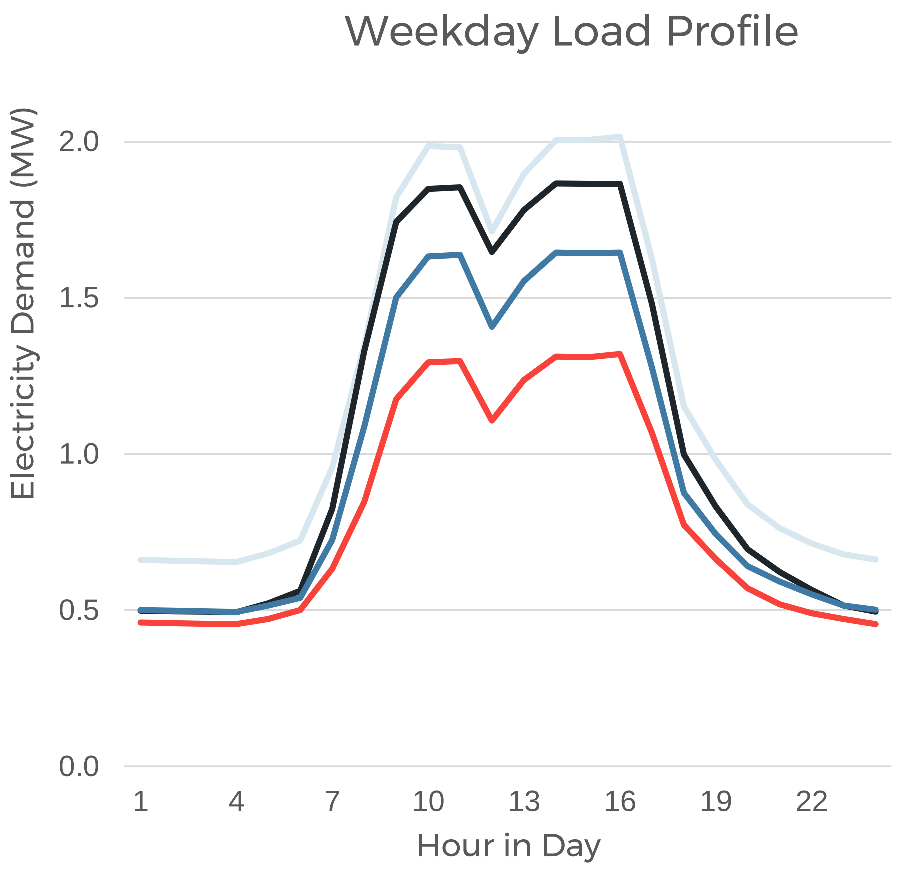
B.1. Definition of Economic Parameters
B.2. Business as Usual Case
B.3. Screening Analysis
B.4. Construction Cost and Schedule
B.5. Operations and Maintenance Cost
B.6. Economic Analysis
B.7. Technical Description

