Helping Massachusetts Municipalities Create a Greener Energy Future

COMMONWEALTH OF MASSACHUSETTS

Charles Baker, Governor
Kathleen Theoharides, Secretary
Patrick Woodcock, Commissioner

Planning and Building High-Performing and Net Zero Buildings

Green Communities Division Webinar

April 15, 2021

Green Communities Division

The energy hub for ***all*** Massachusetts cities and towns, not just designated Green Communities.

Helping Massachusetts Municipalities Create a Clean, Affordable, and Resilient Energy Future

Green Communities Division - Programs & Resources for Municipalities

- Green Communities Designation and Grant Program
- MassEnergyInsight energy tracking and analysis tool
- Municipal Energy Technical Assistance
- Website filled with tools & resources
  www.mass.gov/orgs/green-communities-division
- Email updates via e-blasts – Sign up by sending an email to:
  join-ene-greencommunities@listserv.state.ma.us

Green Communities Regional Coordinators

- Regional Coordinators act as direct liaisons with cities and towns on energy efficiency and renewable energy activities
- Located at each of the DEP Regional Offices:

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Helping Massachusetts Municipalities Create A Greener Energy Future

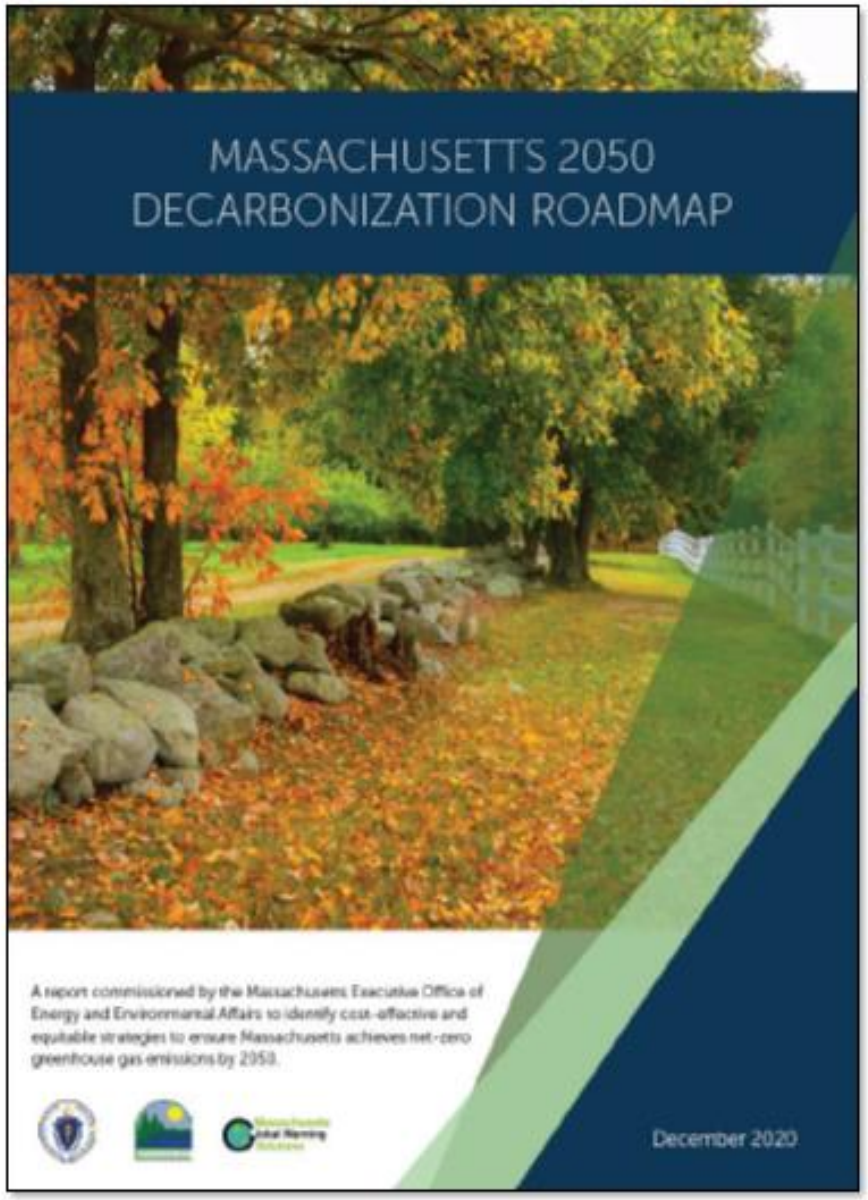
Recording & Presentation

- The webinar is being recorded and will be available on our website in approximately 48 hours at:
  www.mass.gov/orgs/green-communities-division-massdoer
- Click on the camera icon top right of your screen to save any slides for future reference
- Use the Q & A icon on your screen to type in questions

Climate Bill Signed March 2021

The legislation signed by Governor Baker updates the greenhouse gas emissions limits related to the 2008 Global Warming Solutions Act, commits Massachusetts to achieve **Net Zero emissions in 2050**, and authorizes the Secretary of Energy and Environmental Affairs (EEA) to establish an emissions limit of no less than **50% for 2030**, and no less than **75% for 2040**.

State Policy Goals

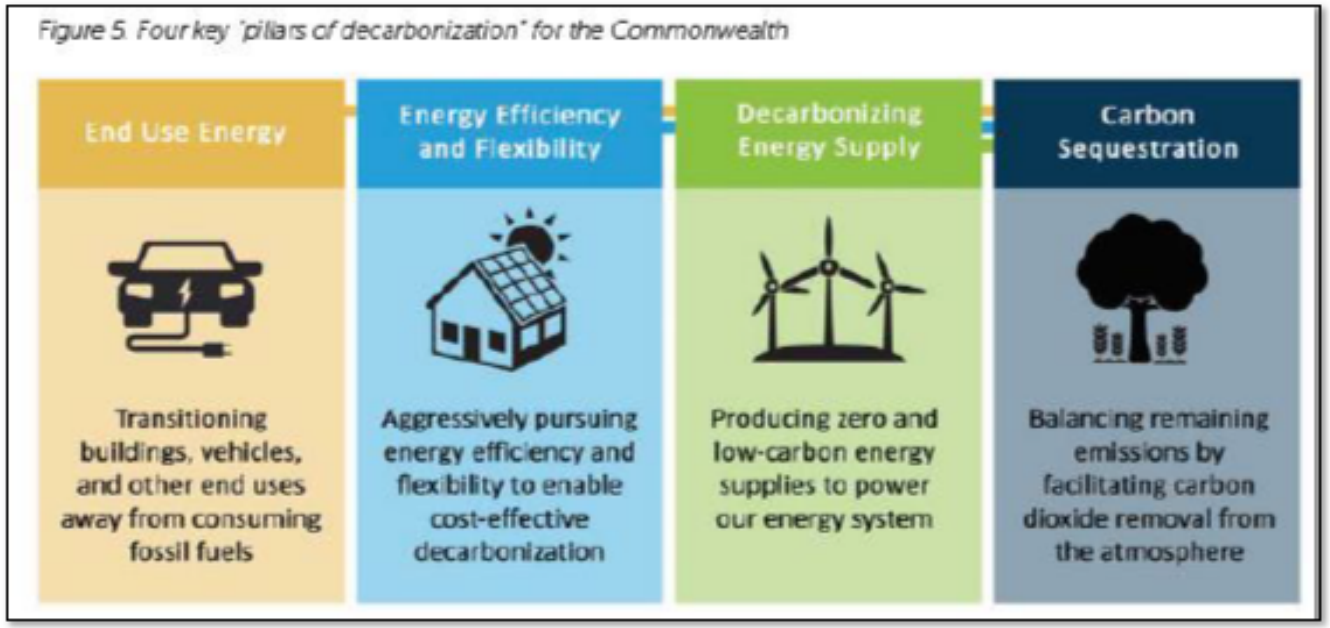


- Two Year Research Effort
- Comprehensive Understanding of 30-year Transition to Net Zero
- Focused on Implementation
- Inform Near-Term Decision-Making
- Results Published Dec. 30, 2020

Strategies to Achieve Net Zero

4 key components of deep decarbonization guided development of implementation strategies:

Figure 5. Four key "pillars of decarbonization" for the Commonwealth



To reduce emissions from energy demand in end uses through electrification, fuel switching, efficiency, and flexibility.

To reliably supply low-to-zero carbon energy resources to Massachusetts residents.

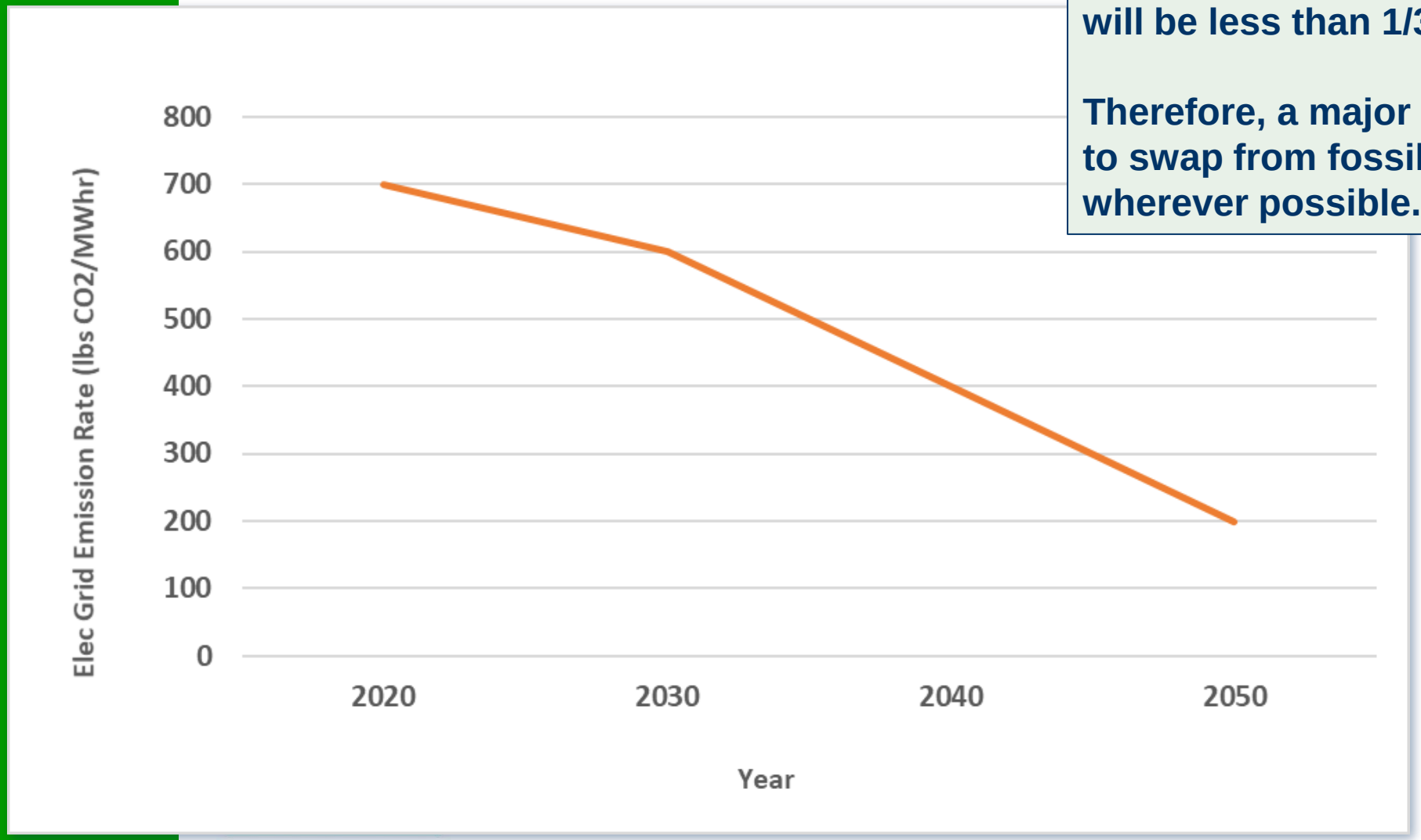
To minimize residual emissions and maximize cost-effective carbon dioxide removal and storage.

For More Information: www.mass.gov/2050Roadmap

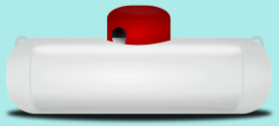
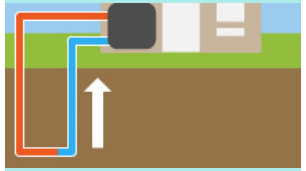
How We'll Get There

Massachusetts electric grid emissions are declining significantly. By 2050, grid emissions will be less than 1/3 of what they are today.

Therefore, a major emission reduction strategy is to swap from fossil fuel to efficient electric grid wherever possible.



