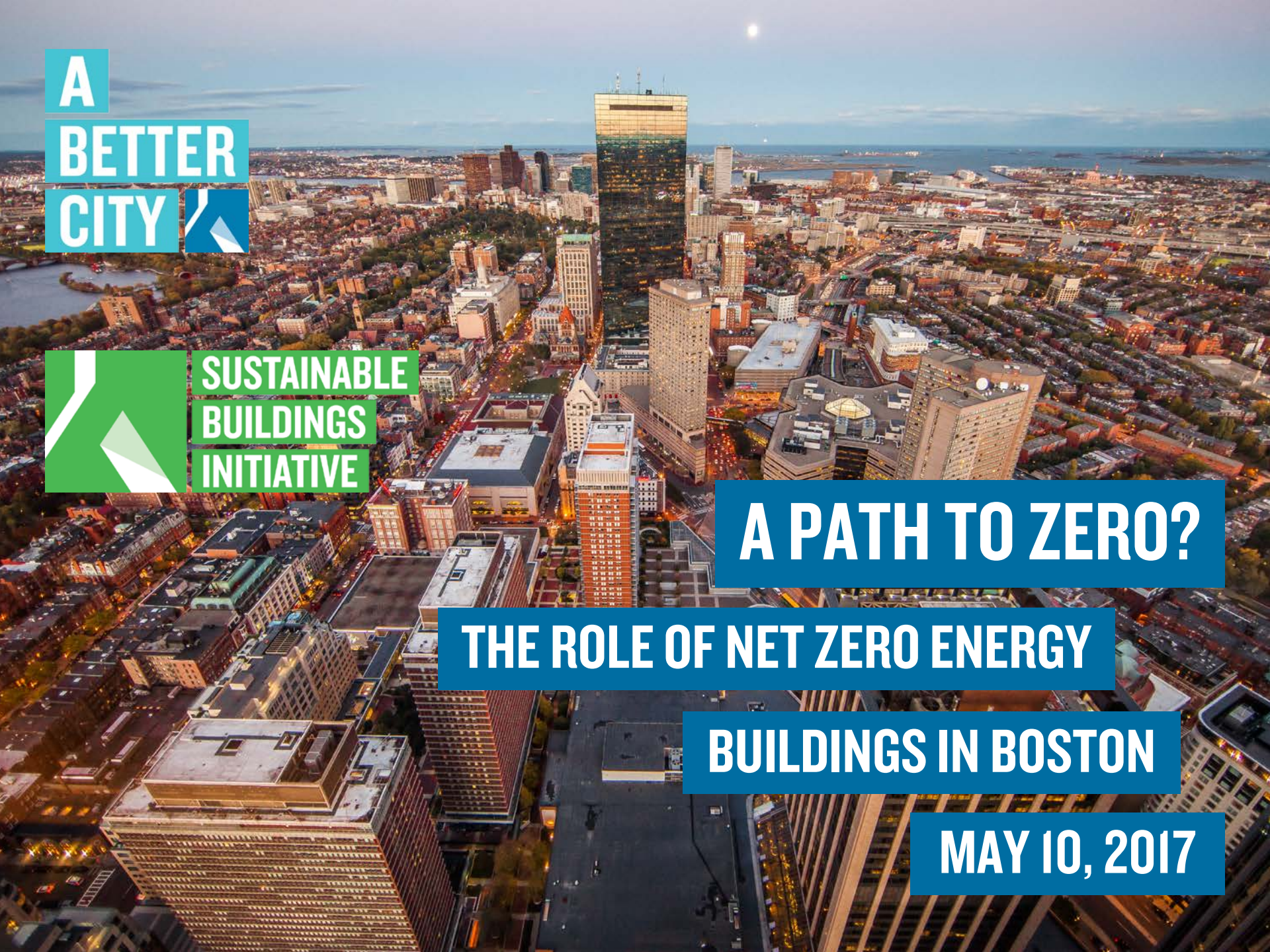
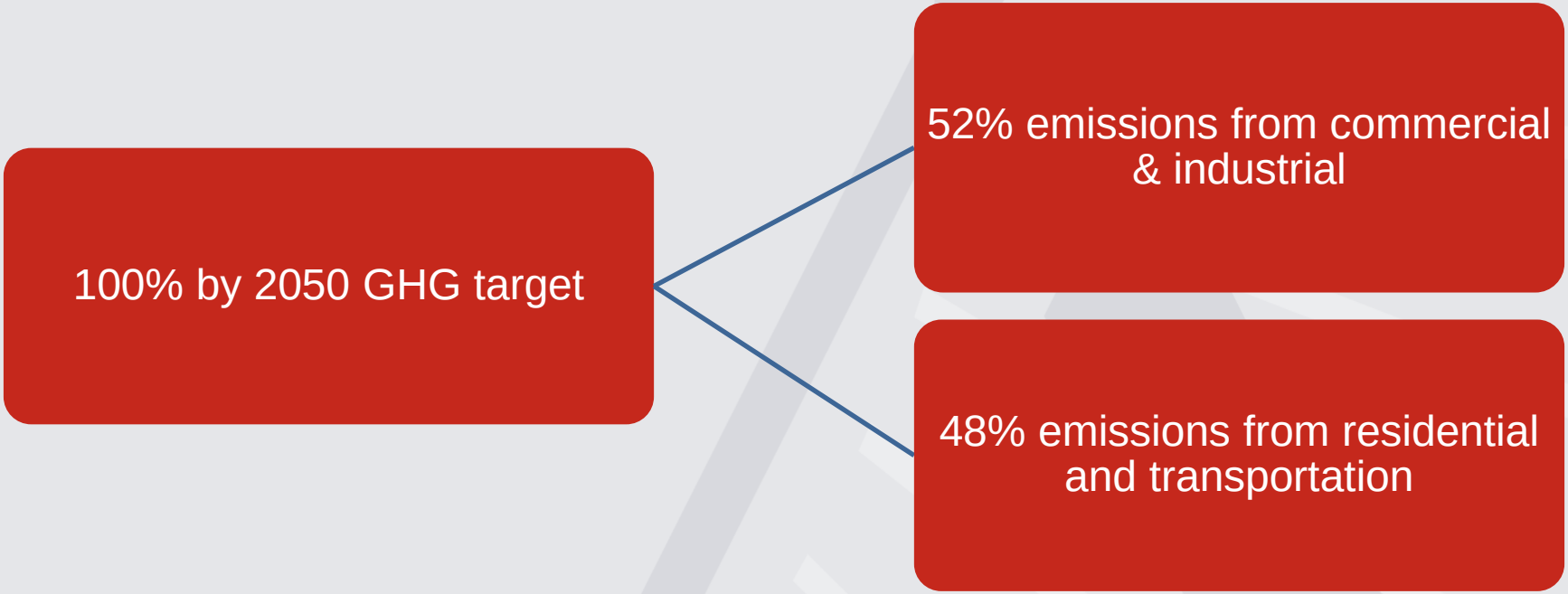

A BETTER CITY
SUSTAINABLE BUILDINGS INITIATIVE
A PATH TO ZERO?
THE ROLE OF NET ZERO ENERGY BUILDINGS IN BOSTON
MAY 10, 2017


RICK DIMINO
A BETTER CITY
SUSTAINABLE
BUILDINGS
INITIATIVE
A
BETTER
CITY

BOSTON'S CLIMATE GOALS

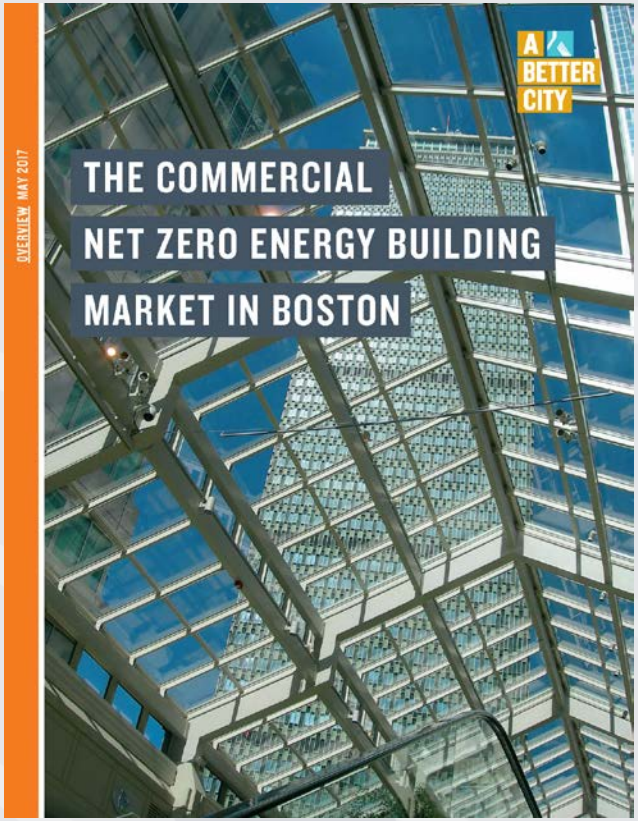
Boston 2014 Climate Action Plan



A BETTER CITY

COMMERCIAL NET ZERO ENERGY BUILDINGS

- Net zero energy buildings are:
  - The next frontier of innovation and energy reduction
  - Key for meeting the City and State 2050 GHG reduction goals
- A Better City's overview document provides:
  - Introduction to net zero buildings and net zero emissions
  - Common barriers
  - Recommended next steps
  - Eight case studies of commercial/institutional net zero or near-net zero buildings in MA or similar climates



A BETTER CITY

AGENDA

Welcome

- **Rick Dimino**, A Better City
- **Bob Biggio**, Boston Medical Center

Panel Presentations

- **John Dalzell**, Boston Planning & Development Authority
- **Jacob Knowles**, Bard, Rao + Athanas Consulting Engineers
- **Jill Kaehler,** Behnisch Architekten
- **Seth Federspiel**, City of Cambridge

Closing Remarks

- **Amy Longsworth**, Boston Green Ribbon Commission

(Optional) Building Tour of Boston Medical Center

- **Bob Biggio** and **Nancy Hanright**, Boston Medical Center

WITH THANKS TO...

Event host:

Event partner:

A BETTER CITY


BOB BIGGIO
BOSTON MEDICAL CENTER
SUSTAINABLE
BUILDINGS
INITIATIVE
A
BETTER
CITY

Why pursue greenhouse gas reductions?

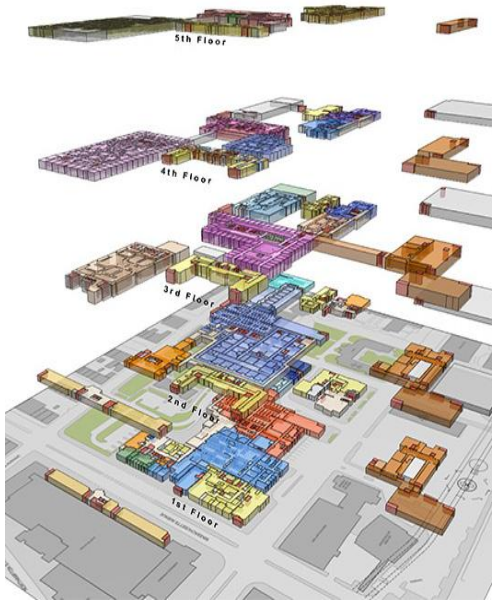
- Boston Medical Center is both the largest level one trauma center and the **largest safety-net hospital in the northeast United States**
- Its leadership as a safety-net provider embeds a focus on **keeping its community healthy into its DNA**
- Healthcare reform creates the an opportunity for the first time in history for BMC to be **financially rewarded for what it does best**
- First hospital in the nation to provide a **hospital-based preventive food pantry**
- **Founded the Medical Legal Partnership** program which is now a model replicated across the country

James W. Varnum National Quality Award Winner

- Doing our part to care for our communities environment was a natural addition to our goal of "**making Boston the Healthiest urban population in the world**"

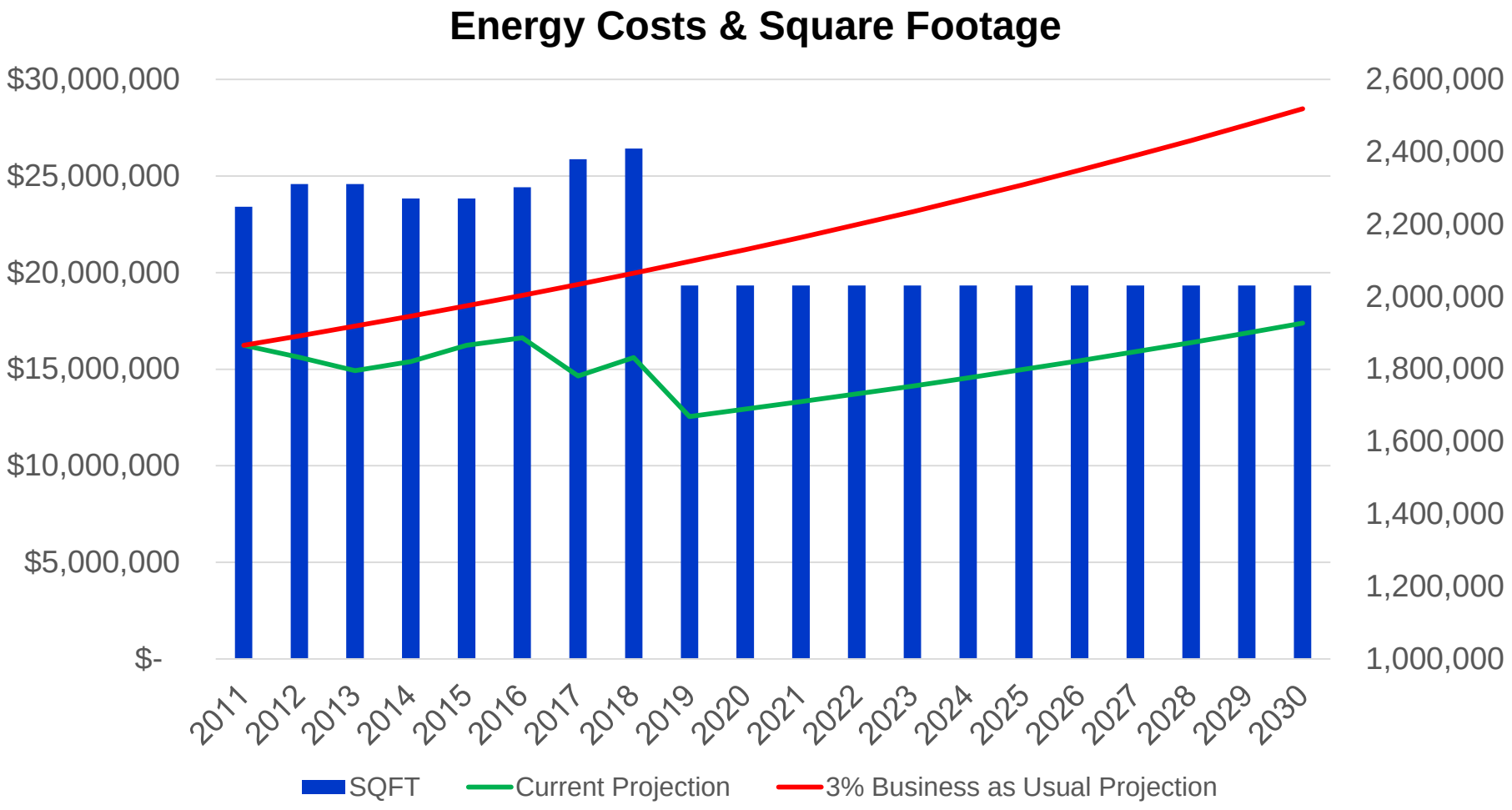
Our Campus Redesign Plan

- In 2012, BMC launched a $350 million redesign of our campus aimed at modernizing its facilities to support its bold aspirations
- Energy efficiency and greenhouse gas emissions reduction were identified as a cornerstone of the plan
- The plan renovates over 500,000sf and constructs 130,000sf of new clinical space
- By consolidating clinical functions into a more efficient design we are reducing total square footage by 400,000sf