WSP Approach

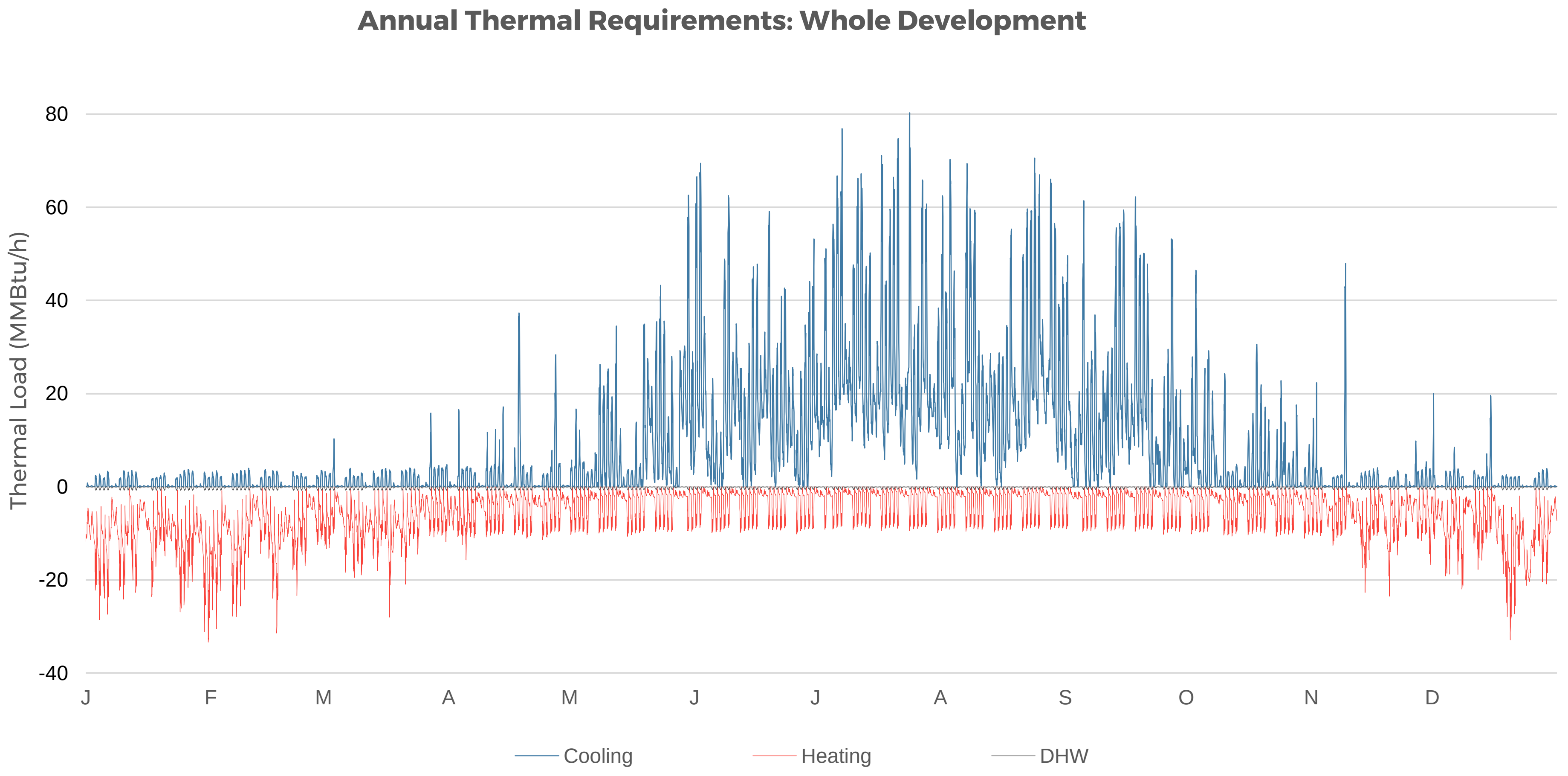
1. Develop energy models to determine building loads
2. Evaluate regulatory and physical constraints + **opportunities**
3. High-level, "**blue ocean**" screening of **energy strategies**
4. Develop multiple alternative scenarios
5. Conduct technical, economic, resiliency, and GHG analysis for scenarios
6. Optimize and develop technical description for most promising alternative scenario

Energy models are used to develop load profiles for business-as-usual and further analysis





Evaluating heating and cooling requirements important for assessing potential of CHP/CCHP



Physical constraints include limited space available for solar and uncertainty regarding utility interconnection

— **Electrical interconnection:** The Site is located on a radial network and receives 4 kV service. The electric utility has expressed concern about the amount of on-site generation that could be implemented on this 4 kV circuit

— **Natural gas supply**: A capacity study conducted by the natural gas utility determined that there were no supply constraints

— **Building design:** Limited rooftop space available to house on-site generation

Regulatory constraints result in limitations to microgrid deployment and on-site generation capacity in MA

- **Minimum Grid Draw:** Electric utility may require that the development draw at least 50 kW from the grid at all times
- **NO_x Emissions Requirements:** Massachusetts limits the NO_x emissions for on-site generation
- **Fire Prevention Code:** The fire department may limit the use of Li-ion batteries as stationary energy storage
- **Electrical distribution:** The electric utility has exclusive rights to distribute electricity within a service territory and asserts that the franchise agreement restricts the transfer of electricity across public rights-of-way
- **Resale of electricity**: The Department of Public Utilities (DPU) restricts the resale of electricity from landlords to their tenants

Regulatory opportunities (incentives) improve economic viability of on-site generation and renewables

— **Federal Investment Tax Credit**: Applies to solar (30%, decreasing to 10% in 2022) and CHP (10%)

— **MACRS Bonus Depreciation**: Applies to solar and CHP, 100% depreciation for qualified projects in service before January 1, 2023

