Stretch Code & Schools

DOER briefing for MSBA Designer Roundtable

October 20, 2022

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Agenda

- Three levels of code (base, stretch, municipal opt-in)
- Key modifications in the updated Stretch code
- Key modifications in the Specialized code
- School case studies

Base, Stretch, Specialized – 3 options

Base Code (IECC 2021)

- New construction in towns & cities not a green community
- **52 communities**

Expected from BBRS: **July 2023**

Stretch Code (2023 update)

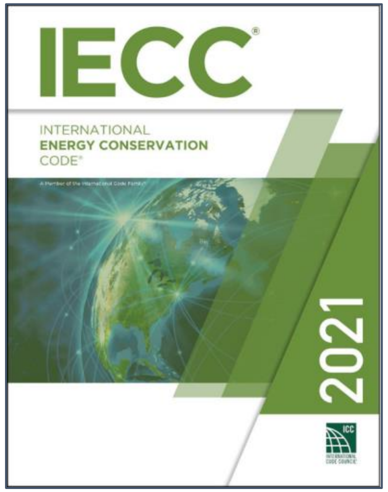
- New construction in towns & cities that are a green or stretch community
- **299 communities**

Residential : Jan 2023
Commercial: July 2023

Specialized Code (“Net-Zero”)

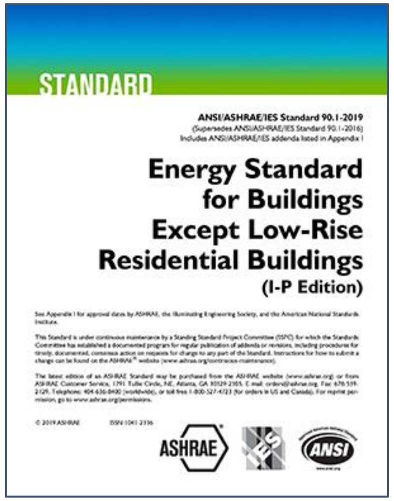
- New Construction in towns & cities that vote to opt-in to this code
- **Effective date:** Typically 6-11 months after Town/City vote

Model Energy Code Status



- Determination
  - 9.4% site energy
  - 8.8% source energy
  - 8.7% energy cost
  - 8.7% carbon emissions
- Removal of Electric-Readiness
- Removal of EVs
- Includes NZE Appendices

- Determination
  - 4.7% site energy
  - 4.3% source energy
  - 4.3% energy cost
  - 4.2% carbon emissions

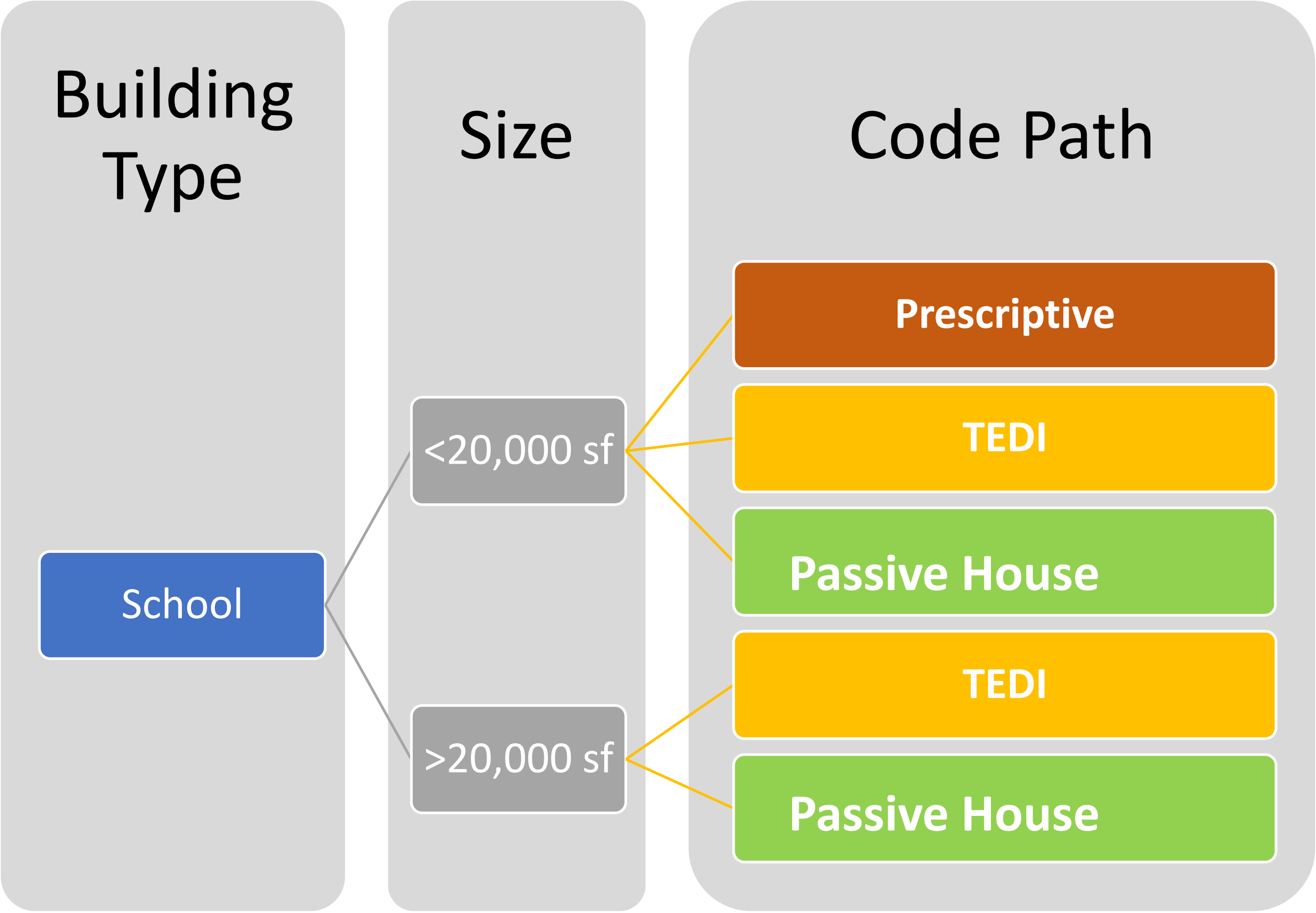


Base, Stretch, Specialized – 3 options

Base code	2021 IECC / ASHRAE 90.1- 2019 with modest tweaks	✚	EV ready parking
Stretch code	2021 IECC / ASHRAE 90.1- 2019 with key modifications	✚	EV ready parking + Solar ready
Specialized code	2021 IECC / ASHRAE 90.1- 2019 with key modifications	✚	EV ready parking + Solar ready All Electric OR Net Zero OR electric ready + solar

STRETCH CODE

Stretch code compliance options

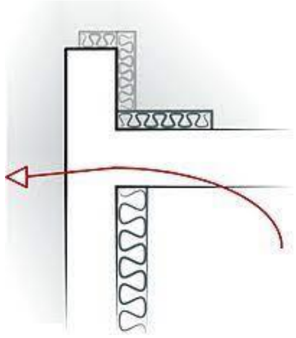


Commercial Stretch – Improved Efficiency

Thermal Energy Demand Intensity (TEDI) Limits

Whole building air-leakage limits and testing

Ventilation energy recovery



Thermal bridge accounting

Emissions, electrification, comfort, durability, and resilience benefits

Thermal Energy Demand Intensity (TEDI)

Heating TEDI

*Total annual energy **delivered to** the building for space conditioning and conditioning of ventilation air, normalized by area (kBtu/sf-yr)*

Cooling TEDI

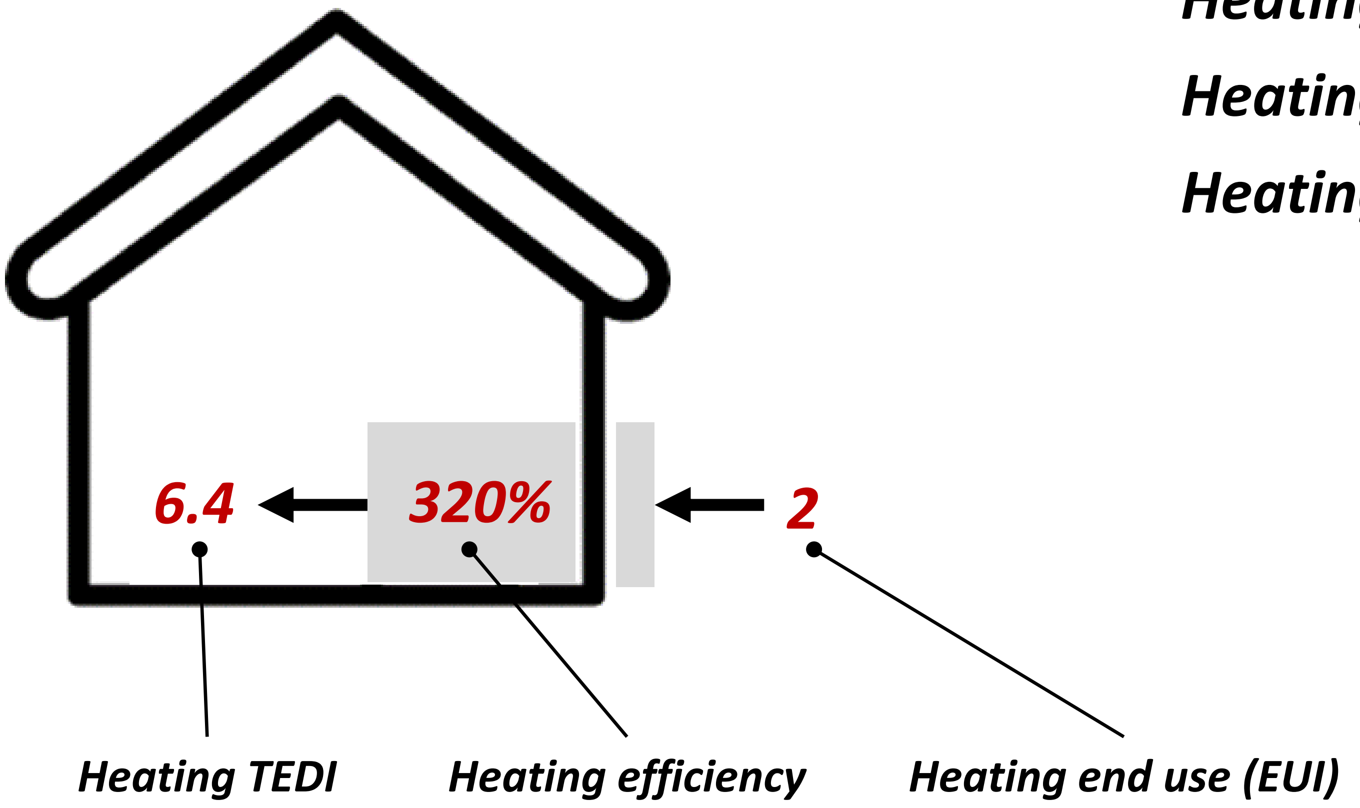
*Total annual energy **removed from** the building for space conditioning and conditioning of ventilation air, normalized by area (kBtu/sf-yr)*

