
phius con
MILWAUKEE 2025

LESSONS FROM PASSIVE SCHOOLS

PRESENTED BY

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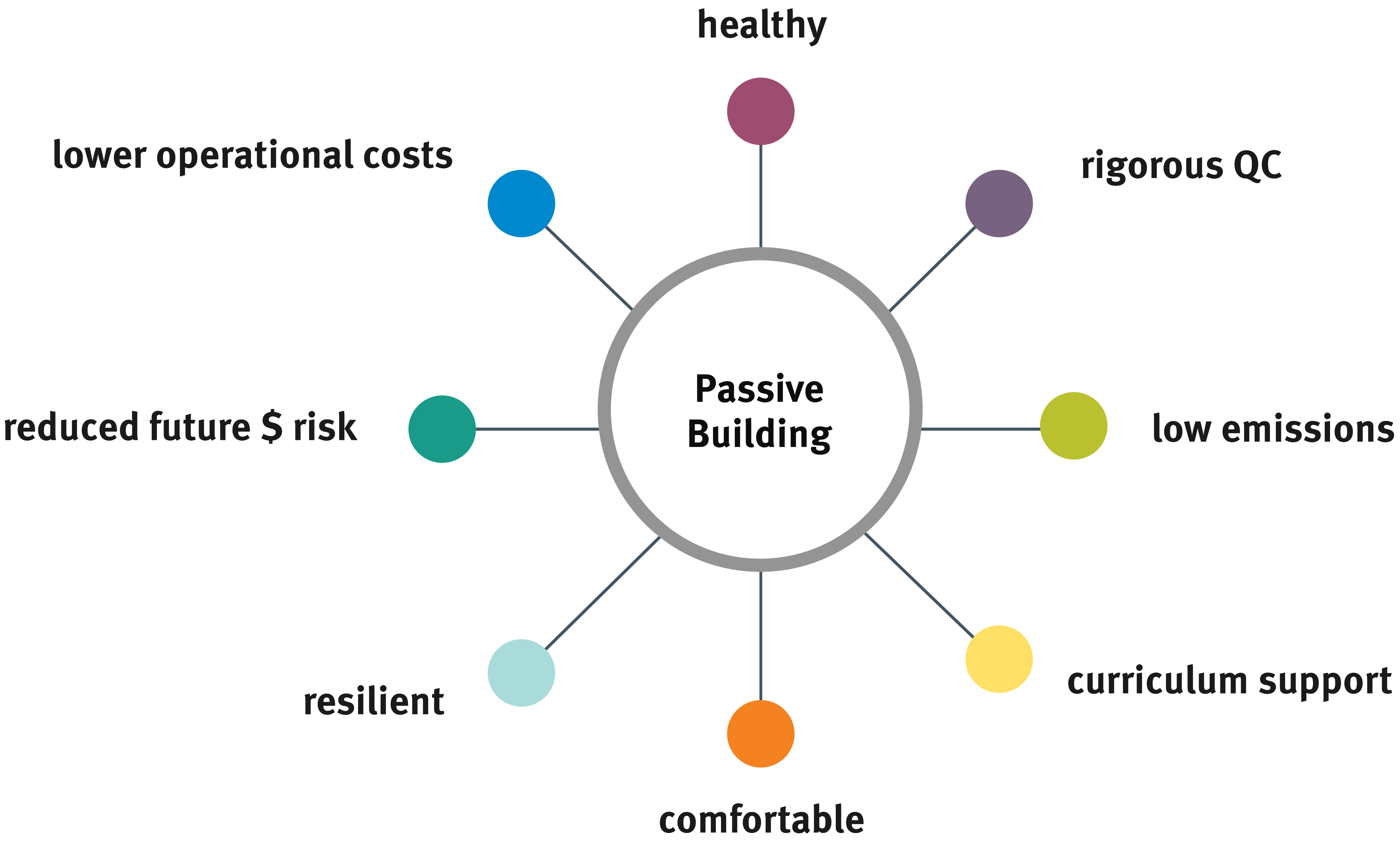
LEARNING OBJECTIVES

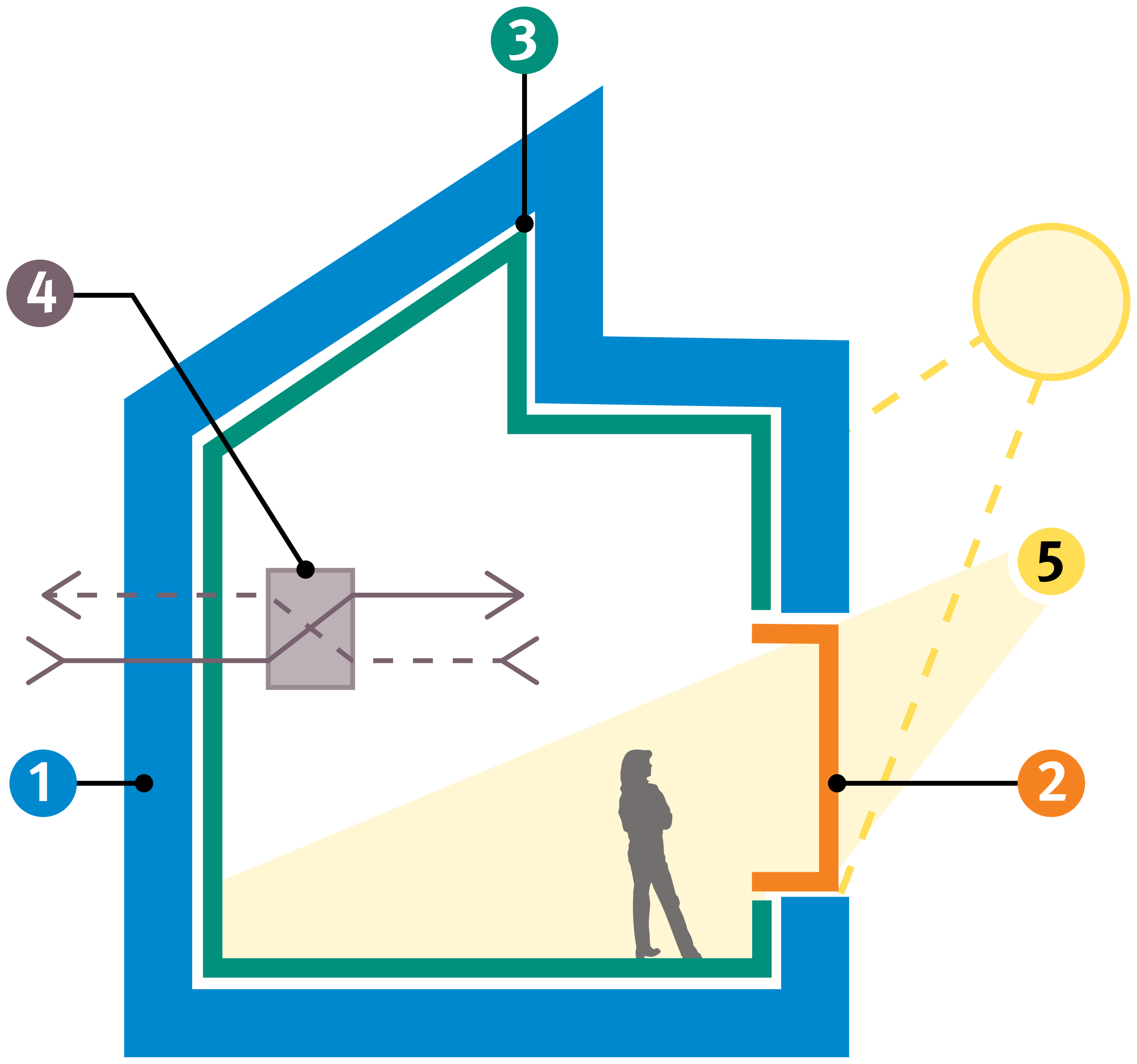
- Recognize unique Passive Building strategies for schools that are different than other building types
- Develop specific exterior assemblies for schools pursuing Phius certification
- Implement WUFI Passive /METr modeling with school building considerations and challenges
- Determine pathway for Phius for non-residential projects

WHY PASSIVE BUILDINGS FOR SCHOOLS

BENEFITS OF PASSIVE BUILDING



Phius for Commercial



1. Continuous High R Insulation
2. High Performance Windows
3. Air Tight Enclosure
4. Balanced Ventilation with Heat Recovery
5. Optimized Solar Orientation

phius

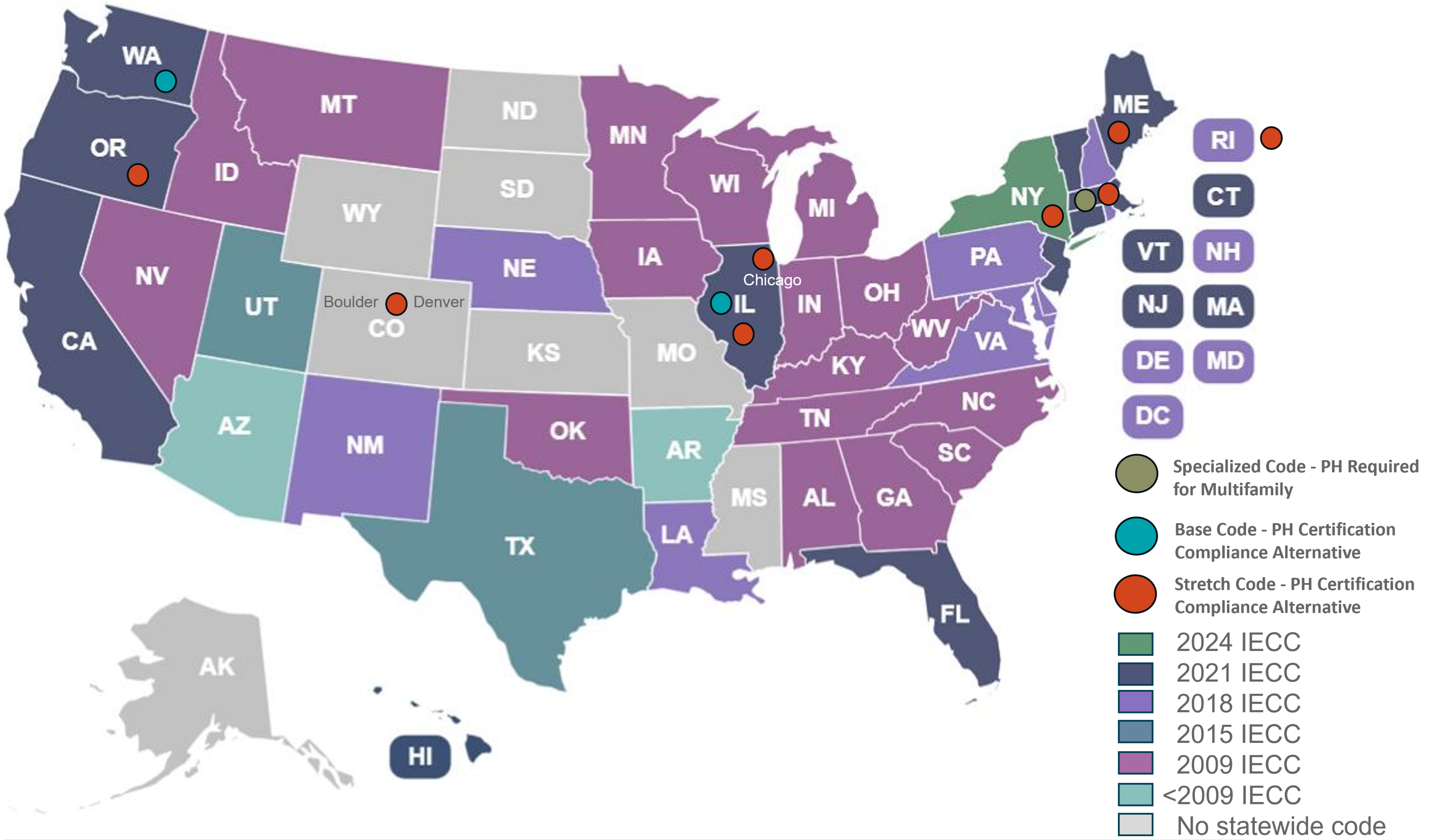
BASED ON CLIMATE, ENVELOPE & FLOOR AREA, OCCUPANCY	**PEAK HEATING LOAD** **ANNUAL HEATING DEMAND** **PEAK COOLING LOAD** **ANNUAL COOLING DEMAND**
ALLOWANCE/SF	**ANNUAL SOURCE ENERGY**
0.06 CFM50/SF	**AIR TIGHTNESS**
	MOISTURE CONTROL
	GLAZING COMFORT/ CONDENSATION
	WATER EFFICIENCY
	EV READY
	PV READY

Phius for Commercial

Unlike residential, commercial projects do not gain additional certifications but components of those programs need to be met