Cogeneration Video Link

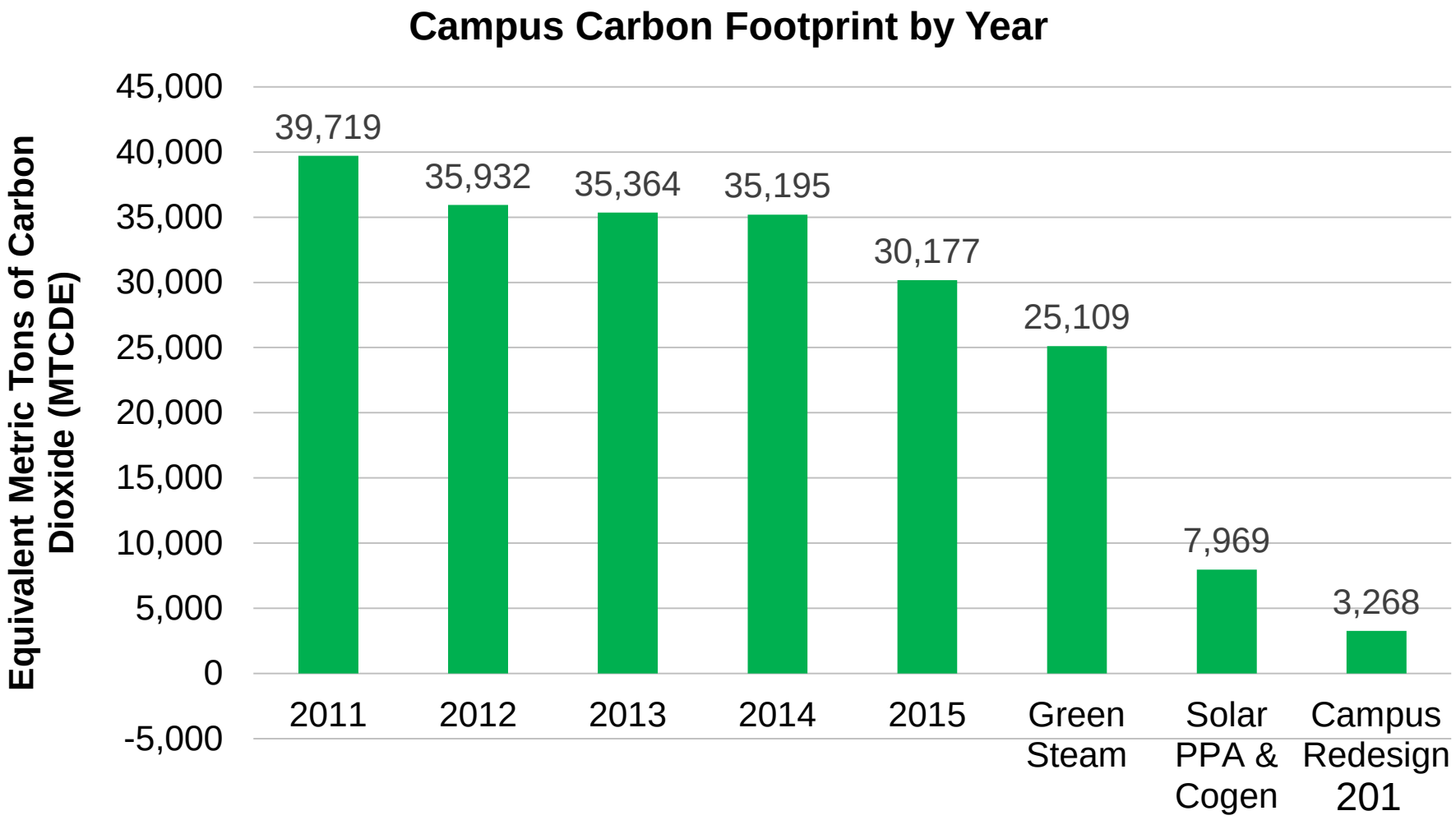
As well as financial successes that will help us as we enter the ACO world



Equivalent Revenue Increase @ $20/Dollar Saved = $135 million

BOSTON MEDICAL CENTER

Going for ZERO



Net-zero would not be possible for BMC without our offsite collaborative PPA for solar

- 60 MW
  - 16MW supports BMC
- 650 acres
  - Boston's South End is ~300 acres
- 255,000 panels


JOHN DALZELL
BOSTON PLANNING & DEVELOPMENT AUTHORITY
SUSTAINABLE
BUILDINGS
INITIATIVE
A
BETTER
CITY

What if…

Buildings and communities could regenerate and sustain the health and vitality of all life?

USGBC Mission Statement, in part

boston planning & development agency

Let's get started…

Big Drivers

Cambridge Net Zero Action Plan
Carbon Free Boston 2050

boston planning & development agency

Let's get started…

Practice and Market Forces

Can we build it…
Can we pay for it…

boston planning & development agency

E+ Green Buildings

ENVIRONMENT + ENERGY + EQUITY

Platinum

Marcella St, Roxbury
Completed Fall 2013

boston planning & development agency

E+ Green Buildings

Energy Positive

ENVIRONMENT + ENERGY + EQUITY

8,140 kWh
Energy Positive

E+ BUILDING DASHBOARD

embue

Welcome to the City of Boston's E+ Green Building Program. Over the course of a year an energy positive building (i.e. E+) will produce more electricity than it consumes. This is achieved through innovative design, a well-constructed building envelope, and use of high-efficiency windows and heating/cooling systems. Rooftop solar panels and solar thermal water heaters provide electricity and hot water for building occupants.

PERFORMANCE MONITORING

Through a grant from the Massachusetts Clean Energy Center, Embue has installed its sensors and systems in these innovative buildings. For the next three years Embue will track electricity consumption, production, and occupant comfort in each of these model homes. Performance information for each building is provided for the public and can be found in the sections below.

MARCELLA STREET

A four-unit multifamily townhouse building totalling 7,900 square feet. Predicted annual electricity production of 44,400 kWh, consumption of 36,900 kWh, net electricity production of 12,600 kWh.

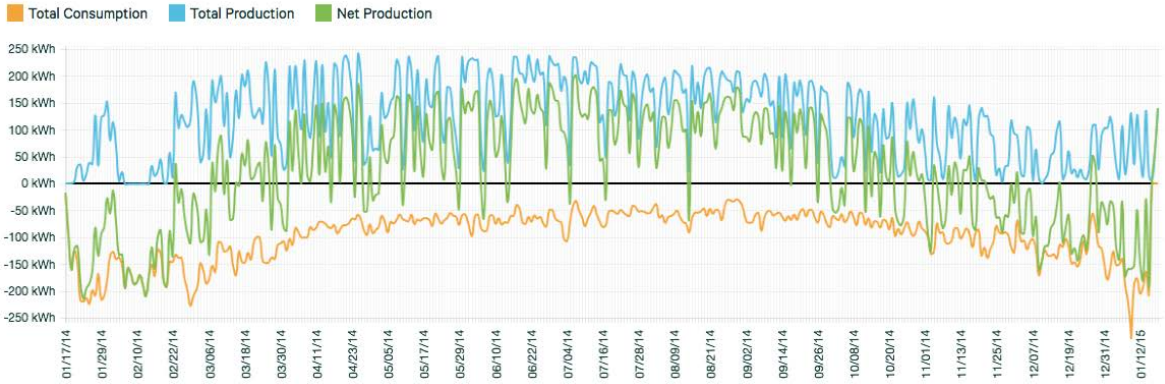
Photo credit Sam Oberter.

TOTAL ELECTRICITY PRODUCTION

Lifetime	8,140 kWh
Year to Date	-1,409 kWh
Last 30 Days	-2,360 kWh

DAILY PRODUCTION & CONSUMPTION

This chart provides daily whole-building performance data for Marcella Street. On days when the green line is above zero, the building is energy positive for that day. For privacy reasons, the most recent two weeks of data are not displayed.

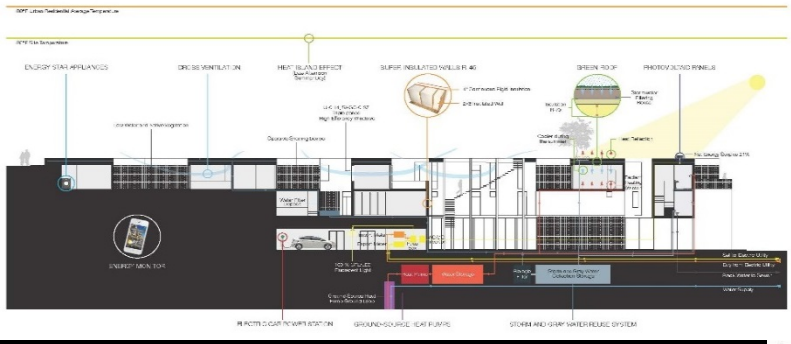


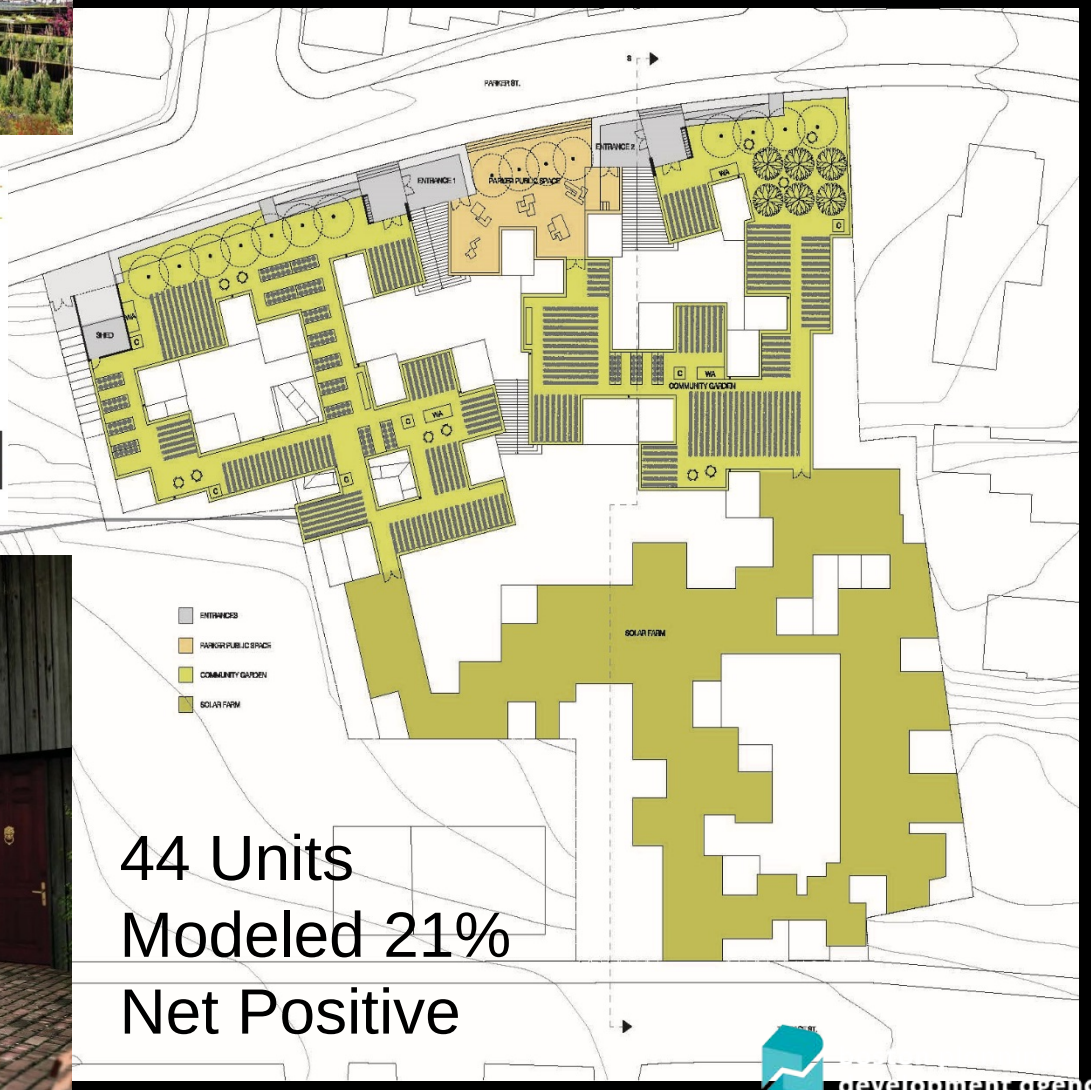
development agency

E+ Green Communities

Selected Developer

SEBASTIAN MARISCAL





44 Units
Modeled 21%
Net Positive

development agency

E+ Green Communities

Proposed

boston planning & development agency

E+ Green Communities

Proposed

boston planning & development agency

E+ Green Buildings – Residential Market Impact

Private Near Net Zero Energy Projects

Dorr Street Residences, Roxbury (completed)

Urbanica Development / Merge Architects

E+ Green Buildings – Public Leadership

Public / Near Net Zero Energy (very near!)