Connection between TEDI and EUI

Heating end use EUI: ***2 kBtu/sf-yr***

Heating efficiency: ***320%***

Heating efficiency: ***6.4 kBtu/sf-yr***



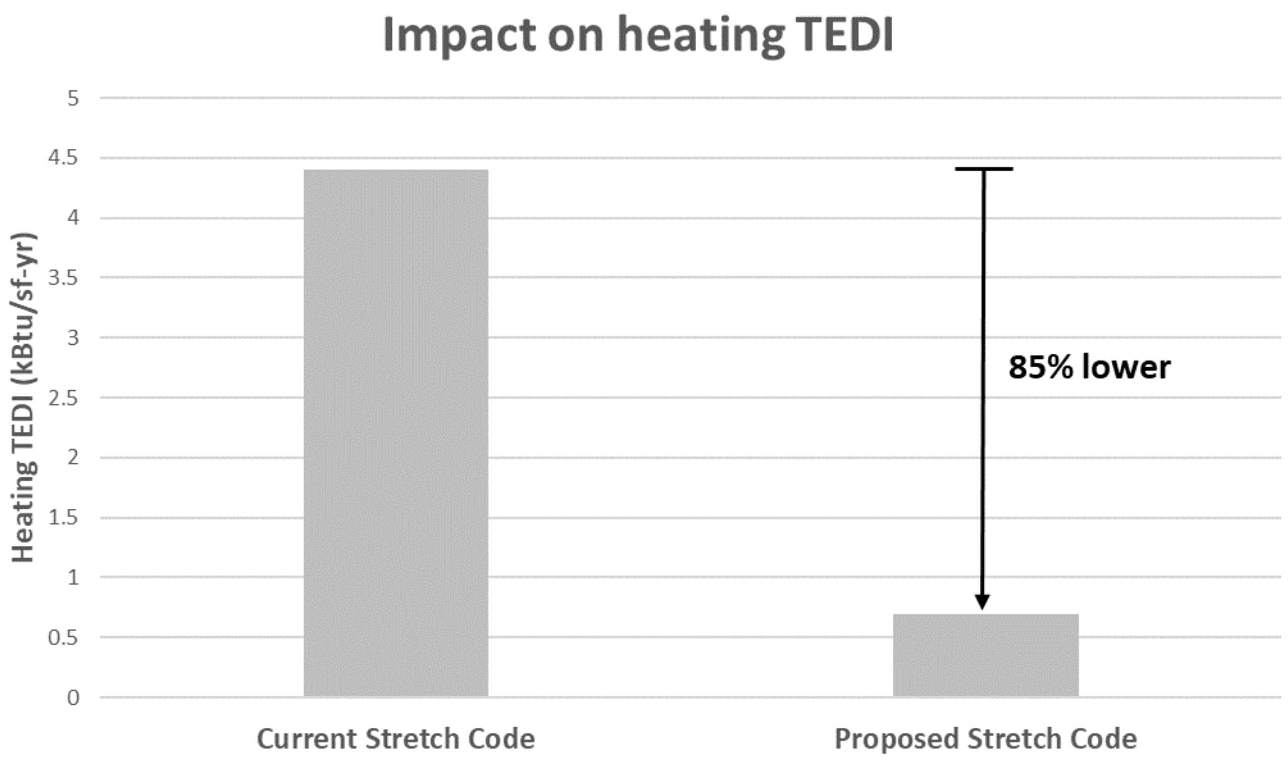
TEDI is not the same as EUI. TEDI is a measure of envelope performance, air infiltration, and ventilation energy recovery.

EUI is a measure of the above, plus equipment efficiency.

TEDI is demand while EUI is consumption

Regulating TEDI means prioritizing envelope, air infiltration, and energy recovery

Benefits of TEDI limits



- 85% less heating demand
- Emissions reduced
- Electrification easier
- Comfort
- Durability
- Resilience

TEDI limits

Size of School building	Heating TEDI limit (kBtu/sf-yr)	Cooling TEDI limit (kBtu/sf-yr)
K-12 school (>= 125,000-sf)	2.2	12
K-12 school (75,000 to 125,000)	2.7 – 0.000004 * Area (sf)	32 - 0.00016 * Area (sf)
K-12 school (<75,000)	2.4	20

The same models currently used for stretch code compliance also produce TEDI information

Strange equations simply draws straight line between values

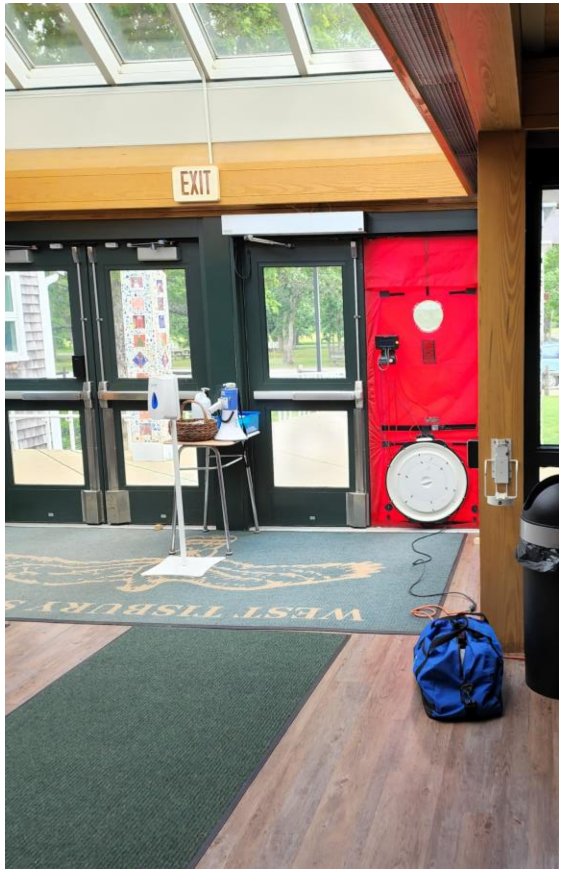
Managing cooling TEDI

Managing cooling TEDI

- Low solar heat gain coefficient (SHGC) windows
- Recessed windows
- External shading
- Reduced air leakage rate

Whole building infiltration

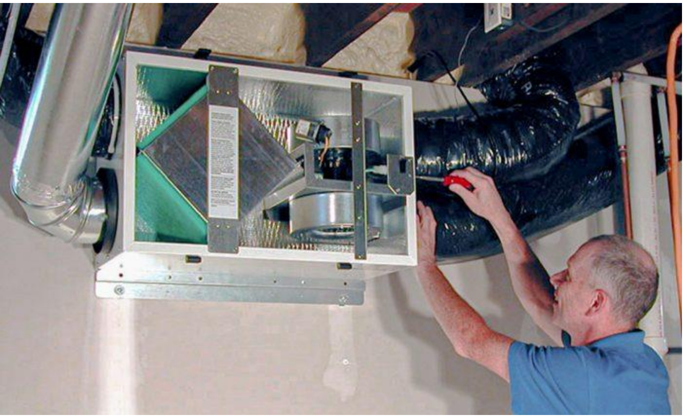
Above photo: Steven Winter Associates



Above photo: RDH/Advanced Building Analysis

- Limit of 0.35 cfm/sf at 75 Pa
- Mandatory field testing
- Credit for even lower air infiltration
- Passive House: routinely gets 0.08 cfm/sf at 75 Pa

Ventilation Energy Recovery



- Enthalpy recovery ratio: 70%
- Class 3 and 4: sensible recovery ratio: 50%

ER required for all but very small buildings for systems operating less than 8,000 hours per year

Mantory Ventilation Energy Recovery (Systems Operating Less than 8,000 hours per year)

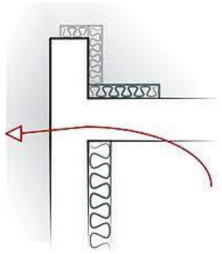
Climate Zone	PERCENT (%) OUTDOOR AIR AT FULL DESIGN AIRFLOW RATE							
	>=10% and <20%	>=20% and < 30%	>=30% and < 40%	>=40% and <50%	>=50% and <60%	>=60% and <70%	>=70% and <80%	>=80%
	Design Supply Fan Airflow Rate (cfm)							
5A	>= 10,000	>= 8,000	>= 2,750	0	0	0	0	0