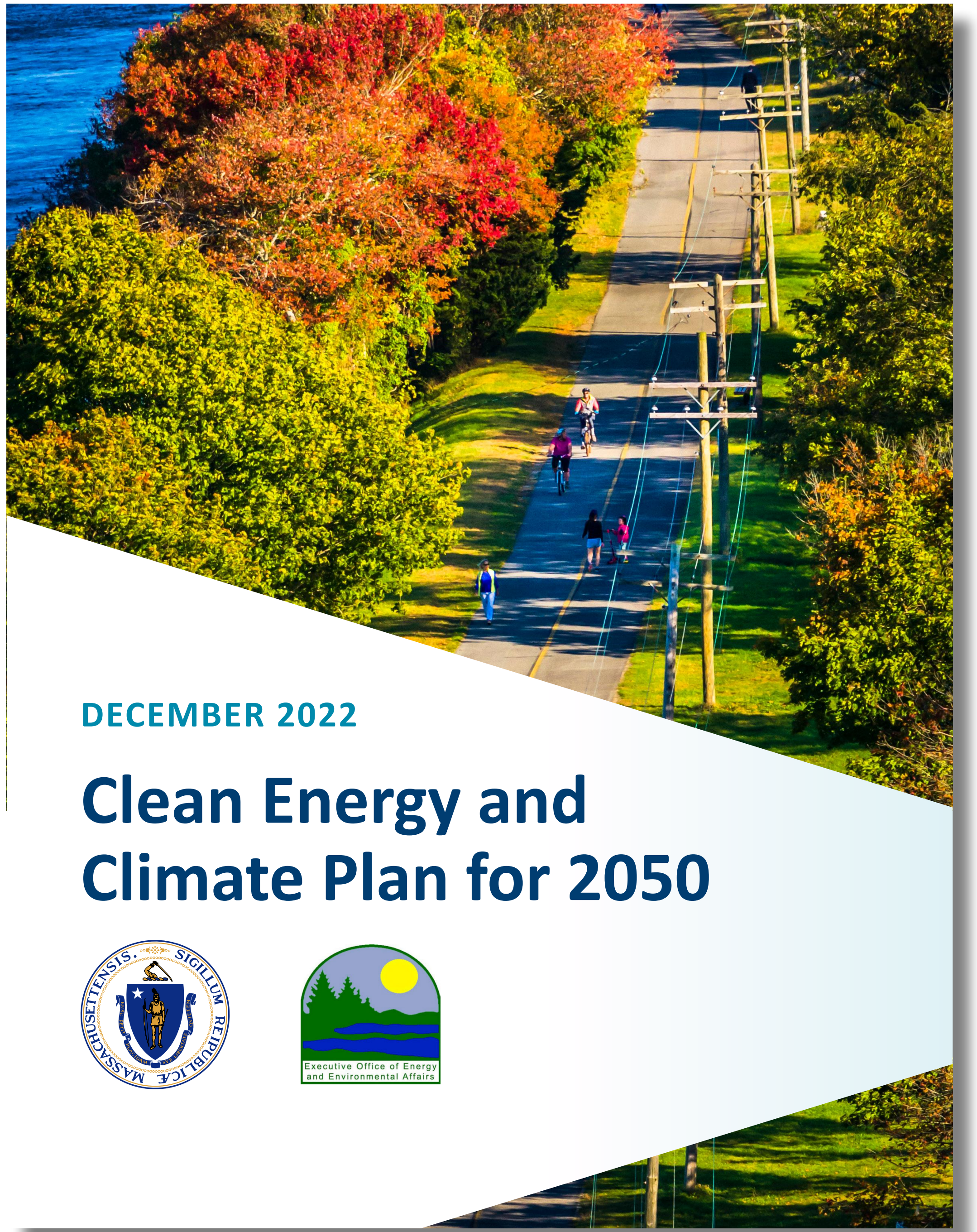
POLICY INFLUENCING PASSIVE BUILDING

PASSIVE HOUSE CERTIFICATION COMPLIANCE IN CODES



FINANCIAL INCENTIVES FOR PHIUS PROJECTS: HTTPS://WWW.PHIUS.ORG/RESOURCES/POLICY-WORK/FINANCIAL-INCENTIVES

WHAT’S HAPPENING IN MASSACHUSETTS



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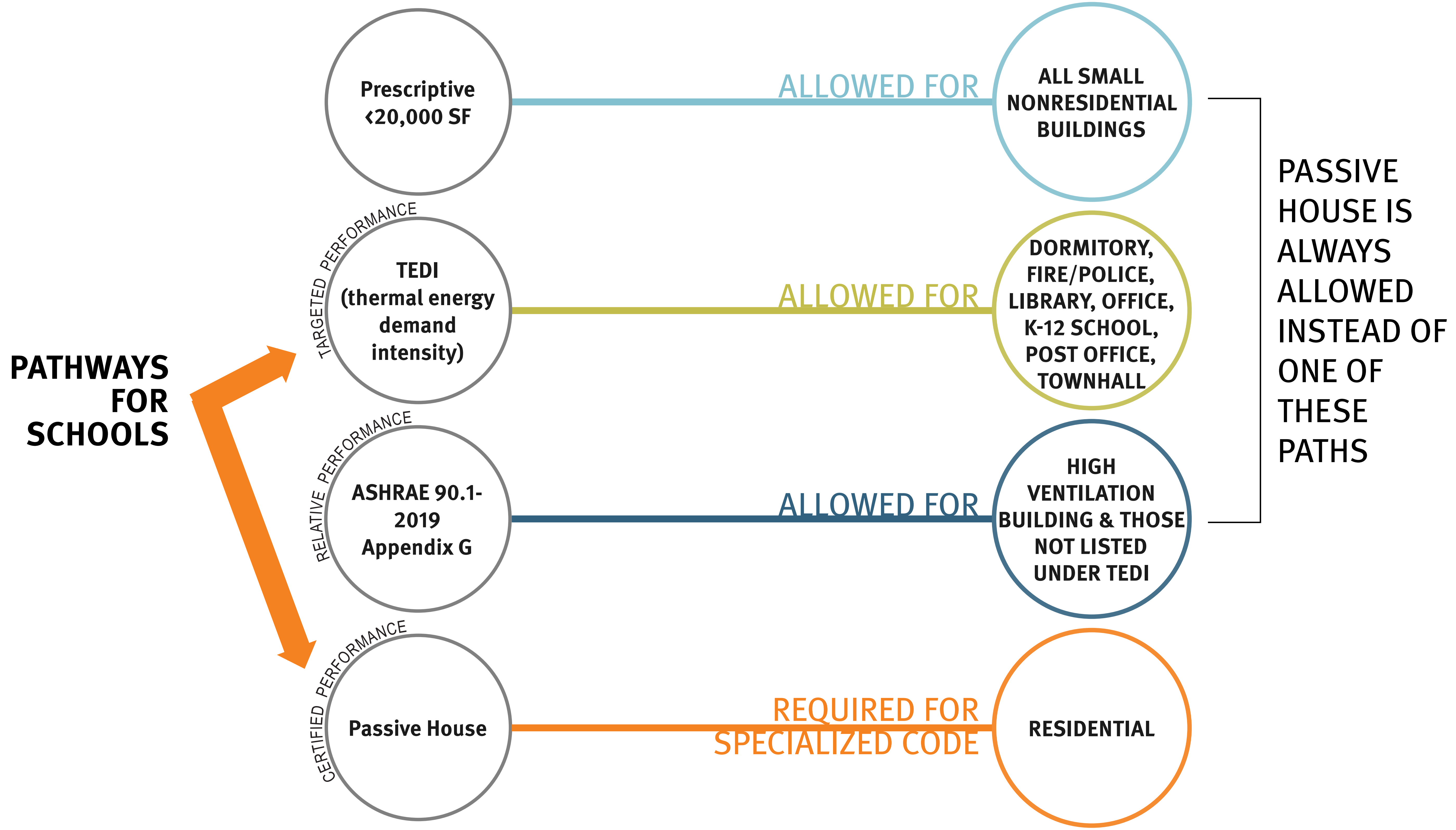