Cronin Field Headquarters, Westborough

Massachusetts Division of Fisheries & Wildlife / Architerra

Let's get started…

…the Path to Zero

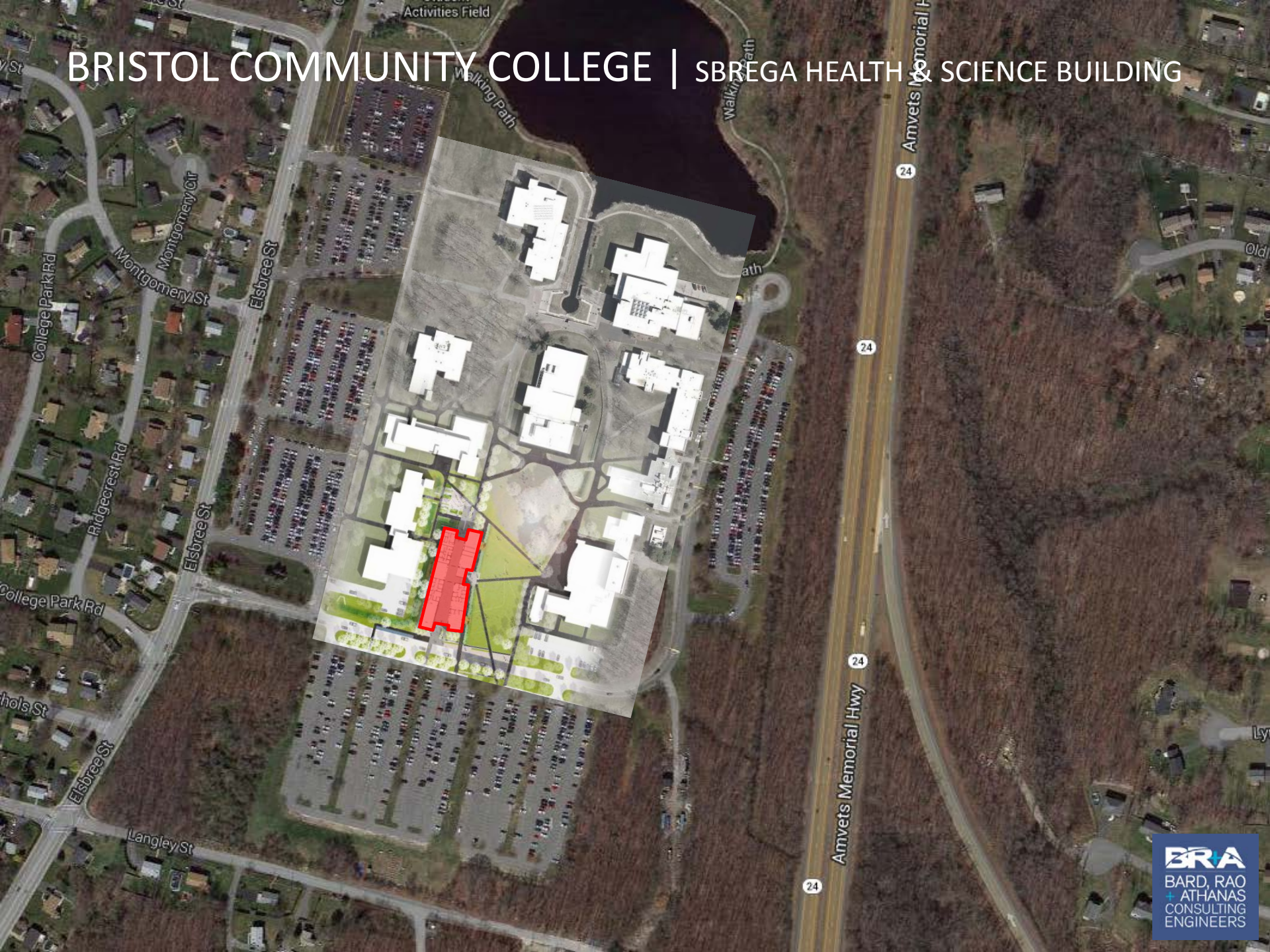
boston planning & development agency


JACOB KNOWLES
BARD, RAO + ATHANAS CONSULTING ENGINEERS
SUSTAINABLE
BUILDINGS
INITIATIVE
A
BETTER
CITY

BRISTOL COMMUNITY COLLEGE | SBREGA HEALTH & SCIENCE BUILDING

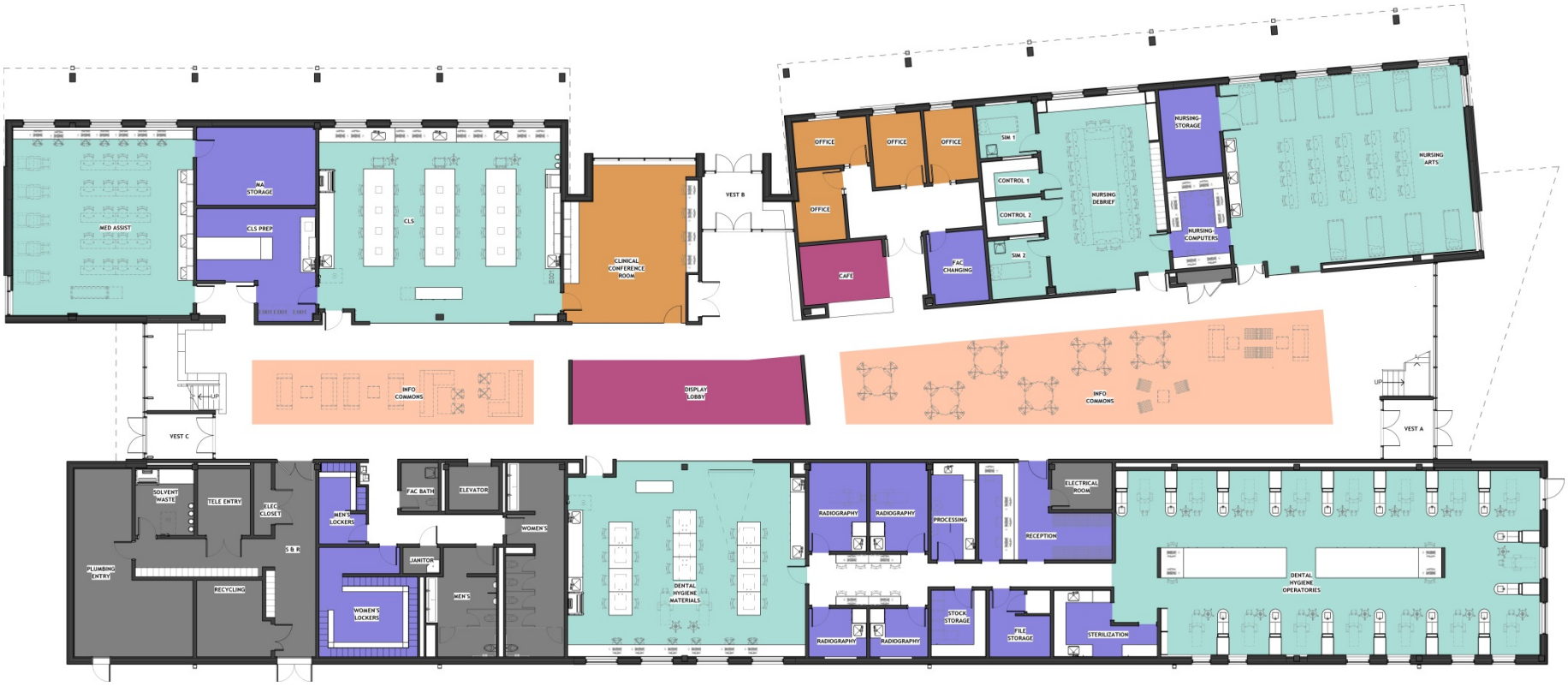
BRA
BARD, RAO + ATHANAS CONSULTING ENGINEERS

BRISTOL COMMUNITY COLLEGE | SBREGA HEALTH & SCIENCE BUILDING



BRA
BARD, RAO + ATHANAS CONSULTING ENGINEERS

BRISTOL COMMUNITY COLLEGE | SBREGA HEALTH & SCIENCE BUILDING



1st Floor

BARD, RAO + ATHANAS CONSULTING ENGINEERS

BRISTOL COMMUNITY COLLEGE | SBREGA HEALTH & SCIENCE BUILDING

BRA
BARD, RAO + ATHANAS CONSULTING ENGINEERS

BRISTOL COMMUNITY COLLEGE | SBREGA HEALTH & SCIENCE BUILDING

2nd Floor

BARD, RAO + ATHANAS CONSULTING ENGINEERS

BRISTOL COMMUNITY COLLEGE | SBREGA HEALTH & SCIENCE BUILDING.

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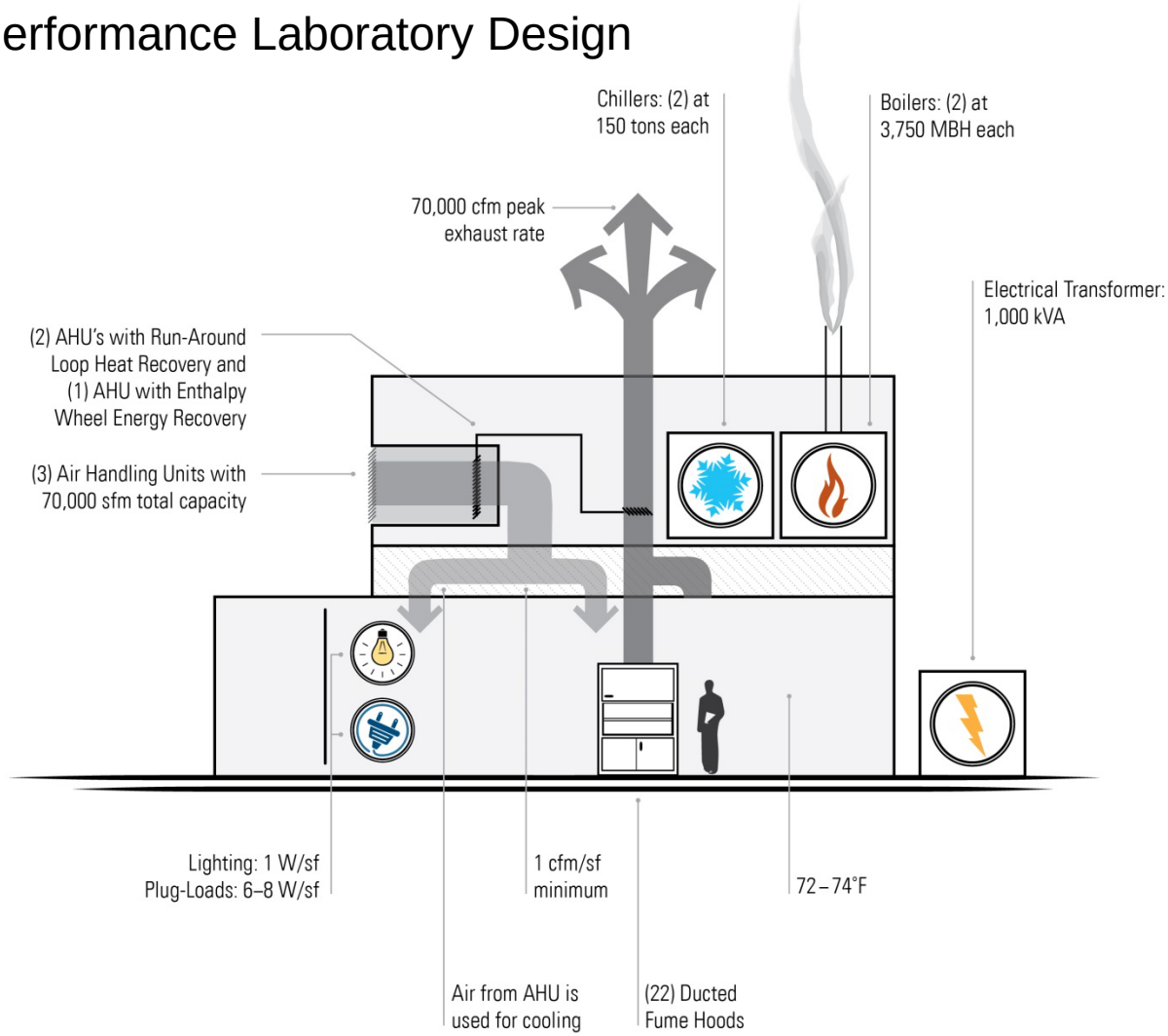
BARD, RAO + ATHANAS CONSULTING ENGINEERS