— **MA Alternative Energy Credits (AECs)**: Qualified alternative energy units produce AECs, which are purchased by utilities to meet their Alternative Portfolio Standard (APS) requirements

— **Massave CHP Incentive:** Per the Massachusetts Green Communities Act of 2008, CHP projects can receive funding as an electricity energy efficiency measure

— **SMART Solar Program:** Massachusetts has a solar carve-out in their renewable portfolio standard (RPS) that requires utilities to procure a certain portion of their electricity from solar

High-level screening analysis results

✓ = Positive ● = Mixed
X = Negative "-" = not applicable

TECHNOLOGY		TECHNICAL	REGULATORY	ECONOMICS	RESILIENCY	SUSTAINABILITY
DISTRICT THERMAL	2-Pipe Loop	✓	✓	X	X	●
	4-Pipe Loop	✓	✓	X	X	●
MICROGRID	Interconnected Buildings	✓	X	✓	✓	●
	Separate Buildings	✓	●	●	✓	●
CONVENTIONAL GENERATION	Fuel cell	✓	✓	●	✓	●
	Microturbines	✓	●	●	✓	●
	Reciprocating Engines	✓	●	✓	✓	●
RENEWABLES	Solar Photovoltaics	●	✓	✓	●	✓
	Wind Microturbines	●	✓	X	X	✓
THERMAL RESOURCES	Cogeneration	✓	✓	✓	●	●
	Trigeneration	●	✓	●	✓	✓
	Horizontal Geoexchange	X	-	-	-	-
	Vertical Geoexchange	●	✓	●	●	●
	Sewer Heat Recovery	X	-	-	-	-
ENERGY STORAGE	Lithium-ion batteries	✓	●	●	✓	●
	Flow batteries	●	✓	●	✓	●
	Thermal storage	●	✓	●	✓	●

Note: Analysis is for a mixed use residential project undergoing same process, not for the Exchange South End.

Individual building systems with natural gas reciprocating engines selected as prime mover

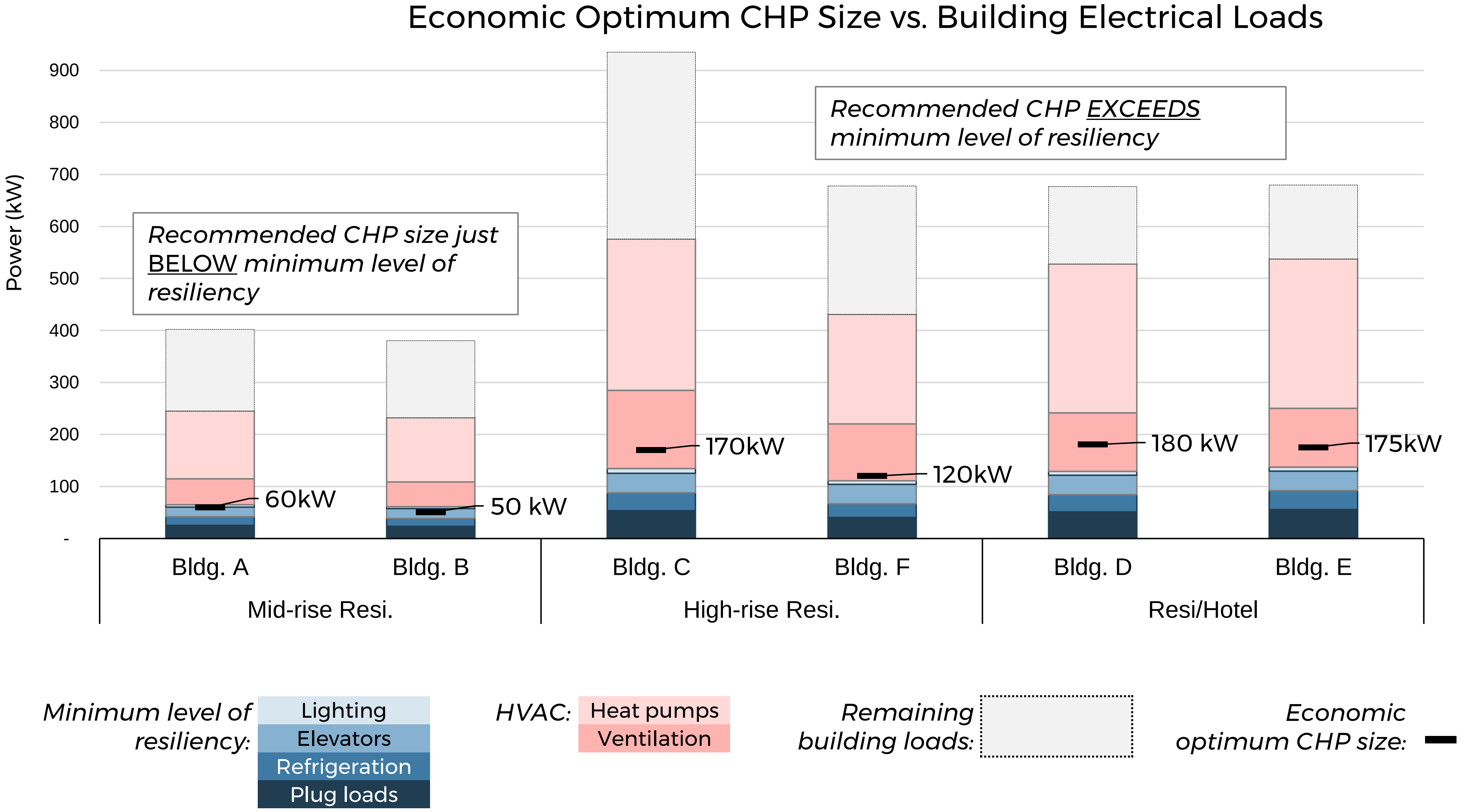
— WSP assessed reciprocating engines, microturbines, and fuel cells for their potential as the prime mover. Reciprocating engines were recommended because:

  — *They have the highest combined efficiency and therefore generate the most alternative energy credits (AECs) per MWh of electricity produced.*

  — *They have the lowest capital cost for small-scale applications.*

SYSTEM SPECIFICATIONS[9]	RECIPROCATING ENGINES	MICROTURBINES	FUEL CELLS
TECHNICAL			
Reference Size	100 kW / 633 kW	200 kW	300 kW / 400 kW
Avg. Electric Efficiency (HHV)	32%	28%	40%
Avg. Thermal Efficiency (HHV)	45%	38%	29%
Avg. Combined Efficiency (HHV)	77%	66%	69%
AECs Earned per MWh	1.7 credit	1.2 credit	1.4 credit
COST			
Capital Cost ($/kW)	$2,900	$3,150	$8,500
Annual O&M ($/kWh)	$0.024	$0.016	$0.041

Trade-off between economic performance and resiliency should be understood



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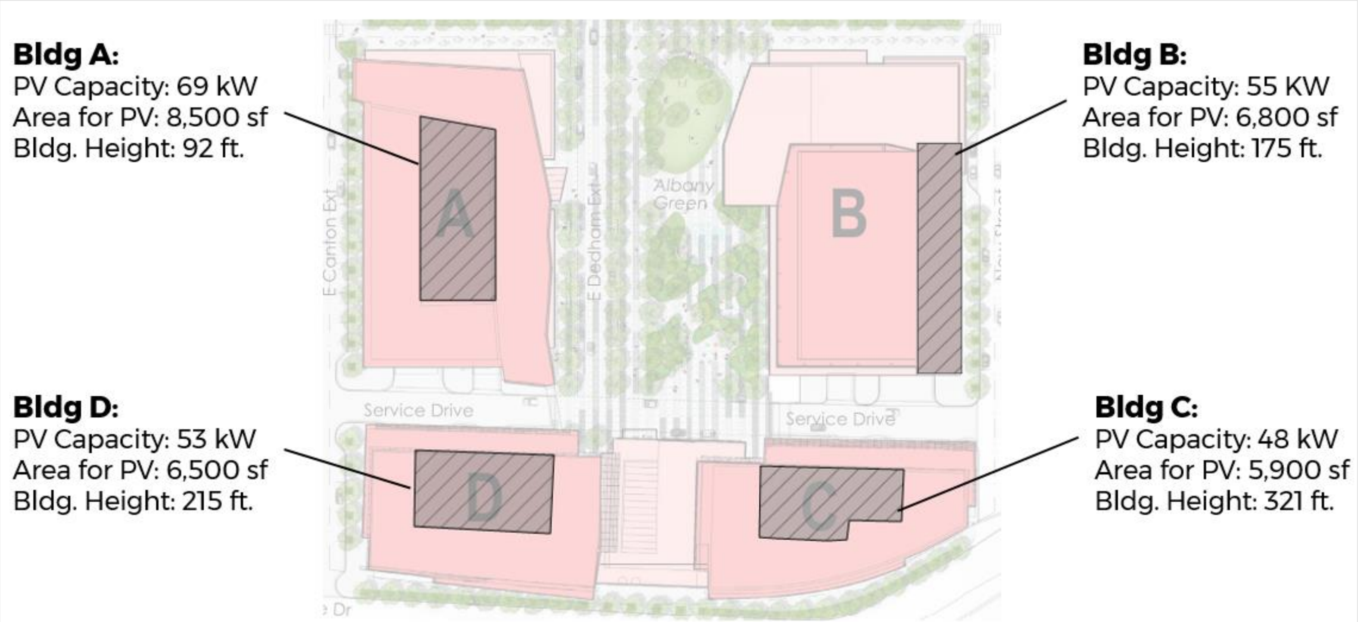
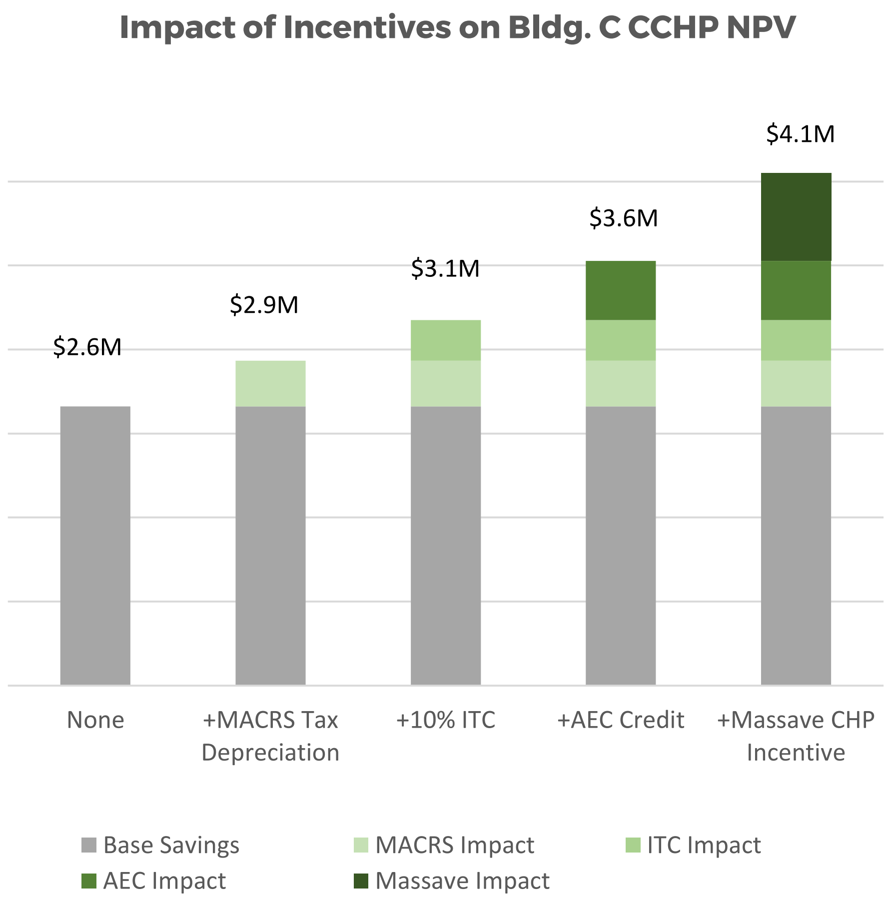
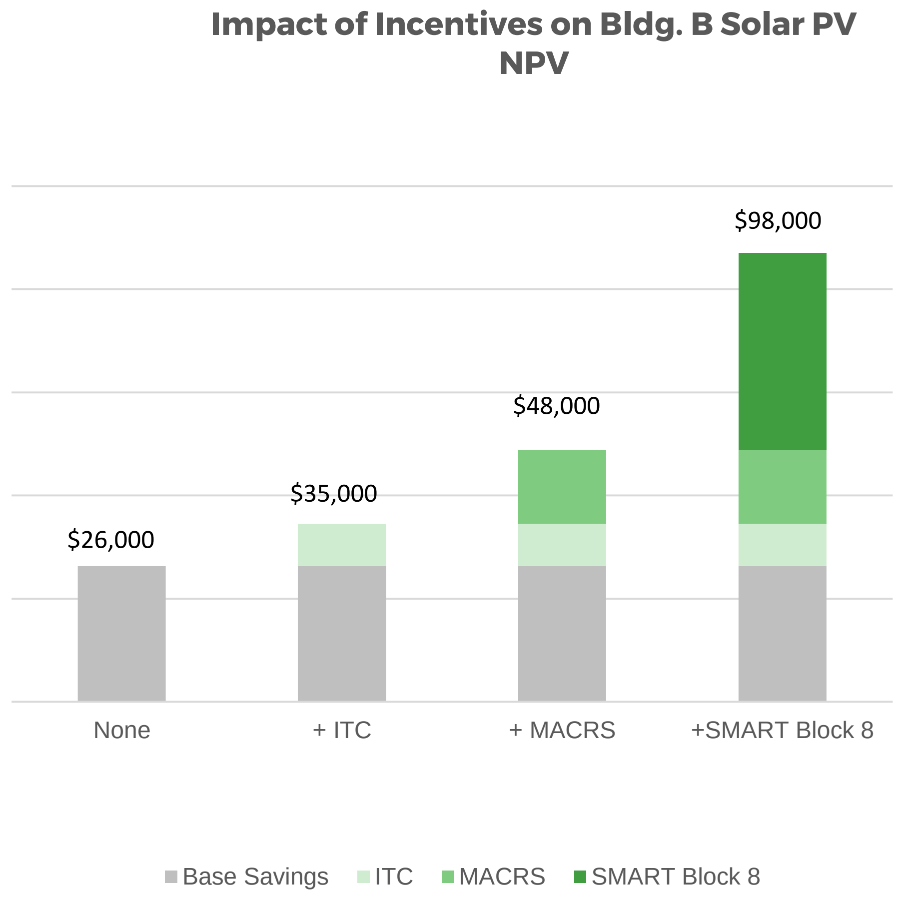
Solar PV makes sense financially, but only covers ~1% of building annual electricity consumption