FEASIBILITY STUDIES

PHIUS FEASIBILITY STUDIES

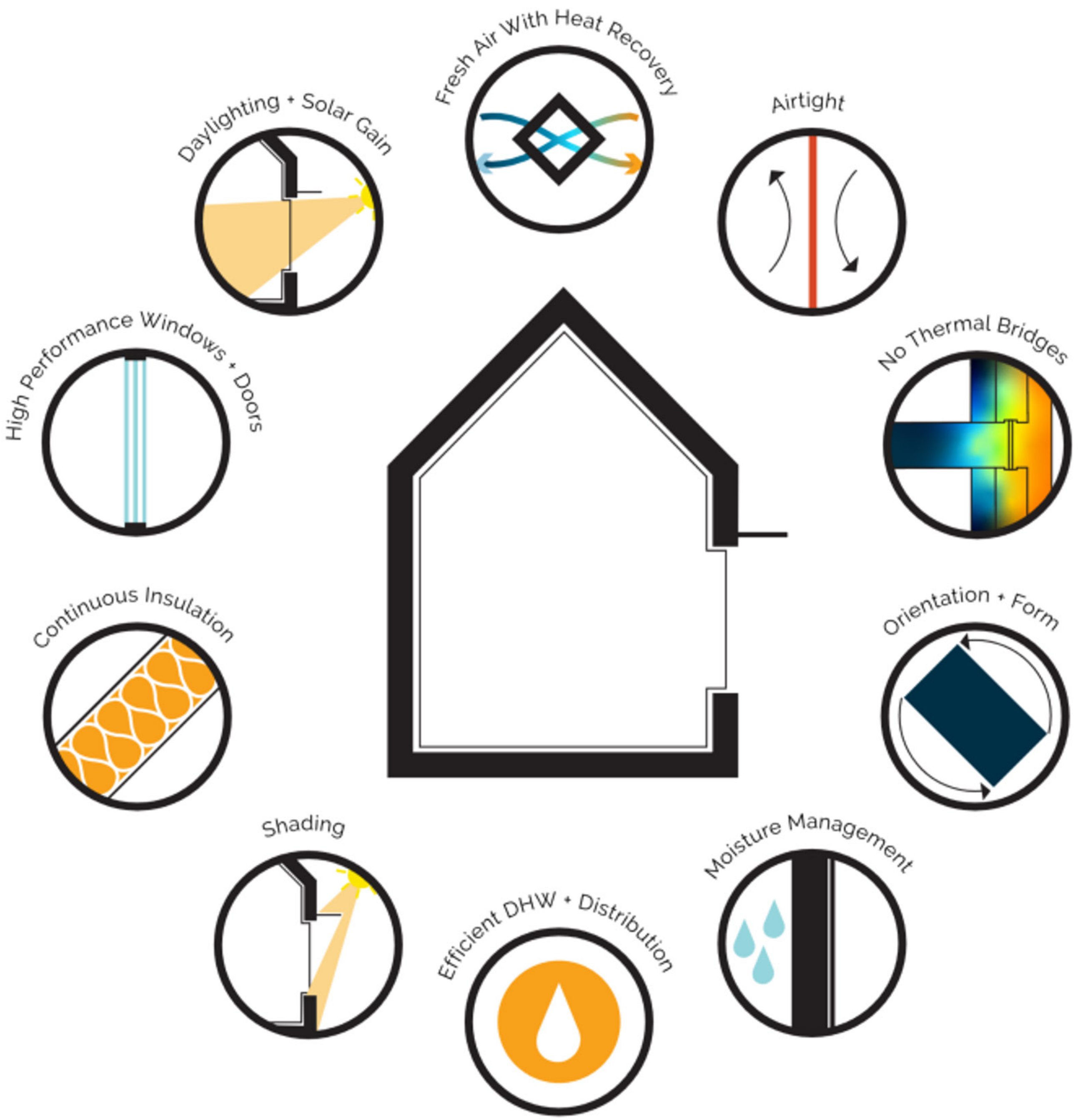


IMAGE INSPIRATION: PASSIVE HOUSE ACCELERATOR

ENGAGING PHIUS EARLY PUTS PROJECTS IN THE RIGHT DIRECTION

PHIUS FEASIBILITY STUDIES

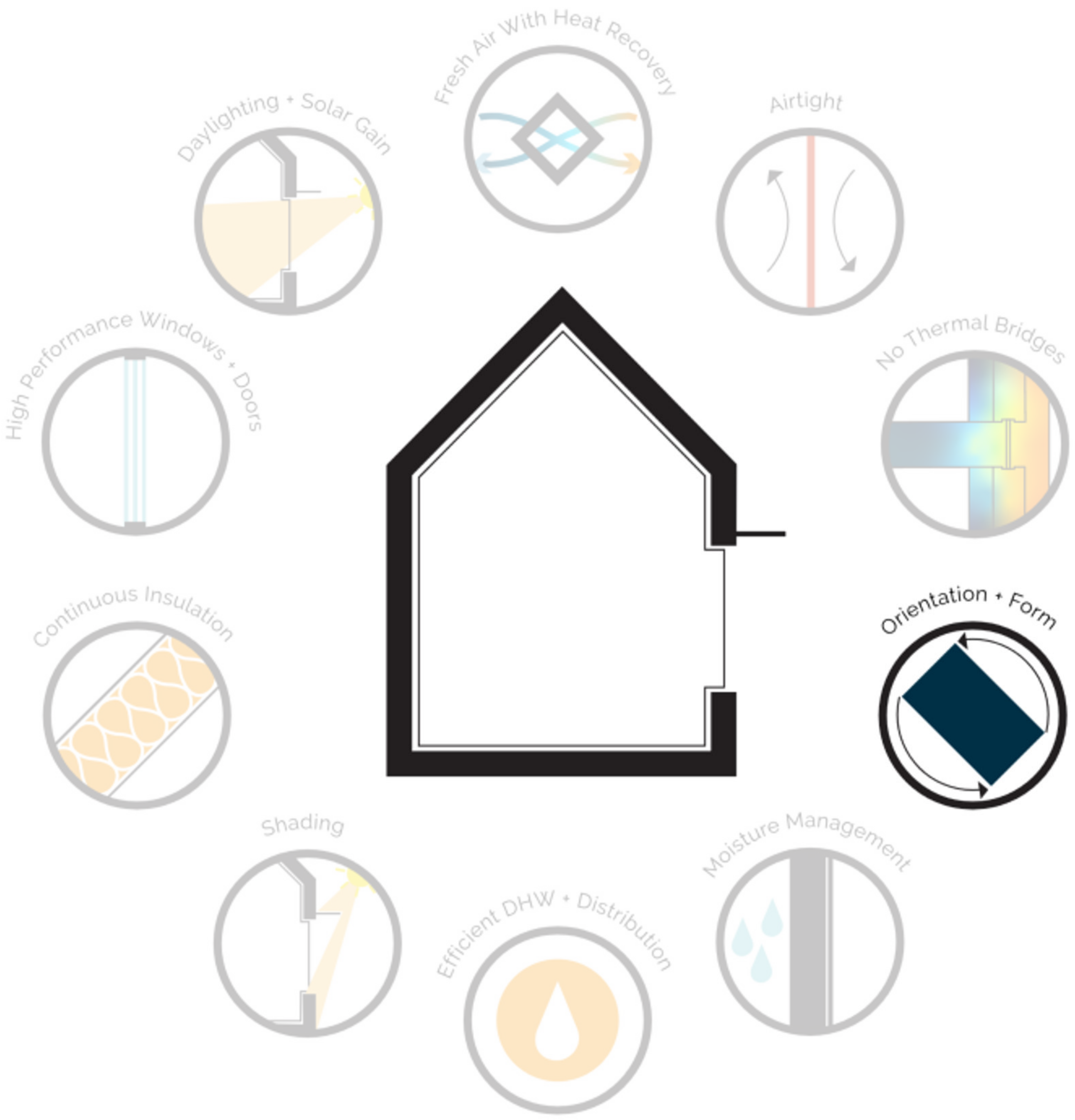


IMAGE INSPIRATION: PASSIVE HOUSE ACCELERATOR

ENGAGING PHIUS EARLY PUTS PROJECTS IN THE RIGHT DIRECTION

Geometry development

Custom climate data

PHIUS FEASIBILITY STUDIES

IMAGE INSPIRATION: PASSIVE HOUSE ACCELERATOR

ENGAGING PHIUS EARLY PUTS PROJECTS IN THE RIGHT DIRECTION

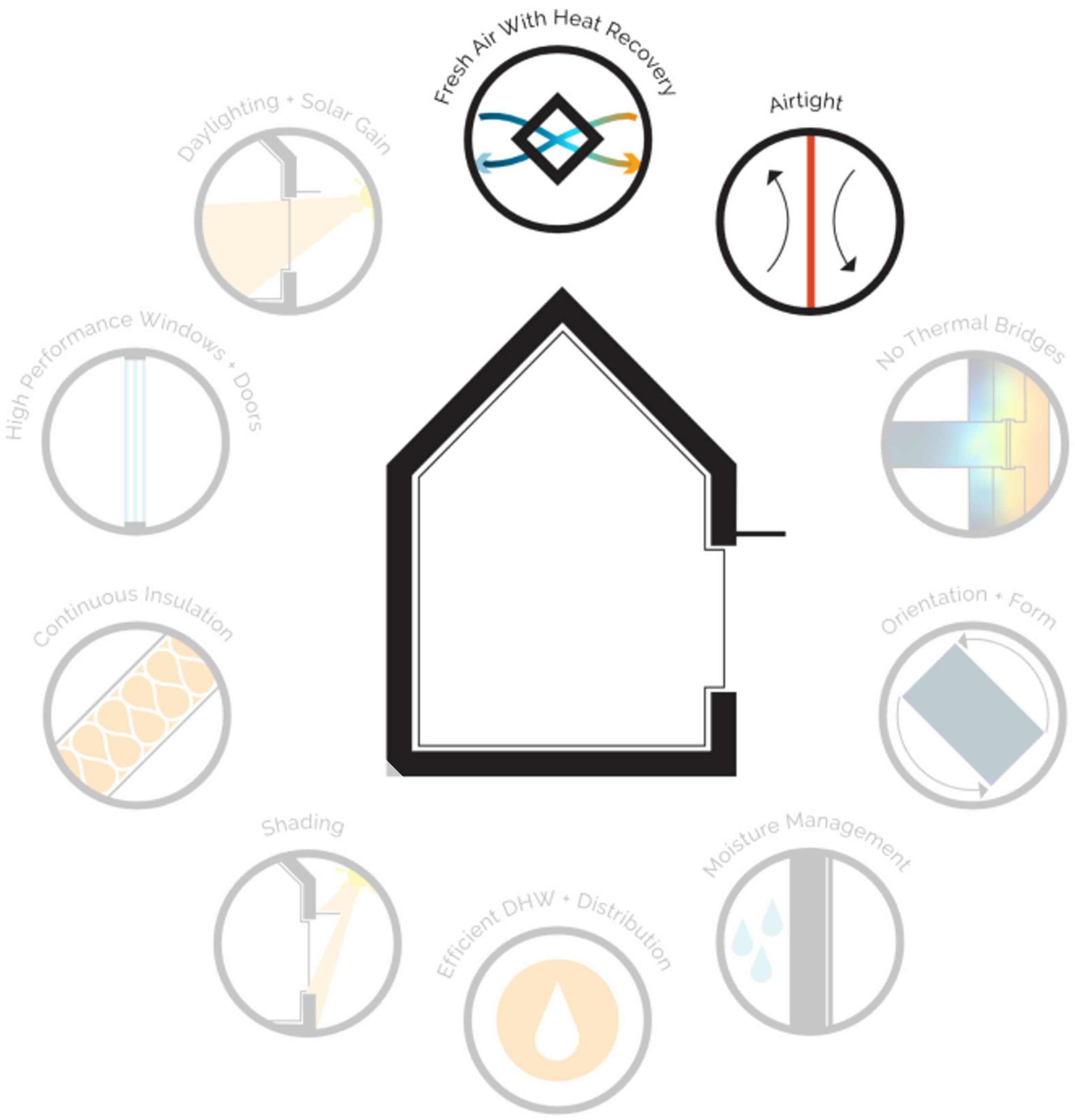
Geometry development

Custom climate data

Window comfort criteria

Comments on envelope optimization

PHIUS FEASIBILITY STUDIES



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ENGAGING PHIUS EARLY PUTS PROJECTS IN THE RIGHT DIRECTION

Geometry development

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Window comfort criteria

Comments on envelope optimization

Coordination on ventilation approach

PHIUS FEASIBILITY STUDIES

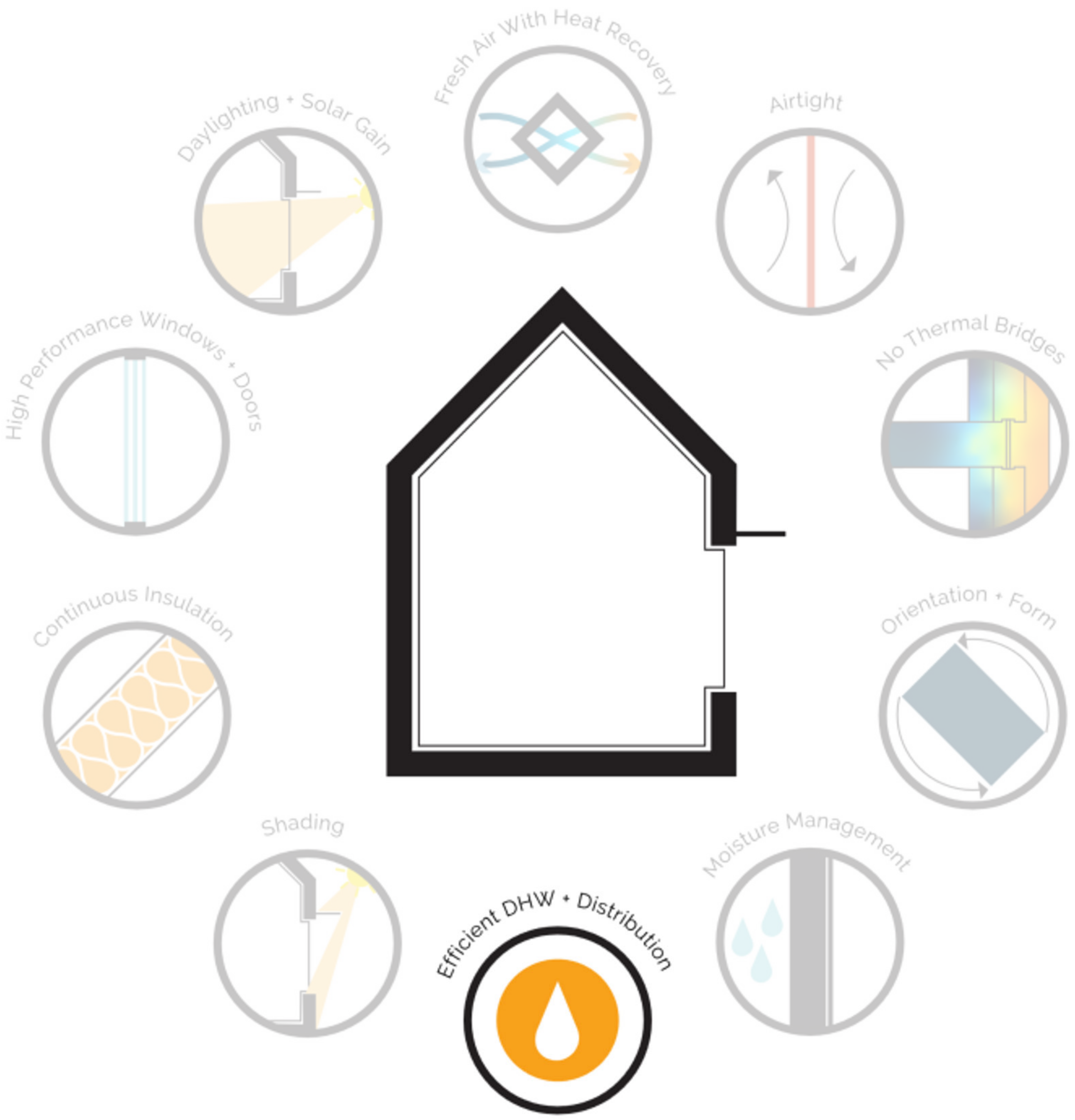


IMAGE INSPIRATION: PASSIVE HOUSE ACCELERATOR

ENGAGING PHIUS EARLY PUTS PROJECTS IN THE RIGHT DIRECTION

Geometry development

Custom climate data

Window comfort criteria

Comments on envelope optimization

Coordination on ventilation approach

Estimates on office and kitchen equipment

DHW usage calculations

PHIUS FEASIBILITY STUDIES

IMAGE INSPIRATION: PASSIVE HOUSE ACCELERATOR

ENGAGING PHIUS EARLY PUTS PROJECTS IN THE RIGHT DIRECTION

Geometry development

Custom climate data

Window comfort criteria

Comments on envelope optimization

Coordination on ventilation approach

Estimates on office and kitchen equipment

DHW usage calculations

Evaluation of key questions:

Squantum ES flat vs pitched roof

Revere HS ER%

+ All non-residential atypical situations

CASE STUDIES

SQUANTUM SCHOOL, CHARLESWOOD SCHOOL,
REVERE HIGH SCHOOL

SQUANTUM SCHOOL

Phius CORE COMM 2024

LEED Schools Gold

380 STUDENTS

K-5 GRADES

80,000 GSF

2 STORIES

CONSTRUCTION
MAR 2025 - JULY 2027

SQUANTUM SCHOOL

ENVELOPE

20.3% WWR

R-60 ROOF

R-28 WALLS

R-45 FLOORS

R-20 SLABS

U-0.15/SHGC 0.33
FIXED & OPERABLE GLAZING

0.06 CFM/SF @50pa
AIR TIGHTNESS

* Wall R-values include clear field but not linear derating

SQUANTUM SCHOOL

SYSTEM HIGHLIGHTS

pEUI 25

Ground Source Heat Pumps

Radiant Heating

Displacement Ventilation w/ Energy Recovery & Demand Control

Heat Pump Hot Water

Daylight Controls & LED Lighting

On-site PV

SQUANTUM SCHOOL

	Technology	Estimated Construction Cost	Rate [1]	Estimated Incentive
Sec 48 Alternative Energy Investment Tax Credit	Solar	$1,400,000	25.5%	$357,000
	Ground Source Heat Pump	$8,507,000	34%	$2,892,380
Mass Save	Path 1			$586,400
MA EVIP Public Access [2]	EV charging	$56,000	100%	$50,000