DOER
Massachusetts Department of Energy Resources

OIL	PROPANE	GAS	ELECTRIC RESISTANCE	ELECTRIC COLD CLIMATE AIR SOURCE HEAT PUMP	ELECTRIC GROUND SOURCE HEAT PUMP
					

Pounds of emissions to deliver 1 MMBtu of heat into a space (in 2020)

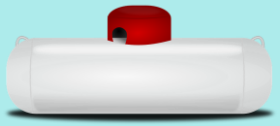
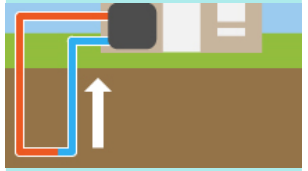
170	145	120	205	65	45

45% Less

Helping Massachusetts Municipalities Create a Clean, Affordable, and Resilient Energy Future

GREEN COMMUNITIES
Massachusetts
DEPARTMENT OF ENERGY RESOURCES

DOER
Massachusetts Department of Energy Resources

OIL	PROPANE	GAS	ELECTRIC RESISTANCE	ELECTRIC COLD CLIMATE AIR SOURCE HEAT PUMP	ELECTRIC GROUND SOURCE HEAT PUMP
					

Pounds of emissions to deliver 1 MMBtu of heat into a space (in 2050)

170	145	120	~~205~~ 59	~~65~~ 18	~~45~~ 13

85% Less

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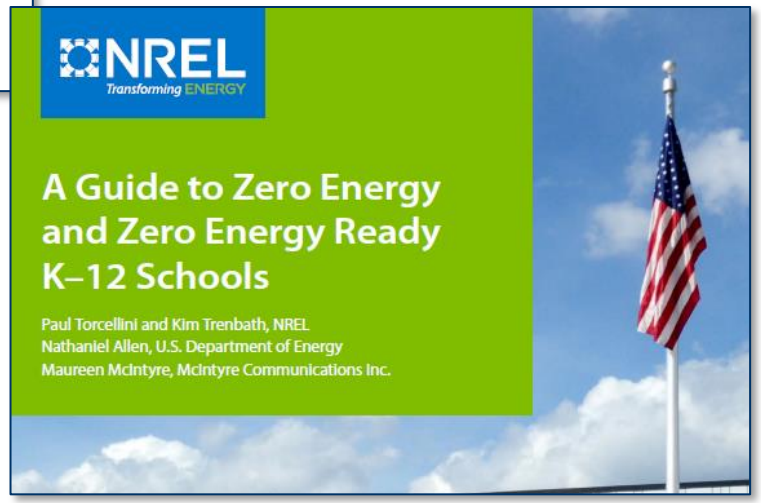
Zero Emission buildings…

- ✓ **Maintenance friendly**
- ✓ **Cost parity; cost savings**
- ✓ **Less complicated**



Today's Presenters

- ***Denise Rouleau*** – New Construction Program Manager, MassSave™, National Grid
- ***Roberto Fitzgerald*** – AIA, LEED AP, Dore & Whittier Architecture/Project Management
- ***Mike Quinlan*** – Chair, Medfield School Building Committee, AIA, Compass Project Management

DOER Planning and Building High Performing Buildings

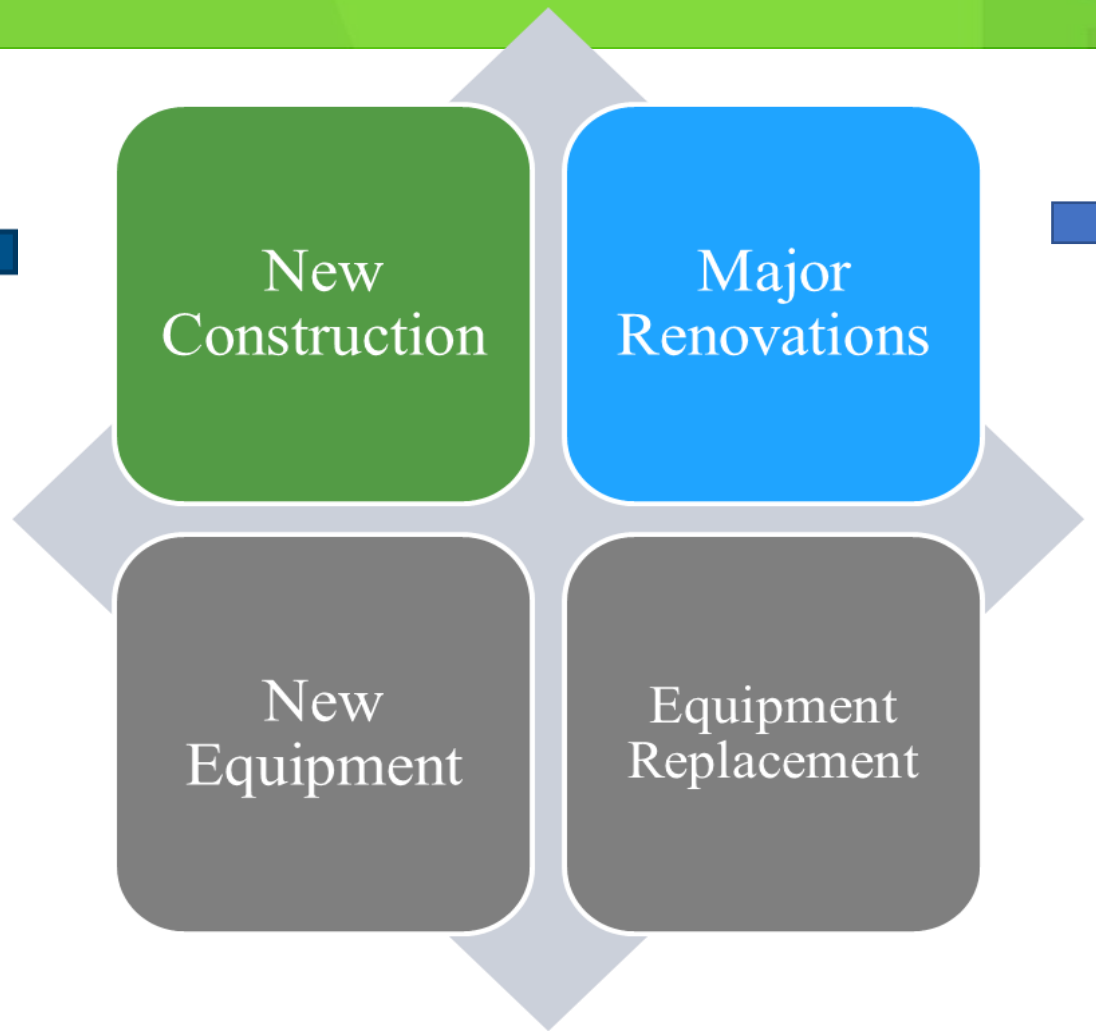
Denise Rouleau, National Grid

April 15, 2021

Who is Mass Save?

“Helping residents and businesses across Massachusetts save money and energy, leading our state to a clean and energy efficient future”

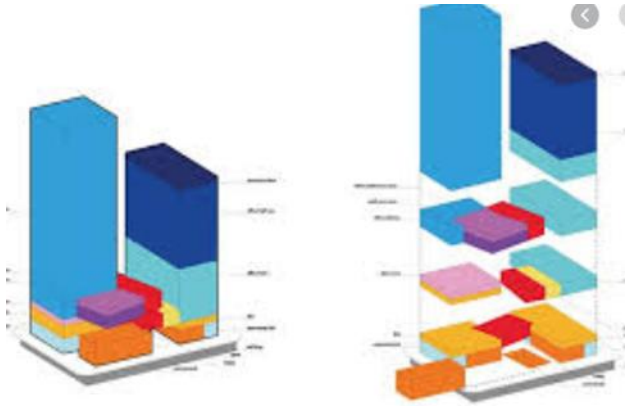
- Ground-up
- Addition



- Change of use
- New tenant
- Ex. Retail to office

When Should We be Reaching Out?

Need Engagement



Terminology Primer

- Energy Use Intensity (kBtu/sf/yr)
- Allows comparison between buildings

EUI

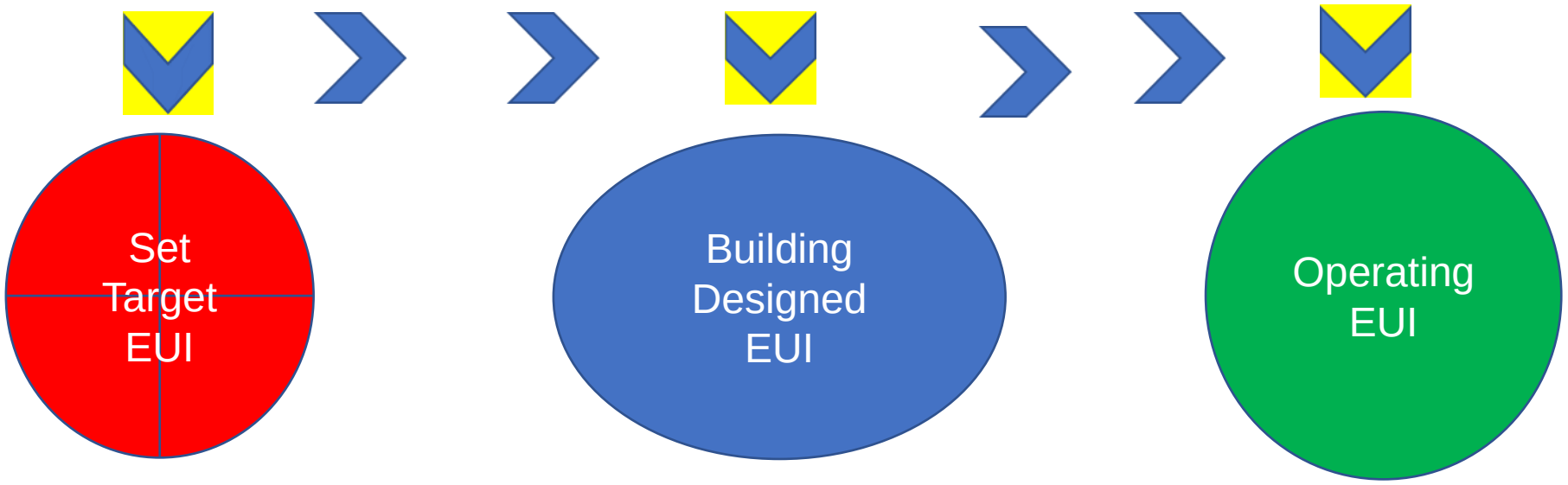
- Buildings that consume as much energy as they produce over a 1 year period
- Related terms: zero net ready, zero net carbon, zero net emissions

Zero Net Energy

The Future!

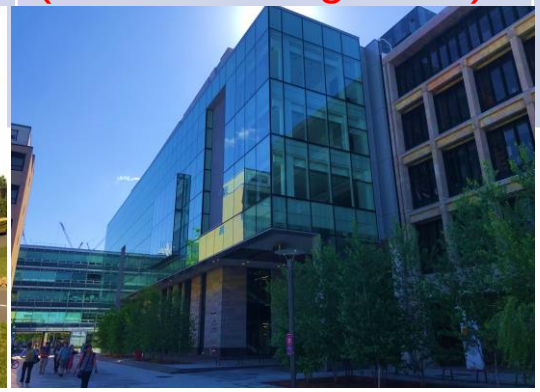
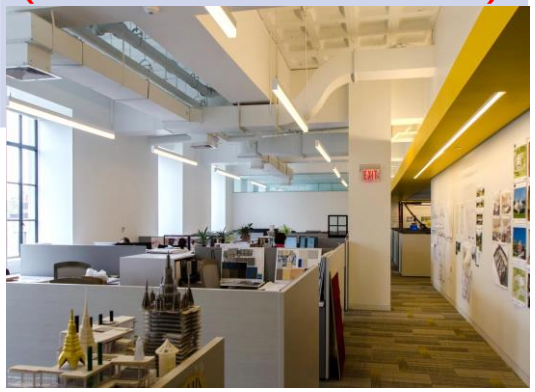
Program EUI Pivot

- A Focus on EUI = More Efficient Building



C&I New Construction Program Pathways

A Path for Each New Construction Project

Path 1	Path 2	Path 3	Path 4
Zero Net Energy/Deep Energy Savings (20,000 sf or greater)	Whole Building EUI Reduction - modeling required (50,000 sf or greater)	Whole Building Streamlined - modeling not required (20,000 sf – 100,000)	System - Prescriptive and limited Custom (<20,000 sf and Other)
			
K-12 School	Large Lab Building	Senior living	Interiors project

Path 1: Zero Net Energy/Deep Energy Savings

USGBC Green Building of the Year 2019

Cambridge King Open/Cambridge Street Upper School

- Opened Fall 2019
- All electric
- About 1,000,000 in annual kWh savings

Intent

- Drive projects toward ZNE and low EUI in operation - focus on outcomes

Requirements

- ZNE or Zero Net Ready
- Minimum 20,000 sf heated and cooled space
- Engage Mass Save Sponsors by early schematic
- Achieve 25 site EUI or lower
- Participate through post-occupancy period

Incentives

- Mass Save Sponsors provides a zero net energy expert and cost shares services
- Final incentives based on actual performance
  - Construction incentive
  - Post occupancy incentive
- Certification incentives
- Design team incentives

Path 1: Zero Net Energy/Deep Energy Savings

Customer Incentives		
Construction Incentive	Paid if project design achieves 25 EUI or negotiated EUI target	$1.25/sf
Post Occupancy Incentive	Available after 1-year post-occupancy period if project achieves target EUI	$1.00/sf
ZNE or PH Certification Incentive	Paid for project ZNE or PH certification	$3,000
Verification Incentive	Optional scope to conduct data review to identify and correct issues	50% of fee up to $10,000
Design Team Incentives		
Calculated at $0.20/sf and capped at $15,000, but not less than $8,000 per project		

Path 2: Whole Building EUI Reduction

Intent

- Drive projects toward low EUIs

Requirements

- Minimum 50,000 sf of heated and cooled space
- Early engagement in design development
- Projects must anticipate at least 10% EUI reduction

Incentives

- Tiers – incentive rates increase with deeper savings
- Design team incentives up to $15k
- Energy modeling required – program sponsors cover 75% of fee

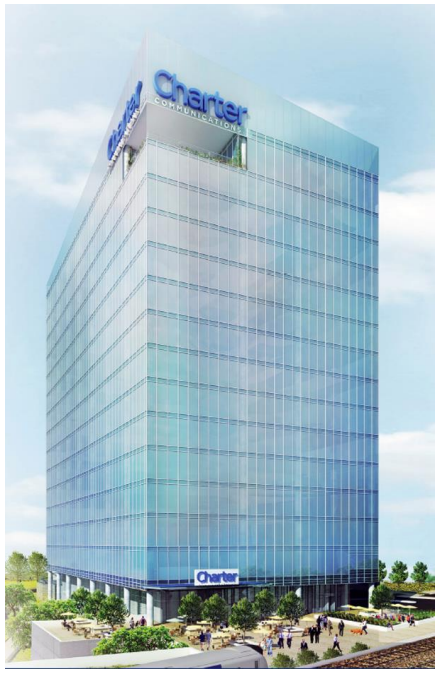
Path 2: Whole Building EUI Reduction

Customer Incentives	
Percent EUI Reduction	Rate
10.0% - 14.9%	$0.35/sf
15.0% - 19.9%	$0.50/sf
20.0% - 24.9%	$0.75/sf
25.0% and above	$1.25/sf
Verification incentive	50% of fee up to $10,000
Design Team Incentives	
Based on Percent EUI Reduction	Rates Vary by Tier (capped at $15,000 per project)