BRISTOL COMMUNITY COLLEGE | SBREGA HEALTH & SCIENCE BUILDING

High Performance Laboratory Design



BRA
BARD, RAO + ATHANAS CONSULTING ENGINEERS

through night and day and in and out of weeks and almost over a year

BCC

BRISTOL COMMUNITY COLLEGE

CO_2

2050

BRA

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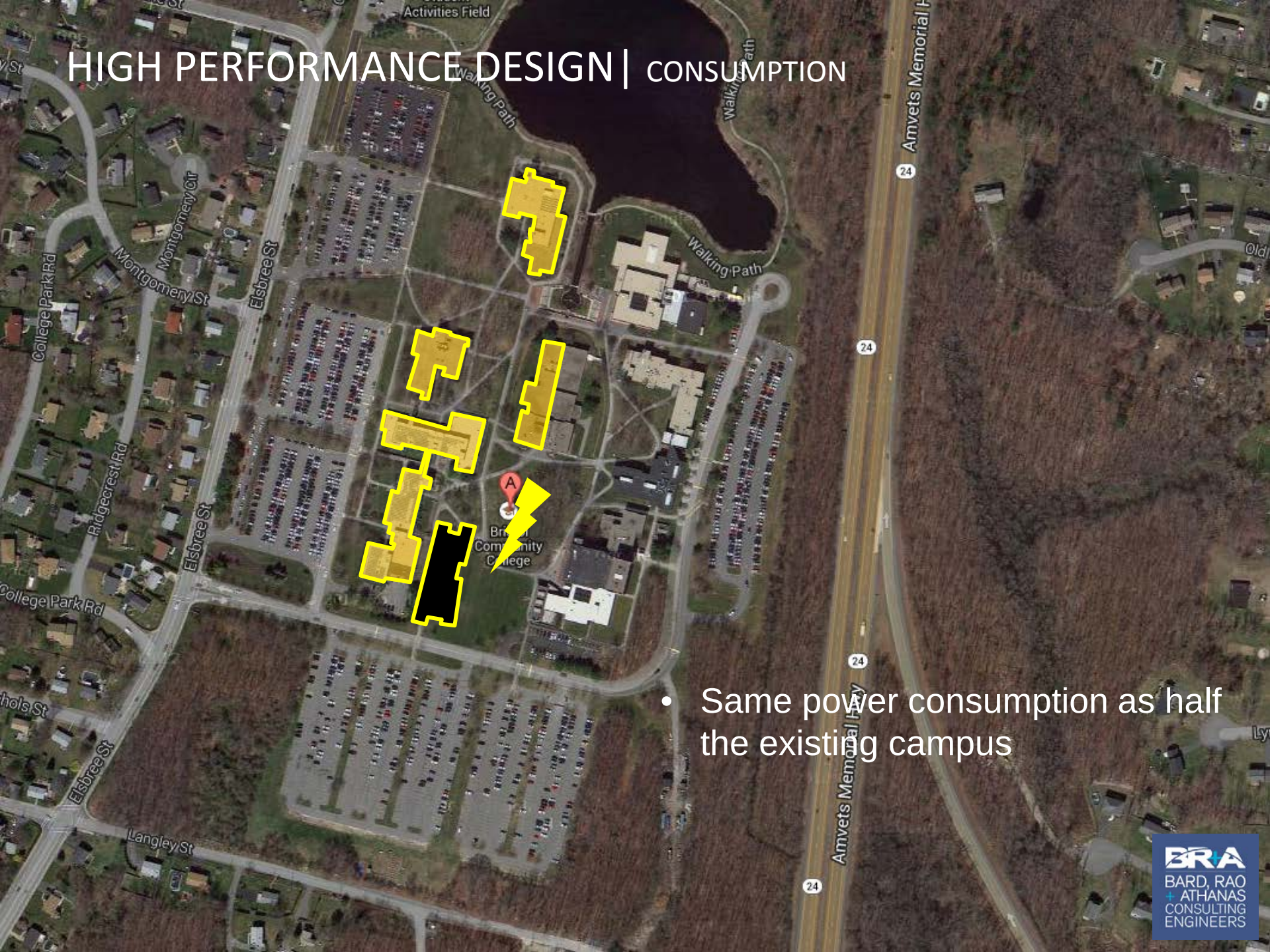
HIGH PERFORMANCE DESIGN| CONSUMPTION

BARD, RAO + ATHANAS CONSULTING ENGINEERS

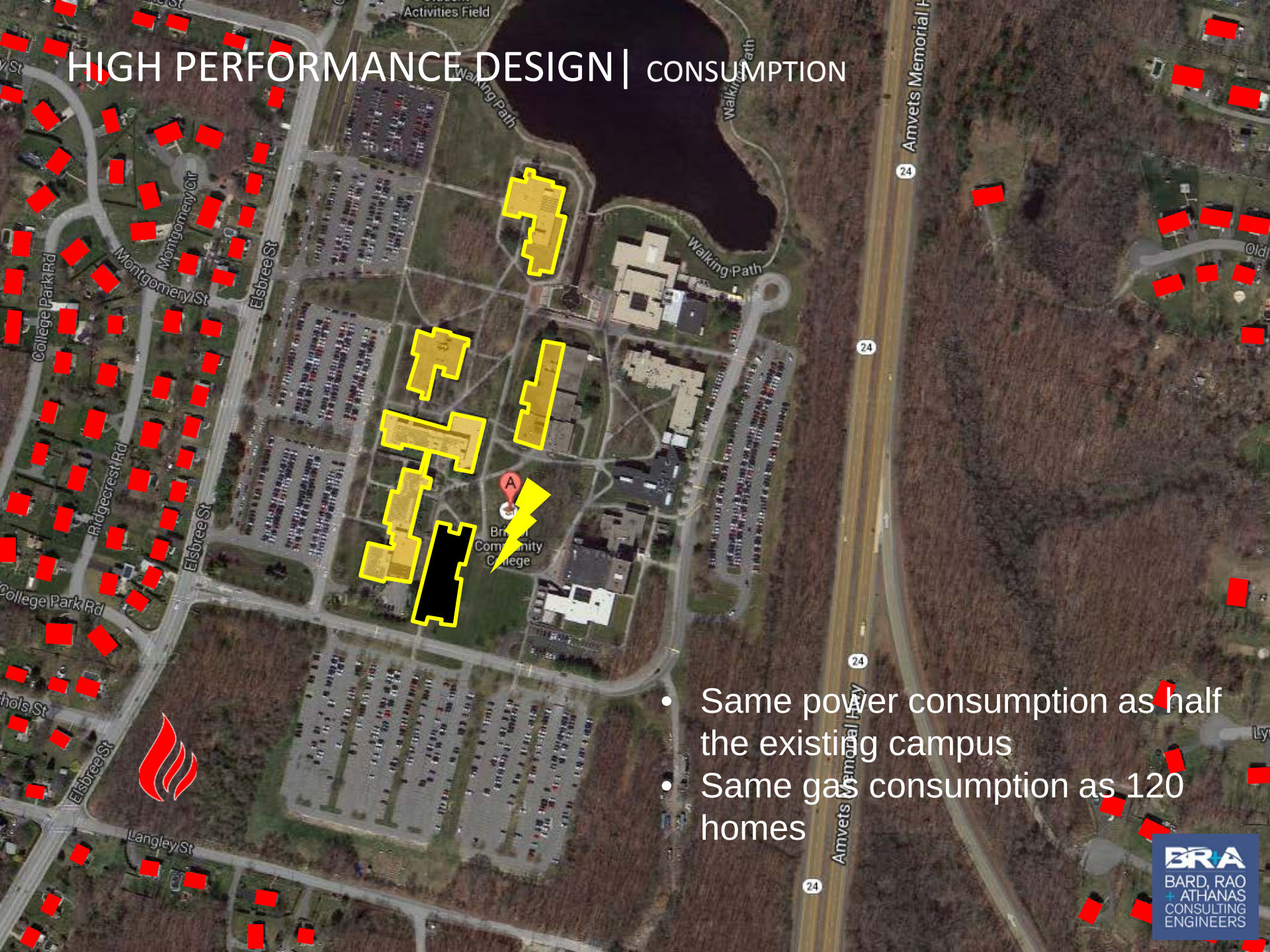
HIGH PERFORMANCE DESIGN| CONSUMPTION



- Same power consumption as half the existing campus

BARD, RAO + ATHANAS CONSULTING ENGINEERS

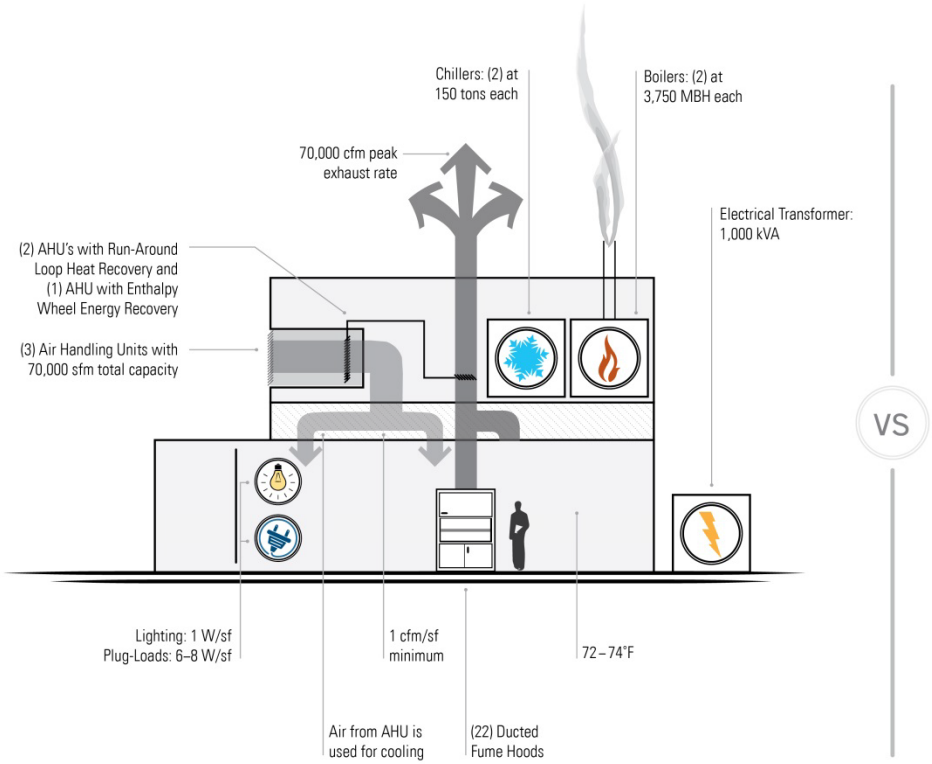
HIGH PERFORMANCE DESIGN | CONSUMPTION



- Same power consumption as half the existing campus
- Same gas consumption as 120 homes

BRA
BARD, RAO + ATHANAS CONSULTING ENGINEERS

High Performance

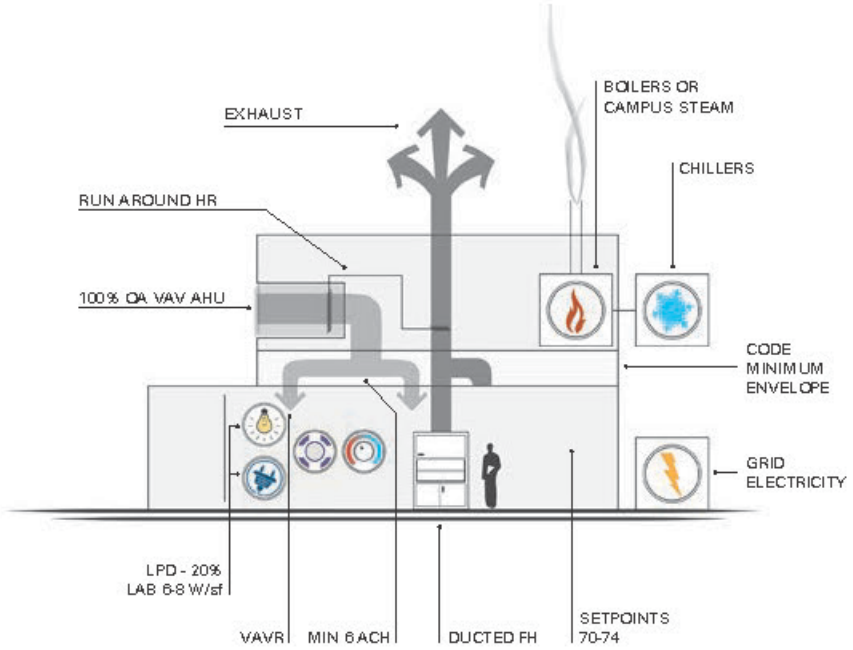


Zero Net Energy

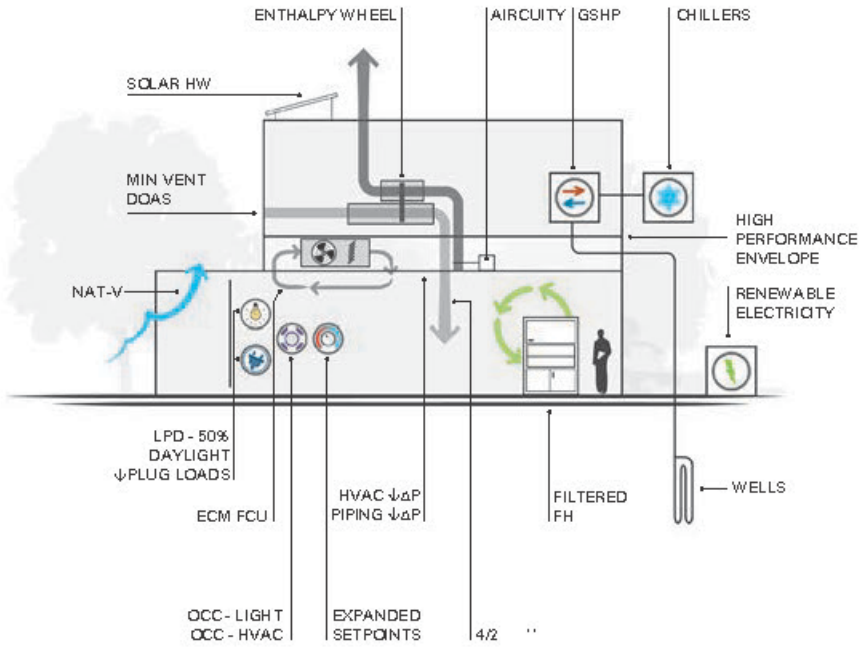
?