$9,963,000
Construction Cost Total

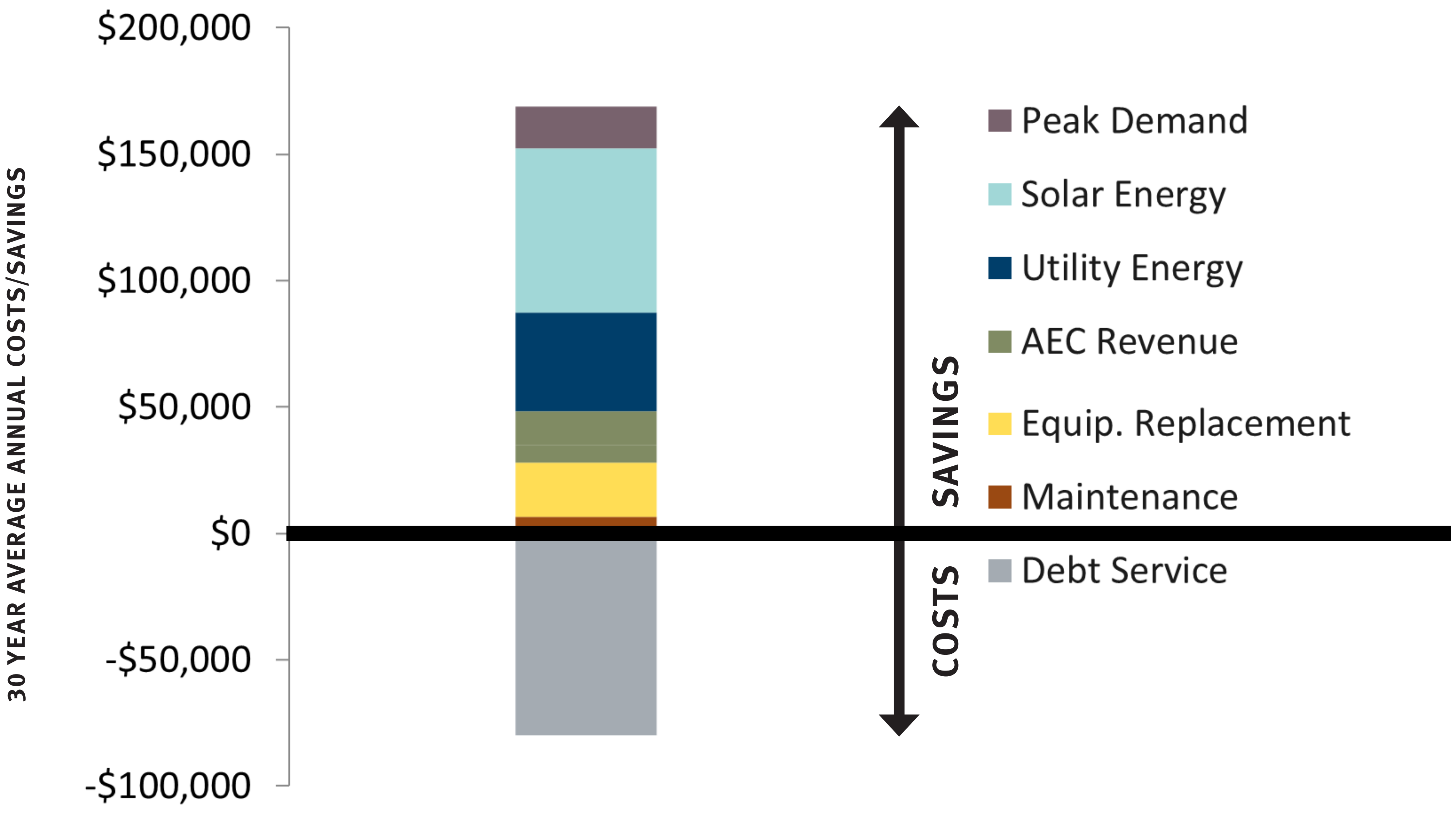
$3,885,780
Potential Incentive Total

$6,077,220
w/ Incentive

1. Assumed using tax-exempt bonds
2. Assumes supplying 4 EVSE

SQUANTUM SCHOOL

OPERATIONAL SAVINGS

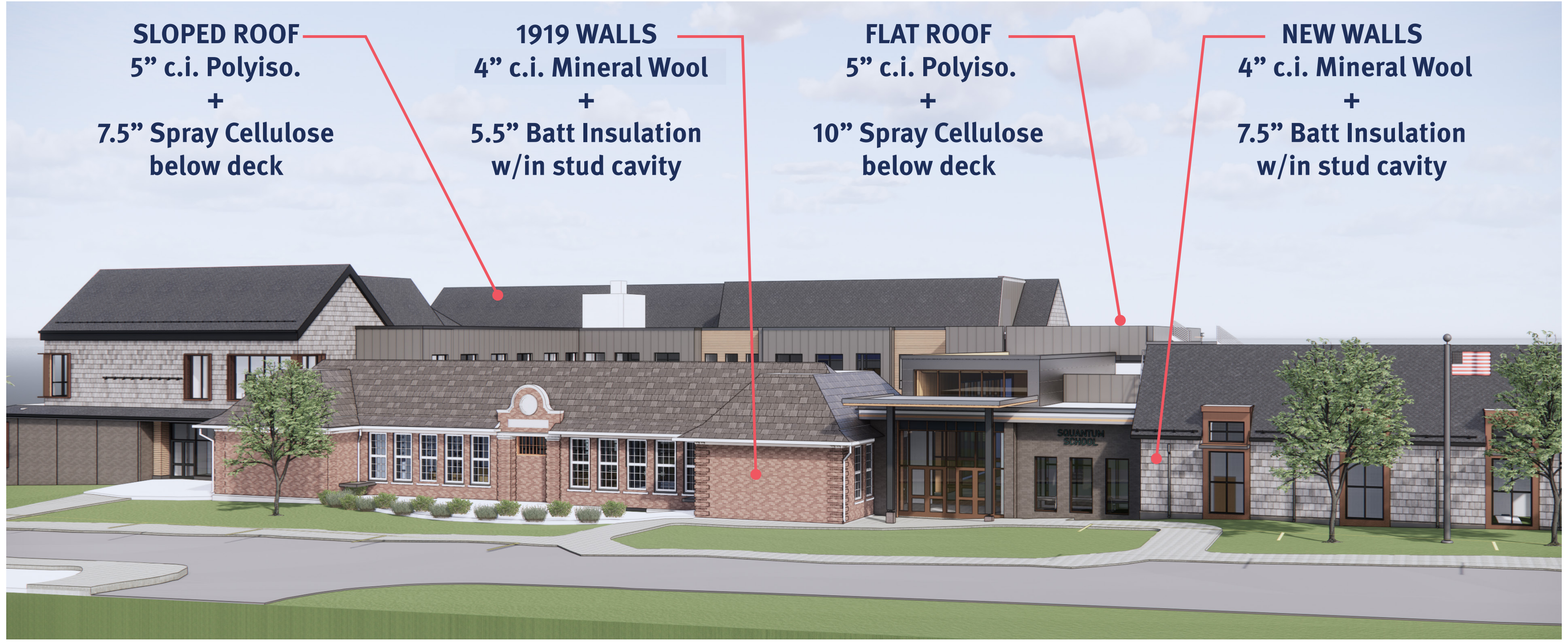


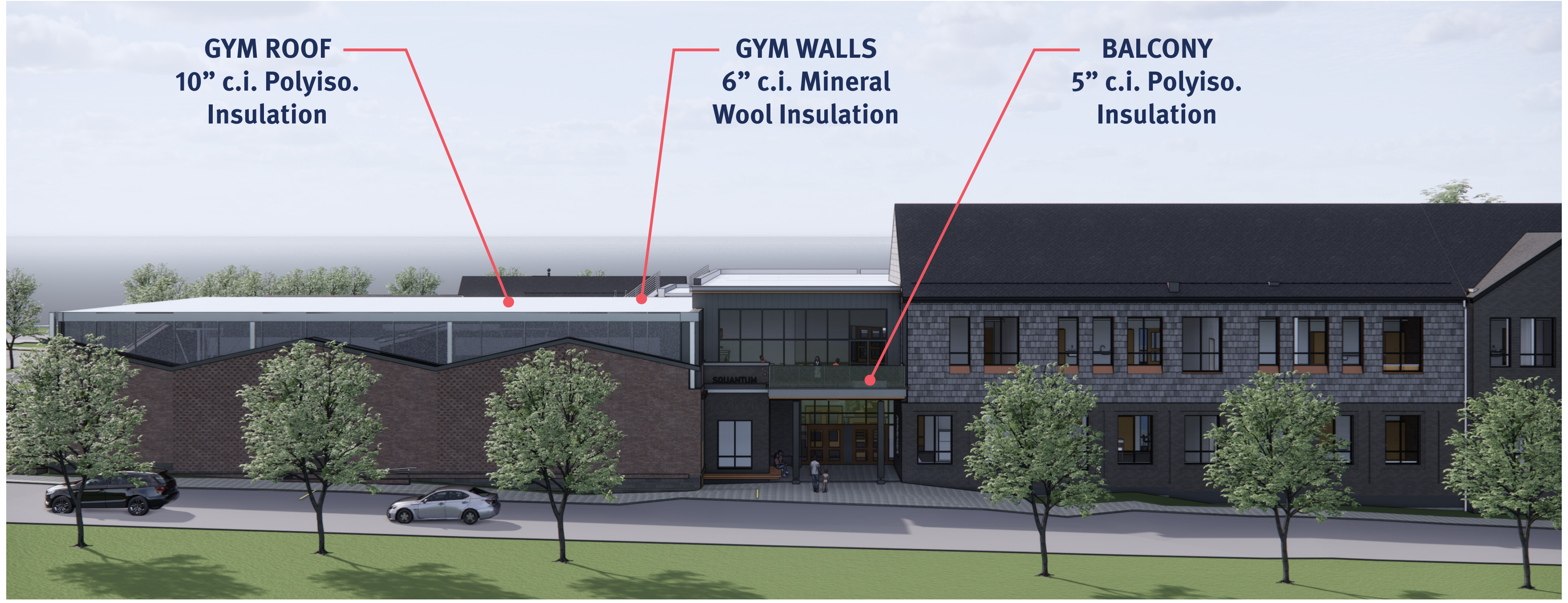
30 Year total
$2,450,000

Savings start year 1

SQUANTUM SCHOOL

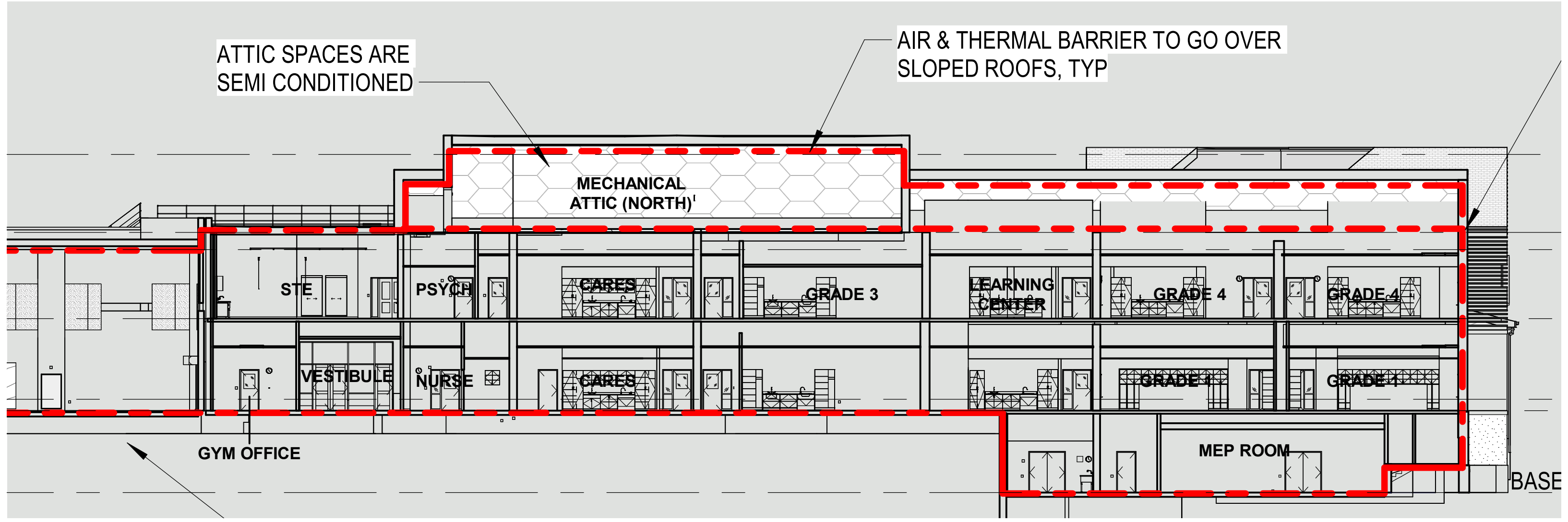
ENVELOPE ASSEMBLIES



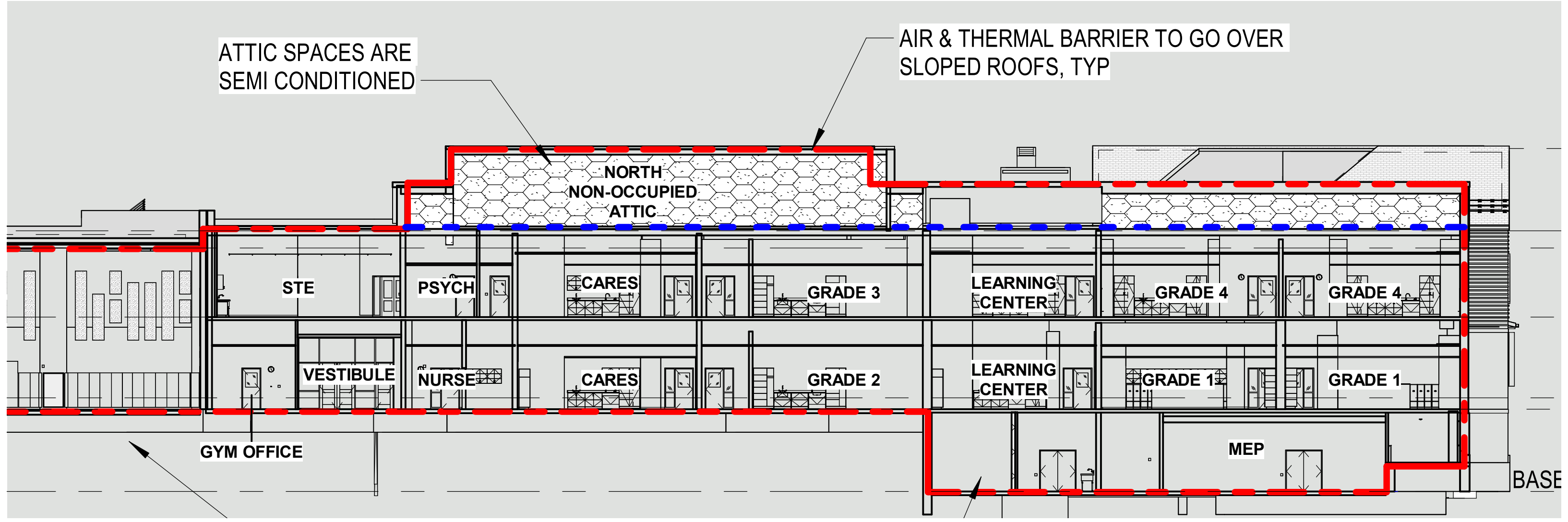


SQUANTUM SCHOOL

THERMAL/AIR BOUNDARY



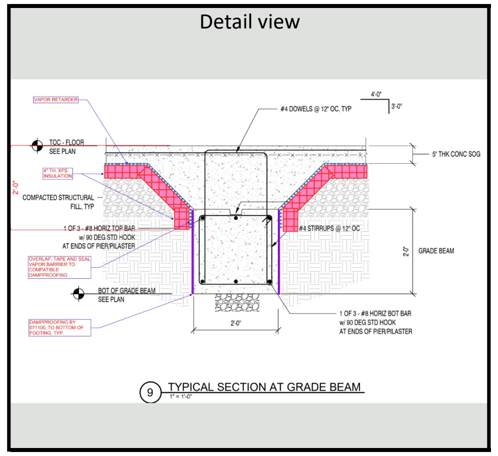
AT SLOPE

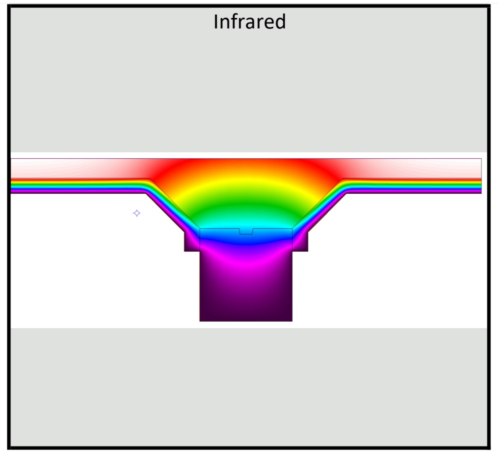


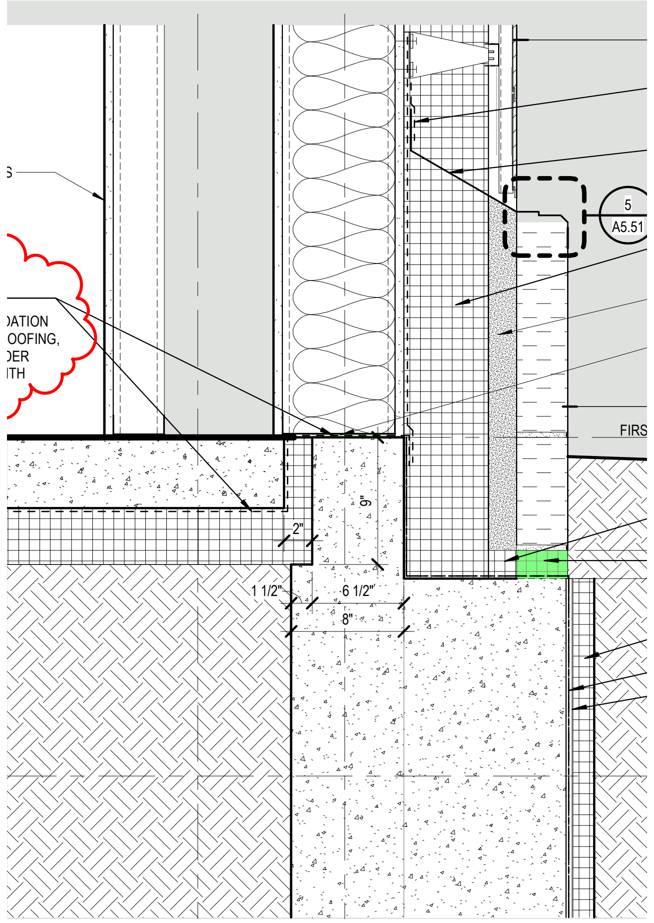
AT FLOOR

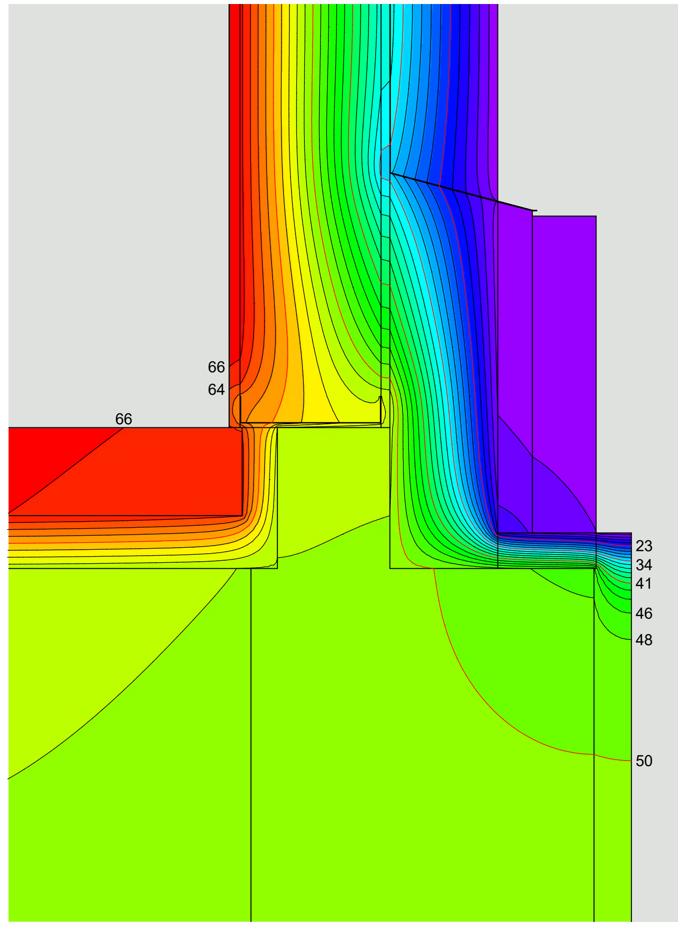
SQUANTUM SCHOOL

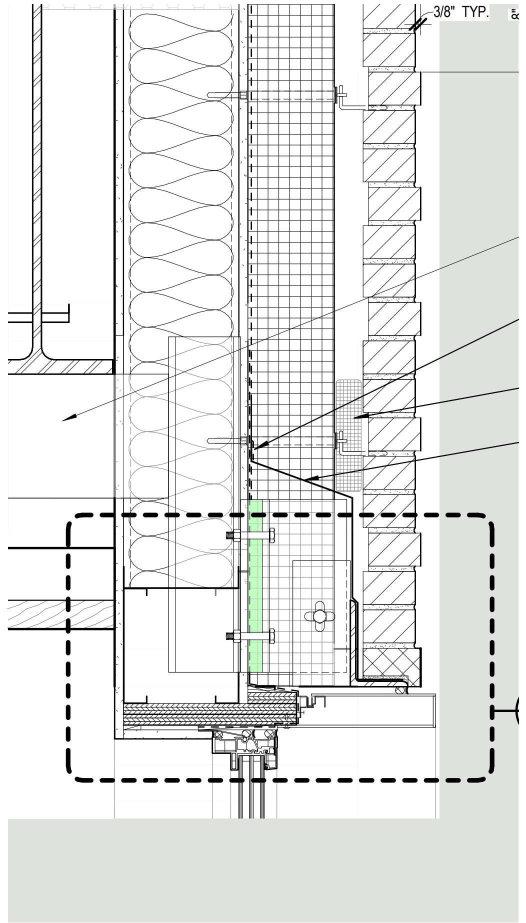
THERMAL BRIDGE MITIGATION

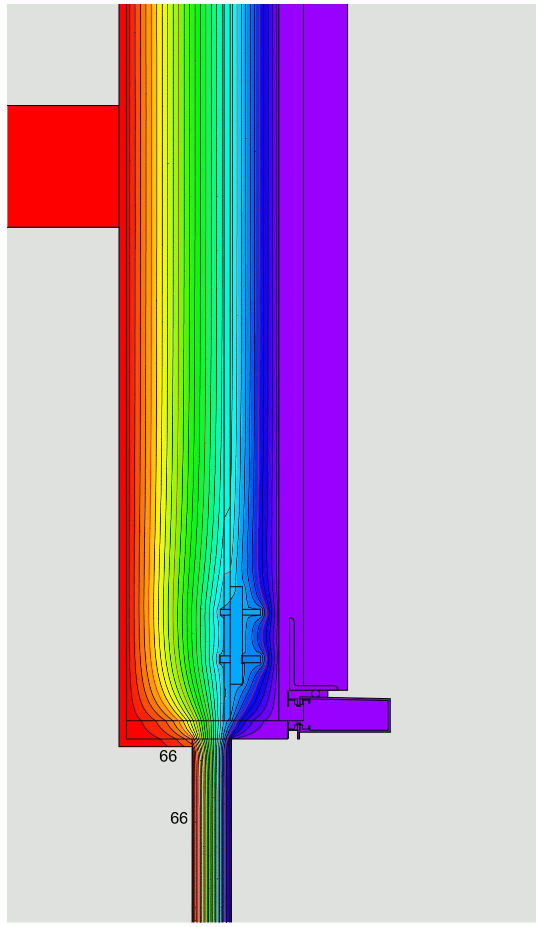












GRADE BEAMS

PSI 0.684

PERIMETER BASE

PSI 0.116

RELIEVING ANGLE

PSI 0.017

CHARLESWOOD ELEMENTARY

Phius CORE COMM 2021

LEED Schools Gold

1,185 STUDENTS

K-5 GRADES

170,000 GSF

3 STORIES

COMPLETION 2027

CHARLESWOOD ELEMENTARY

ENVELOPE

169,600 iCFA

18.7% WWR

R-54 ROOF

R-25 WALLS

R-15 SLABS

U-0.19 FIXED GLAZING
U-0.22 OPERABLE

0.06 CFM/SF @50pa
AIR TIGHTNESS

* Wall R-values include clear field but not linear derating

CHARLESWOOD ELEMENTARY

IMAGE CREDIT: PERKINS EASTMAN

SYSTEM HIGHLIGHTS

Distributed Ground Source Heat Pumps

Dedicated Outside Air System w/ Energy Recovery & Demand Control

Electric Resistance Hot Water

Daylight Controls & LED Lighting

On-site PV

REVERE HIGH SCHOOL


IMAGE CREDIT: PERKINS EASTMAN

Phius CORE COMM 2024

LEED Schools Gold

2,450 STUDENTS

9-12 GRADES

426,000 GSF

6 STORIES

COMPLETION 2028

REVERE HIGH SCHOOL

ENVELOPE

IMAGE CREDIT: PERKINS EASTMAN

426,000 iCFA

11.2% WWR

R-63 ROOF

R-28 WALLS

R-35 FLOOR

U-0.17 FIXED GLAZING
U-0.27 OPERABLE

0.086 CFM/SF @50pa
AIR TIGHTNESS

* Wall R-values includes clear field but not linear derating

REVERE HIGH SCHOOL

IMAGE CREDIT: PERKINS EASTMAN

SYSTEM HIGHLIGHTS

Distributed Ground Source Heat Pumps

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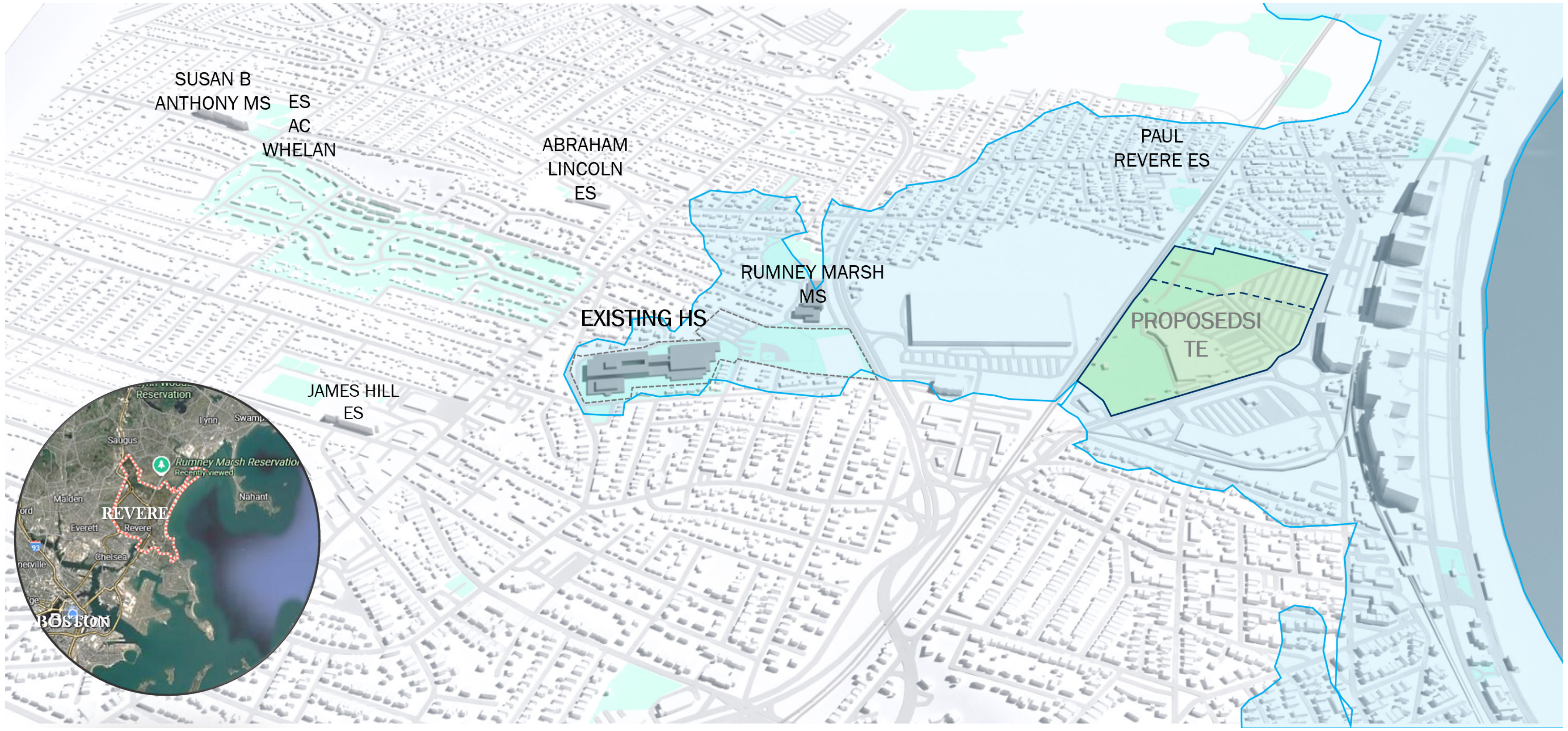
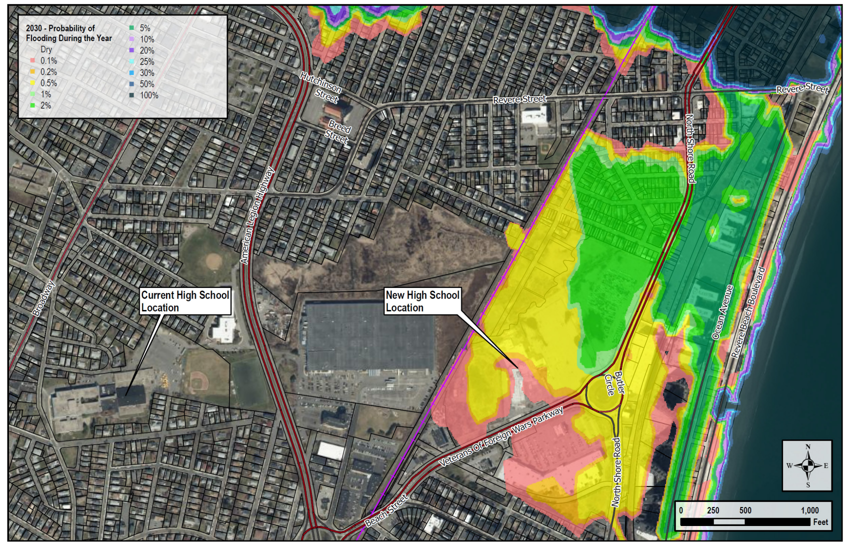
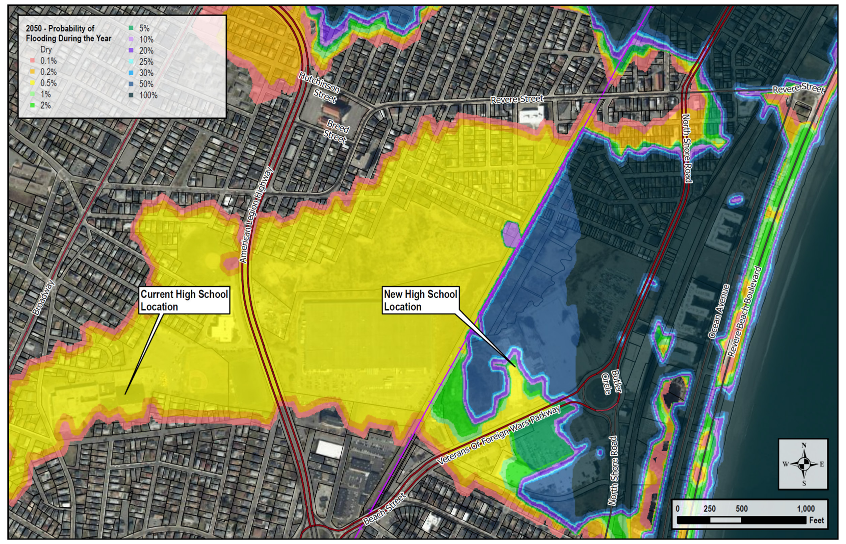
REVERE HIGH SCHOOL