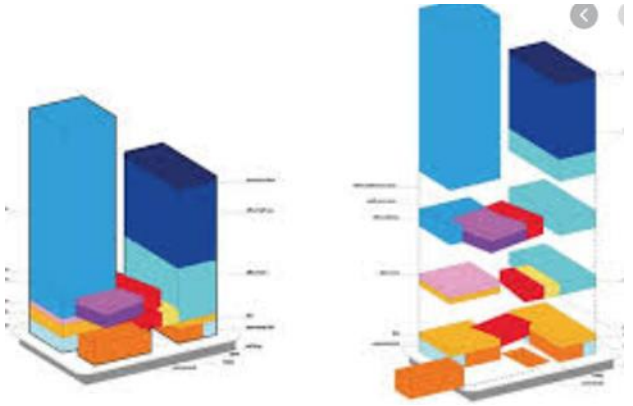
Lead Information Needed

Type of building

SF of Design



Stage of Design



https://www.masssave.com/en/saving/business-rebates/new-buildings-and-major-renovations

New Program Resources

MassSave.com

https://www.masssave.com/en/saving/business-rebates/new-buildings-and-major-renovations

- Program summary and individual pathway overviews
- Program Memorandums of Understanding (MOUs)

Contacts

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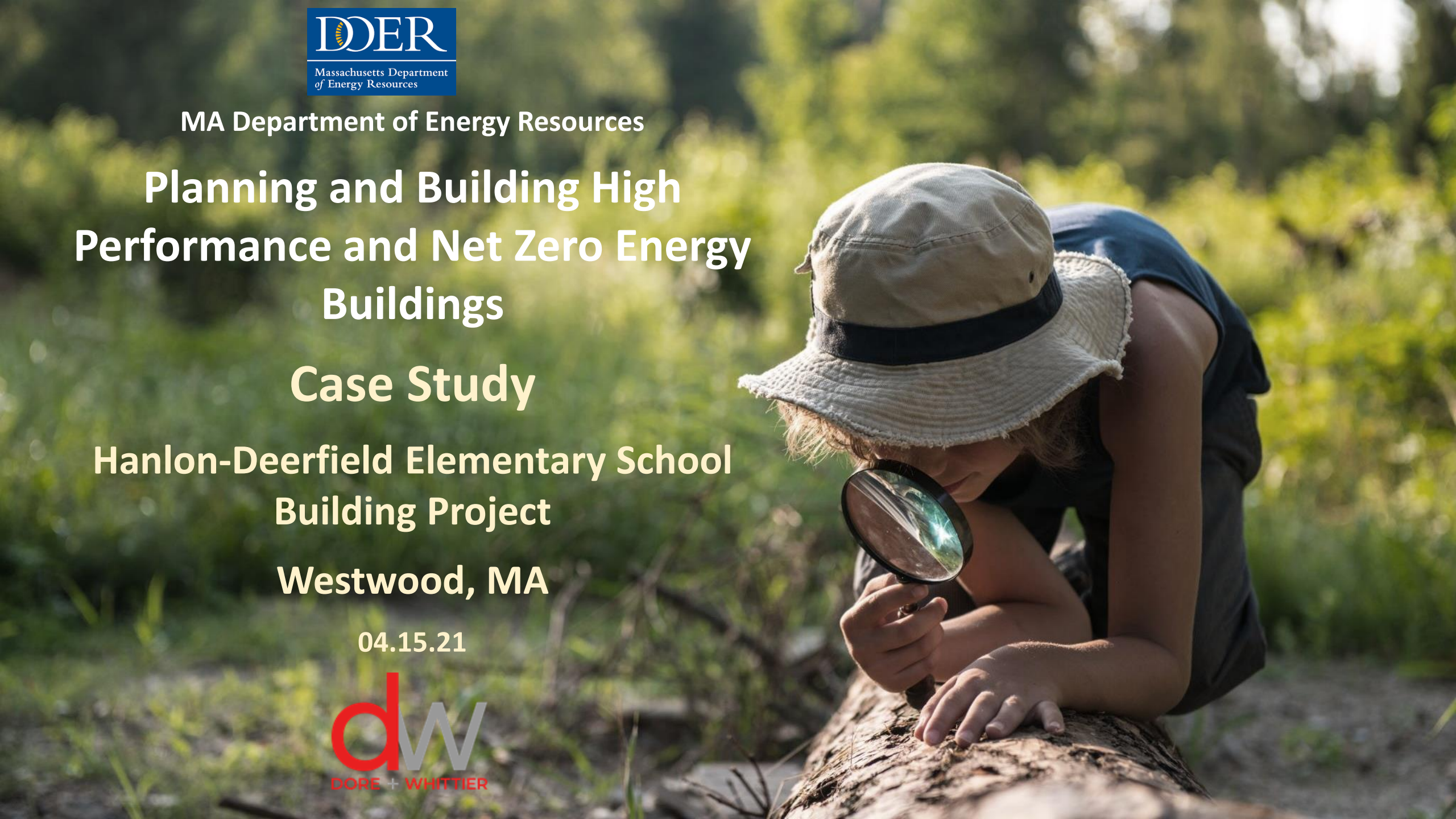