BR+A
BARD, RAO
+ ATHANAS
CONSULTING
ENGINEERS

High Performance



Zero Net Energy



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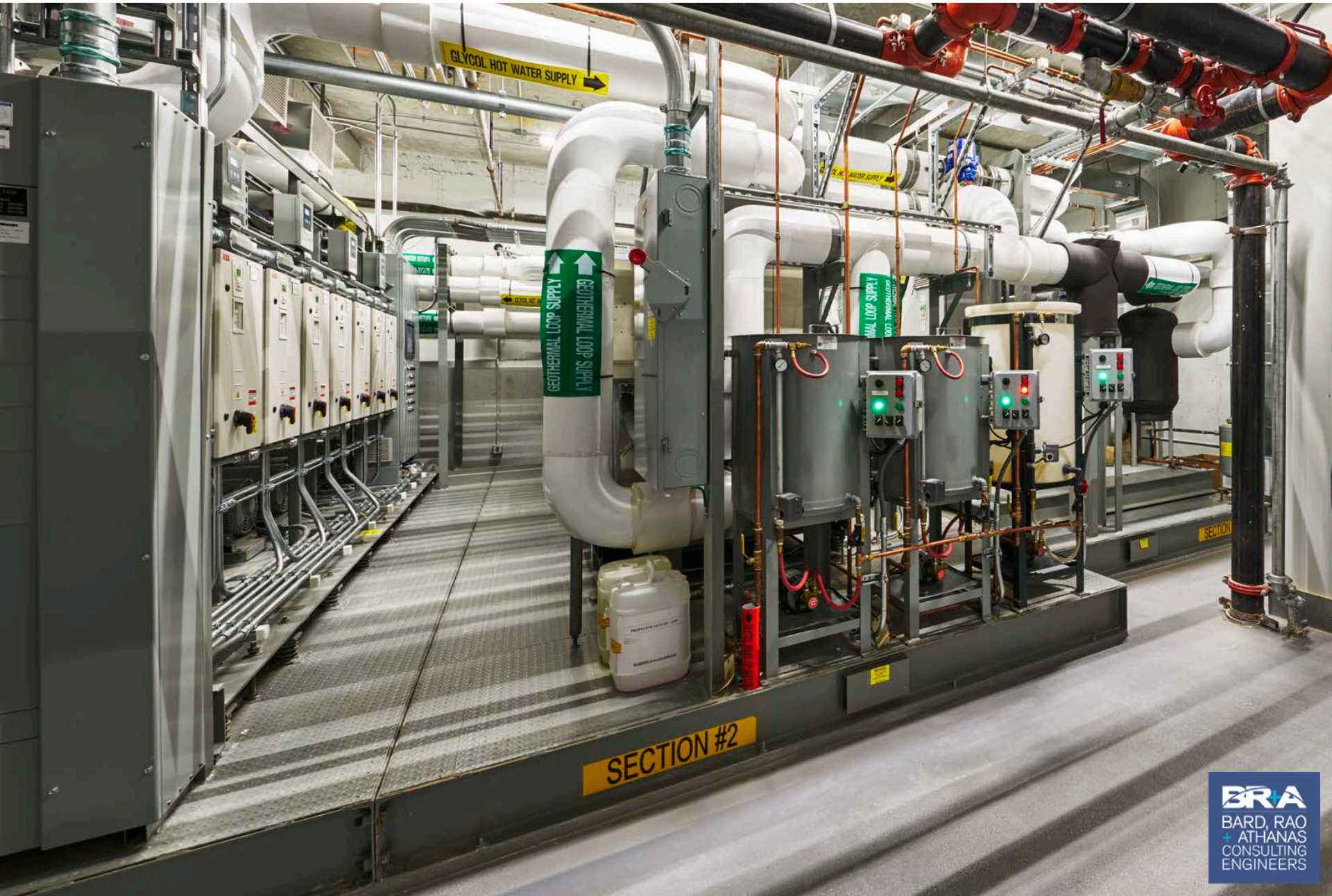
BARD, RAO
+ ATHANAS
CONSULTING
ENGINEERS

ZERO NET ENERGY | GROUND-SOURCE HEAT PUMP



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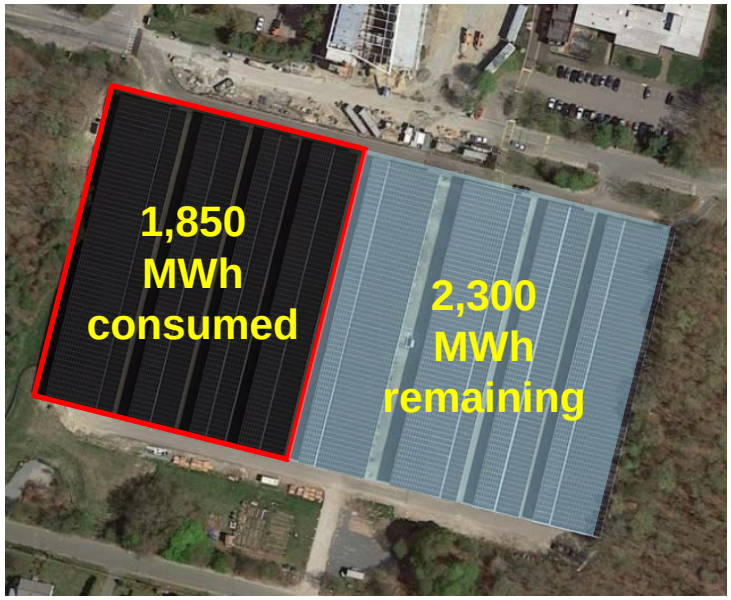
BARD, RAO + ATHANAS CONSULTING ENGINEERS

ZERO NET ENERGY | ON-SITE RENEWABLE ENERGY

ZERO NET ENERGY | MODELED ENERGY CONSUMPTION

High Performance



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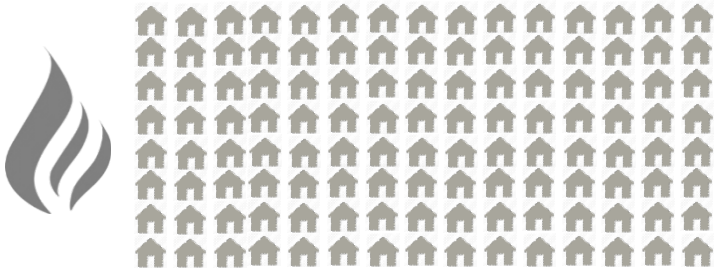

52,500 therms

Zero Net Energy

~0 therms

BRA
BARD, RAO + ATHANAS CONSULTING ENGINEERS

ZERO NET ENERGY | DETAILED CONSTRUCTION COST ESTIMATE

High Performance

TALEVI and HAESCHE, LLC
CONSTRUCTION CONSULTANTS

21 Old Warren Road, West Brookfield, MA 01585
PHONE (508) 867-3222
FAX (508) 867-3993

New Technology and Learning Center
New Construction - Laboratory
Bristol Community College
Fall River, Massachusetts

10-Jun-13

DRAFT for Internal Review

SASAKI - 50% Schematic Design Estimate — Project No: 06387.00

D30 HVAC

Misc. service					
Sleeving,coring,firestopping	20	ea	$235	$4,700	
Coordination Drawings	6	ea	$4,590	$27,540	
Identification	60	ea	$49.80	$2,988	
seismic vibe/isolation	22	ea	$901	$19,822	
Hoisting	2	ea	$8,783	$17,566	
Glycol feed system	1	ea	$2,859	$2,859	
Glycol 50%	1,200	gal	$13.20	$15,840	
				$91,315	$91,315
Cab/Unit & small Coil					
Fin Tube Element only	675	ft	$49.60	$33,480	
Fin Tube Cover only	900	ft	$59.40	$53,460	
Fin Tube Piping Hook Up 3/4 "	25	ea	$1,191	$29,775	
				$116,715	$116,715
Chillers/towers/con					
Air Cooled Chiller,	300	ton	$1,007	$302,100	
Chilled Water Connection Chiller/Heat Exchanger 6"	2	ea	$15,726	$31,452	
				$333,552	$333,552
Pumps & accessories					
Pumps 2-1/2" installedW/ final connection, Insulation	2	ea	$13,304	$26,608	
Pumps 4" installedW/ final connection, Insulation	6	ea	$19,128	$114,768	
Pumps 6" installedW/ final connection, Insulation	2	ea	$26,174	$52,348	
Expansion Tank 150 Gal.	1	ea	$8,937	$8,937	
Expansion Tank 200 Gal.	1	ea	$13,250	$13,250	
Air Separator 6".	2	ea	$11,897	$23,794	
				$239,705	$239,705
AHU & coil connections					
Exhaust Units by CFM inc Energy Coil only	40,000	cfm	$3.40	$136,000	
Air Handling Units by CFM inc Energy Coil	40,000	cfm	$7.60	$304,000	
Air Handling Units by CFM inc Energy Wheel	40,000	cfm	$8.00	$320,000	
AHU Coils 125 to 250 gpm w 2 way control valve 4"	2	ea	$13,282	$26,564	
AHU Coils 250 to 480 gpm w 2 way control valve 5"	4	ea	$18,365	$73,460	
AHU Coils 480 to 800 gpm w 2 way control valve 4" 2high	2	ea	$22,597	$45,194	
				$905,218	$905,218
Hot Water Pipe					
HWS&R Piping w/insulation, Hangers 3/4" Type "L"	4,440	ft	$48.00	$213,120	
HWS&R Piping W/ Insulation , Hangers1" Type "L"	800	ft	$61.40	$49,120	
HWS&R Piping, W/ Insulation, Hangers 11/2" Type "L"	600	ft	$73.20	$43,920	
HWS&R Piping, W/ Insulation, Hangers 2" Type "L"	400	ft	$105	$42,000	
HWS&R Piping, W/ Insulation, Hangers 21/2"	400	ft	$118	$47,200	
HWS&R Piping, W/ Insulation, Hangers 3"	200	ft	$138	$27,600	
HWS&R Piping, W/ Insulation, Hangers 4"	200	ft	$172	$34,400	
HWS&R Piping, W/ Insulation, Hangers 6"	120	ft	$247	$29,640	
				$487,000	$487,000
Chilled Water Pipe					
CHWS&R Piping, W/ Insulation, Hangers1" Type "L"	1,200	ft	$52.40	$62,880	
CHWS&R Piping, W/ Insulation, Hangers11/2" Type "L"	400	ft	$60.80	$24,320	
CHWS&R Piping, W/ Insulation, Hangers 2" Type "L"	400	ft	$90.40	$36,160	
CHWS&R Piping, W/ Insulation, Hangers 2 1/2"	400	ft	$116	$46,400	
CHWS&R Piping, W/ Insulation, Hangers 3"	200	ft	$136	$27,200	
CHWS&R Piping, W/ Insulation, Hangers 4"	200	ft	$170	$34,000	
CHWS&R Piping, W/ Insulation, Hangers 6"	200	ft	$247	$49,400	
				$280,360	$280,360

Sample Page

Zero Net Energy

TALEVI and HAESCHE, LLC
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Hoisting	2	ea	$8,783	$17,566	
Glycol feed system	1	ea	$2,859	Not Required	
Glycol 50%	1,200	gal	$13.20	Not Required	
Aircuity System	1	ea	$30,000	$30,000	
				$102,616	$102,616
Cab/Unit & small Coil					
Fin Tube Element only	675	ft	$49.60	$33,480	
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Air Cooled Chiller,	300	ton	$1,007	Not Required	
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				$47,460	$47,460
Pumps & accessories					
Pumps 2-1/2" installedW/ final connection, Insulation	2	ea	$13,304	$26,608	
Pumps 4" installedW/ final connection, Insulation	6	ea	$19,128	$114,768	
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				$263,758	$263,758
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HWS&R Piping W/ Insulation , Hangers1" Type "L"	800	ft	$61.40	$49,120	
HWS&R Piping, W/ Insulation, Hangers 11/2" Type "L"	600	ft	$73.20	$43,920	
HWS&R Piping, W/ Insulation, Hangers 2" Type "L"	400	ft	$105	$42,000	
HWS&R Piping, W/ Insulation, Hangers 21/2"	400	ft	$118	$47,200	
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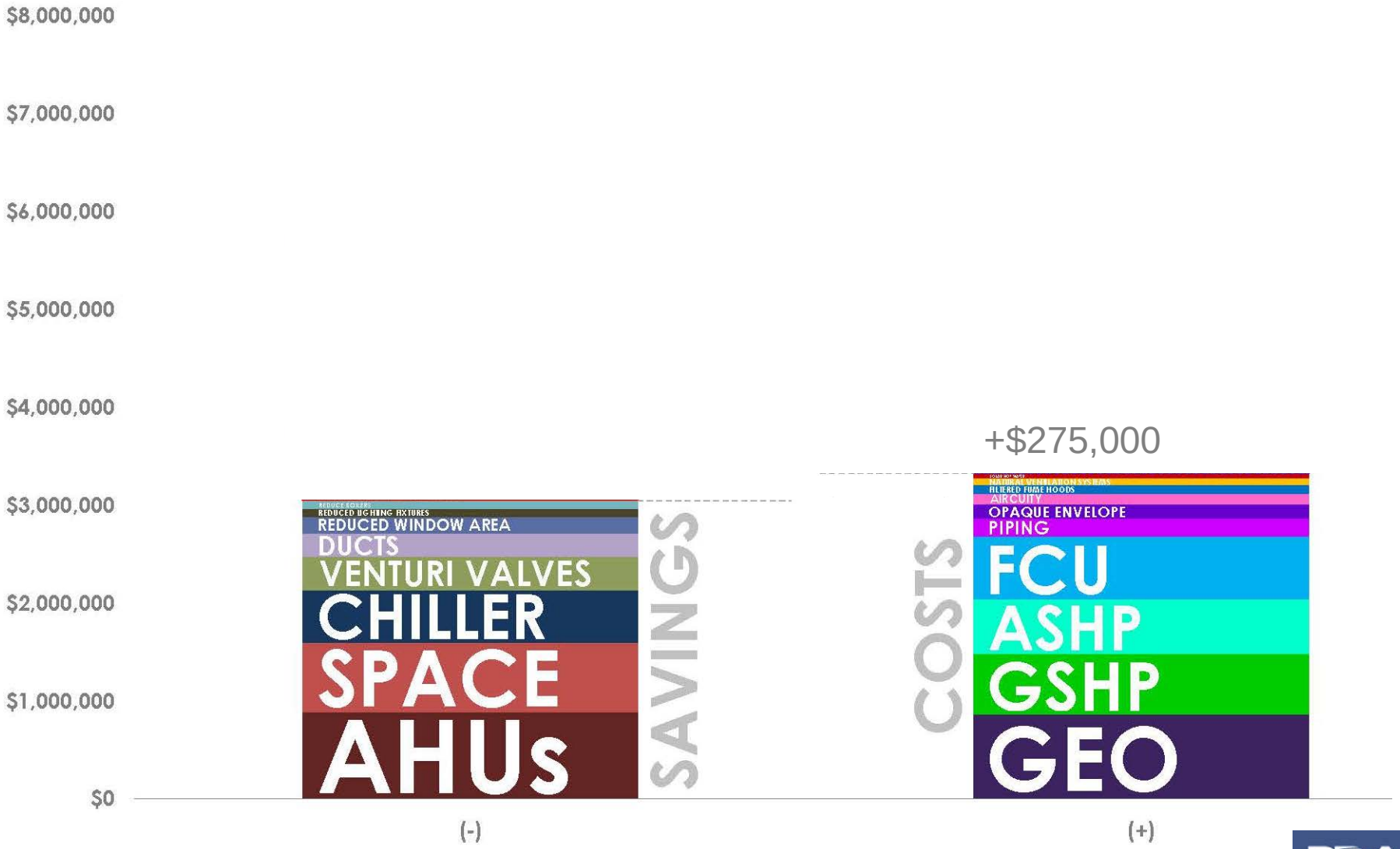
HWS&R Piping, W/ Insulation, Hangers 4"	200	ft	$172	$34,400	
HWS&R Piping, W/ Insulation, Hangers 6"	120	ft	$247	Not Required	
				$534,640	$534,640
Chilled Water Pipe					
CHWS&R Piping, W/ Insulation, Hangers1" Type "L"	3,600	ft	$52.40	$188,640	
CHWS&R Piping, W/ Insulation, Hangers11/2" Type "L"	400	ft	$60.80	$24,320	
CHWS&R Piping, W/ Insulation, Hangers 2" Type "L"	400	ft	$90.40	$36,160	
CHWS&R Piping, W/ Insulation, Hangers 2 1/2"	400	ft	$116	$46,400	
CHWS&R Piping, W/ Insulation, Hangers 3"	200	ft	$136	$27,200	
CHWS&R Piping, W/ Insulation, Hangers 4"	200	ft	$170	$34,000	
CHWS&R Piping, W/ Insulation, Hangers 6"	200	ft	$247	Not Required	
				$356,720	$356,720