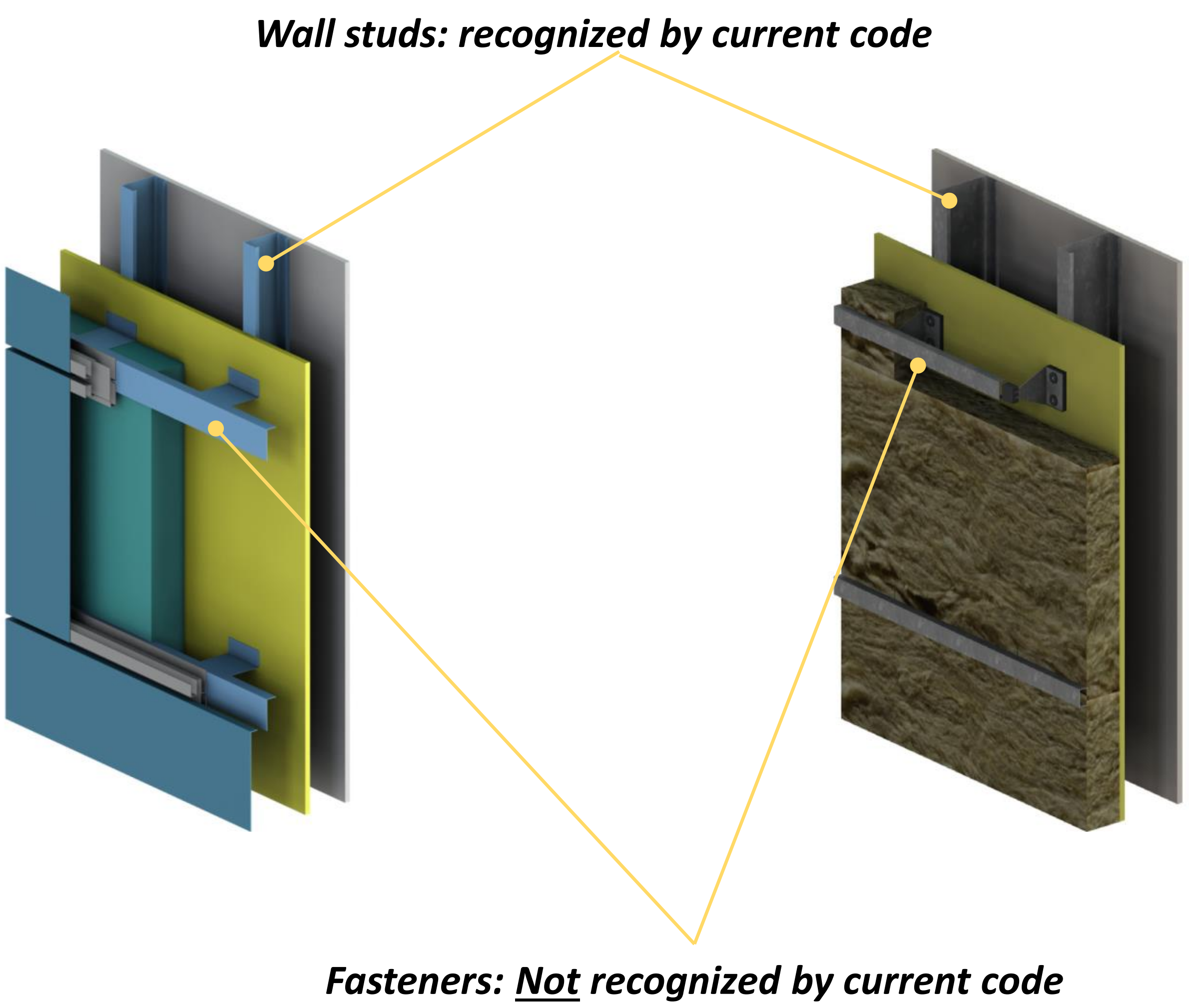
ER required in all cases for systems operating more than 8,000 hours per year

Mantory Ventilation Energy Recovery (Systems Operating Not Less than 8,000 hours per year)

Climate Zone	PERCENT (%) OUTDOOR AIR AT FULL DESIGN AIRFLOW RATE							
	>=10% and <20%	>=20% and < 30%	>=30% and < 40%	>=40% and <50%	>=50% and <60%	>=60% and <70%	>=70% and <80%	>=80%
	Design Supply Fan Airflow Rate (cfm)							
5A	0	0	0	0	0	0	0	0

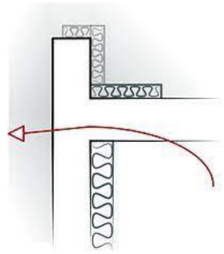
Thermal bridge accounting

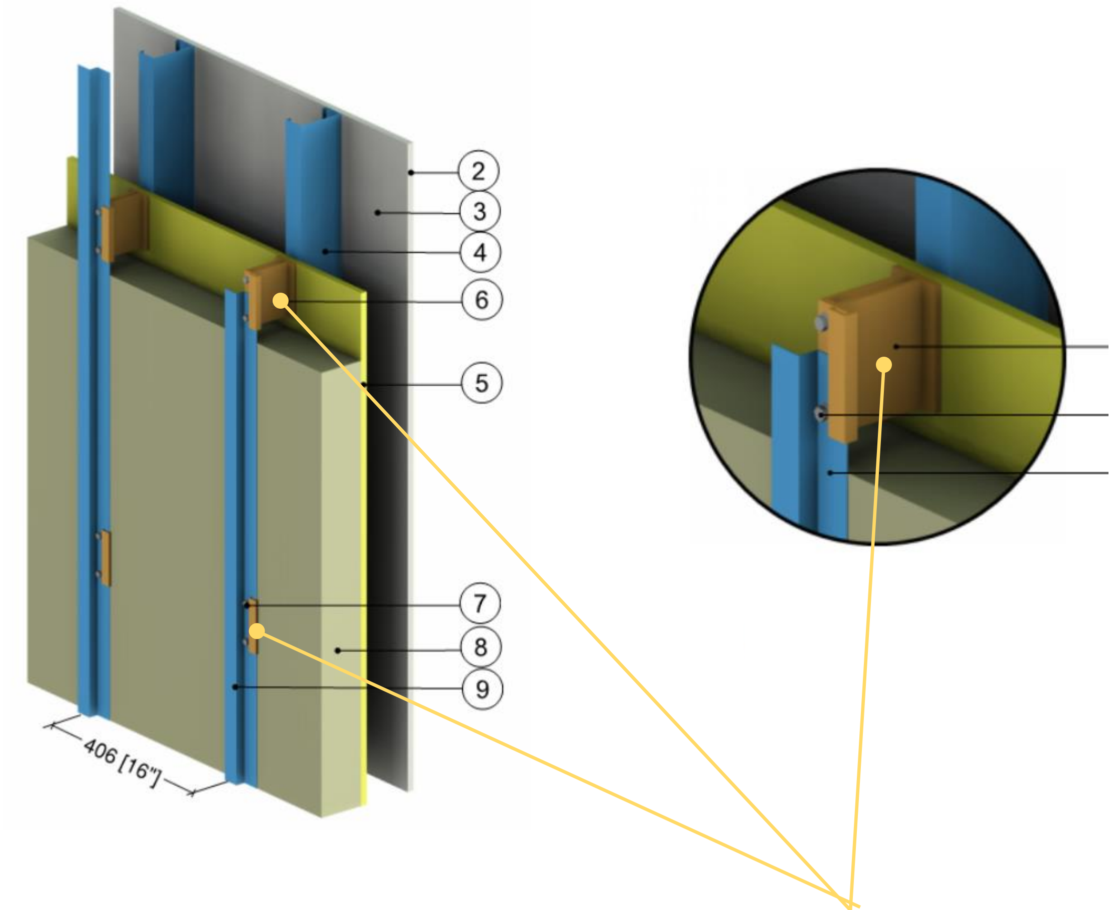




- "Continuous insulation" is NOT continuous. There are fasteners, often metal, which go through the insulation.
- Current stretch code only recognizes thermal bridges caused by wall studs. Current stretch code does not recognize thermal bridges caused by fasteners
- Fasteners have major impact on insulation performance