MA Department of Energy Resources

Planning and Building High Performance and Net Zero Energy Buildings

Case Study

Hanlon-Deerfield Elementary School Building Project

Westwood, MA

04.15.21

DORE + WHITTIER

Sustainability Collaborators

Westwood Public Schools

Town of Westwood

Owner's Project Manager

Architect

Mechanical Engineer

Sustainability Consultant

Utility Company

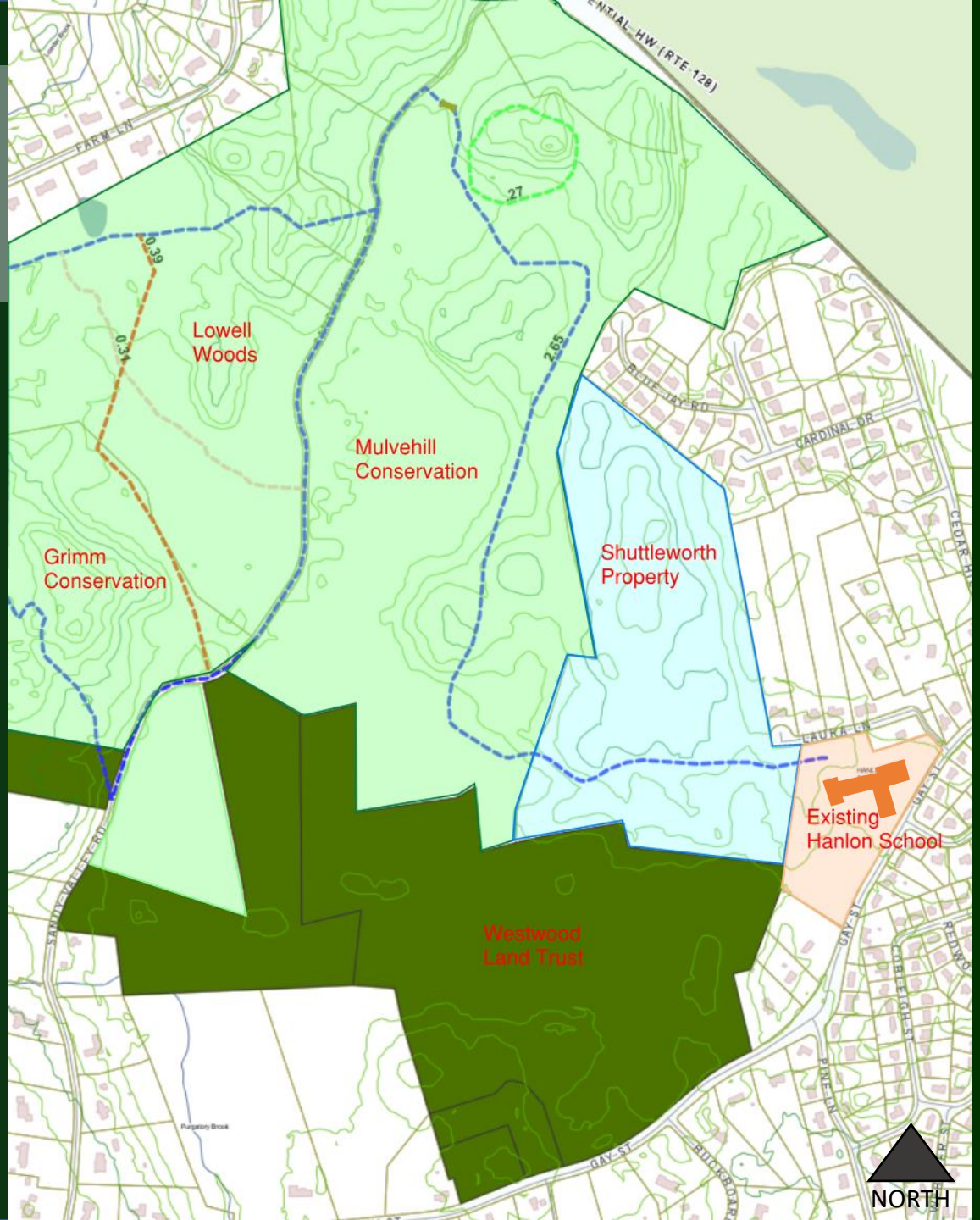
Peer Review
Energy Modeling Consultant

Agenda

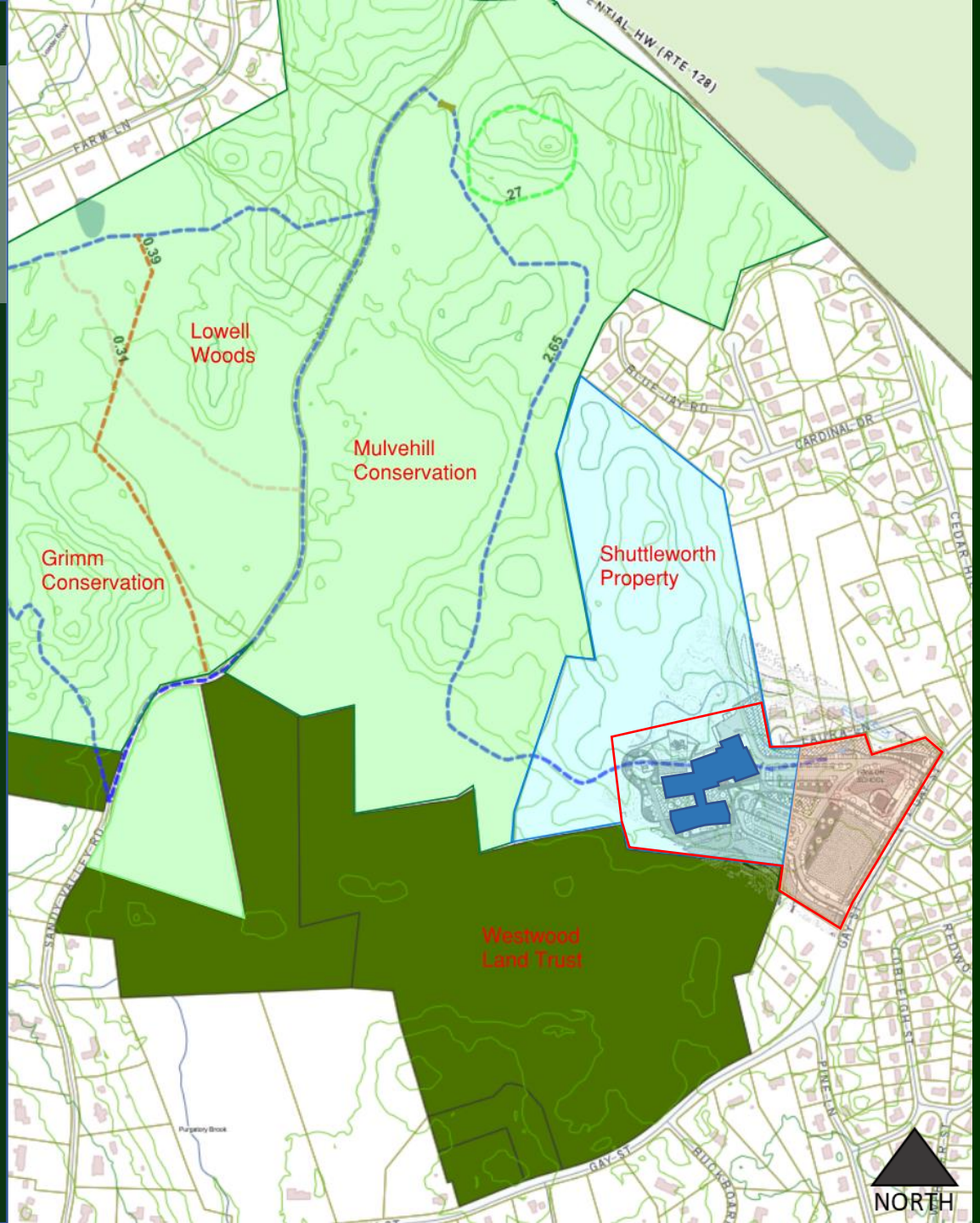
- Overview
- Process
- Outcome

OVERVIEW

Community Context



Community Context



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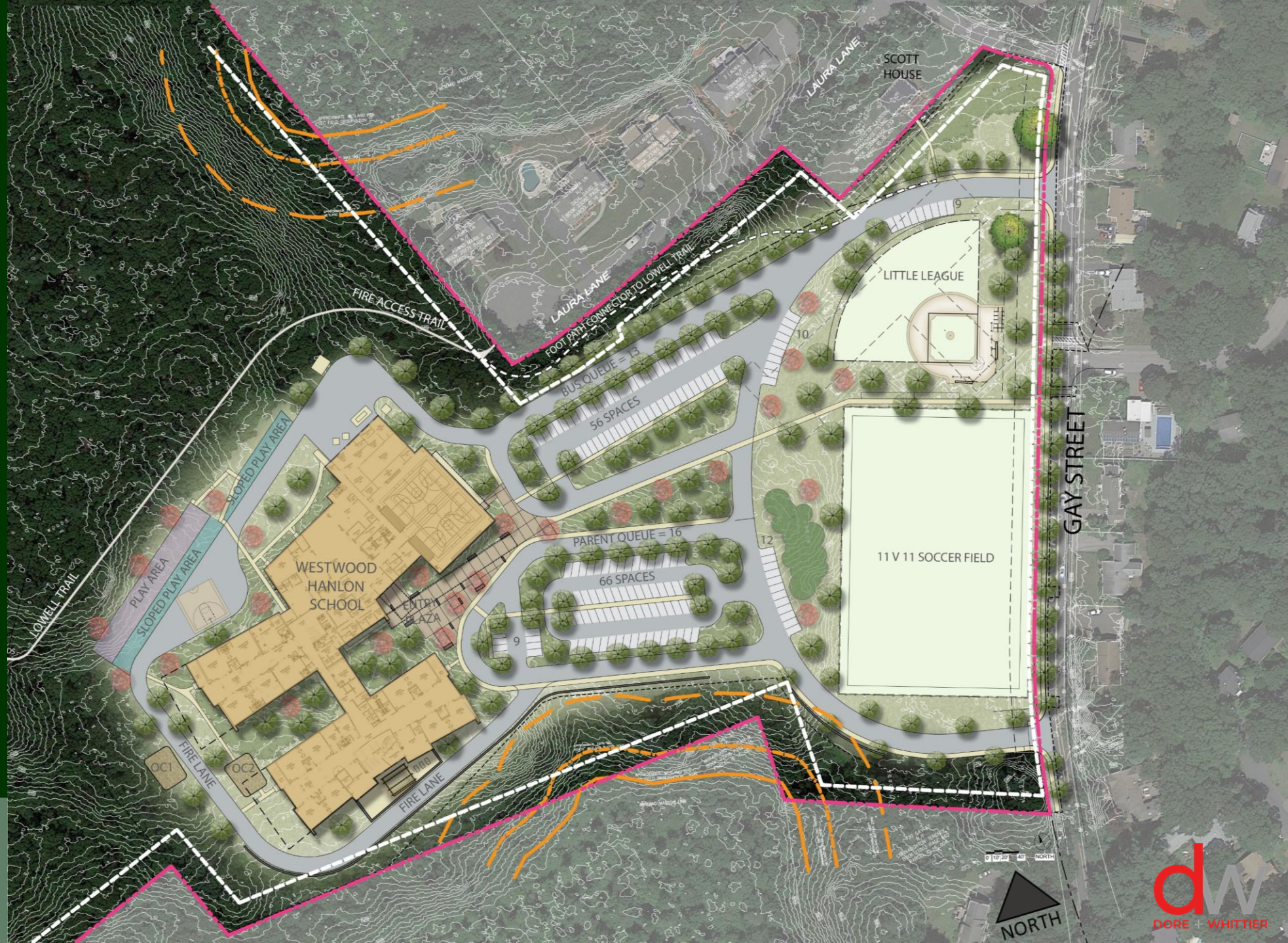
Existing Site Color Palette

"a school in the woods"



Site Plan

113,141 sf building, 18.5 acres +/-

PROCESS

Strategic Approach to Sustainability Integration

- Identify stakeholders
- Embrace Collaboration : Architect, Engineer, Sustainability Consultant, Utility Company/Peer Energy Consultant
- Initiate Sustainability Discussion EARLY
- Hold Charettes – INFORM, BRAINSTORM, PRIORITIZE
- Form Sustainability Subcommittee
- Meet regularly to study/present options, analyze information, make decisions/recommendations

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1st Charette: Identified Community Priorities

Westwood Resiliency & Sustainability Draft Comprehensive Plan

- **Importance of this project: Schools are the largest energy consumers/emitters**
- **Prioritize CO2 reductions**
- **New Net Zero energy standards for new Town buildings**
- **Phase out fossil fuel use**
- **Discourage new natural gas hookups**
- **Install EV chargers**

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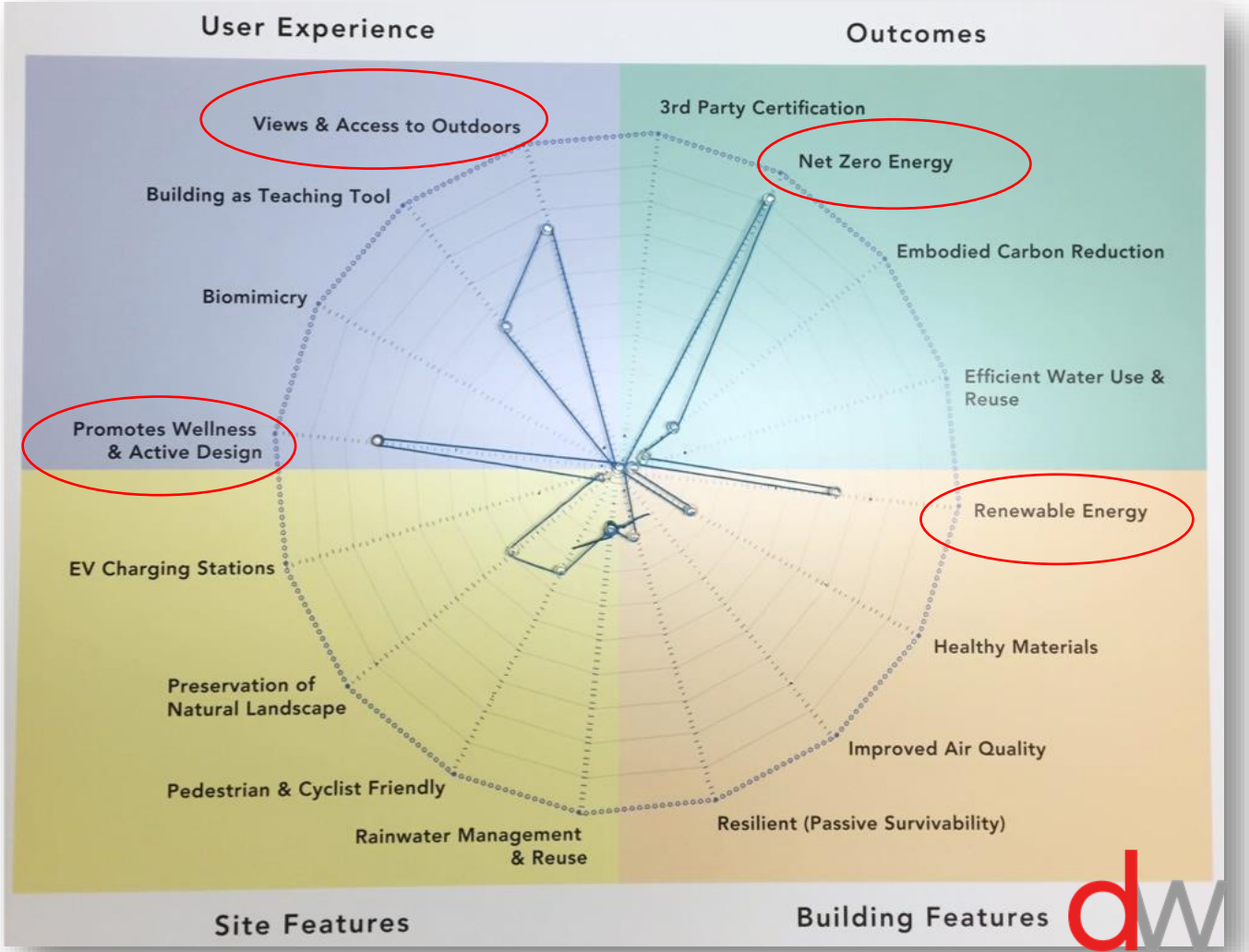
Charette Results: Identified Goals and Direction

Jan 2, 2020 Handout - Goals Sustainability

1. Passive House Design Standard as goal
2. Orientation of building
3. Orientation of roof / eliminating penetrations to maximize PV
4. Minimize thermal bridging between exterior wall and inside to passive house standard
5. Super Insulation – closed cell foam topped off with open cell foam to achieve R60 roof and R43 walls
6. Slab design insulated from building
7. Triple pane argon filled windows
8. Daylighting
9. HQ Air Exchange System
10. Ground Source Heat Pump heating
11. Integration of existing on-site solar into project

Jan 30, 2020 Sustainability Charette



Courtesy of: The Green Engineer

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Identified Goals and Direction

1. **Provide a Sustainably Designed Building that achieves a minimum of:**
    - 20% beyond current Energy Code
    - LEED Certification and receive 2% points from MSBA funding
2. **Explore the capital cost and return on investment (ROI) of achieving:**
    - Net Zero Energy (NZE or ZNE)
3. **Leverage assistance from Eversource/Thornton Tomasetti:**
    - Explore energy efficiency measures to achieve a goal of EUI of 25

Other Considerations

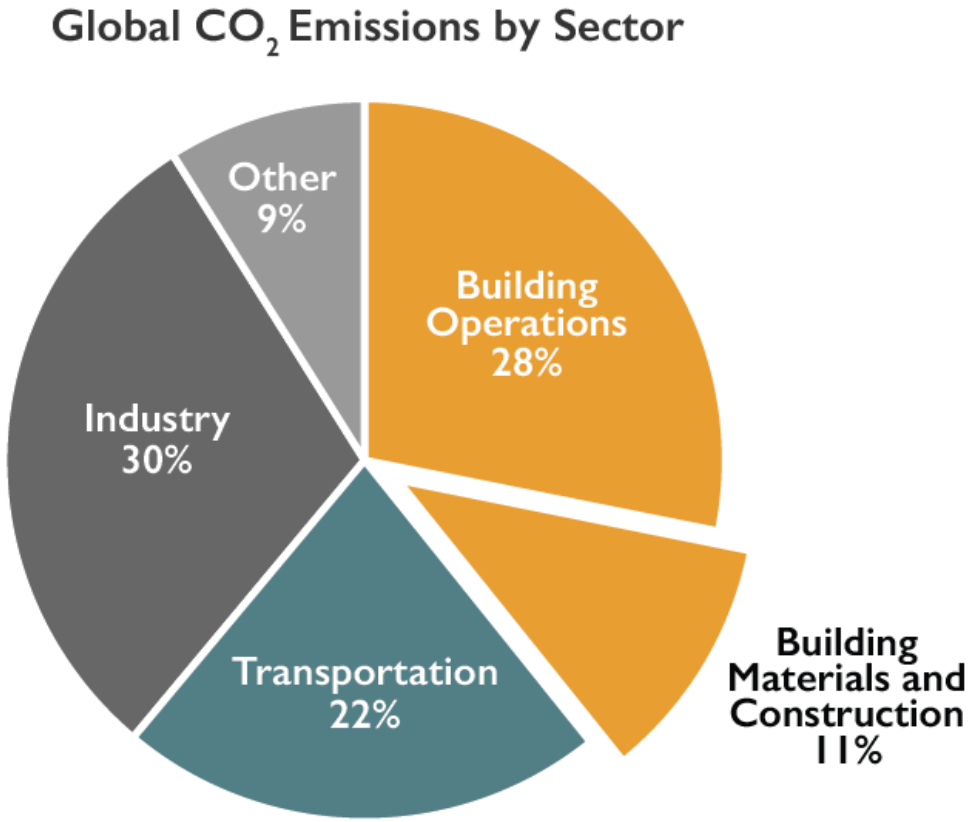
4. Reduce Embodied Carbon footprint by exploring the use of Engineered Cross Laminated Timber (CLT) vs. Steel Frame

Carbon Management

Carbon: Why is Carbon Management Important?

- **Operational** Carbon: released through fossil fuels
- **Embodied** Carbon: amount of carbon used to create a material

i.e. steel has high amount of embodied carbon, meanwhile wood has a very low amount)



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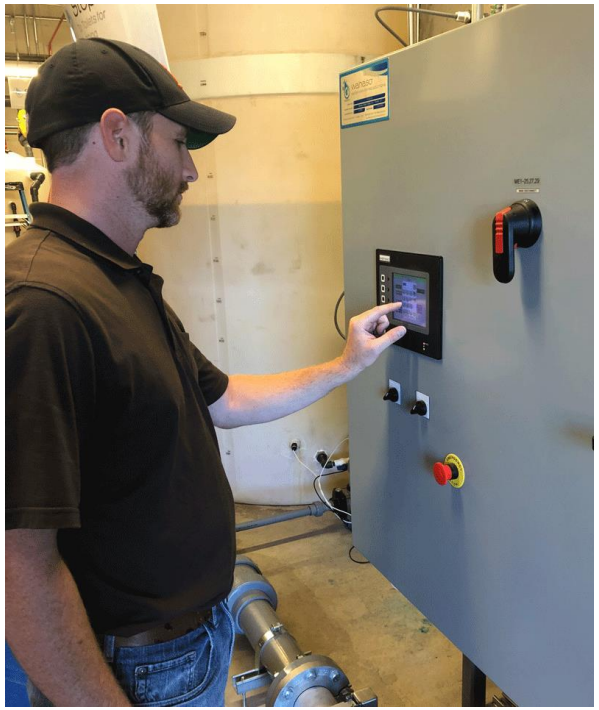
Other Considerations

5. Explore the Use of Rainwater Capture for Reuse: irrigation/greywater

Less potable water used = water conservation



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Identified Goals and Direction

Net Zero Energy: What does it take to achieve this – target areas:

- Exterior Envelope
- Heating: Nat Gas vs. Air/Water Heat Pump vs. Geothermal
- Electricity Reductions – Daylighting Opportunities, Plug Load Management, Controls
- Renewable Energy: PV Panels on or off-site