Sample Page

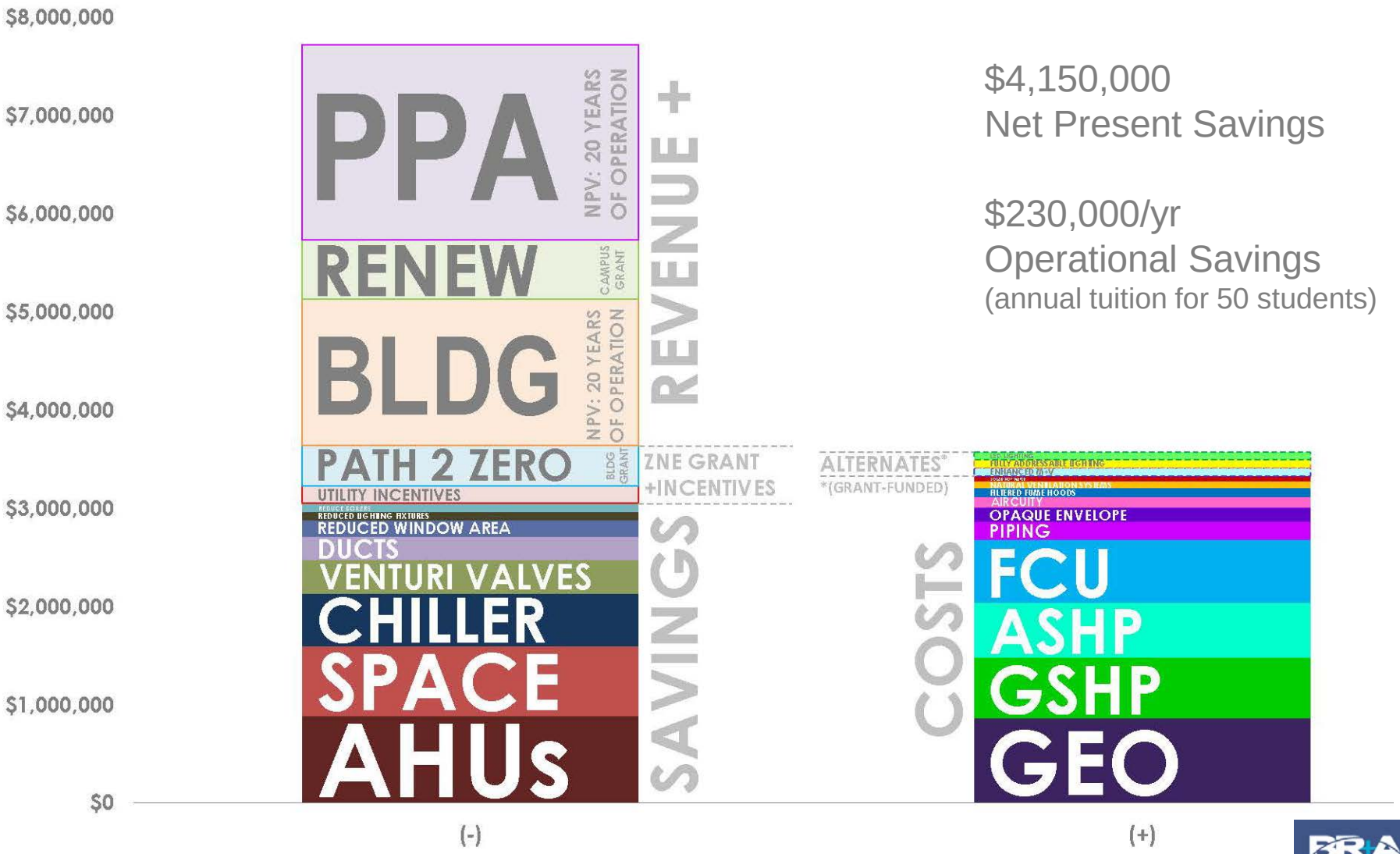
BARD, RAO + ATHANAS CONSULTING ENGINEERS

ZERO NET ENERGY | CONSTRUCTION COST



BARD, RAO + ATHANAS CONSULTING ENGINEERS

ZERO NET ENERGY | LIFE CYCLE COST



$4,150,000
Net Present Savings

$230,000/yr
Operational Savings
(annual tuition for 50 students)

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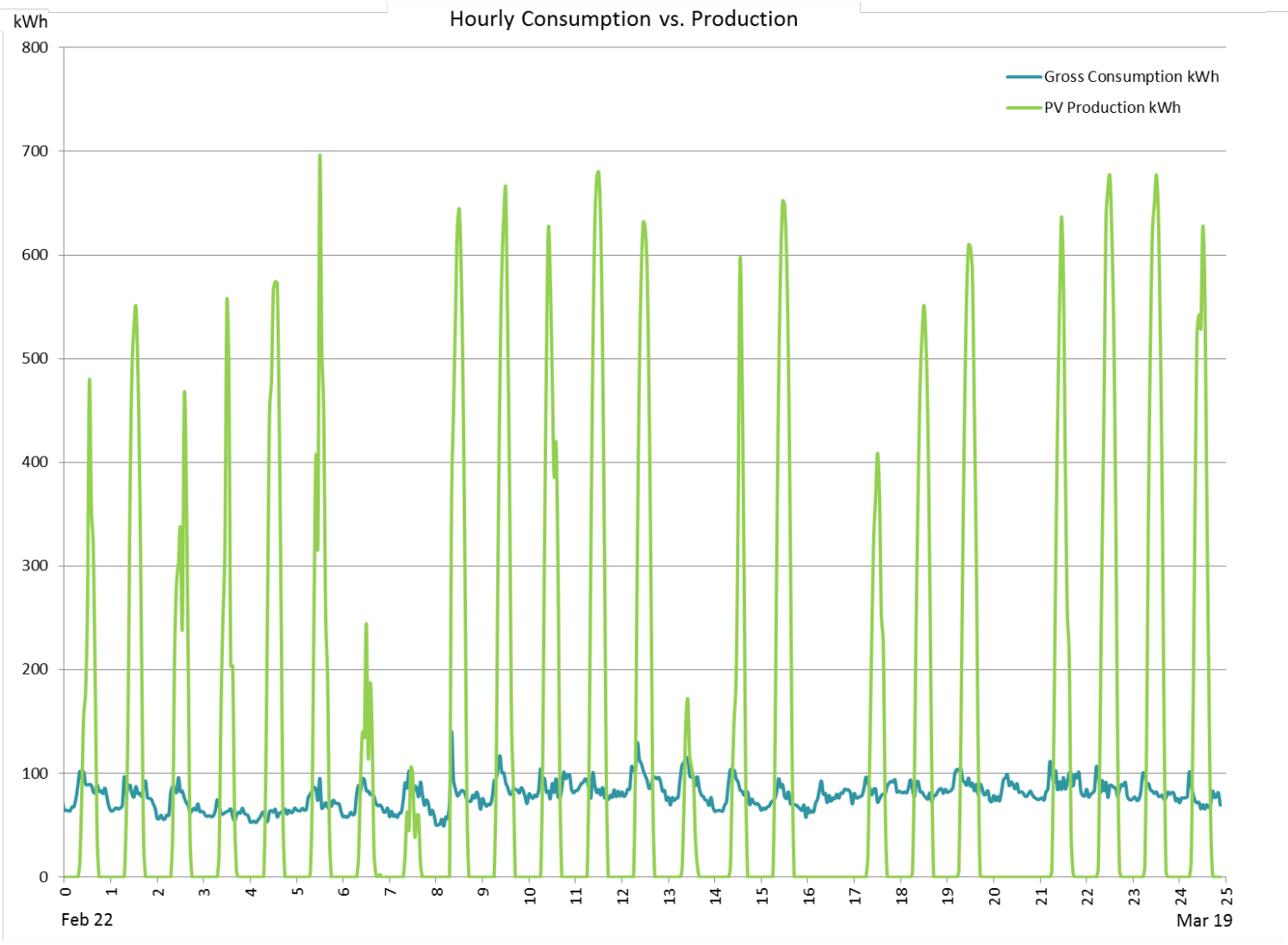
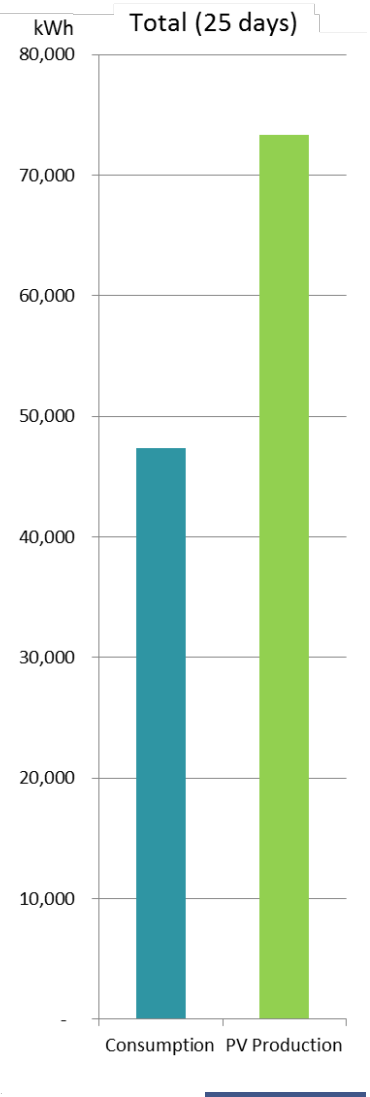
ZERO NET ENERGY | MEASURED RESULTS





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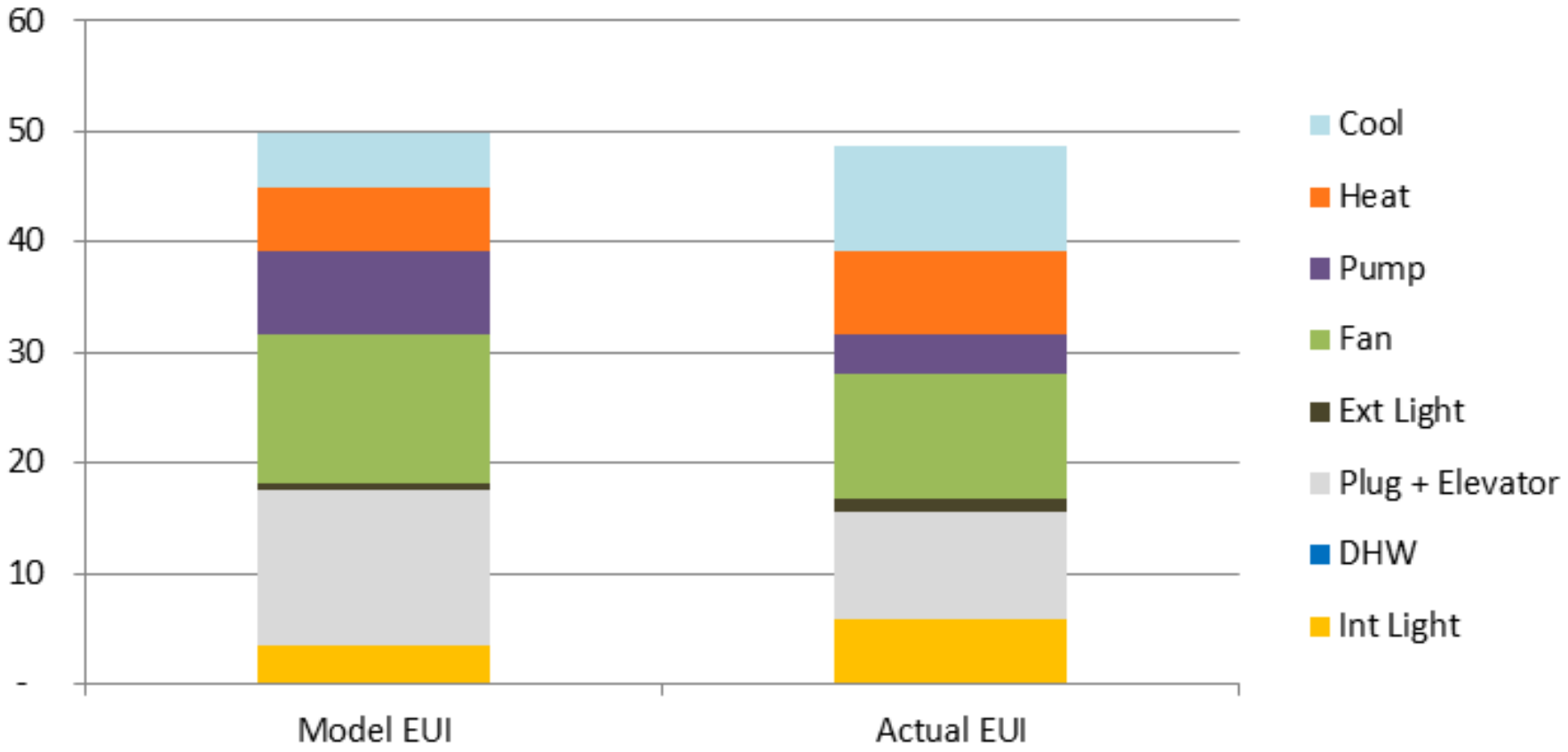
ZERO NET ENERGY | MODELED VS. MEASURED RESULTS