FLOOD RESILIENCE



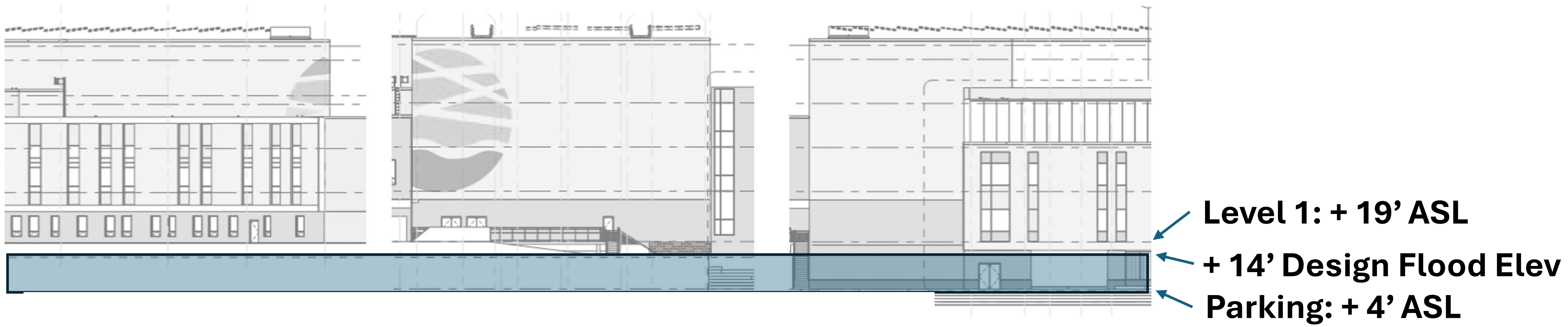


2030 Flood Probability



2050 Flood Probability

FLOOD RESILIENCE



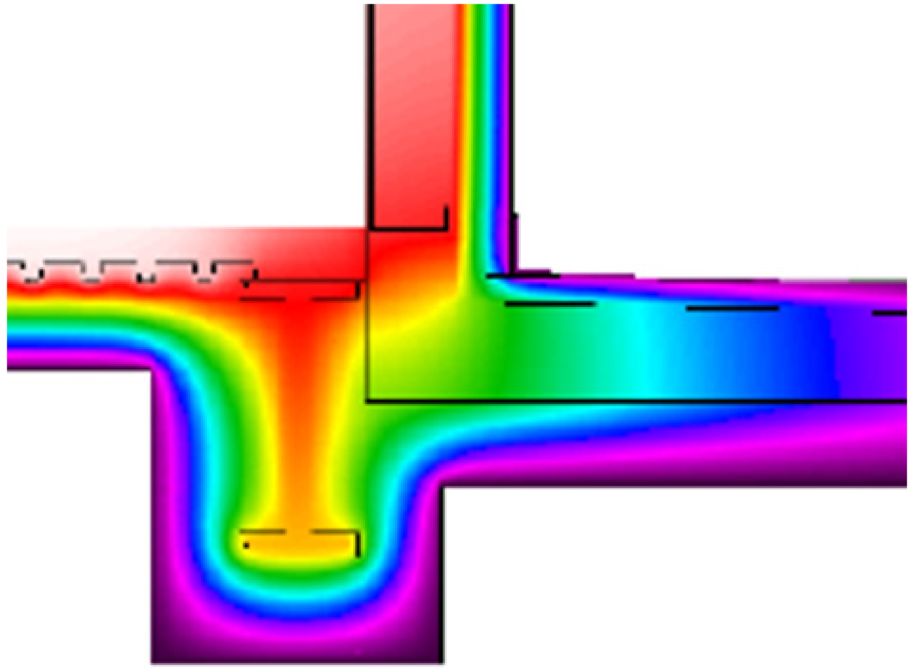
Engineered Flood Vents

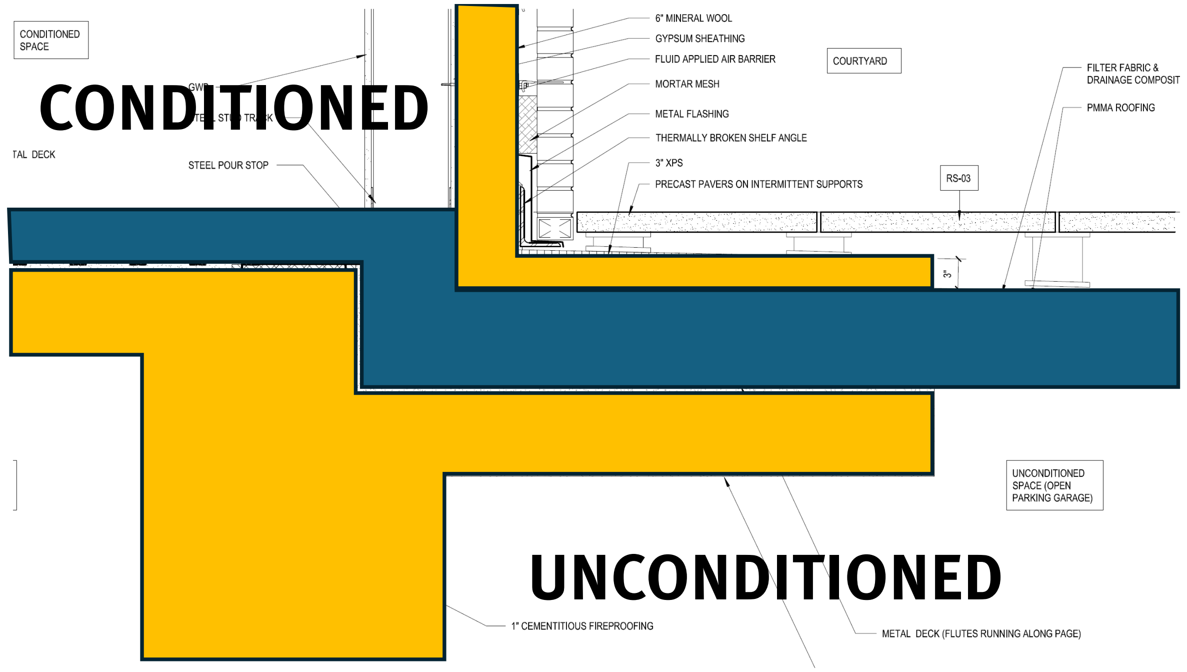
SMART VENT PRODUCTS, INC.

Flood vents protect enclosures by allowing automatic bi-directional water flow that equalizes hydrostatic pressure.

REVERE HIGH SCHOOL

THERMAL BRIDGE CHALLENGE



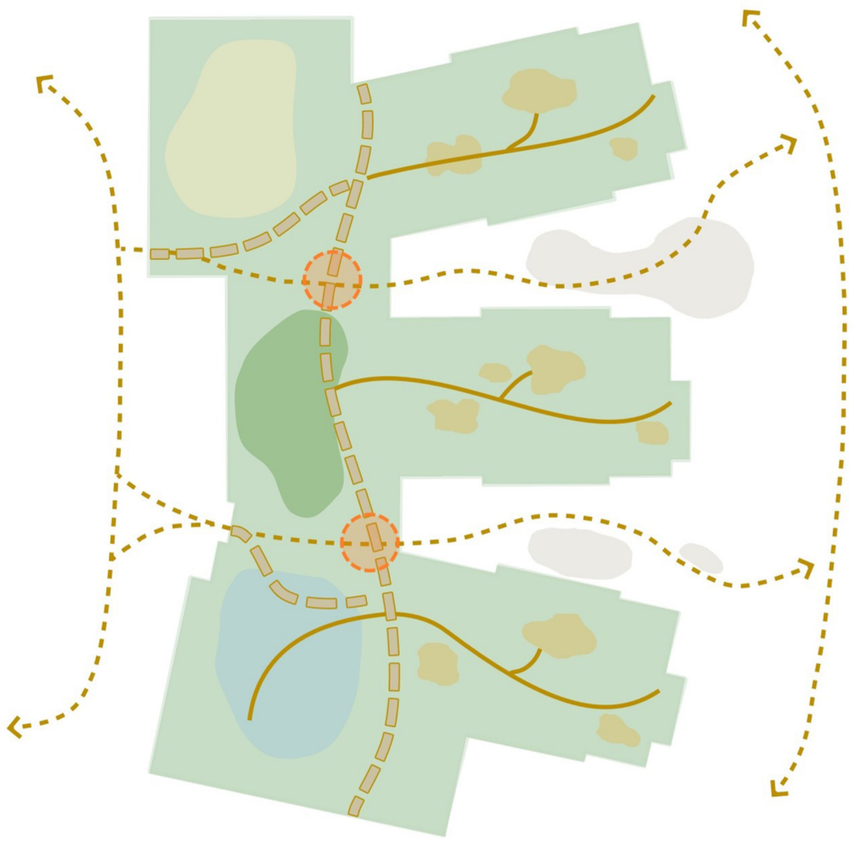


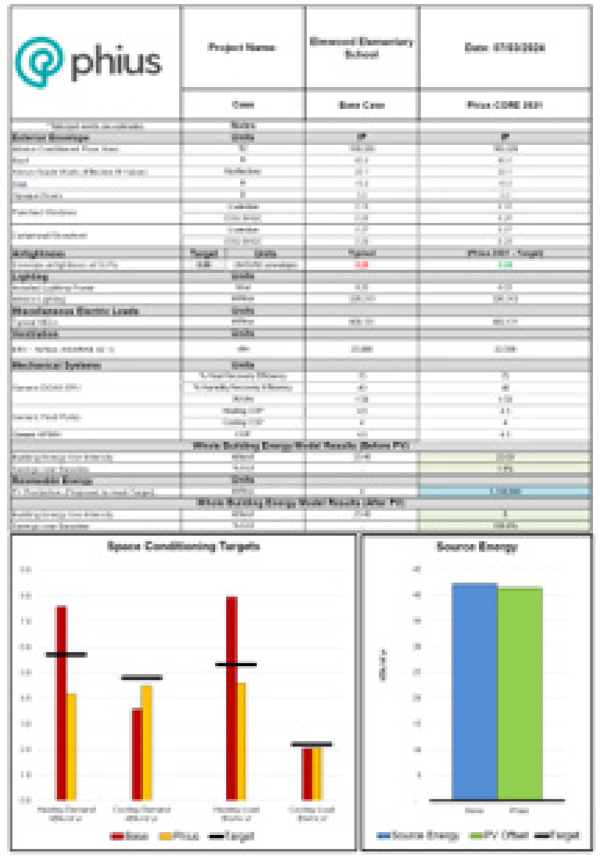
Psi
0.237

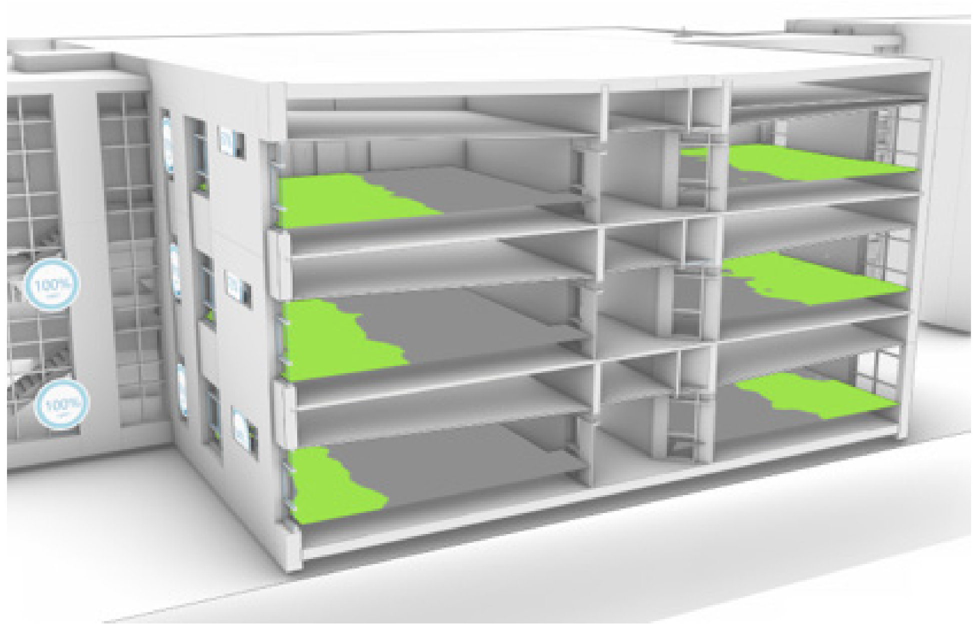
Linear Feet
581

Source EUI Increase
0.07%

DESIGN PROCESS







STARTING PRINCIPLES

- East-west orientation for classrooms, relatively compact form
- Con't insulation, reduced thermal bridging
- Optimized window to wall ratio

SET GOAL & BUILD TEAM

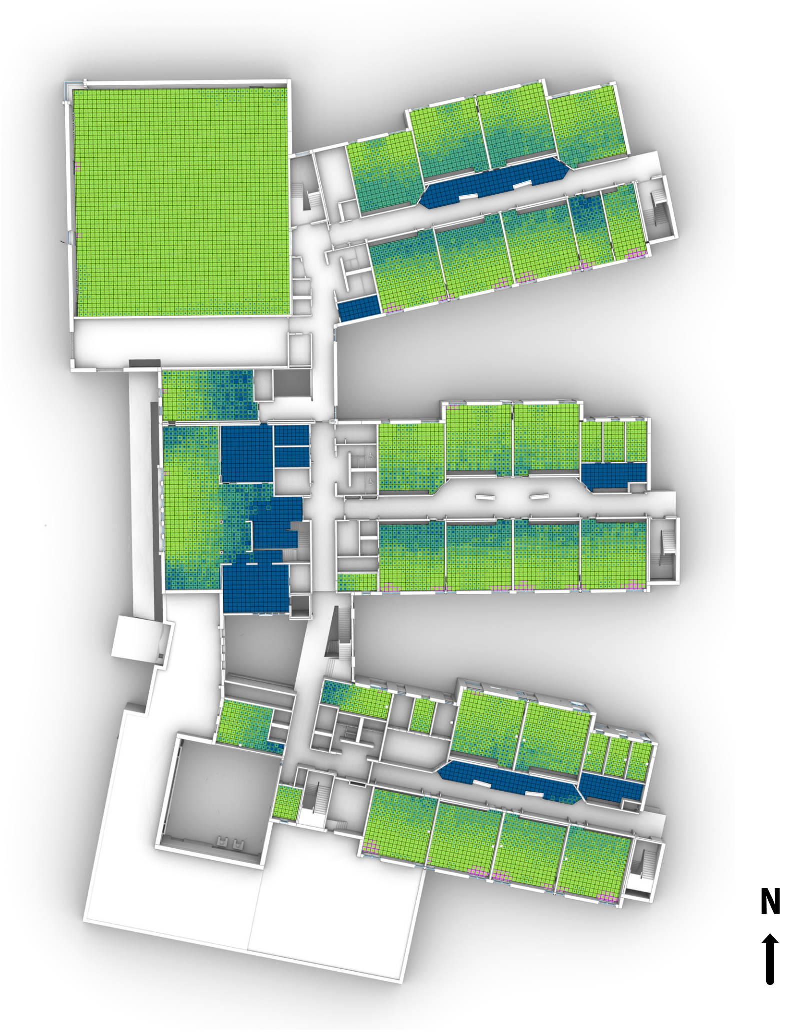
- Hire experienced CPHC & Verifier
- Phius feasibility study
- TEDI vs. Passive House