Thermal bridge accounting

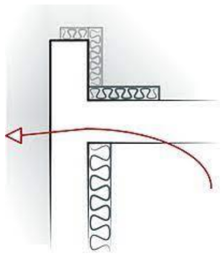


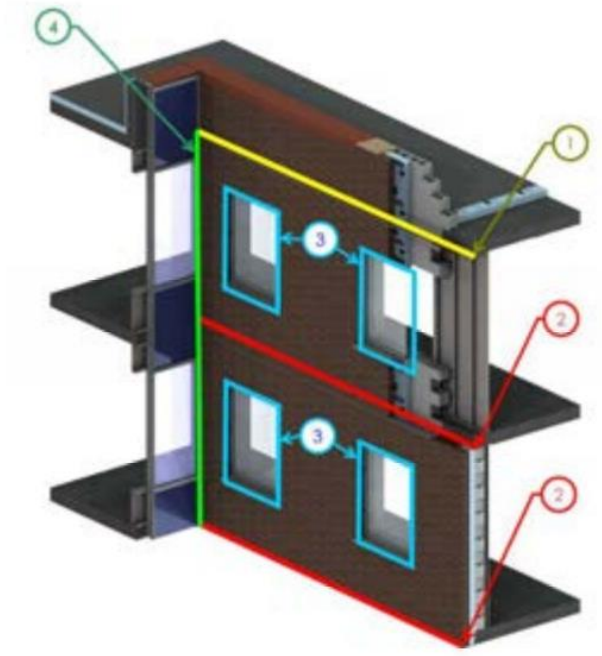


Fasteners made from fiberglass provide thermal break

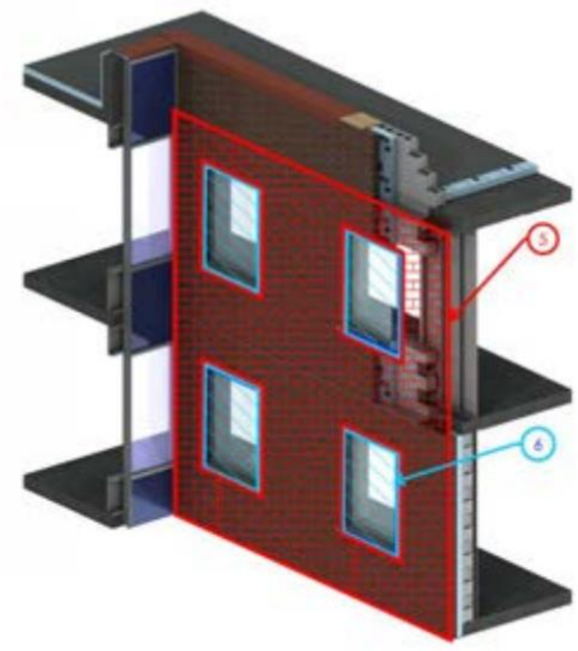
- Solution is to include fasteners that have <u>thermal breaks</u>
- Thermal breaks are often <u>value engineered</u> out because code does not mandate thermal bridge accounting
- Proposed stretch code <u>will</u> mandate thermal bridge accounting which will help protect designs and ensure thermally broken fasteners are used.

Thermal bridge accounting





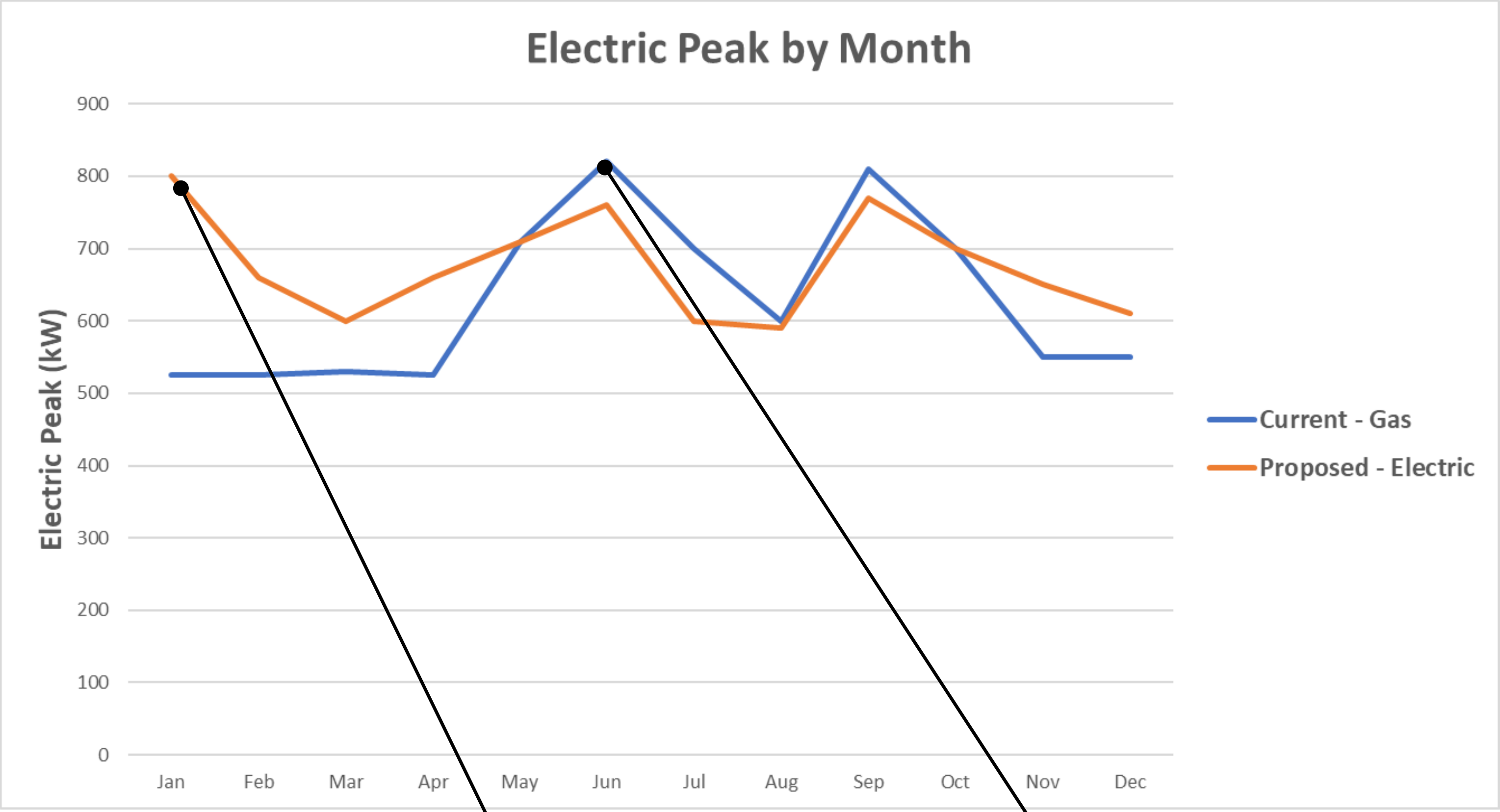
1. Parapet Length
2. Slab Lengths
3. Wall to Window Transition Lengths



4. Corner Length
5. Opaque Brick Wall Area
6. Glazing Area

- Many other thermal bridge locations not recognized by current strertch code
  - Continuous insulation
  - Brick shelves
  - Balconies/protrusions
  - Window/wall intersections
  - Parapets
  - Wall/wall intersections
  - Wall/floor intersections
- Updated stretch code does recognize these. Thermal breaks are available for all these locations

Electrification benefits

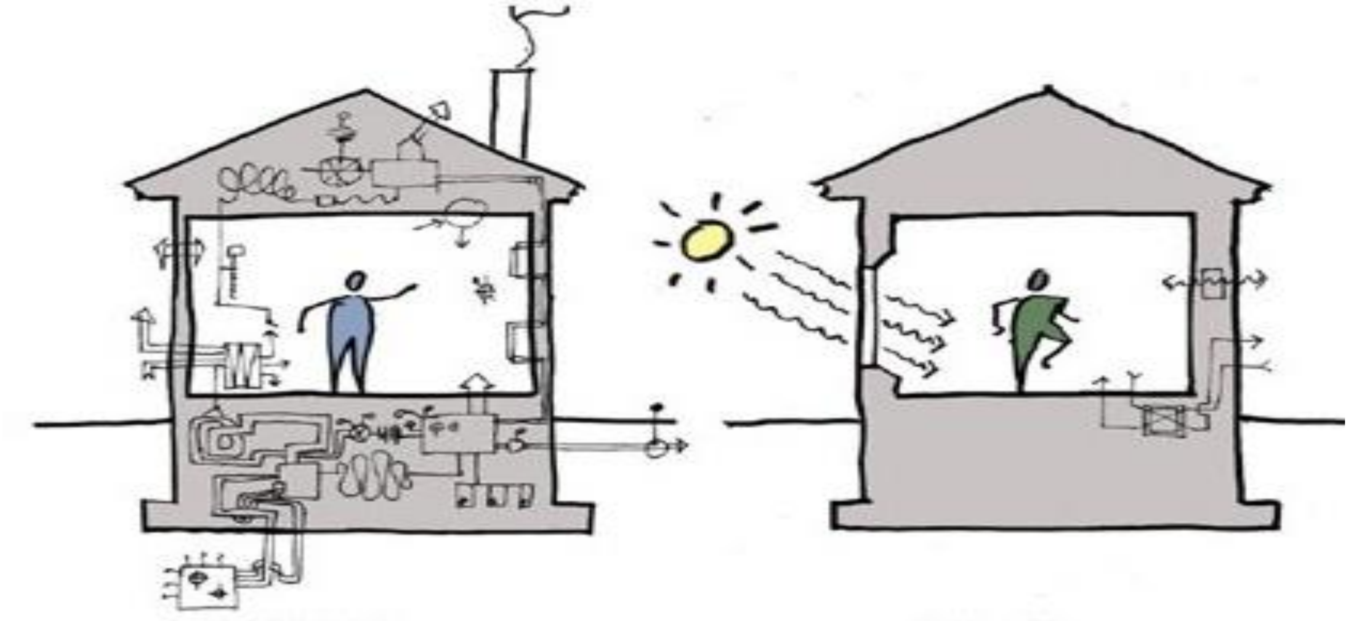


Peak electric use ELEC heated building built to proposed stretch code

Peak electric use GAS heated building built to current stretch code

The proposed stretch code allows transition to electric heating (from gas) without increasing peak electric.