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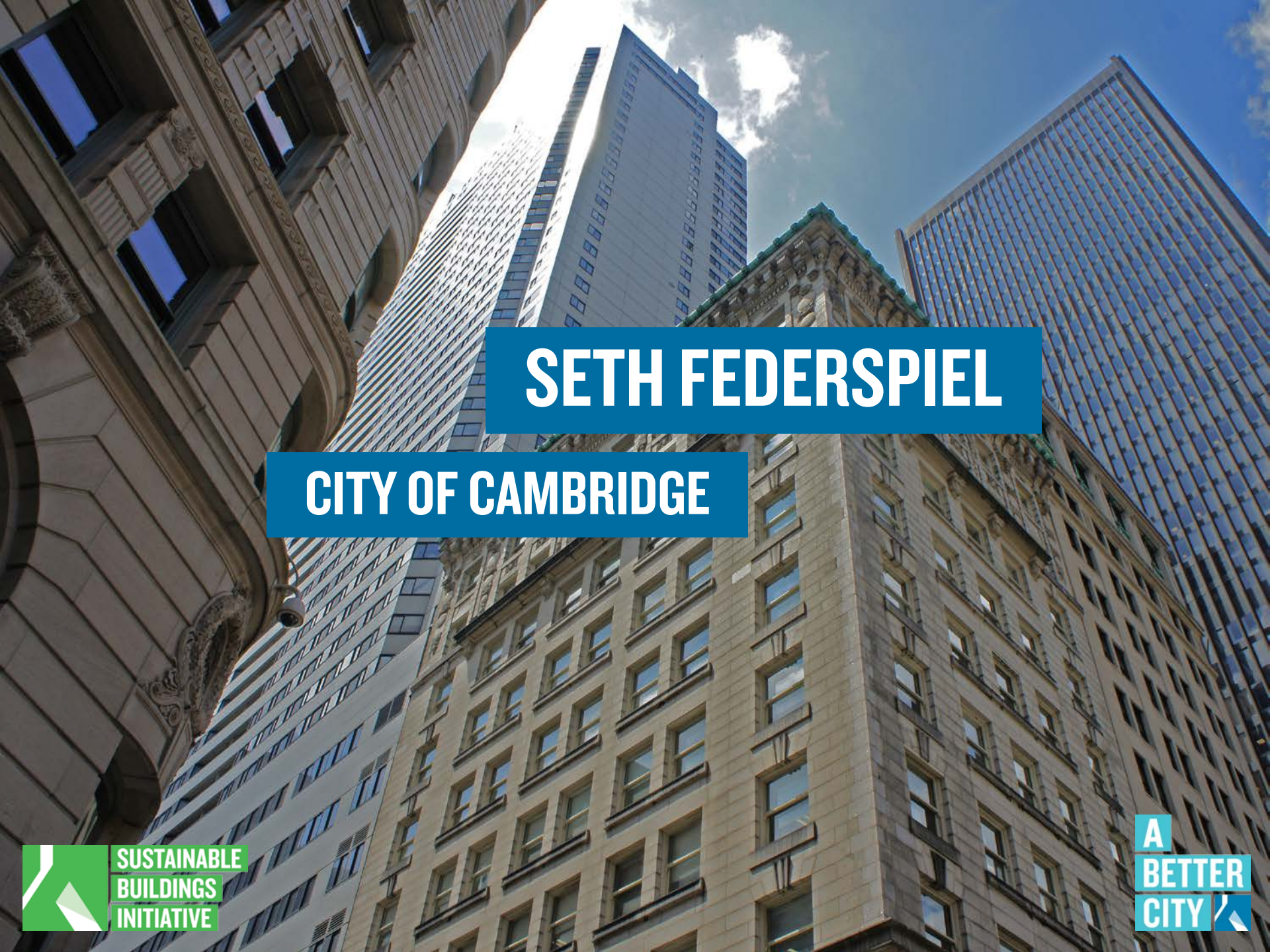
JILL KAEHLER
BEHNISCH ARCHITEKTEN
SUSTAINABLE
BUILDINGS
INITIATIVE
A
BETTER
CITY

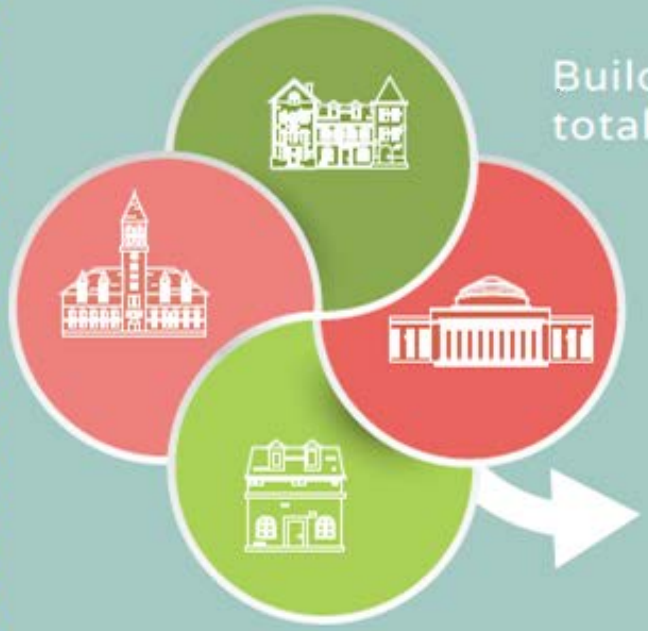

SETH FEDERSPIEL
CITY OF CAMBRIDGE
SUSTAINABLE
BUILDINGS
INITIATIVE
A
BETTER
CITY

City of Cambridge
Getting to Net Zero Action Plan
2015-2040

1 THE CLIMATE IMPERATIVE

Climate change poses a growing set of risks and challenges to cities.

Combating climate change needs to **start locally**



Buildings generate over 80% of Cambridge's total greenhouse gas emissions.

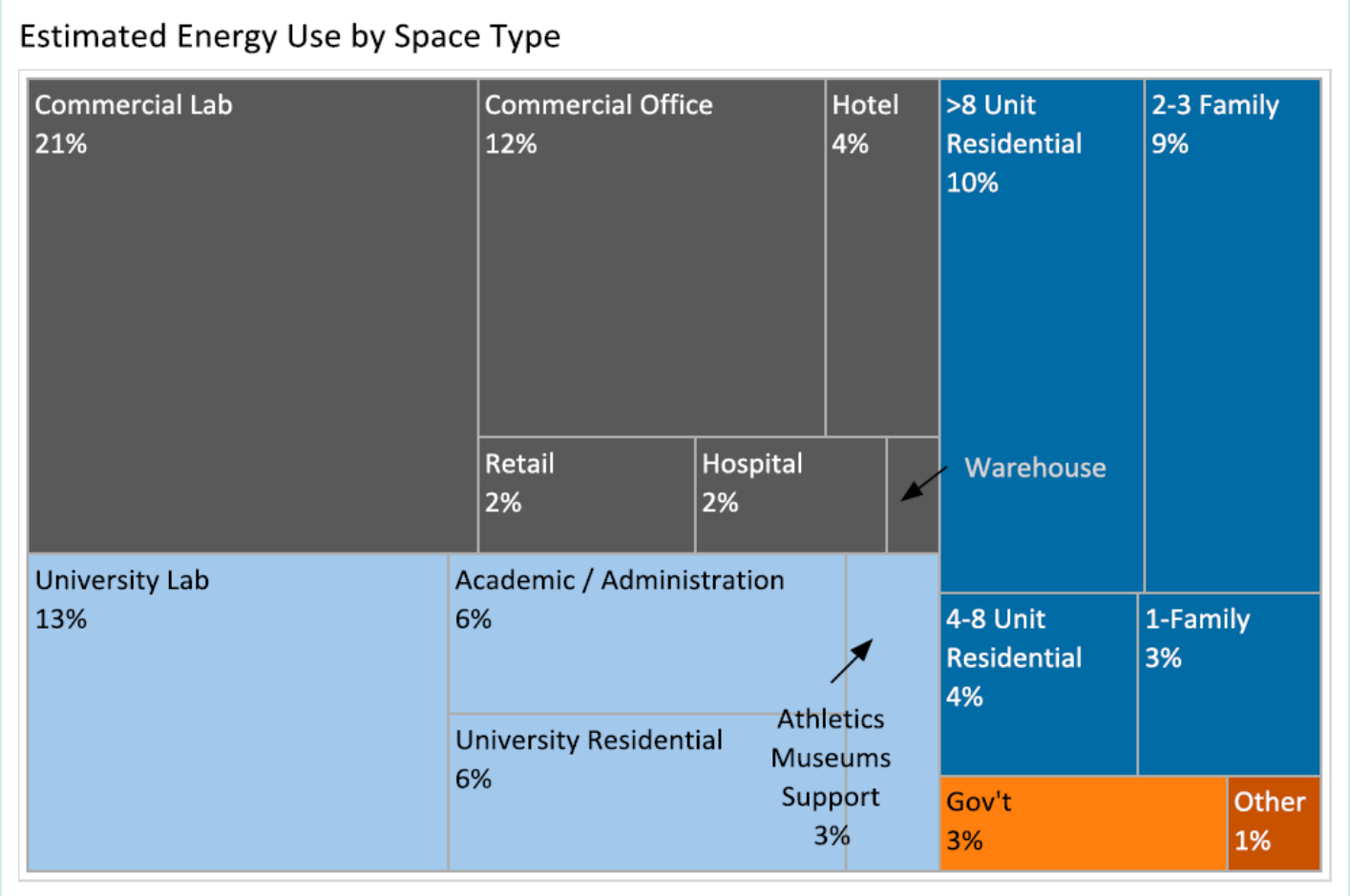
That is why it is Cambridge's aim to achieve

NET ZERO EMISSIONS

from buildings.

Residents, universities, businesses and the City are collaborating to address the immediacy of the climate imperative.

Energy Use in Cambridge



Net Zero Action Plan: The Impetus

- Significant construction activity in the city and concern that any new development makes reducing GHGs harder, unless Net Zero
- Zoning petition filed by residents requiring all new buildings to be Net Zero or annual offsets required (Connolly Petition)
- City Council instead charged Getting to Net Zero Taskforce with developing plan within 12 months
- Net Zero Action Plan adopted by Council on June 22, 2015

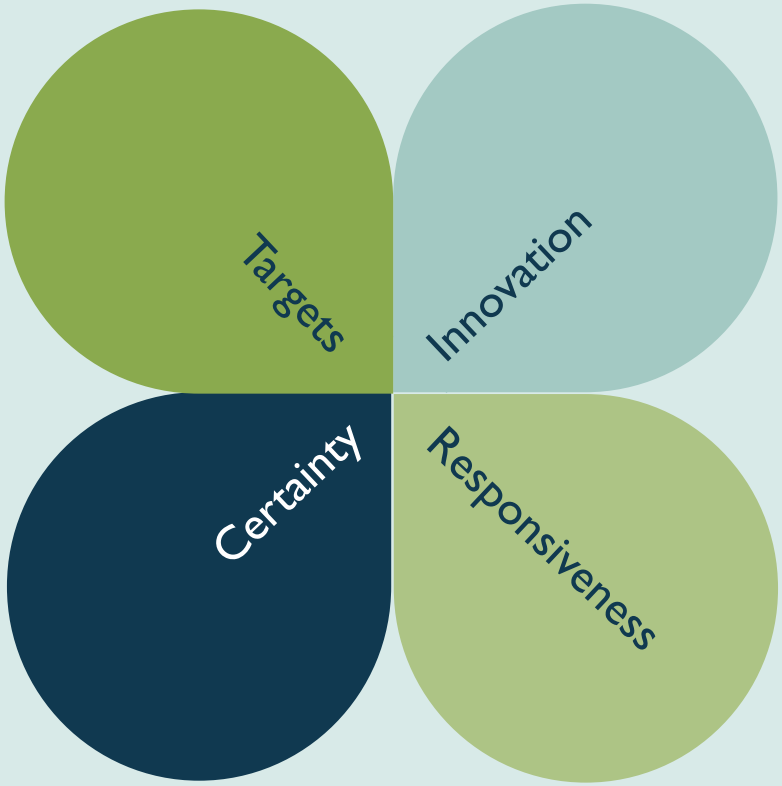
Goal is Game Changing

- All sectors are involved: government, universities, residents and business
- *How* do we get there, not *can* we get there?
- Demonstrates that bold strategies are needed. Current best practice won't get us there

Net Zero Task Force

Jane Carbone,
Director of Development, Homeowner's Rehab, Inc.
Caitriona Cooke,
Program Director, Conservation Services Group
Henrietta Davis,
Resident and former Mayor of Cambridge
Emily Grandstaff-Rice,
Resident (2014), Boston Society of Architects, Cambridge Seven Associates
Heather Henriksen,
Director of the Office for Sustainability, Harvard University
Shawn Hesse,
Architect, Sustainability Expert at Emersion Design
Marc Hoffman,
Resident and Energy Efficiency Advisor
Bill Kane,
Vice President of Leasing & Development, BioMed Realty
Andrea Love,
Resident, and Director of Building Science, Payette Architects
Paul Lyons,
Resident and President, Zapotec Energy, Inc.
Joseph Maguire,
V. P. of Development & Asset Management Services, Alexandria Real Estate Equities
Julie Newman,
Director of Sustainability, Massachusetts Institute of Technology
Tom Sieniewicz,
Resident and Planning Board member, City of Cambridge
Barun Singh,
Resident and Founder & CTO of Wegowise
Quinton Zondervan,
Resident and Executive Director, Climate Action Liaison Coalition

The Framework



The Net Zero Framework is a balance of:

- Defined targets
- A process to adapt and respond to changes in the market and technology
- Costing & impact / opportunity assessment when appropriate
- Regulations & incentives
- New construction & existing buildings
- Equally targets savings from all sectors (no one sector is punished)

2

WHAT IS NET ZERO?