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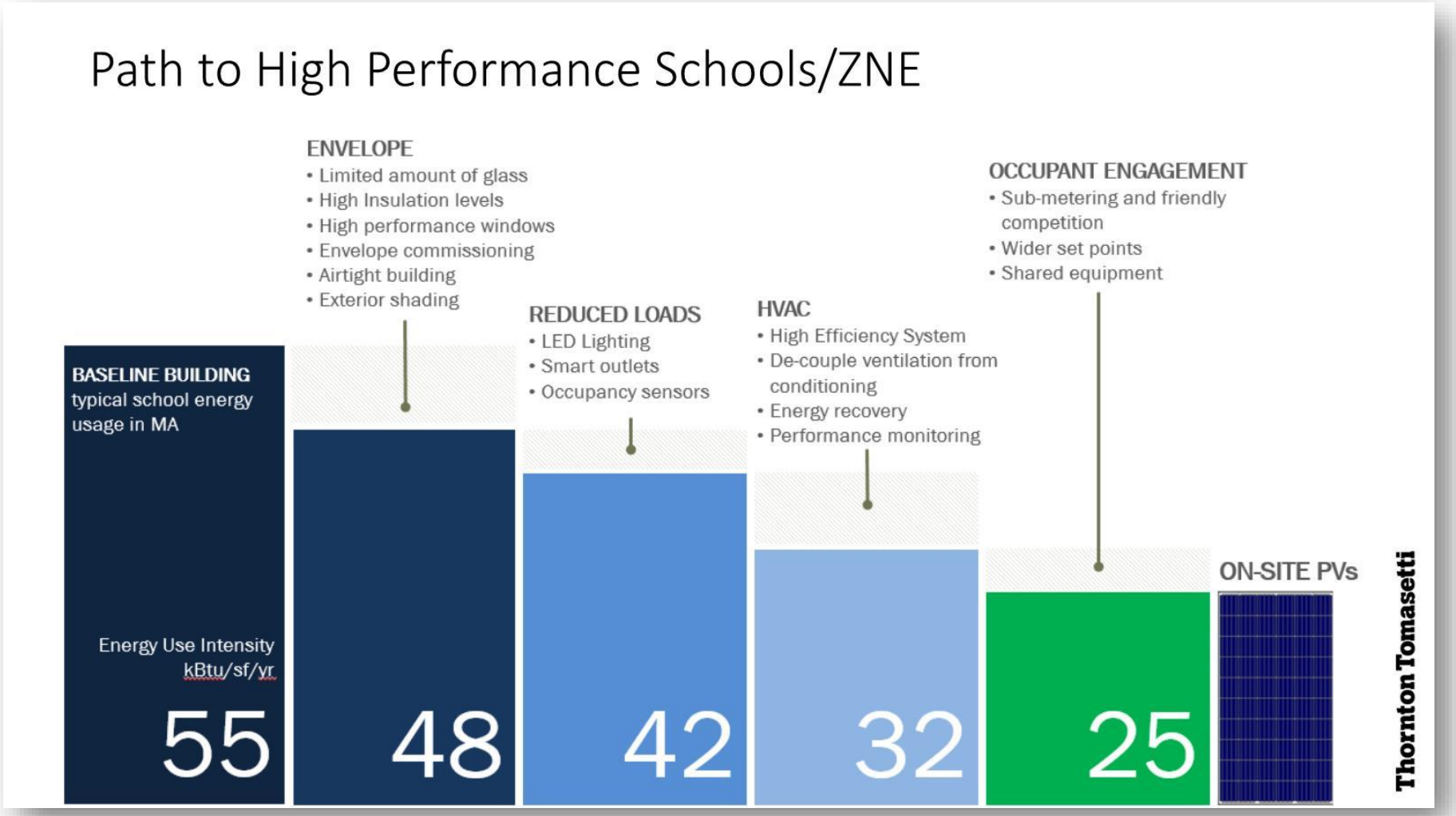
Identified Goals and Direction

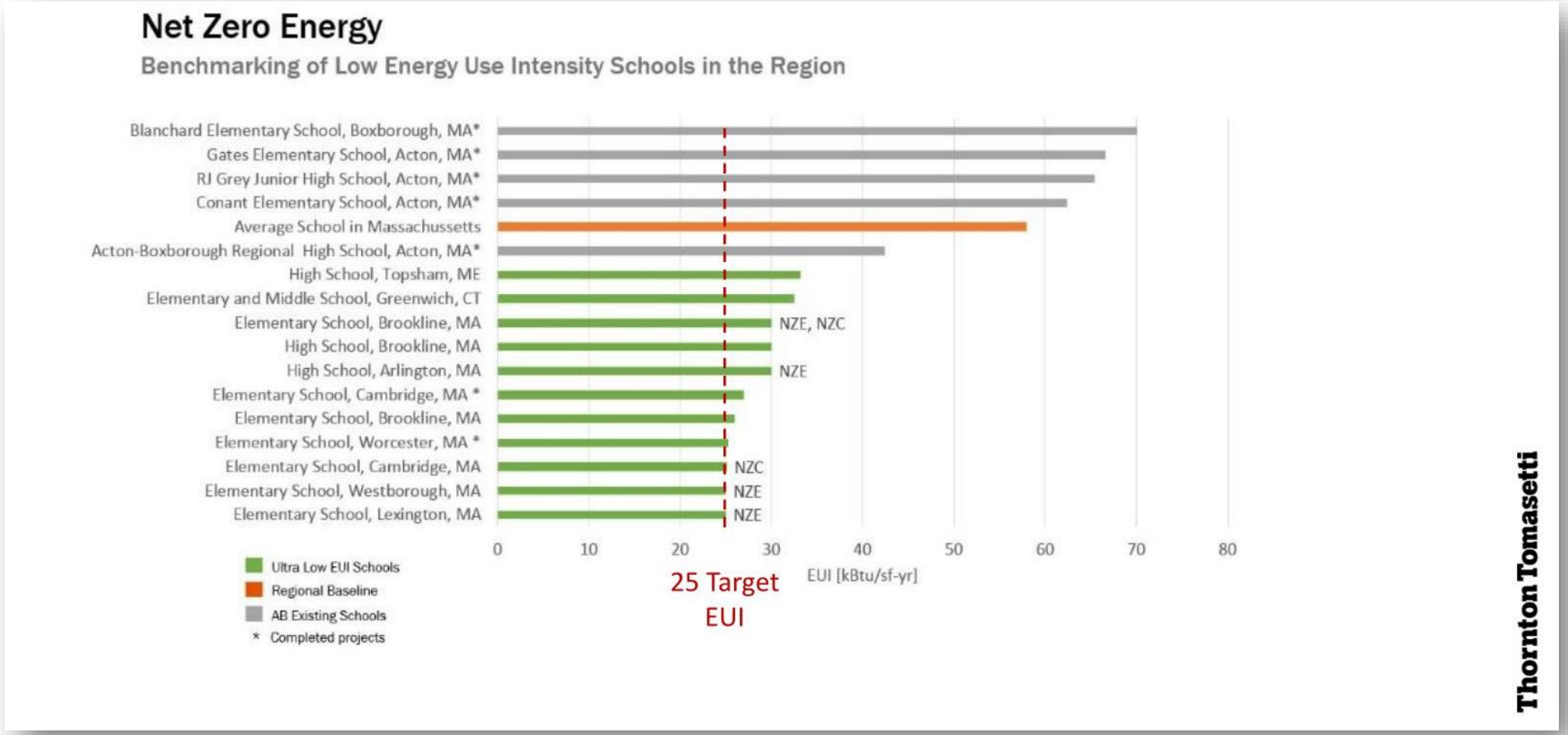
Energy Use Intensity (EUI): energy consumed per square ft / year



EUI

Identified Goals and Direction

EUI – Frame of Reference / Benchmarking



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Outline Study Options – Obtain Consensus

GOAL: Determine Sustainability approach for Return on Investment (ROI) over the life of the building

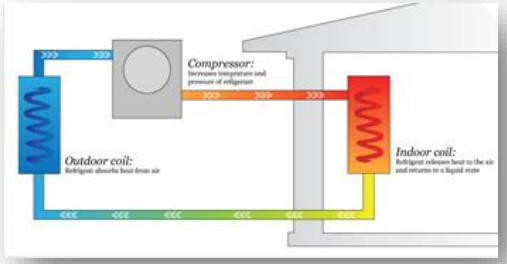
MSBA
Massachusetts School Building Authority
Funding Affordable, Sustainable, and Efficient Schools in Partnership with Local Communities

Baseline Project: MSBA Green Schools + Additional 2% reimbursement

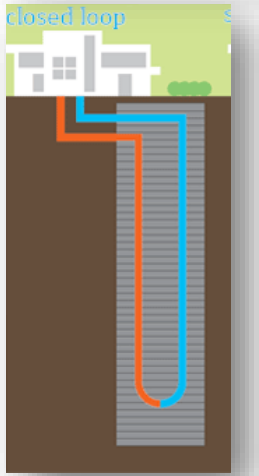
a. Achieve LEED-S v4 "Certified and exceed MA Energy base code by 10%
b. Exceed base MA Energy Code by 20%

Study Possible Sustainability Alternatives:

A. Operational Carbon Reduction: Fossil Fuel Free / All Electric



Tier 1: Use Centralized Air/Water Heat Pump



Tier 2: Use Geothermal Heating System

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Outline Study Options – Obtain Consensus

B. Embodied Carbon Reduction:

Use Timber Frame Construction in lieu of Steel

C. Additional Water Use Reduction

Use Rainwater Cistern for Irrigation

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Investigation, Modeling and Analysis

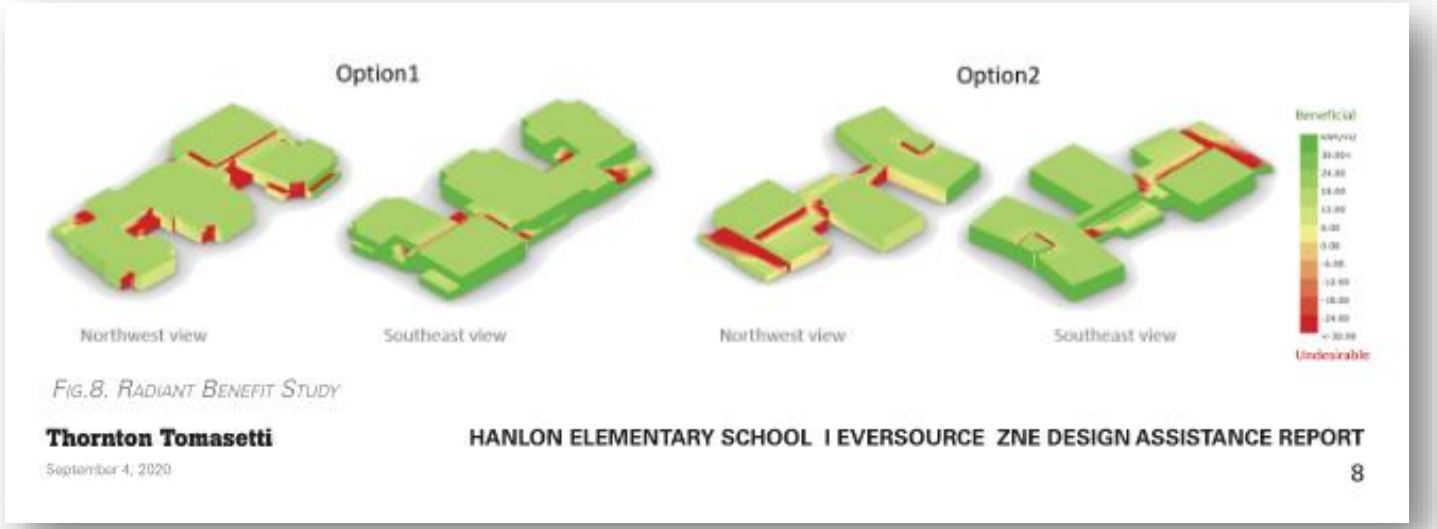


FIG.8. RADIANT BENEFIT STUDY

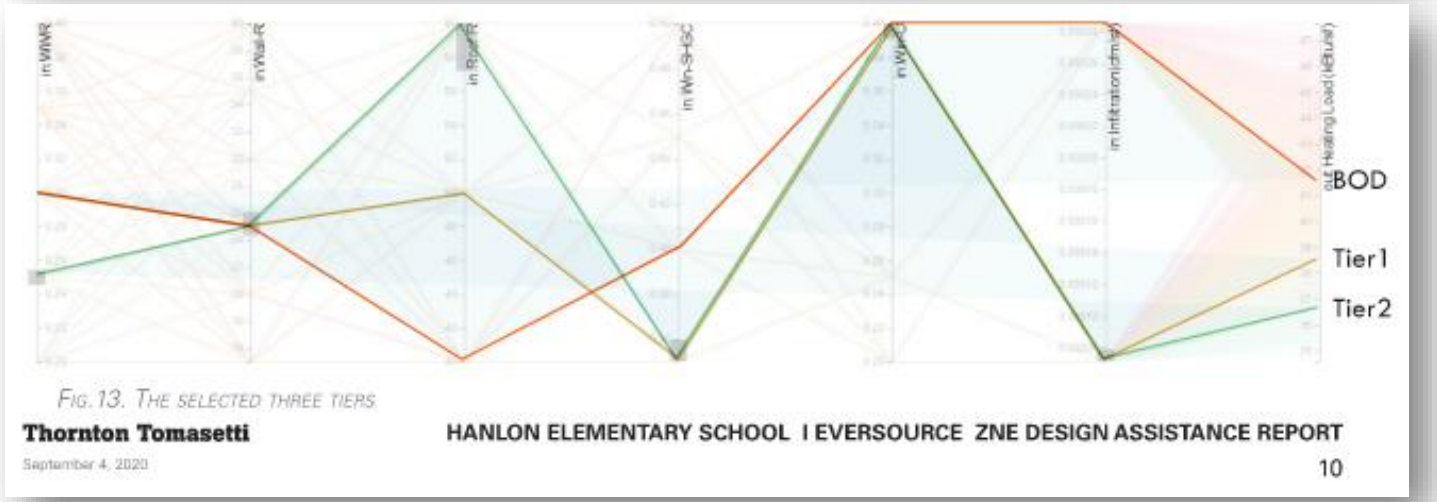
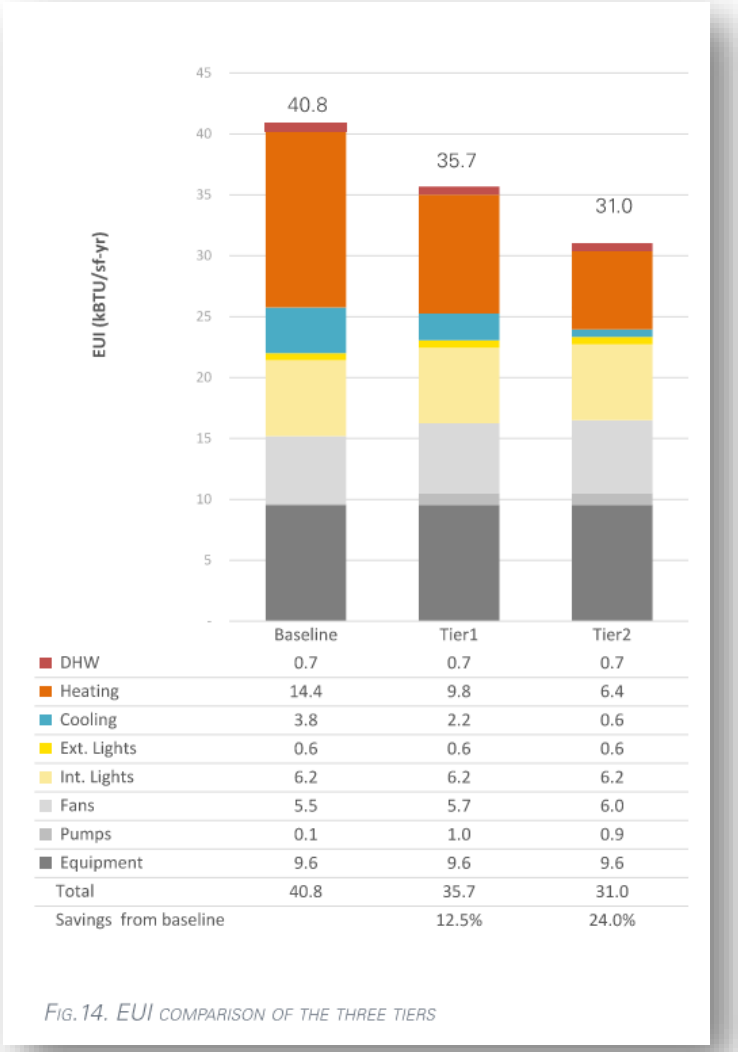