REFINE THE DESIGN

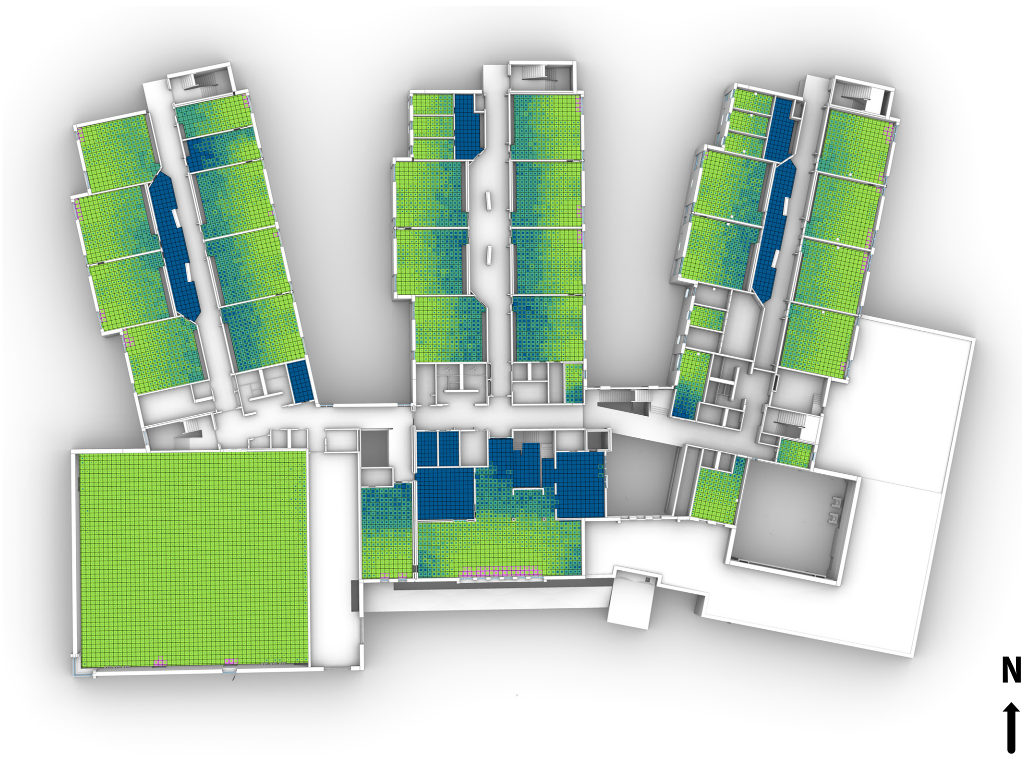
- Windows: size, type, mfr are crucial
- Balance PH with daylight
- Public bidding challenges
- Modeling challenges
- Thermal bridge analysis
- Specs highlight importance of air testing

BENEFITS OF NORTH-SOUTH FACADE ORIENTATION

CHARLESWOOD ELEMENTARY



NORTH-SOUTH



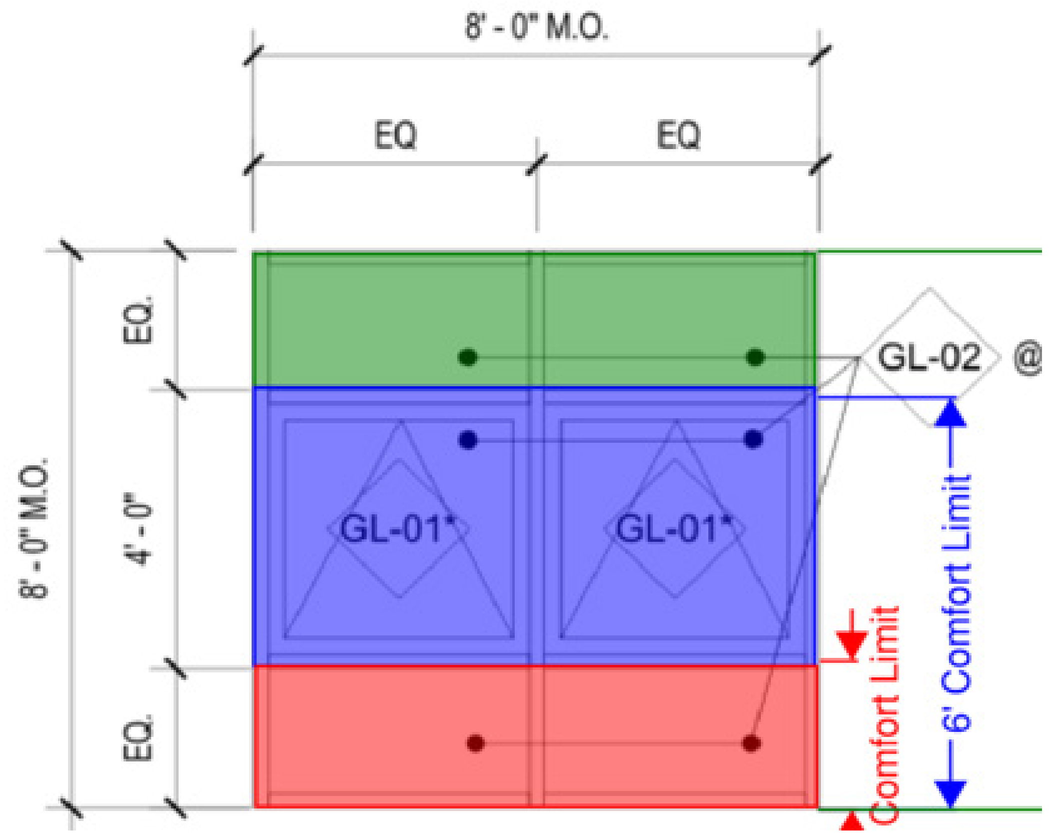
EAST-WEST

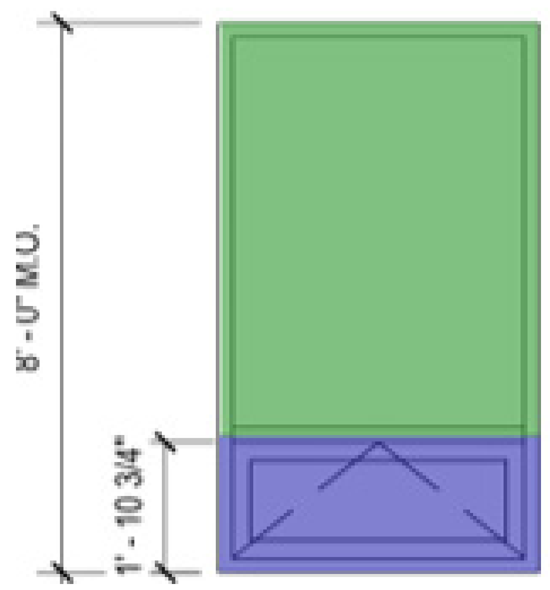
Useful Daylight Illuminance (UDI)
+11.7%

Energy Use Intensity (EUI)
-0.3%

Heating & Cooling Demand
-2.3%

WINDOW COMFORT CRITERIA





STACKED WINDOWS

- Additive approach to assess each lite
- Area-weighted approach to evaluate the whole window

CONSIDERATIONS WHEN ASSESSING COMPLIANCE

Need window-specific (not standard NFRC) U-factors for all windows before bid is awarded

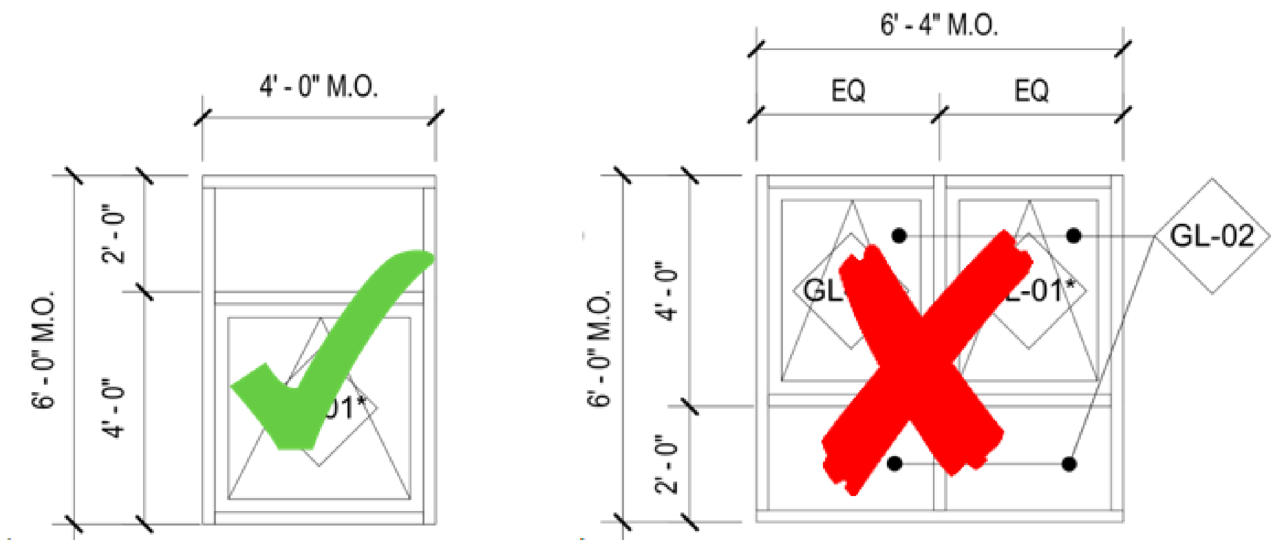
Different manufacturers have different capabilities for casement/awning

Advantageous to use products in Phius database – but small deviations (changing IGU type, different mullion configuration) mean you can’t use the data

Must consider stacked windows as full overall height

Custom climate files stricter than expected

DESIGN & SELECTING SYSTEM



CONSIDER LOCATION AND HEIGHT OF OPERABLE LIGHTS

Use punched windows instead of curtainwall (cost) or storefront (performance)

Consider vinyl or fiberglass

IF USING ALUMINUM

In cold climates, windows no taller than ~6’ (whole opening)

Operable Windows:
Locating below fixed is better
Keep operable height around 3’ max

Perimeter heat required if can’t reach compliance

WINDOW COMFORT CRITERIA

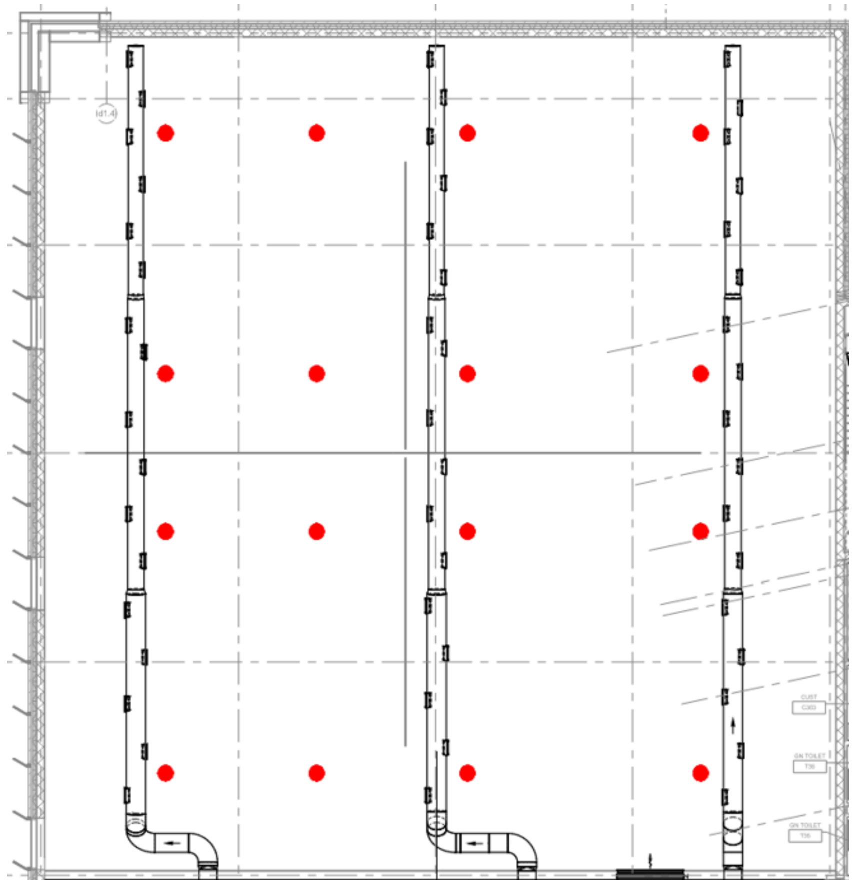
School	Type of window frame	Window selection	Window U-value passes comfort criteria?
Squantum ES	fiberglass	Cascadia	Yes
Charleswood ES	aluminum	Peerless	**No for top fixed panes & operable windows**
Revere HS	aluminum	Peerless	Yes

If window does not pass comfort criteria must provide perimeter heating. Diffusers w/i 3ft of window or sufficient throw to be farther away.