A community of buildings for which, annually, all greenhouse gas emissions produced through building operations are offset by carbon-free energy production.

THE TARGET:

Net zero annual emissions from buildings citywide.

3

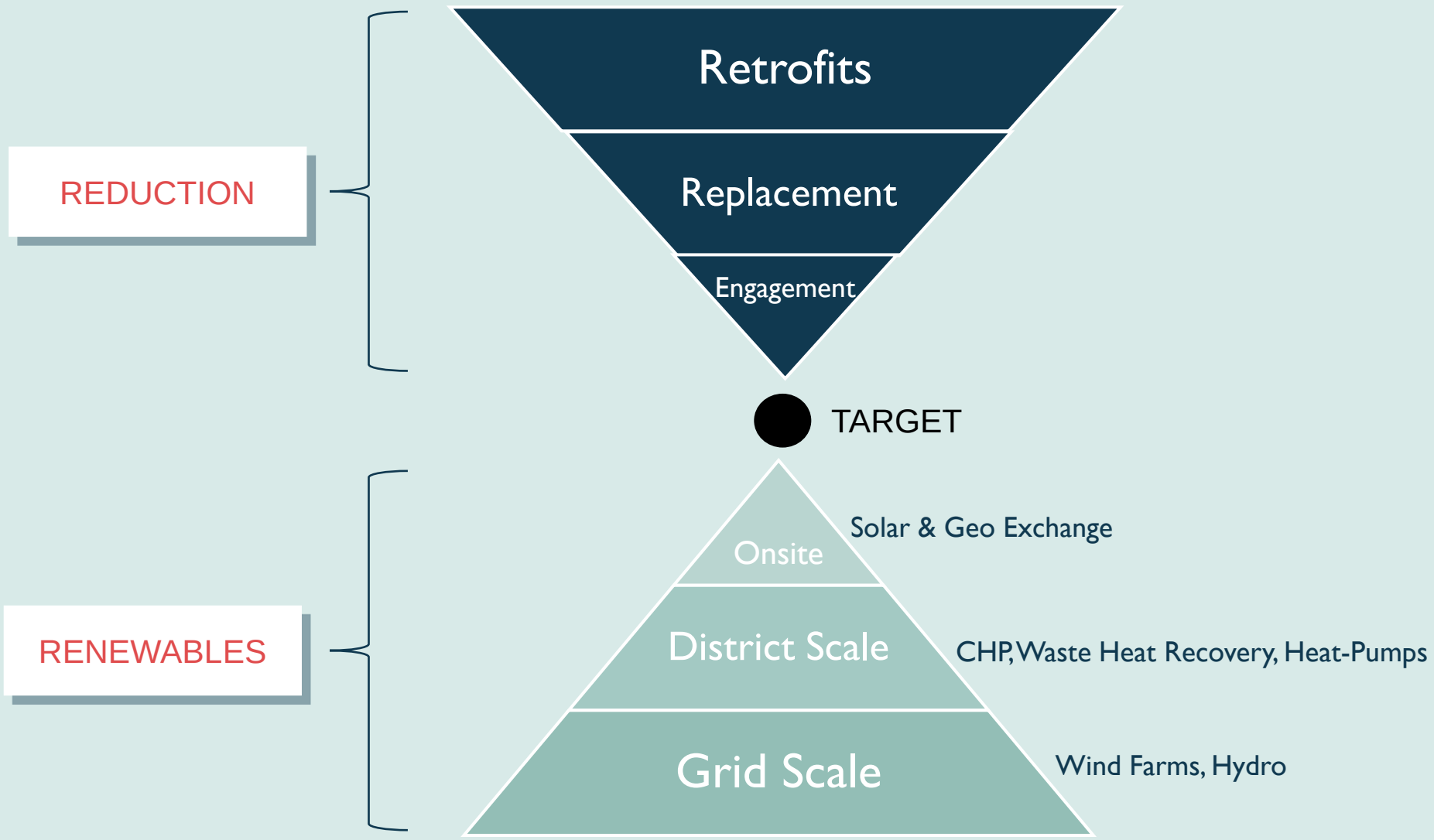
HOW TO ADDRESS CARBON REDUCTION

There are **3** ways to reduce emissions from buildings:

EFFICIENT DESIGN & RETROFITS

IMPROVED OPERATIONS

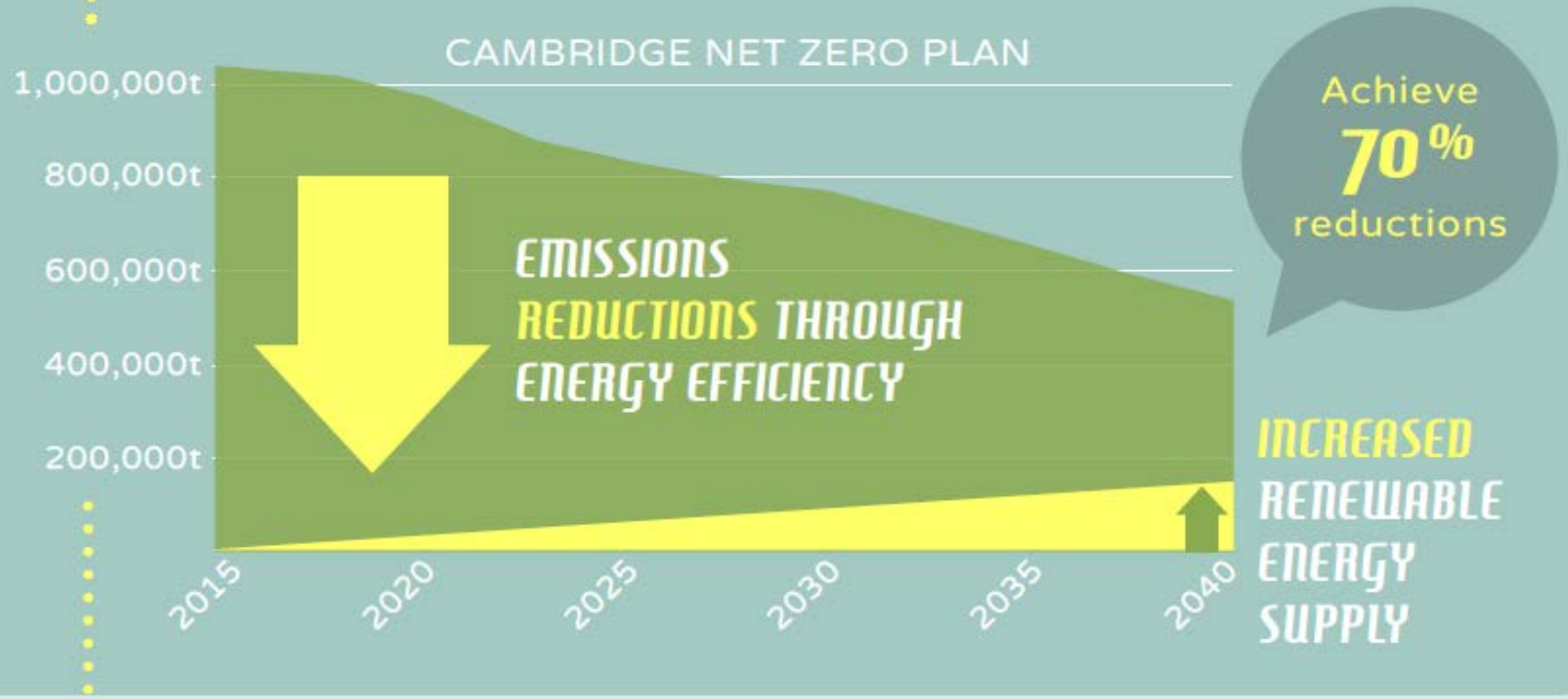
RENEWABLE ENERGY SUPPLY


REDUCTION
Retrofits
Replacement
Engagement
TARGET
RENEWABLES
Onsite
Solar & Geo Exchange
District Scale
CHP, Waste Heat Recovery, Heat-Pumps
Grid Scale
Wind Farms, Hydro

4

THE 25-YEAR NET ZERO STRATEGY

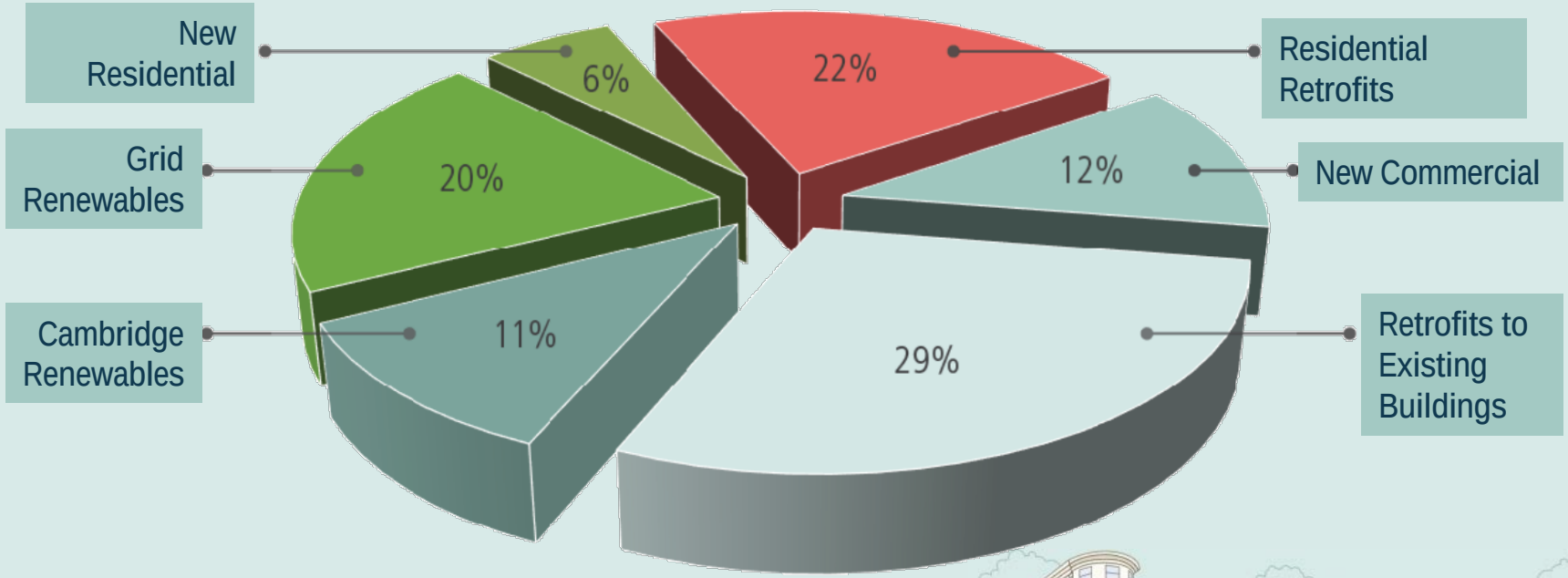
The net zero action plan aims to cut energy demand significantly, and replace fossil fuels with renewable energy.



Cambridge Emissions Reduction Model

Key Actions:

1. Retrofits to Existing Buildings
2. Net-Zero New Construction
3. Energy Supply
4. Local Carbon Fund
5. Engagement & Capacity Building



THE PATH TO A NET ZERO CAMBRIDGE

Net Zero New Construction Targets

Type:	Municipal	Residential	Multi-Family	Commercial	Institutional	Labs
Target year:	2020	2022	2025	2025	2025	2030

The **criteria** that will be evaluated in order to determine the the feasibility is:

- Number of Net Zero Buildings in that building type
- Technical feasibility/industry capacity
- Access to renewable energy
- Economics including NPV analysis
- Contribution to other goals such as resiliency

Key Actions for Commercial Buildings

- New Buildings
  - Zoning
    - Green Building Ordinance (LEED)
    - Rooftop Solar Ready Requirement
    - Removal of Barriers to Increased Insulation
  - Incentives
    - Market Based Incentive Program
    - Height and FAR Bonus

Key Actions for Commercial Buildings

- Existing Buildings
  - Regulations
    - Building Energy Use Disclosure Ordinance (BEUDO)
    - Upgrades at Time of Renovation or Sale
    - Operations and Maintenance Planning
  - Incentives
    - Custom Retrofit Program

Key Actions for Commercial Buildings

- Enabling Actions
  - Low Carbon Energy Supply Strategy
  - Local Carbon Fund Development
  - Communications Strategy

Challenges and Next Steps

- Regulatory Barriers (i.e.: state building code)
  - Stretch Energy Code
  - Collaborative work towards performance-based standards
- Technical Barriers
  - Energy Efficiency Plans and Grid Modernization
  - Net Zero Labs Working Group
  - Joint renewable energy procurement

Thank You!

www.cambridgema.gov/netzero

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(617) 349-4674

AMY LONGSWORTH

GREEN RIBBON COMMISSION

SUSTAINABLE BUILDINGS INITIATIVE

A BETTER CITY


A
BETTER
CITY