FIG.13. THE SELECTED THREE TIERS



	Baseline	Tier1	Tier2
DHW	0.7	0.7	0.7
Heating	14.4	9.8	6.4
Cooling	3.8	2.2	0.6
Ext. Lights	0.6	0.6	0.6
Int. Lights	6.2	6.2	6.2
Fans	5.5	5.7	6.0
Pumps	0.1	1.0	0.9
Equipment	9.6	9.6	9.6
Total	40.8	35.7	31.0
Savings from baseline		12.5%	24.0%

FIG.14. EUI COMPARISON OF THE THREE TIERS

Courtesy of: Thornton Tomasetti

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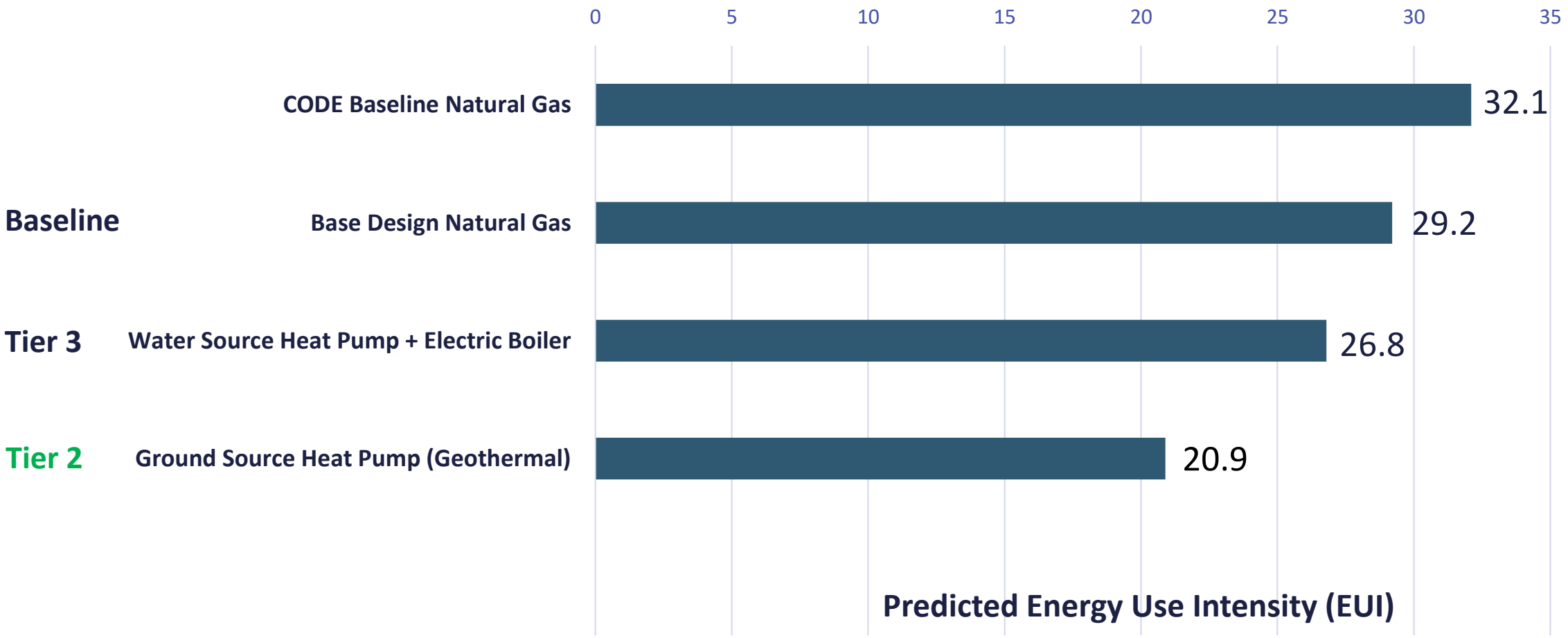
Heating/Cooling Systems
Energy Use Intensity – Summary



From Energy Modeling prepared by Garcia Galuska Desousa

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Fossil Fuel Free vs. Natural Gas - Discussion

Decision Points - Overview

1. **Priority: 20% above new energy code to achieve 2% points from MSBA**
2. **Heating/Cooling System options:**
   - **Baseline: Natural Gas**
   - **Tier 1: Water Source Heat Pump with supplemental electric boiler**
   - **Tier 2: Ground Source Heat Pump (Geothermal) :**
   - **Tier 3: Ground Source Heat Pump (Geothermal): with supplemental electric boiler, less wells**

~~3. Timber Framing~~

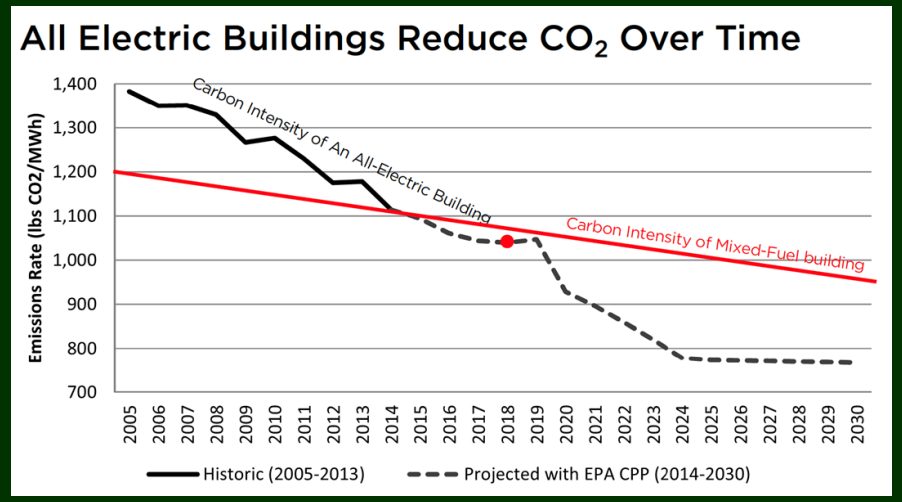
~~4. Rainwater Cistern-Irrigation~~

DORE + WHITTIER

OUTCOME

Sustainability

Net Zero Energy Ready



- Low Energy Building: Tracking 21 EUI
- Fossil Fuel Free - Geothermal
- PV infrastructure and REC's
- High Performance Ventilation
- Improved Envelope Design

NO: Rainwater Cistern
NO: Timber Framing

LEED Checklist

- Targeting LEED-Sv4 Silver Certification

View from Gay Street

DORE + WHITTIER

View from Gay Street at pedestrian walkway

DORE + WHITTIER

View from bus drop off

DORE + WHITTIER

Southern Classroom wing

DORE + WHITTIER

Common Themes of Successful Low - Energy Projects

- **Collaborate with multiple stakeholders**
- **Leverage incentives**
- **Establish Energy Targets + Goals <u>Early</u>**
- **Focus on Reducing Loads – Building Envelope, Right sizing**
- **Test alternatives using Modeling**
- **Prioritize focus**
- **Maintain regular meetings/charettes for consensus building**

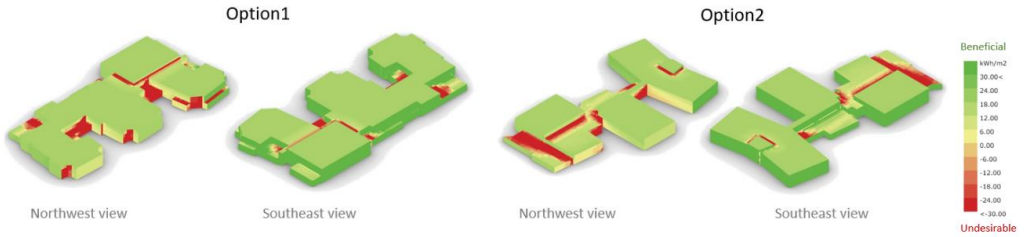


FIG.8. RADIANT BENEFIT STUDY

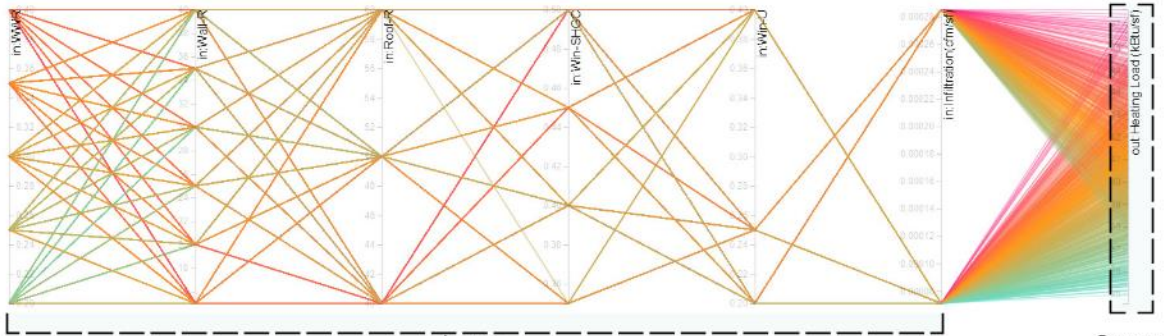


FIG. 10. ENVELOPE PARAMETRIC STUDY INTERACTIVE FORMAT

Courtesy of: Thornton Tomasetti

DORE + WHITTIER

ARROWSTREET

ELEMENTARY SCHOOL PROJECT

SCHOOL BUILDING COMMITTEE

MEDFIELD, MA

24 MARCH 2021

PREPARED FOR

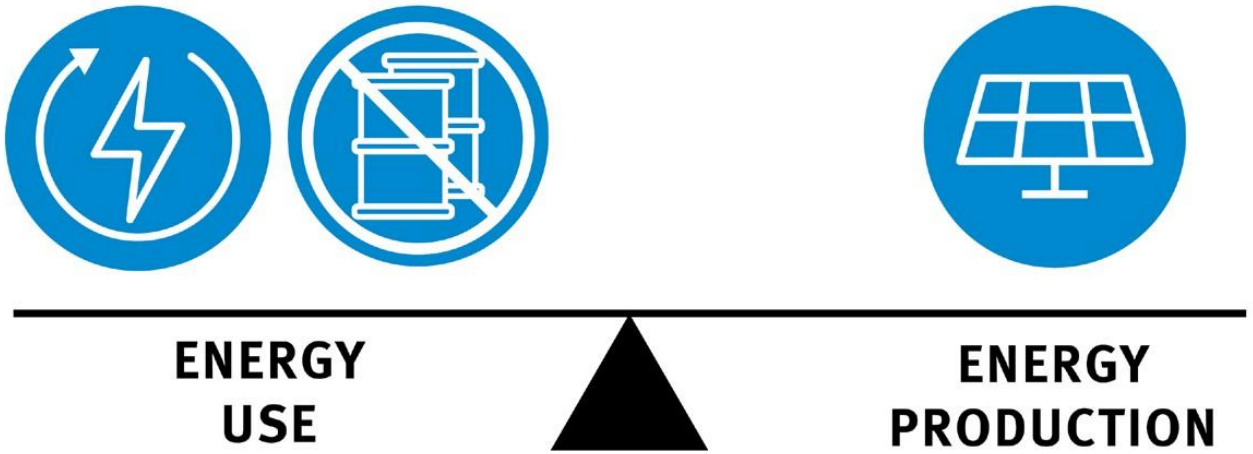
MEDFIELD PUBLIC SCHOOLS

ENERGY & NET ZERO ASSESSMENT

FRAMING THE DISCUSSION

NET ZERO ENERGY DEFINITION

An all-electric building, that has an ultra low EUI, whose annual energy use is equal or less than the amount of new on-site or off-site renewable energy.