WINDOW COMFORT CRITERIA

PERIMETER HEATING ALTERNATIVE APPROACH

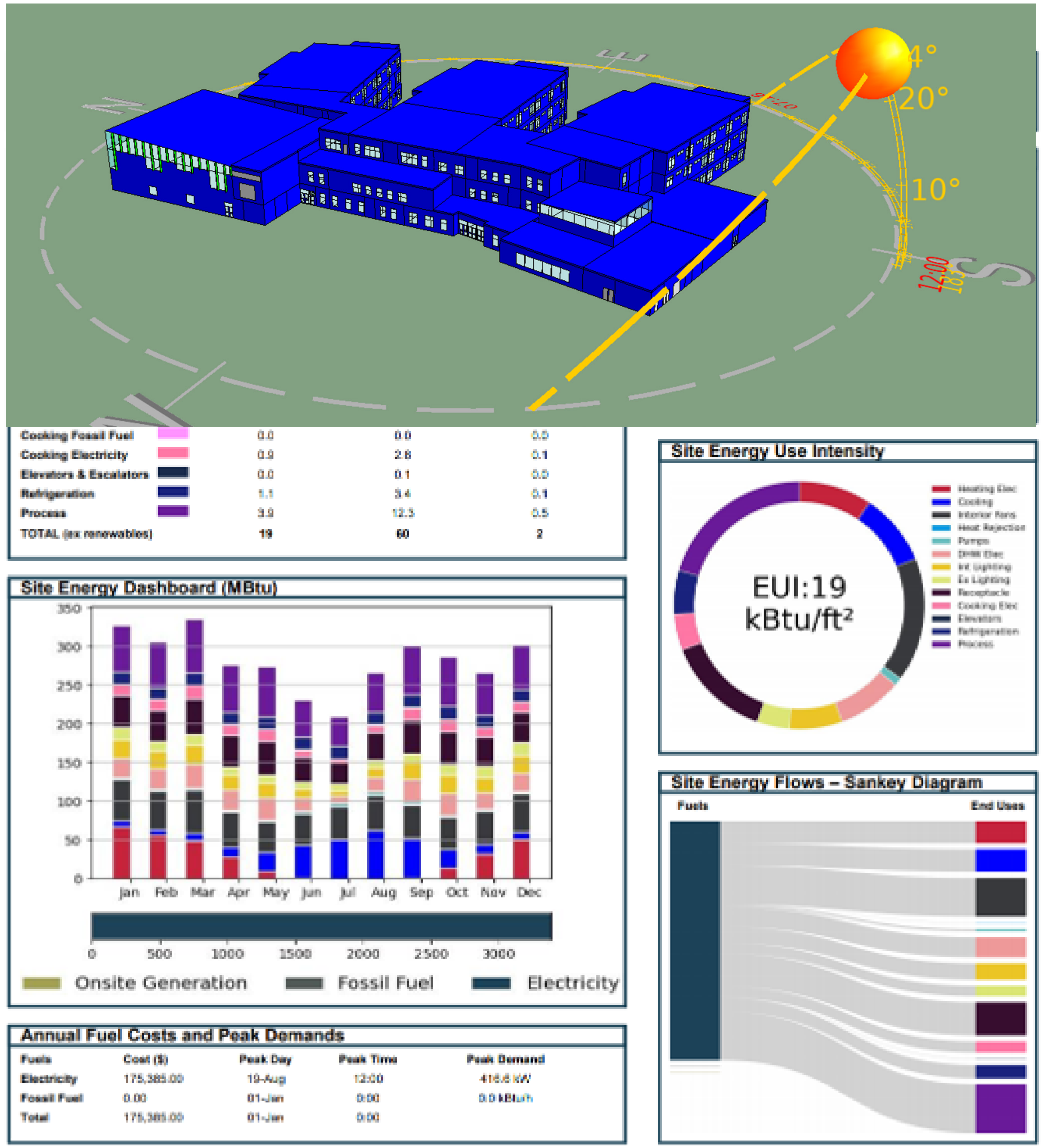
De-stratification



OTHER MEP CONSIDERATIONS

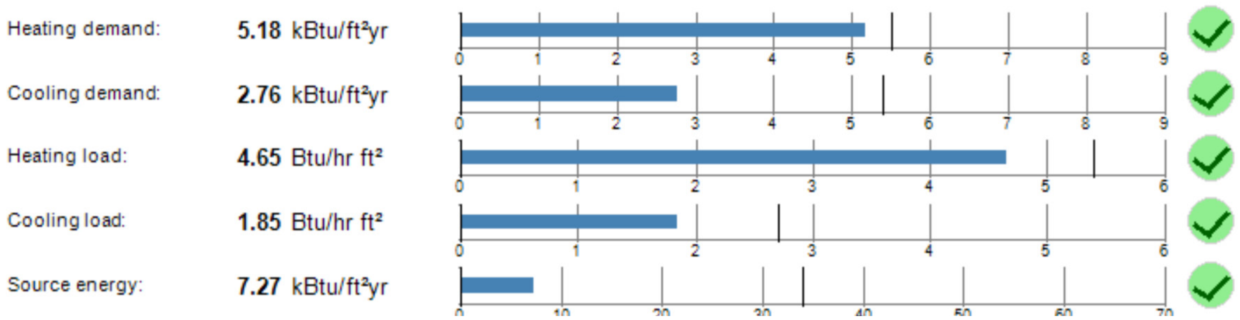
MECHANICAL IMPACTS - ENERGY MODELING

8760 MODEL TIE-IN TO WUFI PASSIVE



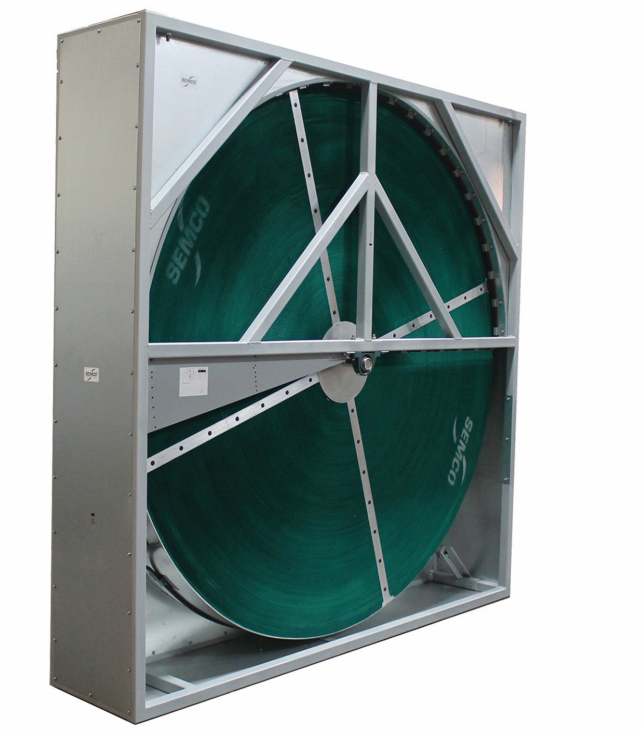
IES-VE OUTPUTS

Equipment
Lighting
Schedules



VENTILATION & ENERGY RECOVERY

INPUT CONSIDERATIONS

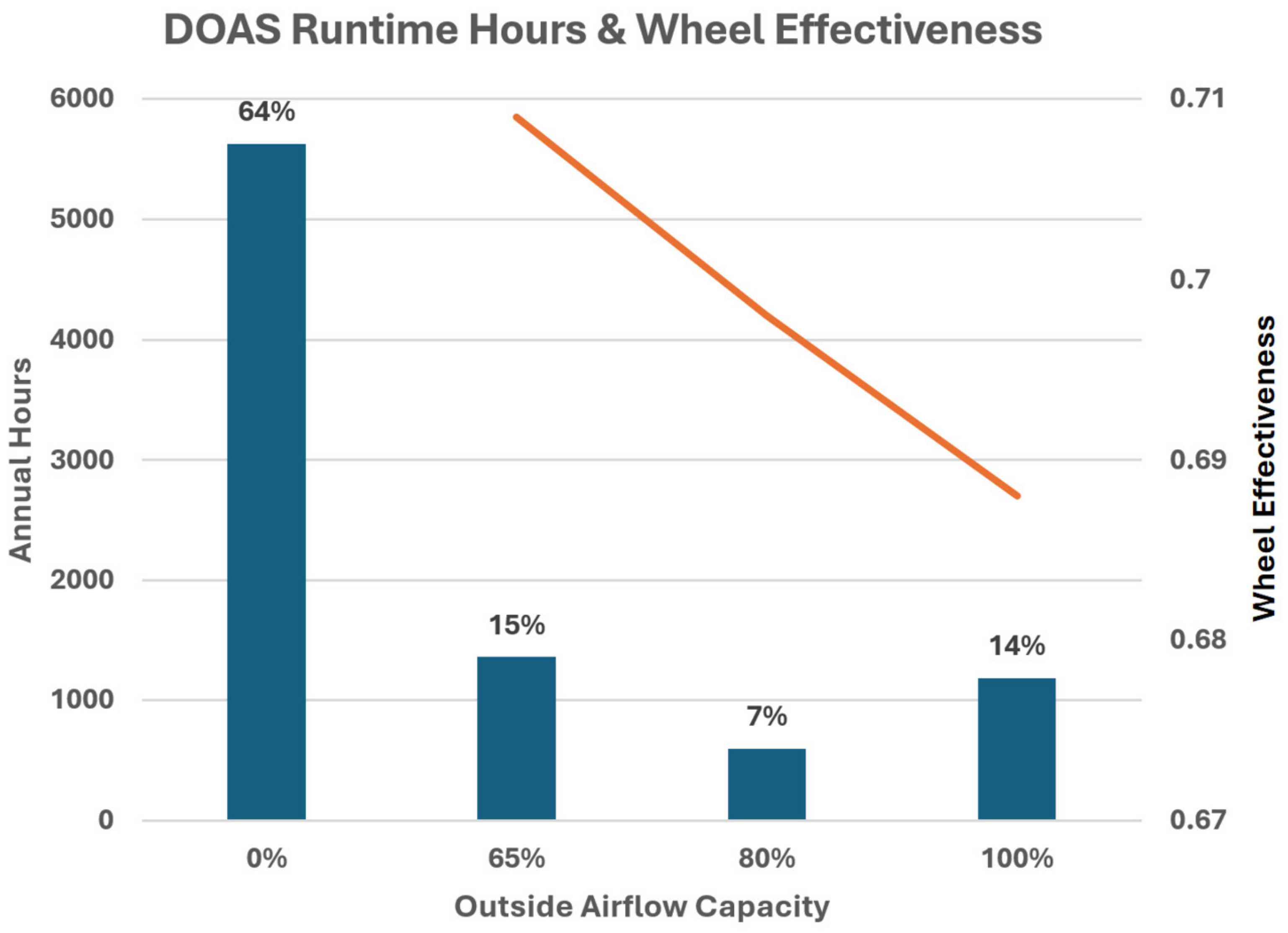


Dedicated Outside Air System

Energy Recovery Wheel Effectiveness

Demand Control Ventilation

INPUT CONSIDERATIONS



Dedicated Outside Air System

Energy Recovery Wheel Effectiveness

Demand Control Ventilation

Phius MODELING CONSIDERATIONS

OCCUPANCY & UTILIZATION PATTERNS

Calculating Occupancy in Non-Residential Phius projects

Occupant Quantity	210	*For input in WUFI the Occupancy > Occupant Quantity*
Maximum Occupancy	1,341	*For input in the Phius 2021 target setting calculator*

Utilization Patterns for WUFI & Occupancy Inputs

Type of Space	Begin Utilization	End Utilization	Annual Utilization Days	Relative Absence	Occupant Quantity for Pattern
Classrooms	7	16	235	0.25	1184
Admin Offices	7	17	235	0.30	8
Janitorial	5	22	235	0.90	5
Food Prep	7	16	180	0.25	9
Gym Staff + Students	0	0	180	0.00	0

Spaces		Start Hours	End Hours	Weeks/yr	Relative Absence	Maximum Occupancy per day M-F	Maximum Occupancy per day Wknd
Students in Classrooms	Classrooms	8	15	32.5	0.25	1200	
Teachers in Classrooms	Classrooms	7	16	32.5	0.25	119.4	
Office Workers	Offices	7	17	40	0.3	7.5	0
Cafeteria Workers	Food Prep	7	16	35	0.25	9	
Janitorial Staff	Janitorial	5	22	40	0.9	5	
Gym Staff + Students	Gym	15	22	32.5	0.5	63.6	

Phius Criteria & Internal Loads

- Calc early + update
- Phius occ ≠ code occ

VENTILATION APPROACH

UNDERSTAND AND MODEL TYPICAL OPERATION

Different space types

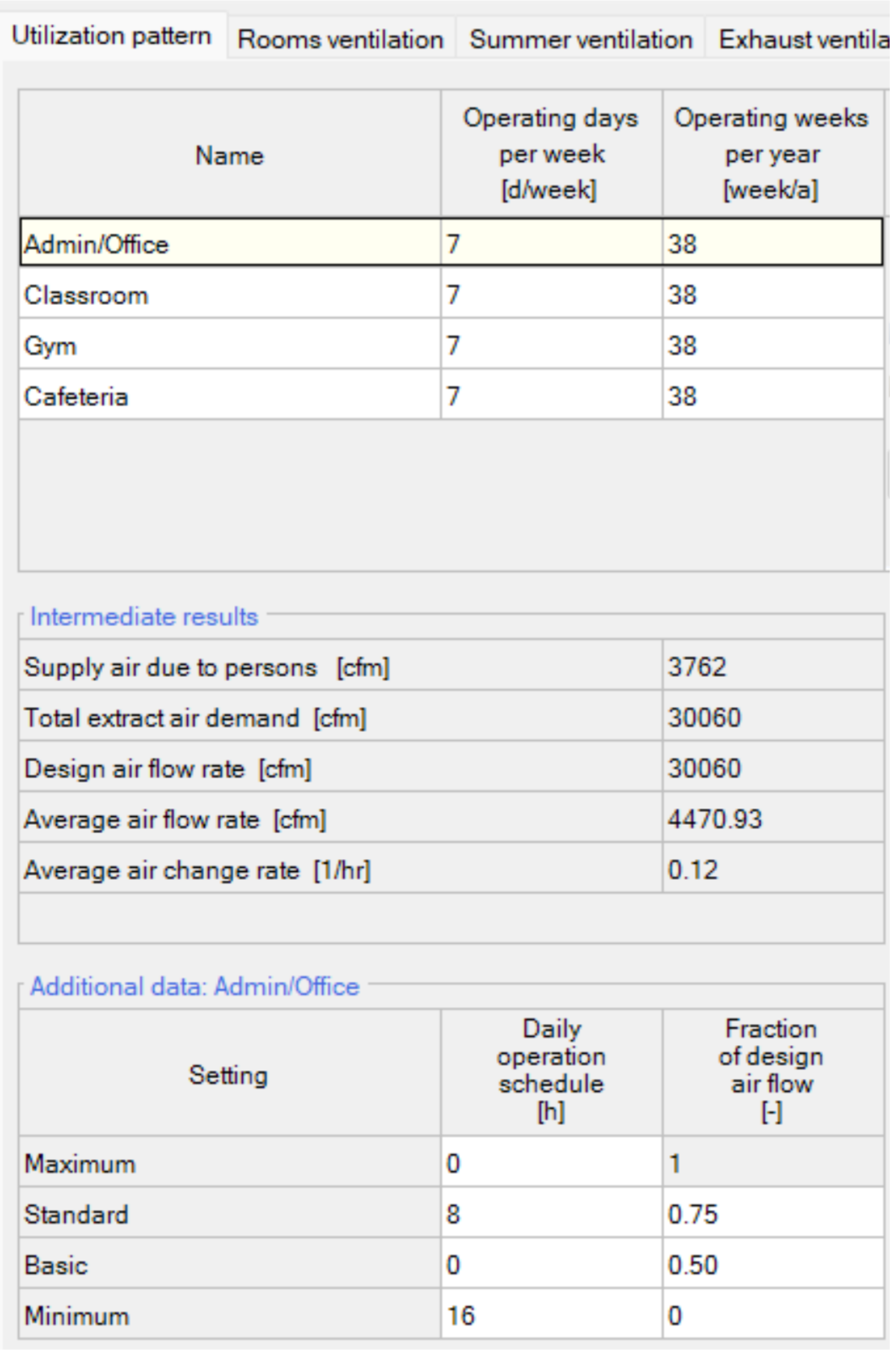
Diversity of space use (unlike residential)

+ Project criteria & buffer

	Whole Building Energy Model?	Performance Criteria Buffers	Ventilation Approach
Squantum ES	OpenStudio	None	DCV Protocol
Charleswood ES	IES-VE model	Moderate	Utilization patterns by space type using IES-VE model
Revere HS	Not yet	High	Utilization patterns by device (and space type) using logical early estimates

VENTILATION APPROACH #1: UTILIZATION PATTERNS

Space Type	Max cfm	# of spaces	Total cfm	# of days/week	# of weeks/yr	Hours at 0%	Hours at 50%	Hours at 75%	Hours at 100%	total hours "on"
Admin/Office	30	50	1,500	7	38	16	0	8	0	8
Classroom	340	54	18,360	7	38	18	1	5	0	6
Gym	6,700	1	6,700	7	38	17	6	0	1	7
						Hours at 0%	Hours at 33%	Hours at 66%	Hours at 100%	
Cafeteria	3,500	1	3,500	7	38	16	4	2	2	8
						Hours at 0%	Hours at 25%	Hours at 65%	Hours at 100%	
Kitchen	4,845	1	4,845	5	38	21	1	2	0	3


Utilization pattern | Rooms ventilation | Summer ventilation | Exhaust ventila

Name	Operating days per week [d/week]	Operating weeks per year [week/a]
Admin/Office	7	38
Classroom	7	38
Gym	7	38
Cafeteria	7	38

Intermediate results

Supply air due to persons [cfm]	3762
Total extract air demand [cfm]	30060
Design air flow rate [cfm]	30060
Average air flow rate [cfm]	4470.93
Average air change rate [1/hr]	0.12

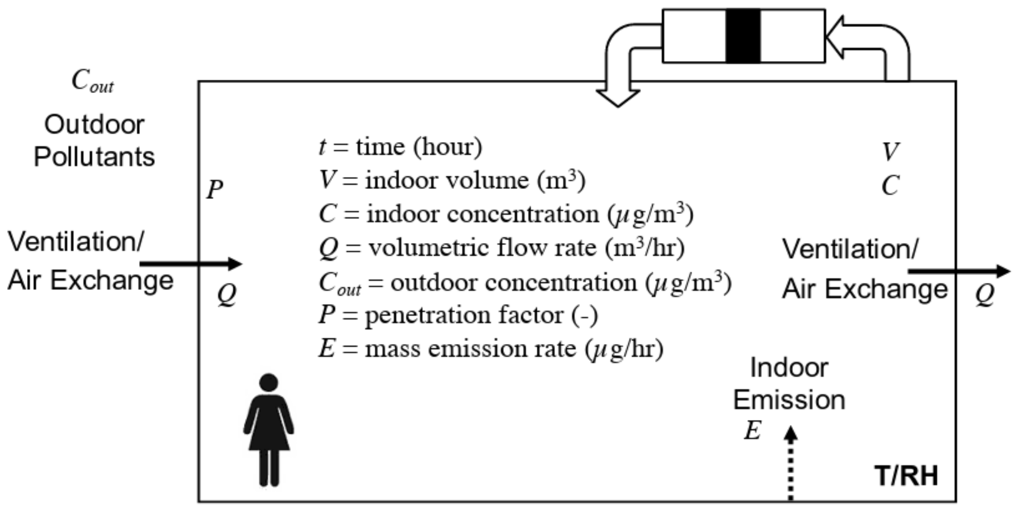
Additional data: Admin/Office

Setting	Daily operation schedule [h]	Fraction of design air flow [-]
Maximum	0	1
Standard	8	0.75
Basic	0	0.50
Minimum	16	0