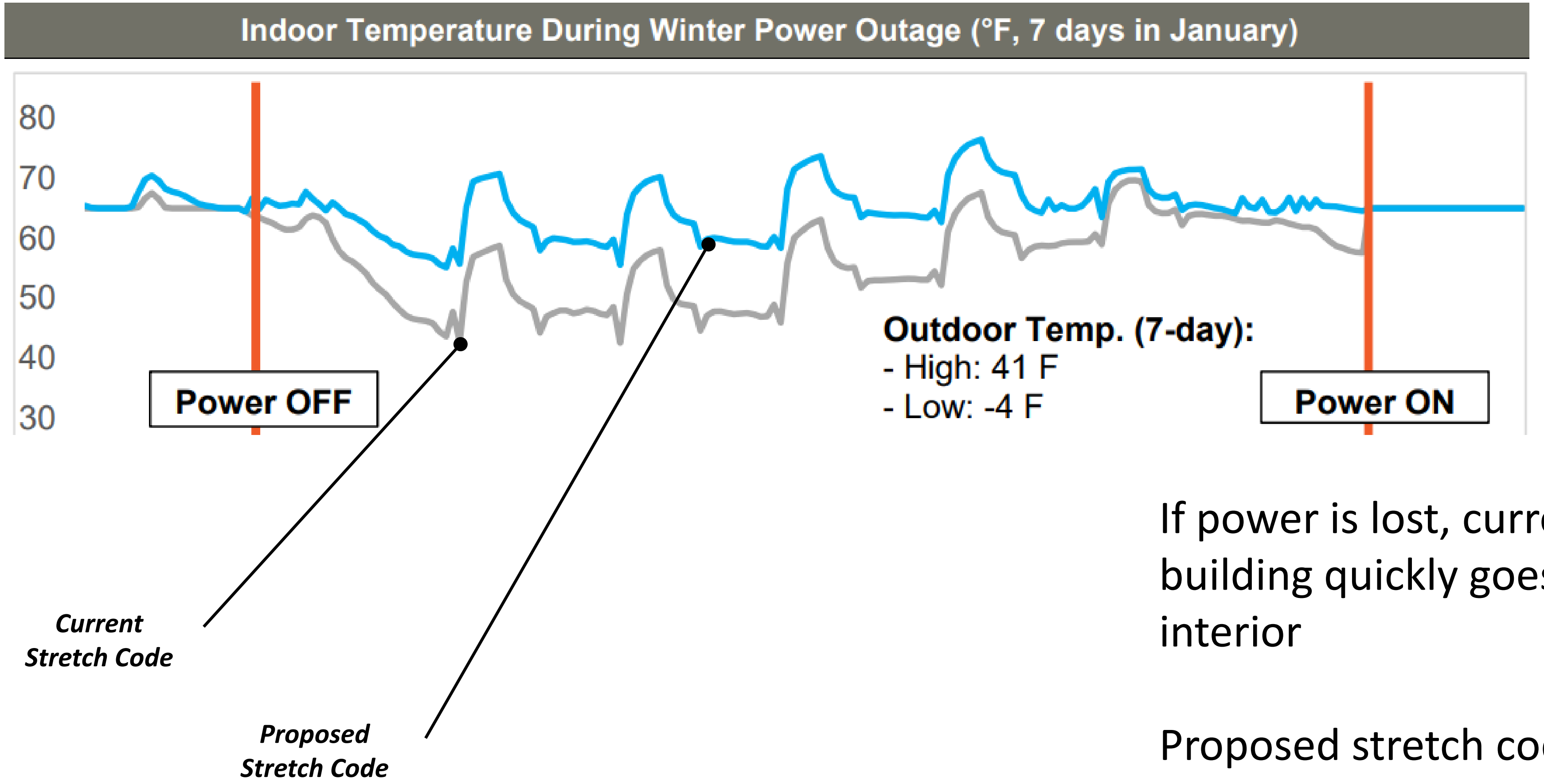
Durability benefits



A focus on heating/cooling TEDI results in:

- Smaller HVAC systems
- More robust envelope
- Less moving parts

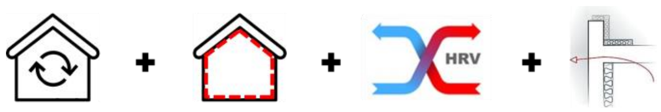
Resilience/comfort benefits

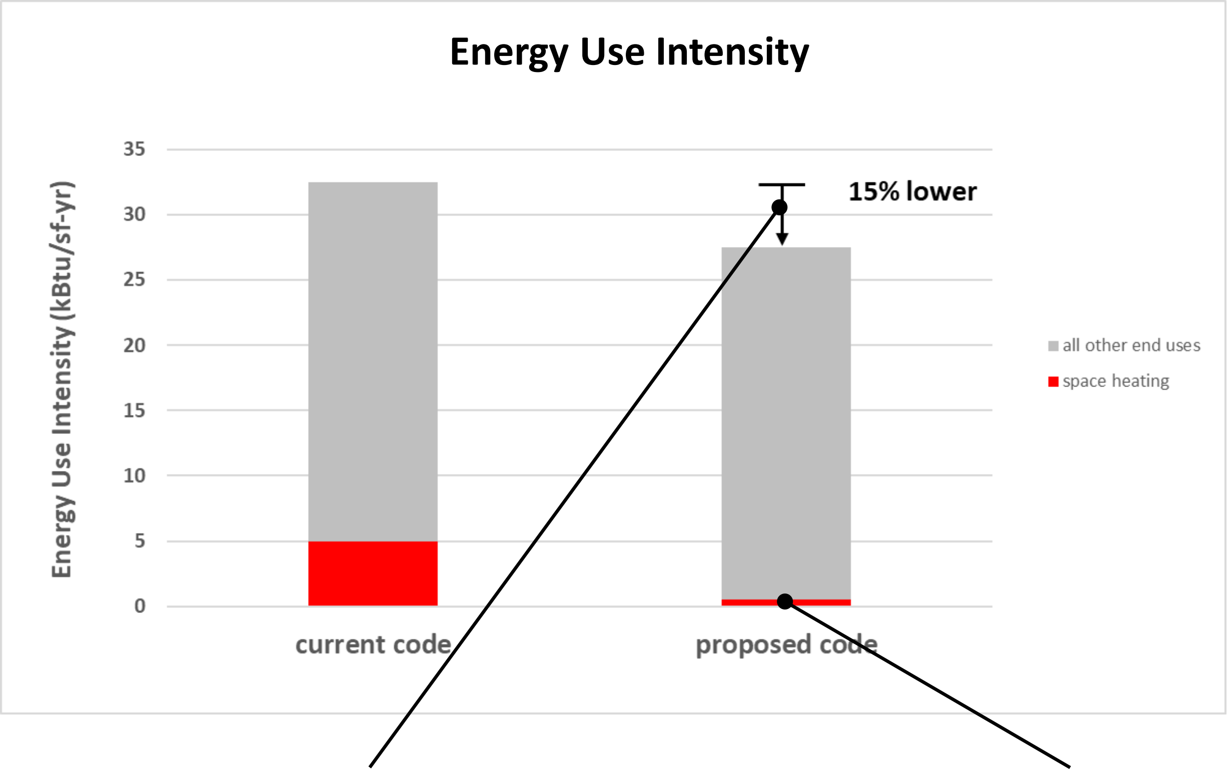


If power is lost, current stretch code building quickly goes to almost 40 F interior

Proposed stretch code – always stays above 55 F interior.