SETTING EUI TARGET

EUI 25	EUI 28	EUI ~30
Eversource Path 1	highest to be NZ	MSBA Req

NET ZERO BUILDING

LOWER EUI = LESS ENERGY USE

HVAC SYSTEM OPTIONS

GAS

#1

Air Cooled Heat Pump Chiller & Gas Boiler

Displacement Ventilation

ALL-ELECTRIC

#2

Air Cooled Heat Pump Chiller & Electric Boiler

Displacement Ventilation

ALL-ELECTRIC NET ZERO

#3

Ground Source Heat Pump

Displacement Ventilation

ALL-ELECTRIC NET ZERO

#4

VRF

Overhead Ventilation

ENERGY & NET ZERO ASSESSMENT

FINDINGS

MEDFIELD PUBLIC SCHOOLS / ELEMENTARY SCHOOL PROJECT

HVAC SYSTEM OPTIONS
QUALITATIVE COMPARISON

		Net Zero	Meets Eversource EUI	EUI	Carbon Emissions	Indoor Air Quality	Acoustics	Annual Energy Cost	Annual Maintenance Cost
#1	Air Cooled Heat Pump Chiller & Gas Boiler (baseline)			◌	◌	○	●	○	●
#2	Air Cooled Heat Pump Chiller & Electric Boiler			○	◌	●	●	◌	●
#3	Ground Source Heat Pump	✓	✓	●	●	●	●	●	●
#4	VRF	✓		○	○	○	○	○	◌

← HIGHEST PERFORMER

Scale

● ○ ◌

Better ↔ Worse

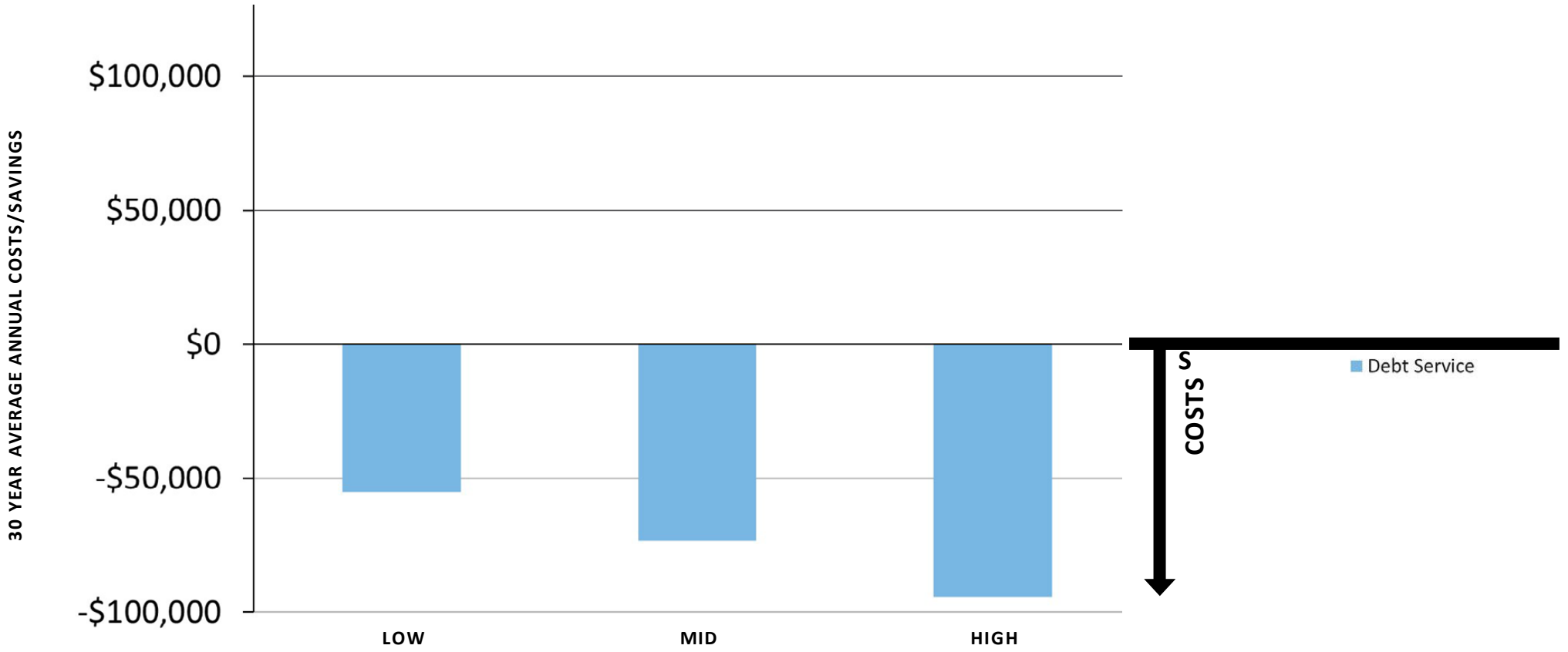
HVAC SYSTEM OPTIONS
SIMPLE COST COMPARISON

		EUI	HVAC Capital Investment Cost			Annual Energy Cost		Annual Maintenance Cost		Combined Annual Cost Delta
				Delta	Total construct cost Dleta	$/sf	Delta	$/sf	Delta	
#1	Air Cooled Heat Pump Chiller & Gas Boiler (baseline)	33.4	$9,488,781			$1.36		$0.61		
#2	Air Cooled Heat Pump Chiller & Electric Boiler	29.8	$9,539,515	1%	0.1%	$1.57	16%	$0.59	-3%	-$19,472
#3	Ground Source Heat Pump	24	$10,995,520	16%	3.3%	$1.27	-7%	$0.59	-4%	$11,069
#4	VRF	28.4	$9,481,897	0%	0.0%	$1.50	10%	$0.80	31%	-$32,531
	Existing Dale St Building	89	na			$1.88		$0.21		

-Red values indicate there is additional cost, not savings, compared to Option 1
-Capital Cost does not include Eversource incentives
-Energy Cost does not include peak demand charges