SPECIFICATION		BLDG. A	BLDG. B	BLDG. C	BLDG. D
Rooftop Area	High Roof Area (ft^2)	8,447	6,760	5,904	6,547
	Low Roof Area (ft^2)	12,071	16,090	10,963	11,983
	TOTAL	20,518	22,850	16,867	18,530
	Area covered with PV panels (ft^2)	4,224	3,380	2,952	3,274
PV System Size	Number of Panels[14]	200	160	140	155
	System Size (kW)	69	55	48	53
System Output	Annual Output (kWh)	74,818	51,075	63,848	70,657
	Capacity Factor	12%	11%	15%	15%

Incentives for CHP and solar projects in MA greatly improve project NPV





Technical description and considerations

SYSTEM SPECIFICATIONS	BLDG. A	BLDG. B	BLDG. C	BLDG. D
Engine Selection	3X152kW (456 kW)	2X285kW (570 kW)	3X152kW (456 kW)	3X152kW (456 kW)
Capacity Factor	97.7%	99.0%	98.4%	98.4%
% Electric Load Covered	60%	54%	49%	53%
Thermal Utilization	74%	76%	76%	81%
% Heating Load Met	90%	88%	87%	82%
% Cooling Load Met	25%	22%	23%	19%
% Change GHG Emissions	-6%	-8%	-7%	-9%

— **Reciprocating engines as the prime mover:** Reciprocating engines were selected over fuel cells and microturbines because of their high efficiency and low capital cost. Their high efficiency also yields the most AECs.