Emissions benefits

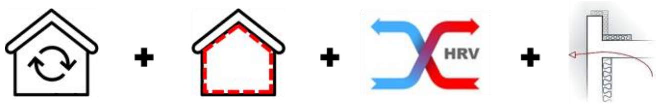


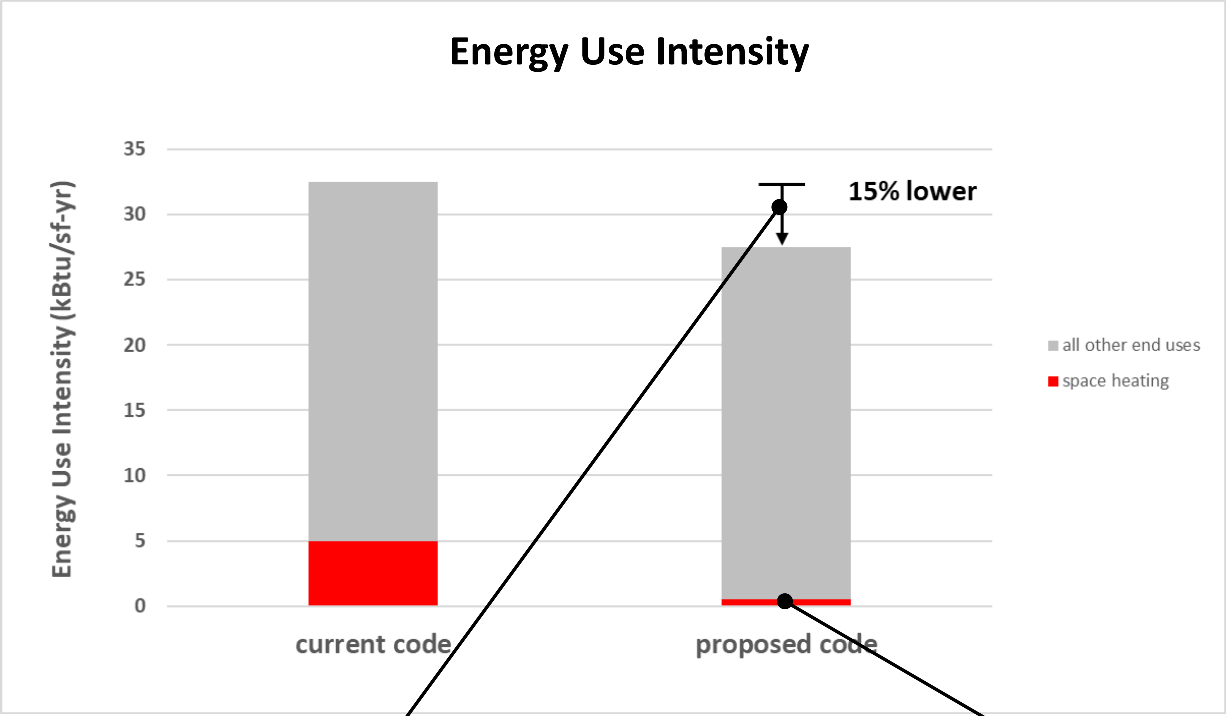


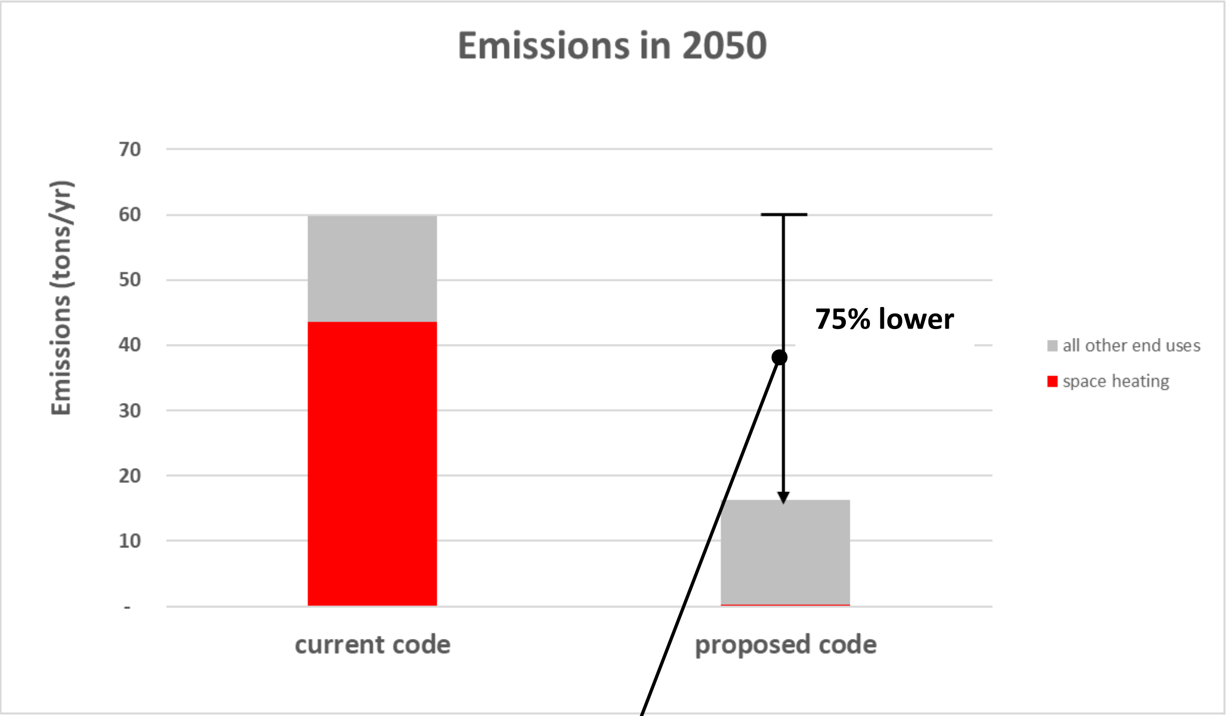
Overall reduction in energy use seems modest (15%)

However, heating end use is significantly reduced (90%)

Emissions benefits







Overall reduction in energy use seems modest (15%)

However, heating end use is significantly reduced (90%)

The payoff is huge reduction in building emissions (75%)

EV READY WIRING

Minimum 10% of spaces wired for Level II EVSE

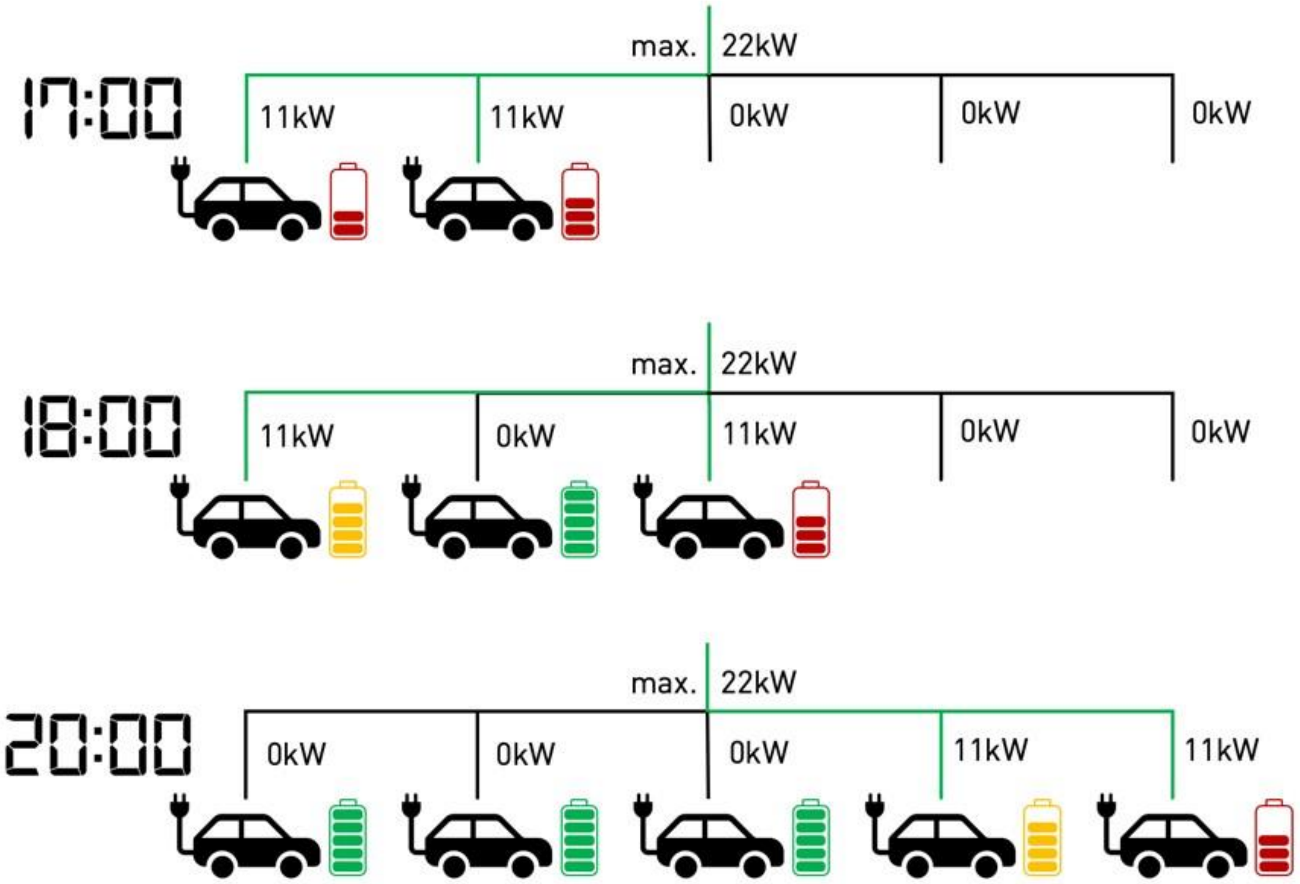
- Recommended to use load management (ALMS)
- Options to use Level I for more spaces or DC fast-charging

TABLE C405.13.1 EV-READY PERFORMANCE REQUIREMENTS

Circuit Breaker Amperage	Maximum Parking Spaces that May Share a Branch Circuit with 10%-60% EV Ready spaces	Maximum Parking Spaces that May Share a Branch Circuit with 61-100% EV Ready spaces
40A	1	2
50A	1	2
60A	2	4
70A	3	6
80A	4	8
90A	5	9
100A	6	10

EV wiring with ALMS – Advanced Load Management Systems for multiple vehicles

- Dedicated circuits to each vehicle (Current IECC model code language) lead to high installed capacity requirements
- Larger shared circuits allow multiple vehicles to charge at different rates, allowing similar charging while lowering electric capacity requirements (Canadian & Australian model language)

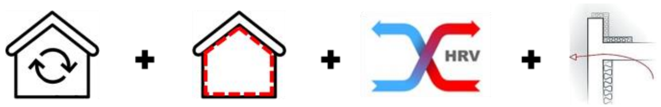


SPECIALIZED CODE

Base, Stretch, Specialized – 3 options

Base code	**2021 IECC / ASHRAE 90.1- 2019 with modest tweaks**	✚	**EV ready parking**
Stretch code	**2021 IECC / ASHRAE 90.1- 2019 with key modifications**	✚	**EV ready parking + Solar ready**
Specialized code	**2021 IECC / ASHRAE 90.1- 2019 with key modifications**	✚	**EV ready parking + Solar ready** **All Electric OR Net Zero OR Electric ready + Solar**

Specialized (Municipal opt-in) Code



TEDI limits

Air infiltration

Ventilation energy recovery

Thermal bridging

Meet all the requirements of stretch code

+

All electric systems

or

Rooftop solar where feasible and electric readiness

or

Net Zero energy on-site with all electric systems
Or electric readiness if using gas

Specialized code - Requirements

- Key Efficiency requirements in Stretch code
- All –electric or Pre-wired for Electrification
- Solar PV on available space – minimum size
- EV ready 10% of spaces minimum

Solar PV

- Required:
  - Using Fossil fuels
  - Using Net Zero path
- Optional:
  - All-electric school

- Exceptions for shaded sites can reduce min. size

Solar PV minimum sizing

CC105.2 On-site renewable energy. New mixed-fuel buildings shall have equipment installed for on-site renewable energy with a rated capacity of not less than 1.5 W/ft² (16.1 W/m²) multiplied by the sum of the gross conditioned floor area of the three largest floors.