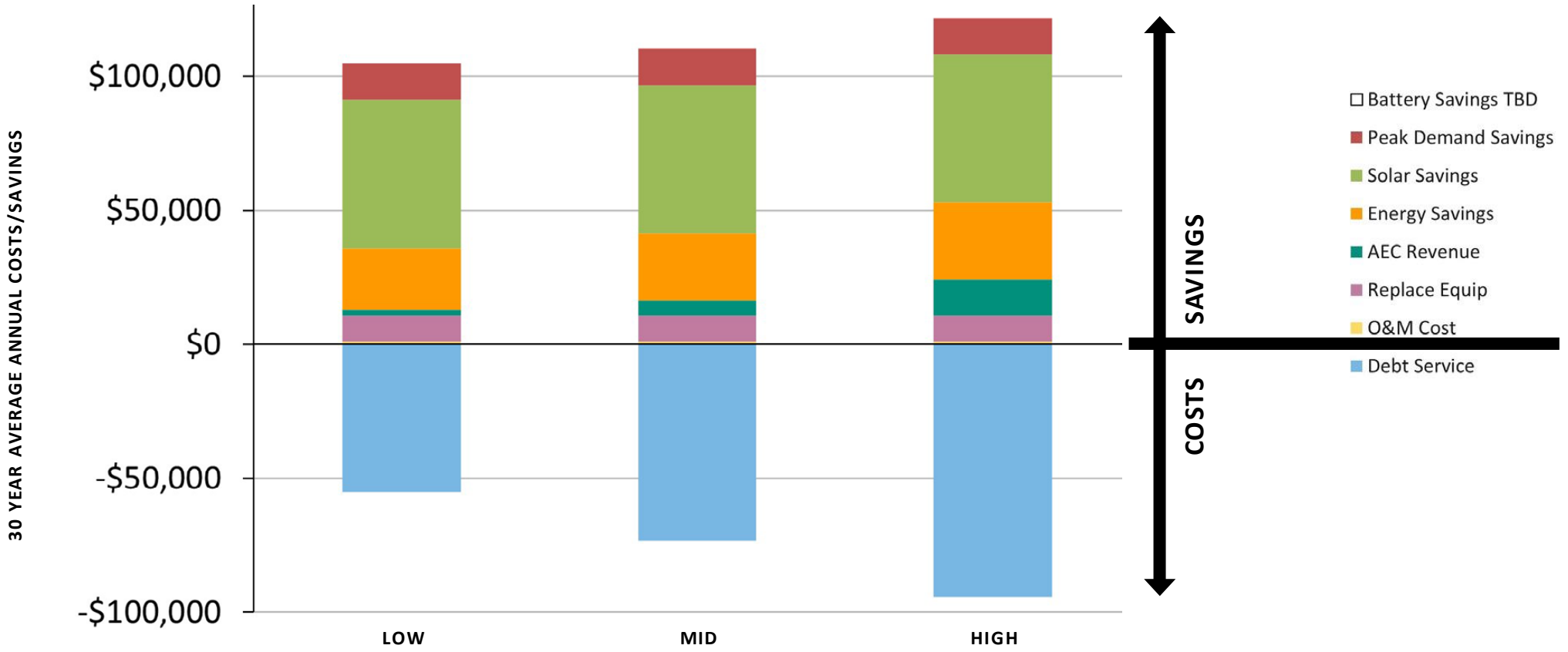
ANNUAL SAVINGS vs. DEBT SERVICE

#3 GROUND SOURCE HEAT PUMP vs. #1 GAS BOILER



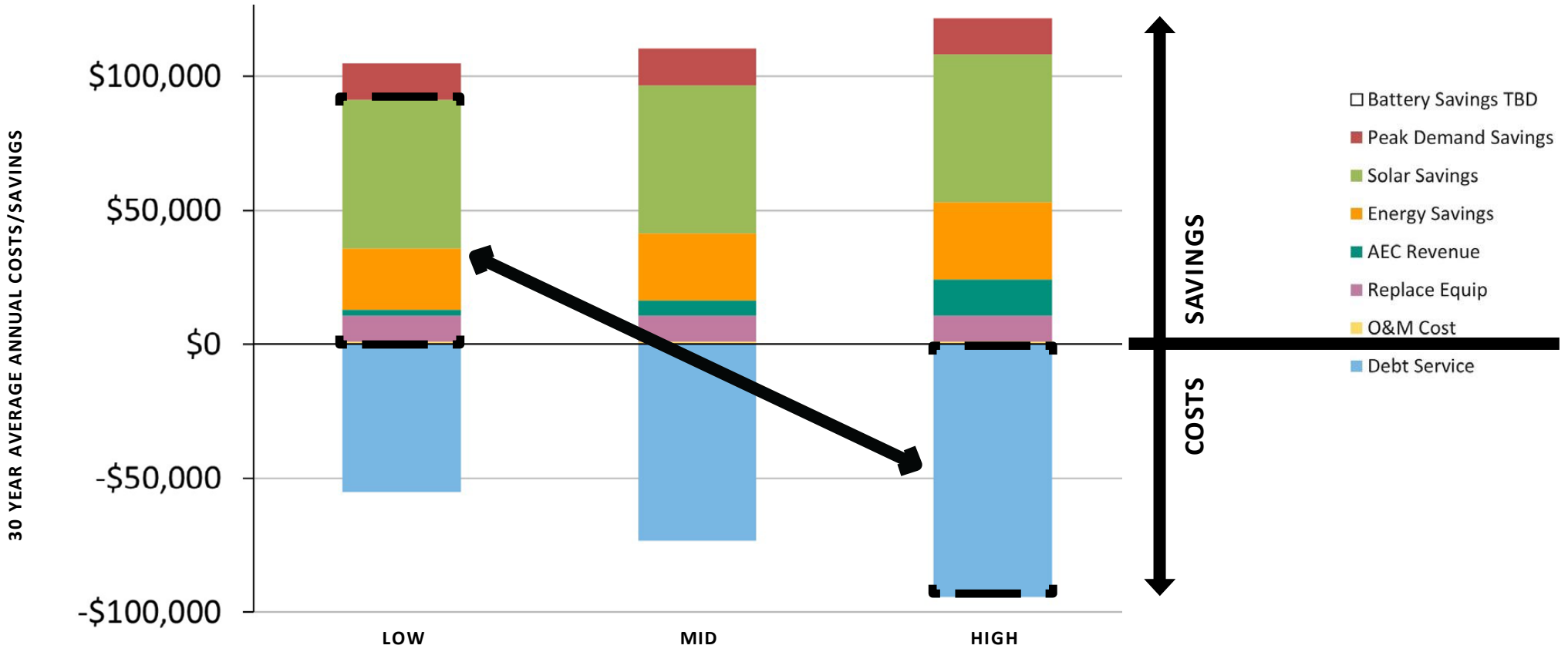
ANNUAL SAVINGS vs. DEBT SERVICE

#3 GROUND SOURCE HEAT PUMP vs. #1 GAS BOILER



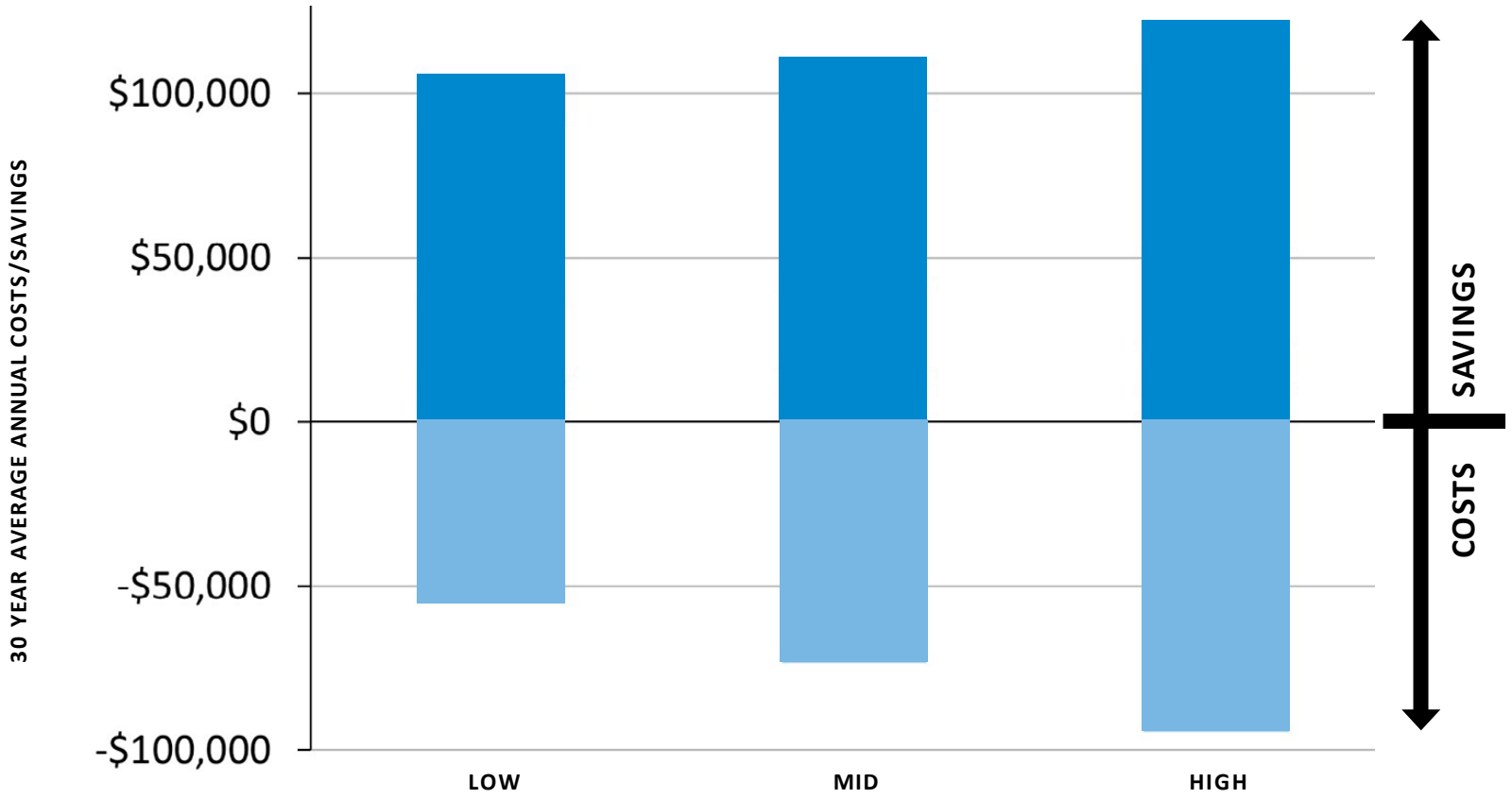
ANNUAL SAVINGS vs. DEBT SERVICE

#3 GROUND SOURCE HEAT PUMP vs. #1 GAS BOILER



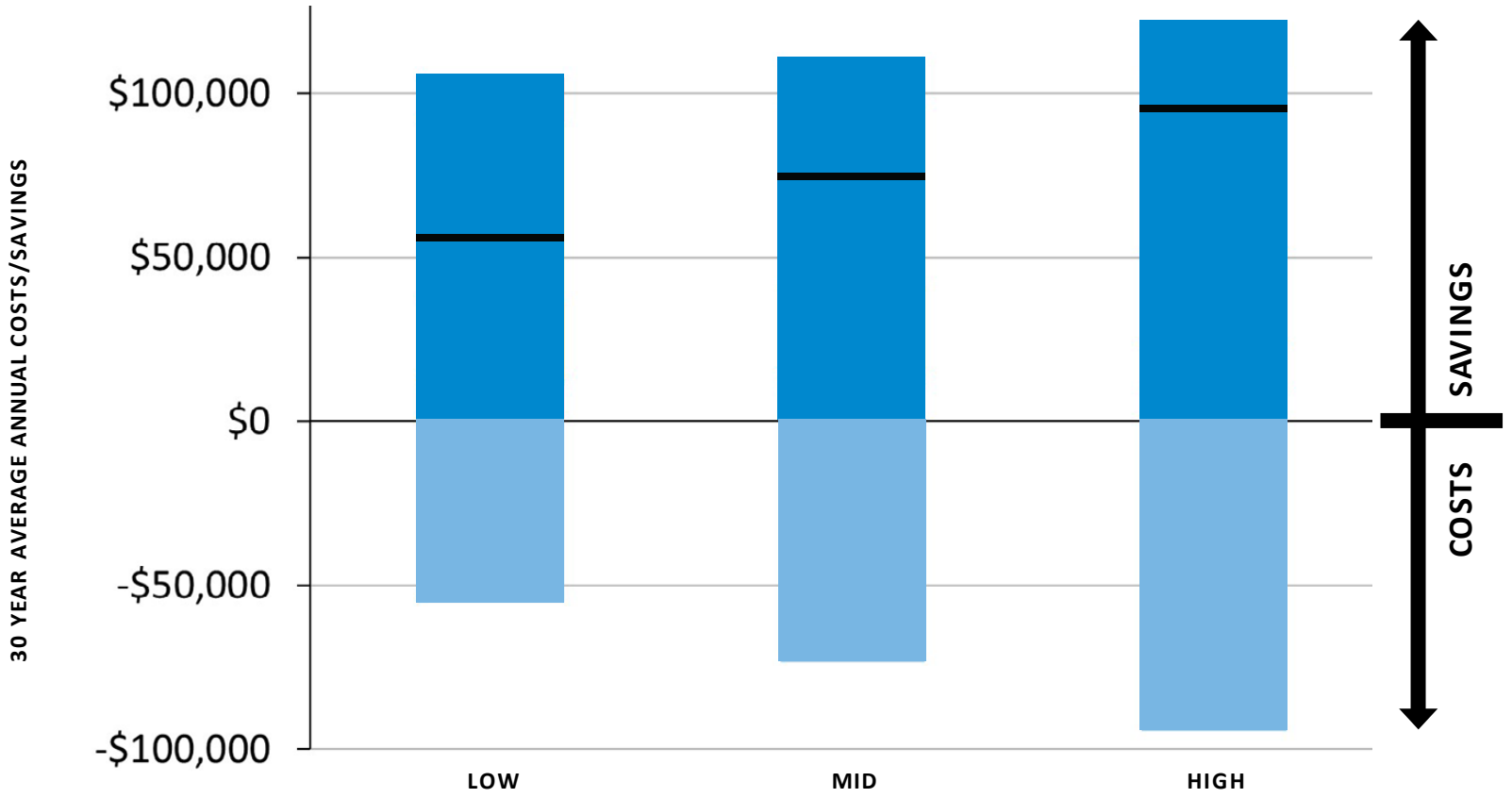
ANNUAL SAVINGS vs. DEBT SERVICE

#3 GROUND SOURCE HEAT PUMP vs. #1 GAS BOILER



ANNUAL SAVINGS vs. DEBT SERVICE

#3 GROUND SOURCE HEAT PUMP vs. #1 GAS BOILER



ANNUAL SAVINGS vs. DEBT SERVICE

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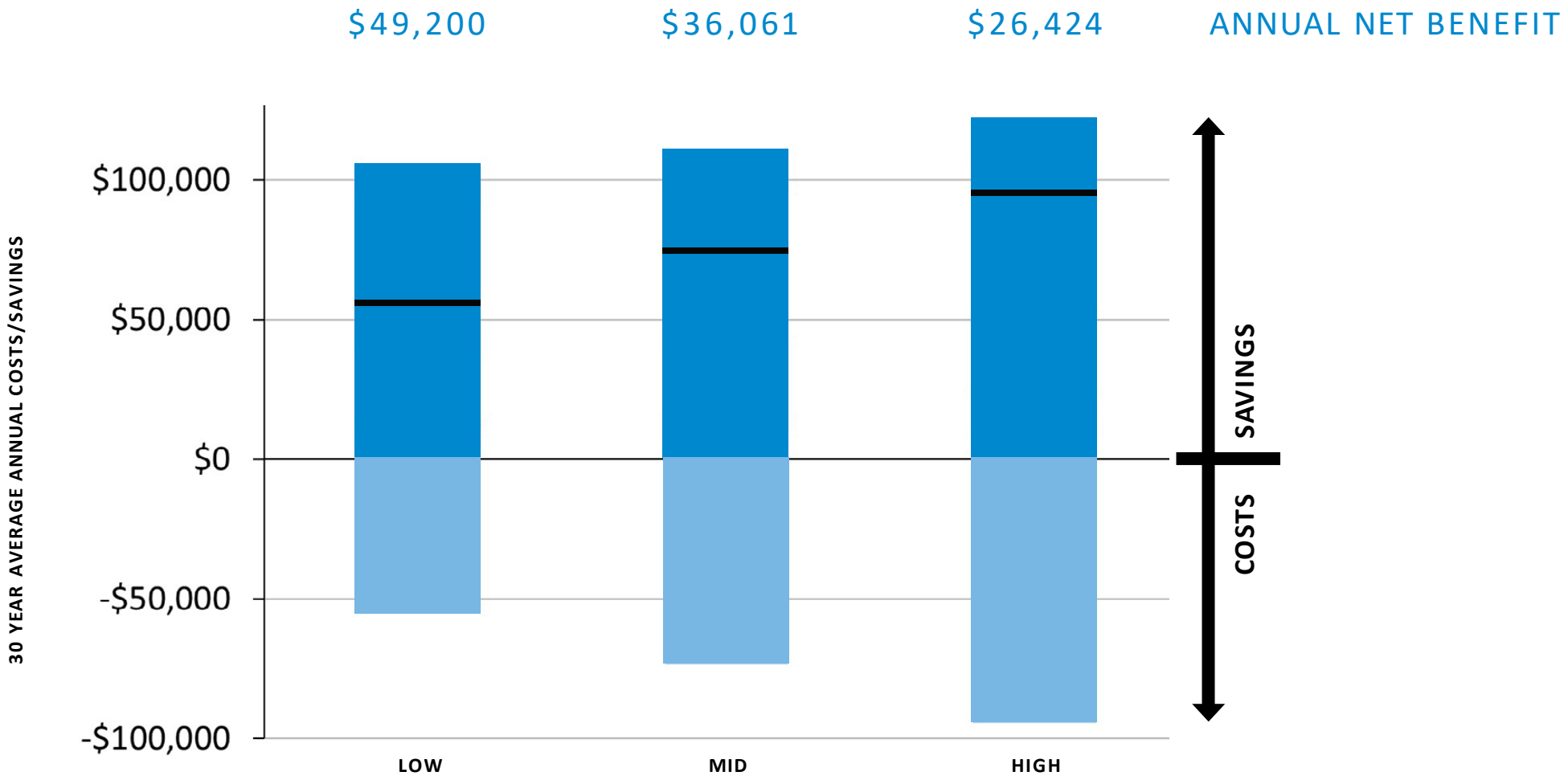

ANNUAL SAVINGS vs. DEBT SERVICE

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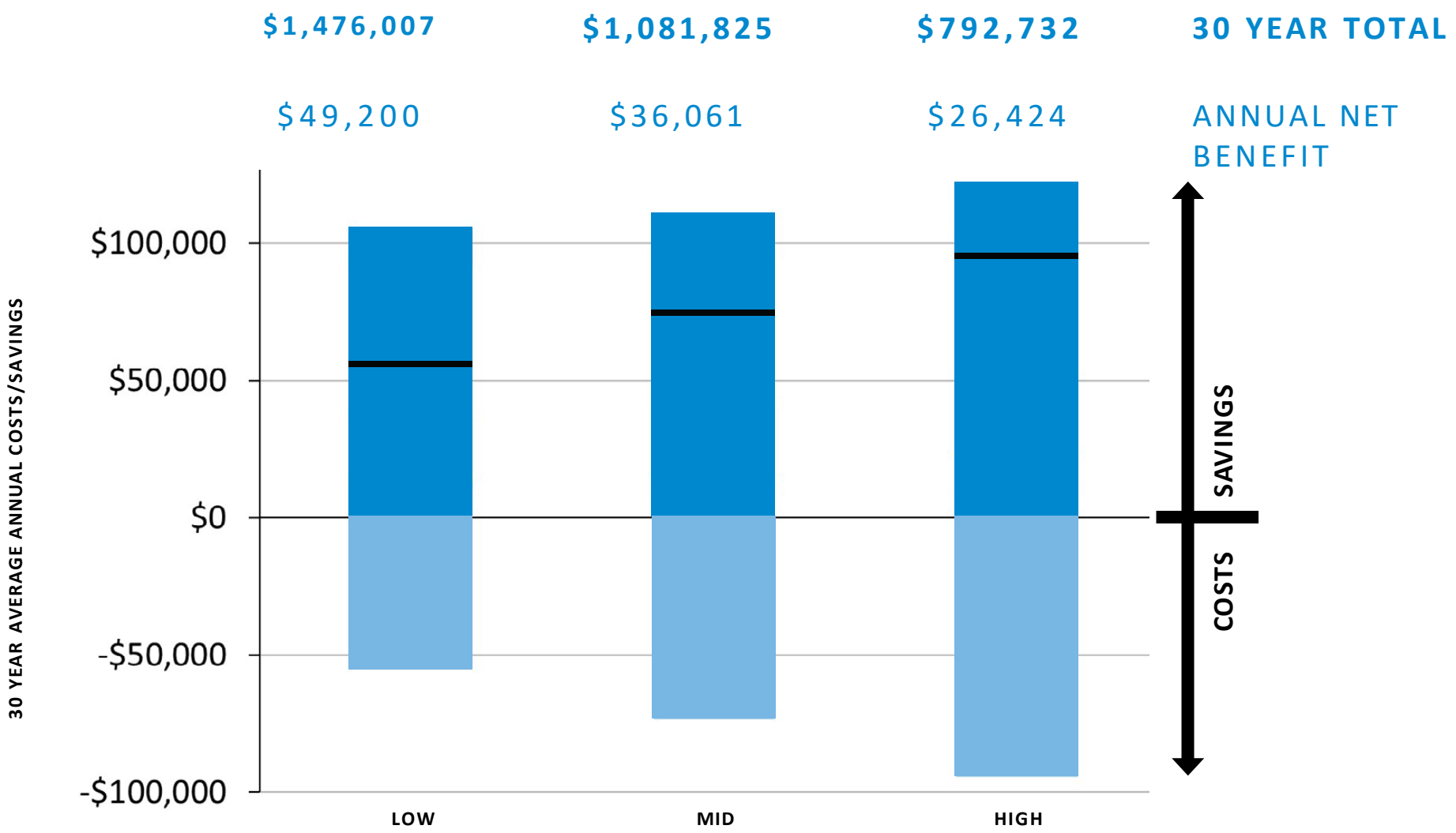

CONCLUSION OF FINDINGS
SUMMARY CHART

	GAS	ALL-ELECTRIC NET ZERO	ALL-ELECTRIC NET ZERO
	#1 Gas Boiler	#3 Ground Source HP	#4 VRF
EUI	33.4	24	28.4
ANNUAL SAVINGS YR 1-30	-	$26,424	$20,240
ANNUAL SAVINGS YR 30-50	-	$104,208	$76,541
SAVINGS TOWARD NEW BUILD O&M	-	YES	YES
BEST INDOOR ENVIRONMENT	NO	YES	NO
MAINTENANCE CONCERNS	NO	NO	YES

NOTE: SAVINGS ARE FROM LOW (WORST CASE)

NET ZERO HAS MANY BENEFITS

NET ZERO MAKES SENSE

- Option #3 GSHP has the most benefits
- Cash flow positive - debt service on incremental capital is offset by annual savings (on average)
- The savings could be used to offset increased operating budget for the new school
- Energy savings will continue after debt service is paid
- The assumptions in the financial assessment are conservative

NET ZERO MAKES SENSE

- Net zero provides healthy and comfortable learning environment
- Net zero provides educational opportunities
- Fossil fuel free - best choice for the climate
- Aligns with Massachusetts' goal to be net zero in 2050

Questions?

- www.masssave.com/en/saving/business-rebates/new-buildings-and-major-renovations
- www.neep.org
- https://www.nrel.gov/docs/fy19osti/72847.pdf
- https://builtenvironmentplus.org/road-to-net-zero/