VENTILATION APPROACH #2: DCV PROTOCOL

Step 1: Phius (Al Mitchell) developed DCV protocol spreadsheet

- **Discretized indoor environment dynamic mass balance equation**
  - **Ventilation x pollutants**
  - **CO_2 generation for the occupants: L/s › PPM**
- **GitHub Repo + python: iterative loop**
- **Ventilation in each space**



$$V\frac{dC}{dt} = PQC_{out} - QC + E$$

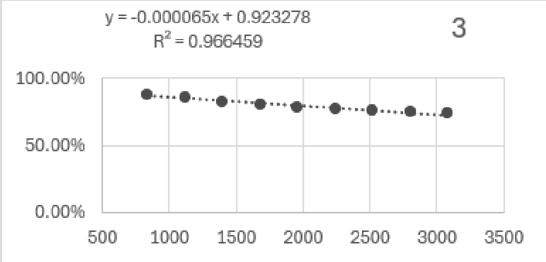
```python
for row in range(0,39,1):
    rm = roomData['Rm'].iloc[row]
    vol = roomData['Vol m3'].iloc[row]
    mg_hr_gen = roomData['ppm'].iloc[row]
    ct_1 = oa_ppm

    c_list = []
    achs = []
    print("solving room number " + str(rm))
    for hour in range(0,8759,1):
        occ = schedules['Gen Occ'].iloc[hour]
        ach = initACH
        c = ct_1 +((1*ach*oa_ppm) - (ach*ct_1) + ((mg_hr_gen*occ)/vol))
        while c > ppm_target:
            if ach < 40:
                ach = ach + 0.1
                c = ct_1 +((1*ach*oa_ppm) - (ach*ct_1) + ((mg_hr_gen*occ)/vol))
            else:
                break

        achs.append(ach*vol)
        c_list.append(c/1.8)
        ct_1 = c
        print(c)
        print(ach)
```

cfm	123.1947536	123.1947536	125.5337472	122.1236337	124.5046597
m3/h	209.3092194	209.3092194	213.2831947	207.4893751	211.534764
	AHU-3	AHU-3	AHU-3	AHU-3	AHU-3
	Room_217	Room_215	Room_213	Room_211	Room_209
0	30.17358585	30.17358585	32.89285296	29.809148	30.49441577
1	30.17358585	30.17358585	32.89285296	29.809148	30.49441577
2	30.17358585	30.17358585	32.89285296	29.809148	30.49441577
3	30.17358585	30.17358585	32.89285296	29.809148	30.49441577
4	30.17358585	30.17358585	32.89285296	29.809148	30.49441577
5	30.17358585	30.17358585	32.89285296	29.809148	30.49441577
6	30.17358585	30.17358585	32.89285296	29.809148	30.49441577
7	30.17358585	30.17358585	32.89285296	29.809148	30.49441577
8	3047.532171	3047.532171	3322.178149	3010.723948	3079.935993
9	452.6037878	452.6037878	493.3927944	447.13722	457.4162366
10	603.471717	603.471717	624.9642062	596.18296	609.8883154
11	603.471717	603.471717	592.0713533	596.18296	609.8883154
12	603.471717	603.471717	592.0713533	596.18296	609.8883154
13	603.471717	603.471717	592.0713533	596.18296	609.8883154
14	603.471717	603.471717	592.0713533	596.18296	609.8883154
15	603.471717	603.471717	592.0713533	596.18296	609.8883154
16	120.6943434	120.6943434	131.5714118	119.236592	121.9776631
17	120.6943434	120.6943434	131.5714118	119.236592	121.9776631
18	120.6943434	120.6943434	131.5714118	119.236592	121.9776631
19	120.6943434	120.6943434	98.67855888	119.236592	121.9776631
20	120.6943434	120.6943434	131.5714118	119.236592	121.9776631
21	30.17358585	30.17358585	32.89285296	29.809148	30.49441577

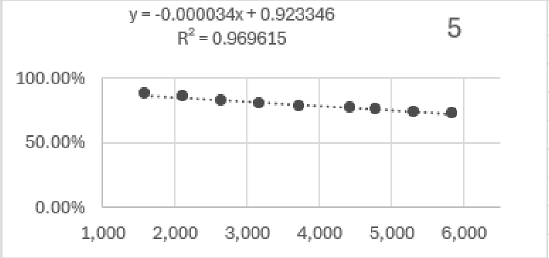
VENTILATION APPROACH #2: DCV PROTOCOL

Step 2: TT used manufacturer data + spreadsheet to generate new sensible recovery efficiencies (SREs)

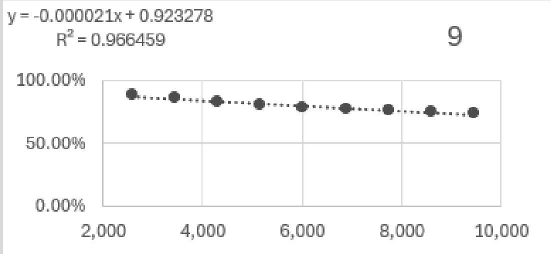
	Model Number: TE (CFM)			
EFFECTIVENESS	**3**	**5**	**9**	**13**
88%	840	1,590	2,580	3,930
86%	1,120	2,120	3,440	5,240
82.5%	1,400	2,650	4,300	6,550
80.5%	1,680	3,180	5,160	7,860
78.5%	1,960	3,710	6,020	9,170
77%	2,240	4,420	6,880	10,480
76%	2,520	4,770	7,740	11,790
74.5%	2,800	5,300	8,600	13,100
73.5%	3,080	5,830	9,460	14,410



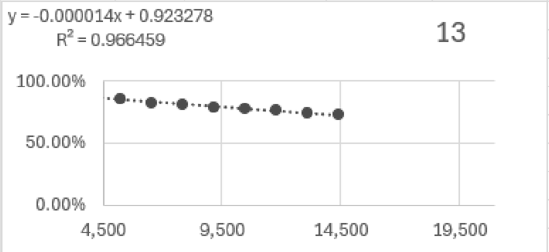
	CFM	interpolated eff.		scheduled eff.
AHU-4	1,400	78.7%	vs	82.0%



	CFM	interpolated eff.		scheduled eff.
AHU-7	3,000	77.1%	vs	80.0%



	CFM	interpolated eff.		scheduled eff.
AHU-2	5,000	76.5%	vs	78.0%
AHU-5	4,500	78.0%	vs	78.0%
AHU-6	3,500	81.0%	vs	86.0%



	CFM	interpolated eff.		scheduled eff.
AHU-1	7,000	81.7%	vs	78.0%
AHU-3	6,000	83.1%	vs	82.0%

	AHU-1					AHU-2					AHU-3				
per m3/h	**CFM**	**Frac**	**Freq**	**Bin Eff%**	**Weighted Eff%**	**CFM**	**Frac**	**Freq**	**Bin Eff%**	**Weighted Eff%**	**CFM**	**Frac**	**Freq**	**Bin Eff%**	**Weighted Eff%**
0.5886	5,430	9,226	6724	88%	67.6%	2,580	4,383	6,724	88%	67.6%	5,430	9,226	8,498	88%	85.4%
	7,240	12,301	1774	86%	17.4%	5,160	8,767	1,174	80.5%	10.8%	7,240	12,301	-	86%	0%
	9,050	15,376	0	82.5%	0%	6,020	10,228	599	80.5%	5.5%	9,050	15,376	208	86%	2%
Hrs	10,860	18,451	0	82.5%	0%	6,880	11,689	1	80.5%	0.0%	10,860	18,451	-	86%	0%
8759	Overflow		261	82.5%	2.46%	Overflow		261	80.5%	2.40%	Overflow		53	86%	0.52%
		Max OA	DCV OA		**87.4%**		Max OA	DCV OA		**86.3%**		Max OA	DCV OA		**87.9%**
cfm		7,000	2,595				5,000	1,929				6,000	1,592		
m3/h			4,409					3,277					2,705		
0			370.76					222.59					276.61		
1			370.76					222.59					276.61		
2			370.76					222.59					276.61		
3			370.76					222.59					276.61		
4			370.76					222.59					276.61		
5			370.76					222.59					276.61		
6			370.76					222.59					276.61		
7			370.76					222.59					276.61		
8			148304.40					89034.97					110644.58		
9			6093.53					4017.85					4166.80		
10			12013.93					10921.05					7115.07		
11			11205.72					8673.43					6540.13		
12			11169.09					8684.02					6562.72		
13			11269.94					8748.63					6540.57		
14			11154.01					8733.36					6597.88		
15			11147.41					8874.90					6584.83		
16			2223.54					1755.28					1328.25		
17			2258.52					1726.35					1328.25		
18			2187.22					1755.28					1328.25		
19			2294.84					1755.28					1295.36		

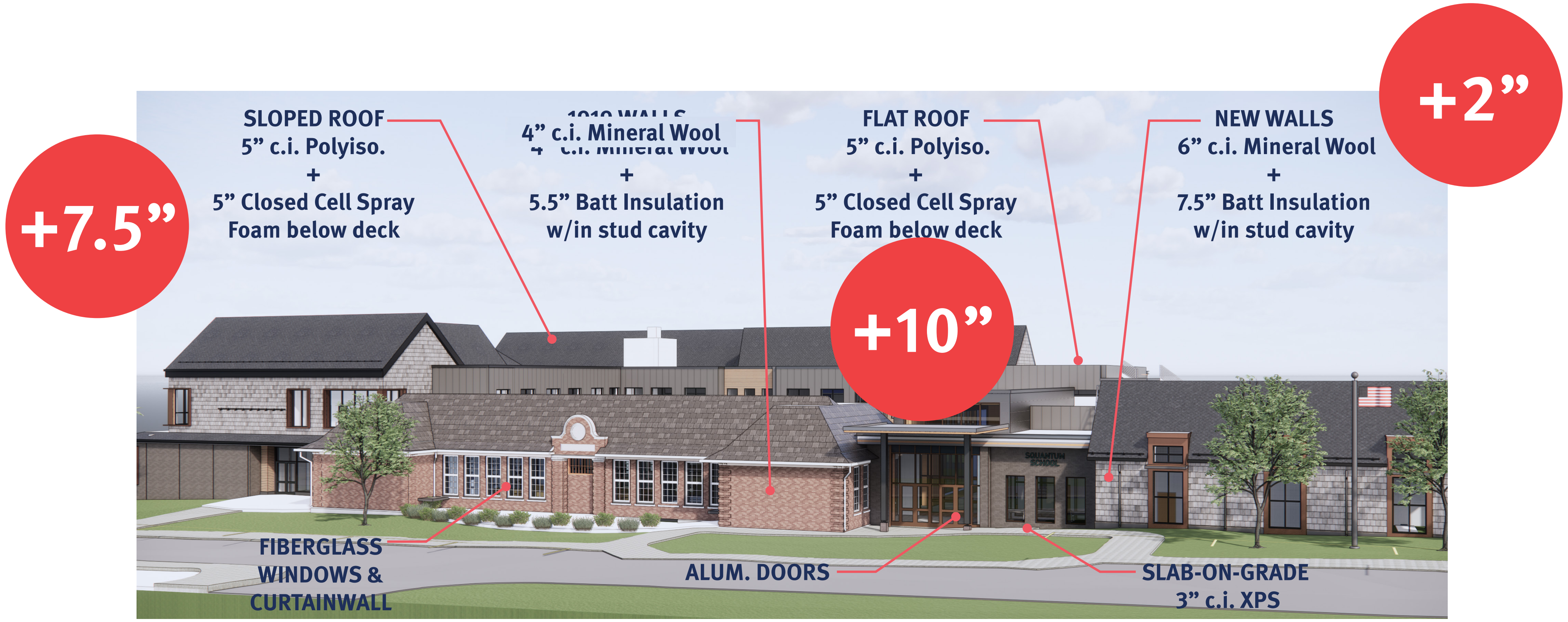
VENTILATION APPROACH #2: DCV PROTOCOL

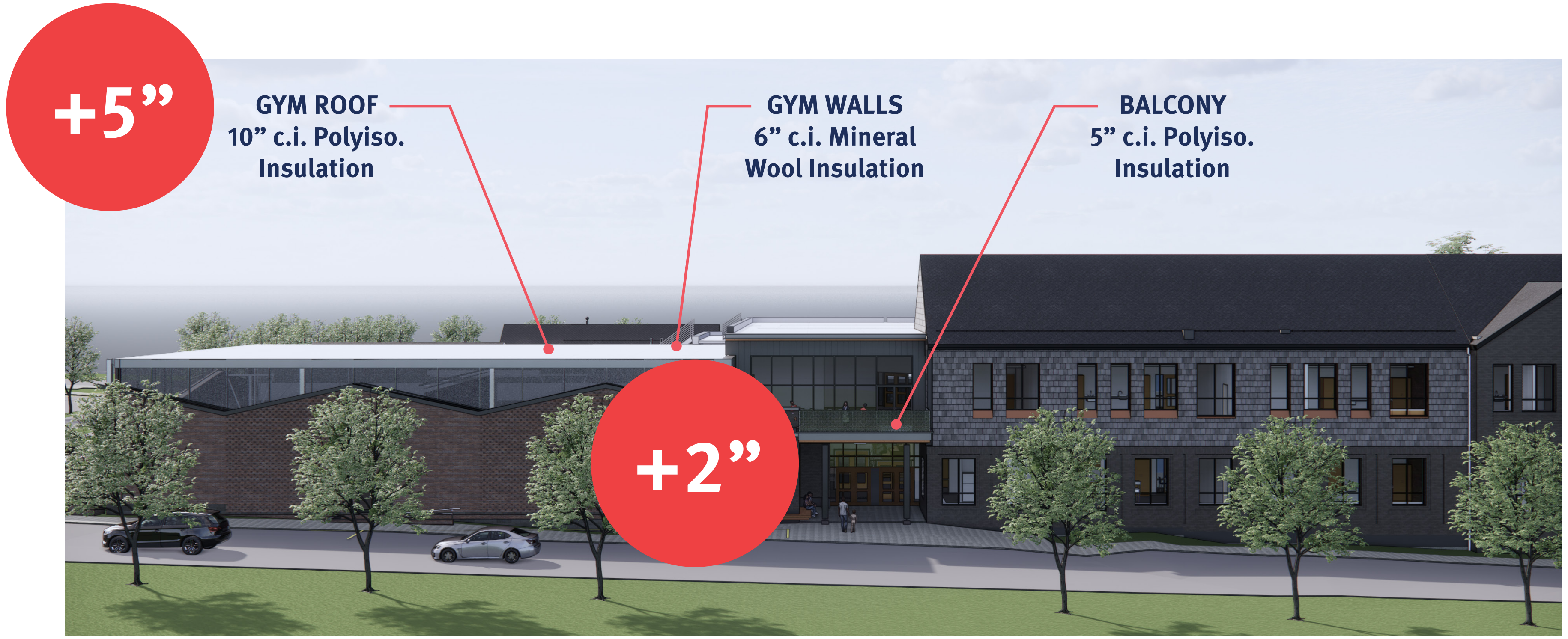
Step 3: Use new SREs in WUFI Passive

AHU	Design OA CFM	Min OA CFM	Mechanical Schedule SRE	New SRE
1	7,000	2,000	78%	**87.4%**
2	5,000	1,300	76%	**86.%**
3	6,000	1,700	82%	**87.9%**
4	1,400	300	83%	**86.7%**
5	4,500	1,000	78%	**86.3%**
6	3,500	1,000	86%	**86.7%**
7	2,400	750	80%	**86.2%**

WHOLE LIFE CARBON

SQUANTUM SCHOOL





EMBODIED CARBON IMPACT

Phius design
3,214 MTCO2e

Typical net zero design
2,956 MTCO2e

Embodied Carbon: + 9%

Annual Operational Carbon: - 7%

Whole Life Carbon: + 2%

IMAGE CREDIT: ARROWSTREET

CHARLESWOOD ELEMENTARY

		ENVELOPE EMBODIED CARBON	HVAC EMBODIED CARBON	OPERATIONAL CARBON
		kgCO$_2$e/m^2	kgCO$_2$e/m^2	kgCO$_2$e/m^2
	**DOUBLE TO TRIPLE PANE IGU** 42.4 kgCO$_2$e/m^2 Reduction	+ 2.2	- 2.9	- 41.7
	**R-18 TO R-25 MIN WOOL** 8.8 kgCO$_2$e/m^2 Reduction	+ 0.7	- 0.2	- 9.3
	**ADD R-15 XPS AT SLAB** 14.5 kgCO$_2$e/m^2 Reduction	+ 4.1	- ~6	- 18.6

COMPARED TO IECC 2021 PRESCRIPTIVE CODE OVER 60 YEARS

THANK YOU!

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OTHER MISC CALCULATIONS

Run Time for Dryer	
hours/day	4
days/week	5
weeks/year	38
hours/yr	760
mins/yr	45600

Run Time for Aux Energy		
	General EF-1,2	Kitchen KEF-1,2
hours / day	8	3
days / week	5	5
weeks / year	38	38
hours / year	1520	570
khr / year	1.52	0.57
minutes/year	91,200	34,200

Type of Occupant	# ppl	gal/day/ea	gal/day	Notes
Students	1140	5	5700	DHW at 110F (60 F delta from 50F)
Teachers	122	5	610	
Food Prep	9	10	90	
Janitorial Staff	5	10	50	
			0	
			0	
		Summed Total	6450	
		Calculated Total	4300	DHW at 140F (90 F delta from 50F)
Office / Admin	7	3.2	22	DHW at 140F (90 F delta from 50F)
Total	1283		4322	DHW at 140F (90 F delta from 50F)
			3.4	effective gal/p.day for WP model (at 140F)

Total DHW taps in the building
272

Type of Occupant	# ppl	# HW taps opened/person/day	WUFI - Tap openings/person.day	Notes
Students	1140	10	0.03	averages per occupancy group
Teachers	122	10	0.00	
Food Prep	9	20	0.00	
Janitorial Staff	5	20	0.00	
Office / Admin	7	3	0.00	
			0.00	
			0.00	
Total	1283		0.04	effective hot water-tap openings/p.day for WP model