> **Exception:** Where the building site cannot meet the requirement in full with an on-site renewable energy system, the building site shall install a partial system designed to utilize not less than 75% of the *Potential Solar Zone Area*.

Examples of minimum Solar PV size:

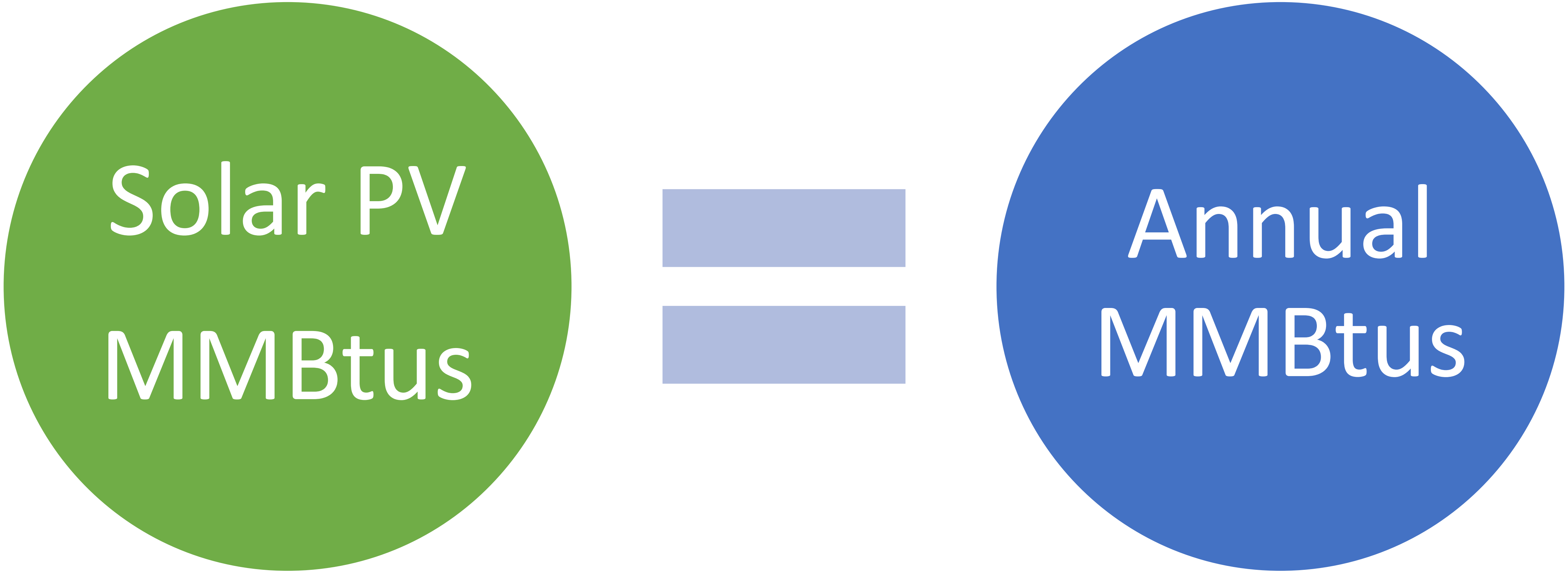
- 4 story 200,000 sf High school: 160,000 sf on 3 largest floors

  Min. Solar = 1.5 x 160,000 = 240 kW system

- 3 story 80,000 sf Elementary

  Min. Solar = 1.5 x 80,000 = 120 kW system

Net Zero with On-site renewables



CASE STUDIES

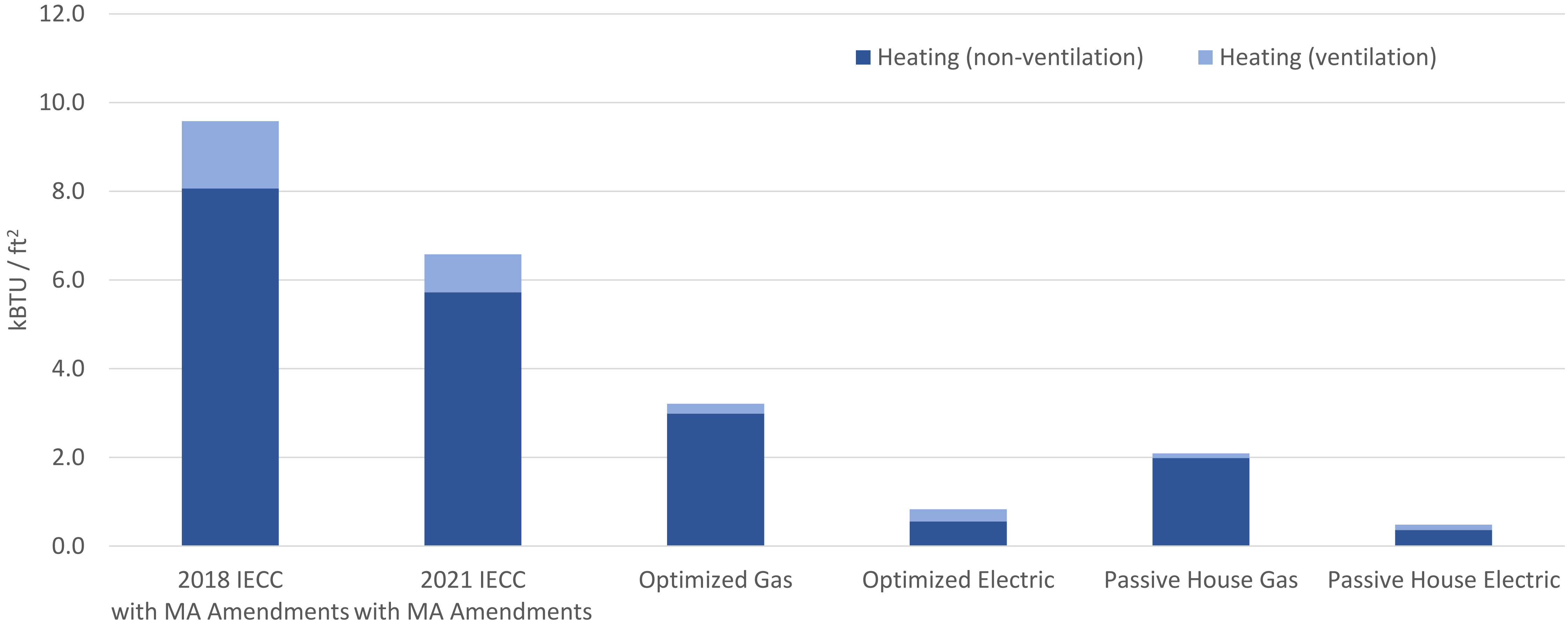
- 74,000 sf Primary School
- 328,000 sf Secondary School

Case study: 74,000-sf primary school

Item	Current Stretch Code	Proposed Stretch Code
Roof	R-40	R-45
Wall	R-19 + 8.4 c.i.	R-19 + 21 c.i.
Thermal breaks	None	Included
% fenestration	22%	
Fixed window	U-0.33 (R-3.0 equiv)	U-0.23 (R-4.3 equiv)
Operable window	U-0.39 (R-2.6 equiv)	U-0.28 (R-3.6 equiv)
Infiltration	1 cfm at 75 Pa	0.4 cfm at 75 Pa
Infiltration testing	No	Yes
Heating plant	Gas mid-efficiency	Gas condensing OR air source VRF
Heating terminals	Baseboard	VRF fan coil units
Cooling plant	Direct expansion	Direct expansion OR VRF
Cooling terminals	VAV/CAV	VAV/CAV OR VRF FCU
Ventilation energy recovery	50%	75%
Lighting	0.61 watts/sf average across whole building	

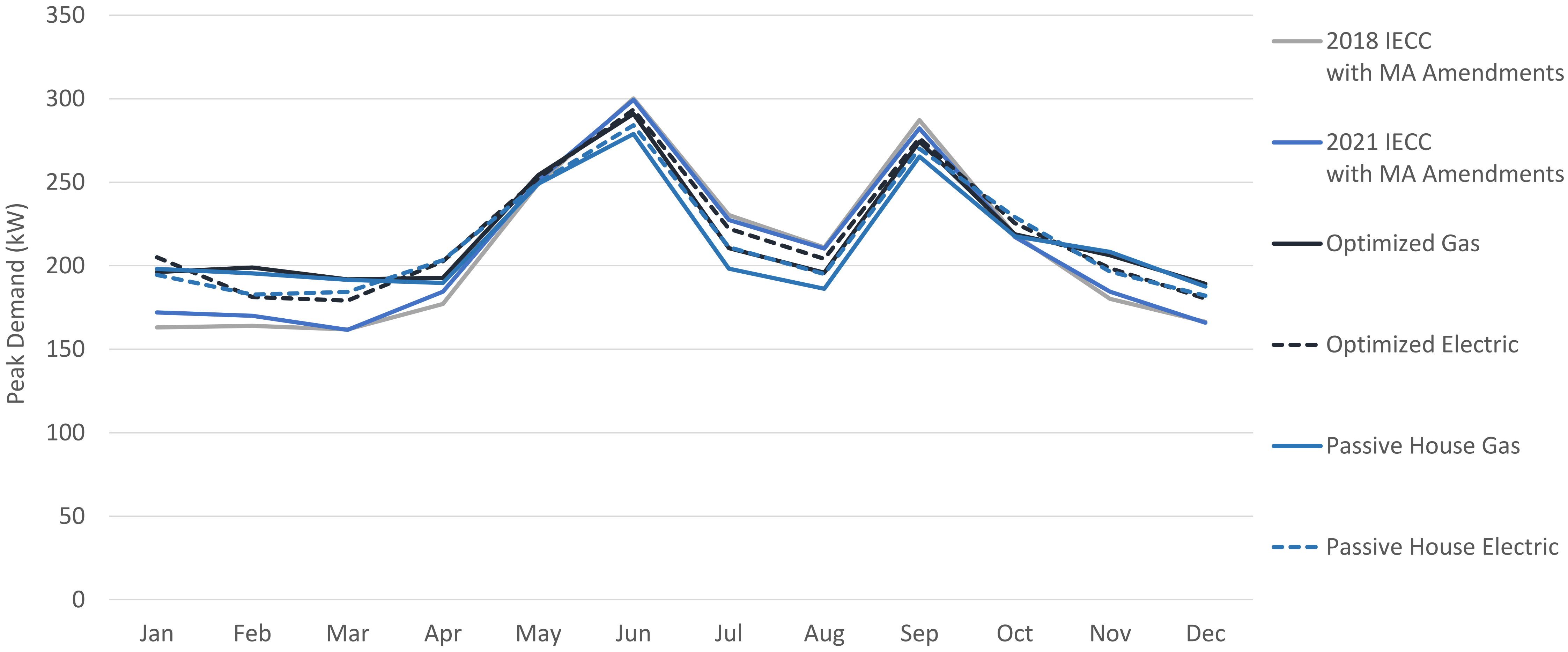
Primary School - target heating fuel reduction