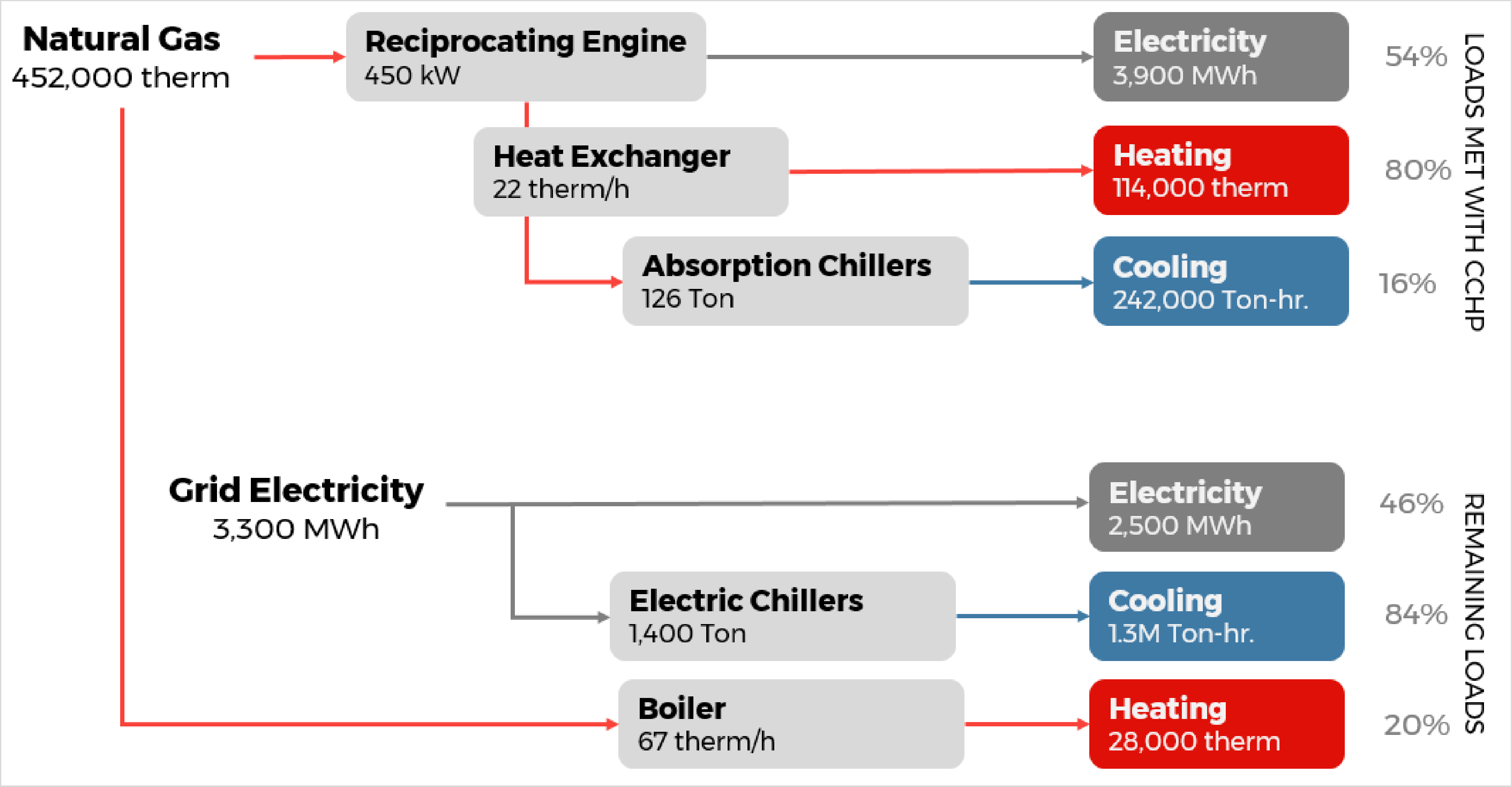
— **CCHP preferred over CHP-only**: Implementing absorption chillers (the cooling component of CCHP) is cost effective, despite its added capital cost and low impact on overall cooling loads.

— **MAN, Siemens, or equivalent engines:** These engines are recommended for their abundance throughout the Northeast and low operating costs.

— **Multiple smaller engines:** Installing multiple smaller engines (under 285 kW) to meet the ideal capacity is preferred because they can meet MA's strict NO_x requirements without requiring a SCR.

— **Cention or equivalent absorption chillers:** These chillers are recommended because they have a high COP (0.80) and can operate at part load capacity without compromising performance.

System performance schematic for Building D



Challenges

— Developers have not experienced higher market value for resiliency features; this may change in the future

— Feasibility study is conducted early in the design process when building mechanical systems and loads are unknown or may change

— SMART Utility Policy does not define levels of resiliency or emissions reductions that proposed district energy microgrid systems should achieve

— Regulations restrict metered sale of electricity, limiting ability of project owner or developer to recover costs for on-site generation projects

Lessons learned

- Frequent meetings with planning and development agency will help align feasibility study with policy goals
- Feasibility study should be done at a high level because designs and programs can change frequently
- Use conservative assumptions to test best/worst case scenarios early in the project and remove technologies or designs are not feasible
- Final design in new builds should consider the uncertainty of buildings loads, including providing empty pads for future expansion

Questions?

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