Heating Energy - TEDI



Primary School – maintain or reduce electric demand

Electricity – Monthly Peak Demand

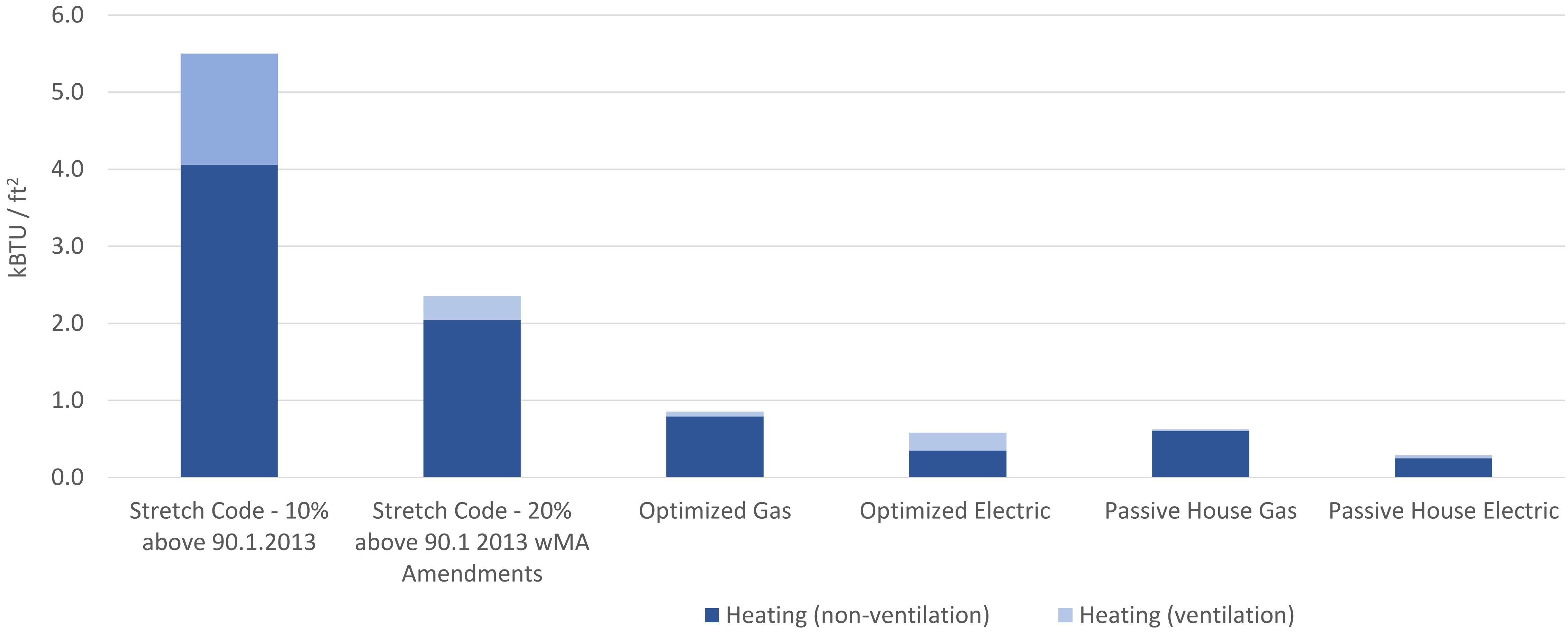


Case study: 328,000-sf secondary school

Item	Current Stretch Code	Proposed Stretch Code
Roof	R-40	R-45
Wall	R-19 + 8.4 c.i.	R-19 + 21 c.i.
Thermal breaks	None	Included
% fenestration	22%	
Fixed window	U-0.32 (R-3.1 equiv)	U-0.23 (R-4.3 equiv)
Operable window	U-0.38 (R-2.6 equiv)	U-0.28 (R-3.6 equiv)
Infiltration	1 cfm at 75 Pa	0.4 cfm at 75 Pa
Infiltration testing	No	Yes
Heating plant	Gas mid-efficiency	Gas condensing OR central heat pump
Heating terminals	VAV and baseboard	Fan coil units
Cooling plant	Water cooled chiller with direct expansion RTUs	
Cooling terminals	VAV	Fan coil units, constant air volume terminals
Ventilation energy recovery	50%	75%
Lighting	0.61 watts/sf average across whole building	

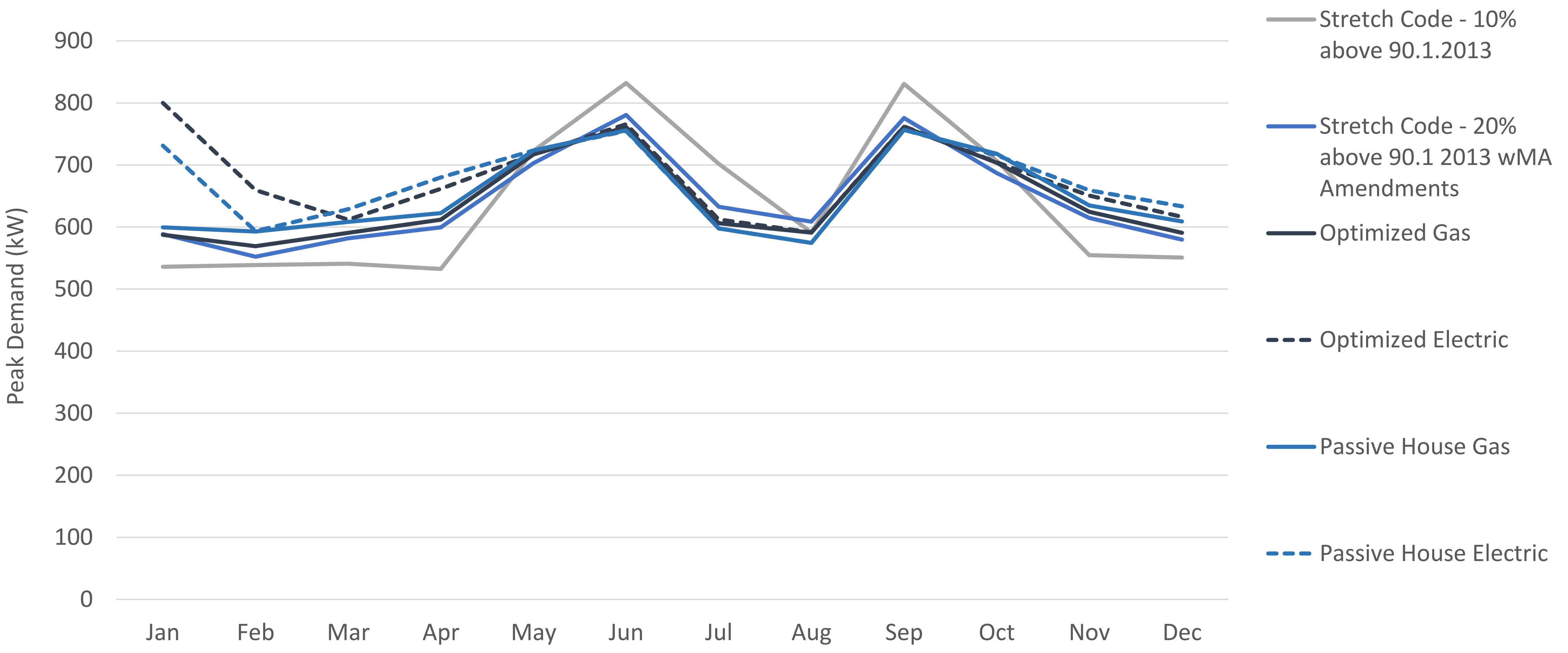
Secondary School

Heating Energy - TEDI



Secondary School

Electricity – Monthly Peak Demand



Questions?

Contact DOER:

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Study Teams

Commercial and large multifamily

Steven Winter Associates, Inc.
Improving the Built Environment Since 1972

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CONSIGLI
Est. 1905

BURO HAPPOLD

Residential low rise

PERFORMANCE SYSTEMS DEVELOPMENT

NORESCO