The Path to Net Zero for Multi-Unit Residential Buildings (MURBs)

July 22, 2021

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Welcome!

✓ This presentation will provide

an overview of design elements and considerations related to net zero energy

X This presentation will not provide

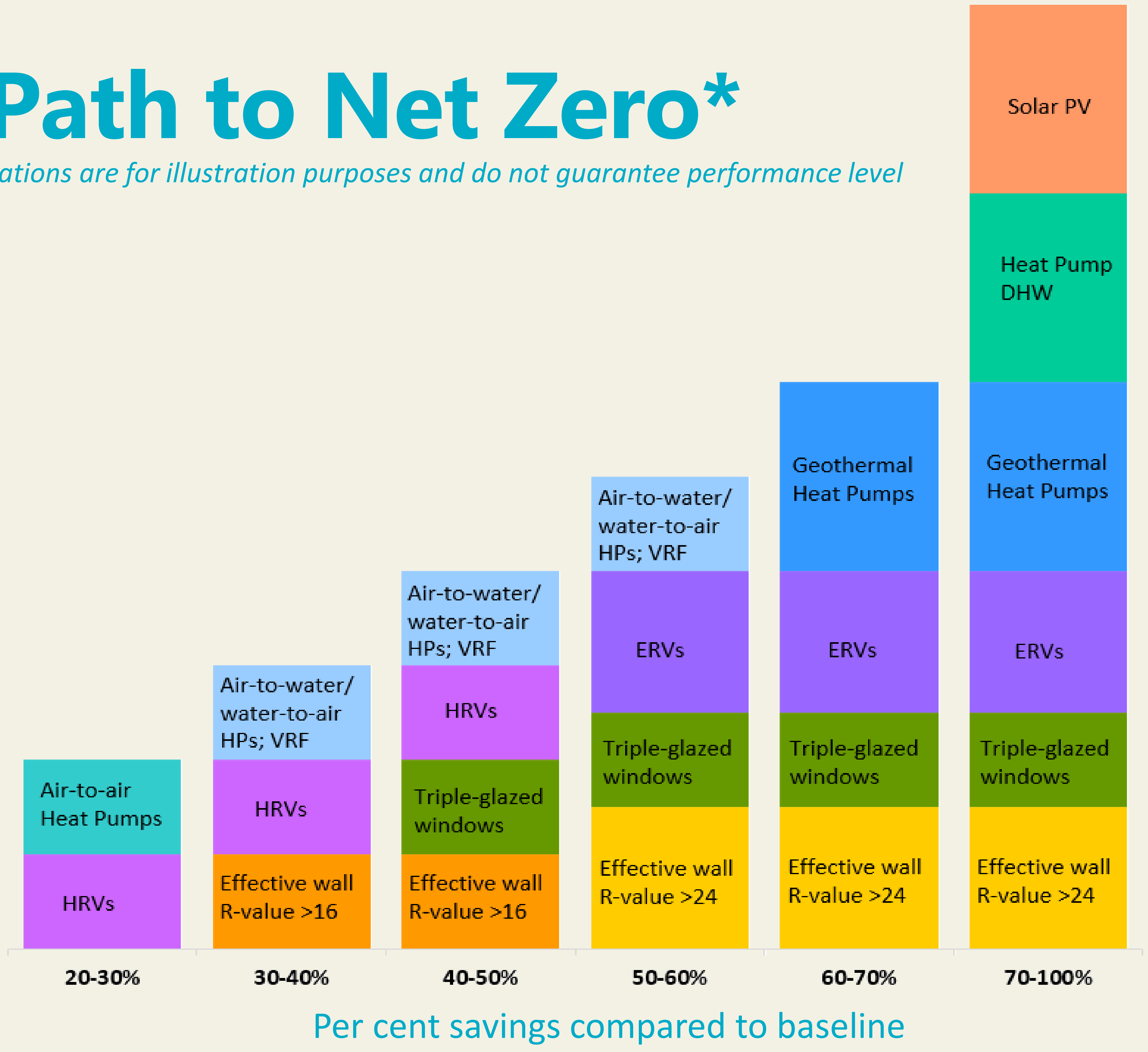
a prescribed design for net zero MURBs

Agenda

- Why build a Net Zero MURB?
- How do we define/measure Net Zero?
- What should be considered in Net Zero MURB designs?
- What's the best way to achieve a Net Zero design?

The Path to Net Zero*

**measure combinations are for illustration purposes and do not guarantee performance level*



The Case for Net Zero MURBs

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Why Net Zero?

Buildings (commercial and residential) account for 28% of Canada's energy consumption and 22% of national GHG emissions (NRCan, 2020)

- Net Zero design is a critical part of reducing energy and GHGs in this sector
- Other benefits of Net Zero buildings:
  - Lower operating costs
  - Higher occupant comfort
  - Longer service life of key systems

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“Isn’t it expensive?”

- Net Zero can be achieved using standard materials/methods/technologies
- Average incremental capital cost is **approx. 6% for mid-rise MURBs*** (CaGBC, 2019)
  - *this is for Zero Carbon, with NECB 2011 baseline
- Higher capital is balanced by significant operational cost savings
  - Payback varies based on utility costs, carbon pricing

Incentives available to assist with capital costs

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Defining Net Zero

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Terms and Definitions

Focus of today's presentation

Net Zero Energy

- Building produces as
- much *energy* as it
- consumes (from all
- sources), annually

Net Zero Carbon

- Net carbon balance
- over building life-cycle
- (embodied + operational
- – offsets) must be zero

Net Zero Ready

- Building is designed to
- achieve Net Zero Energy,
- but solar PV has not
- been installed

Related terms:

Thermal Energy Demand Intensity (TEDI)

Energy Use Intensity (EUI)

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Net Zero Energy

Can I just build a regular MURB and add a large ground-mounted solar PV system?

Mathematically, yes.

Sustainably, no.

(also likely no due to net metering caps… more on that later)

“soft” definition of Net Zero Energy

Reduce

- Energy loads (TEDI)
- Energy losses (efficiency)

Reuse

- /recover
- (energy
- recovery)

Renewables

- Add renewables
- to a low-energy
- design

Net Zero *Energy* Standards for Commercial Buildings

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Future Net Zero Energy Code: *National Energy Code of Canada for Buildings* (NECB) 2030

CaGBC's Zero Carbon Buildings Standard (ZCB)

- Voluntary standard
- Focused on Net Zero Carbon
- Includes specific energy-related requirements
- Metrics aligned with NECB 2017

ZCB Energy Criteria

OPTION 1 Flexible Approach	OPTION 2 Passive Design Approach	OPTION 3 Renewable Energy Approach
• **Thermal energy demand intensity** (**TEDI**) of 30-40 kWh/m²/year, as a function of climate zone; and • **Site energy use intensity** (**EUI**) 25% better than the *National Energy Code for Buildings* (NECB) 2017	• **Thermal energy demand intensity** (**TEDI**) of 20-30 kWh/m²/year, as a function of climate zone	• **Thermal energy demand intensity** (**TEDI**) of 30-40 kWh/m²/year, as a function of climate zone; and • Zero carbon balance for **operational carbon** achieved without **green power products** or **carbon offsets**

- Emphasis on TEDI
  - i.e., reduce!
- **Buildings must show reduced heating load**

Key Elements of Net Zero Design

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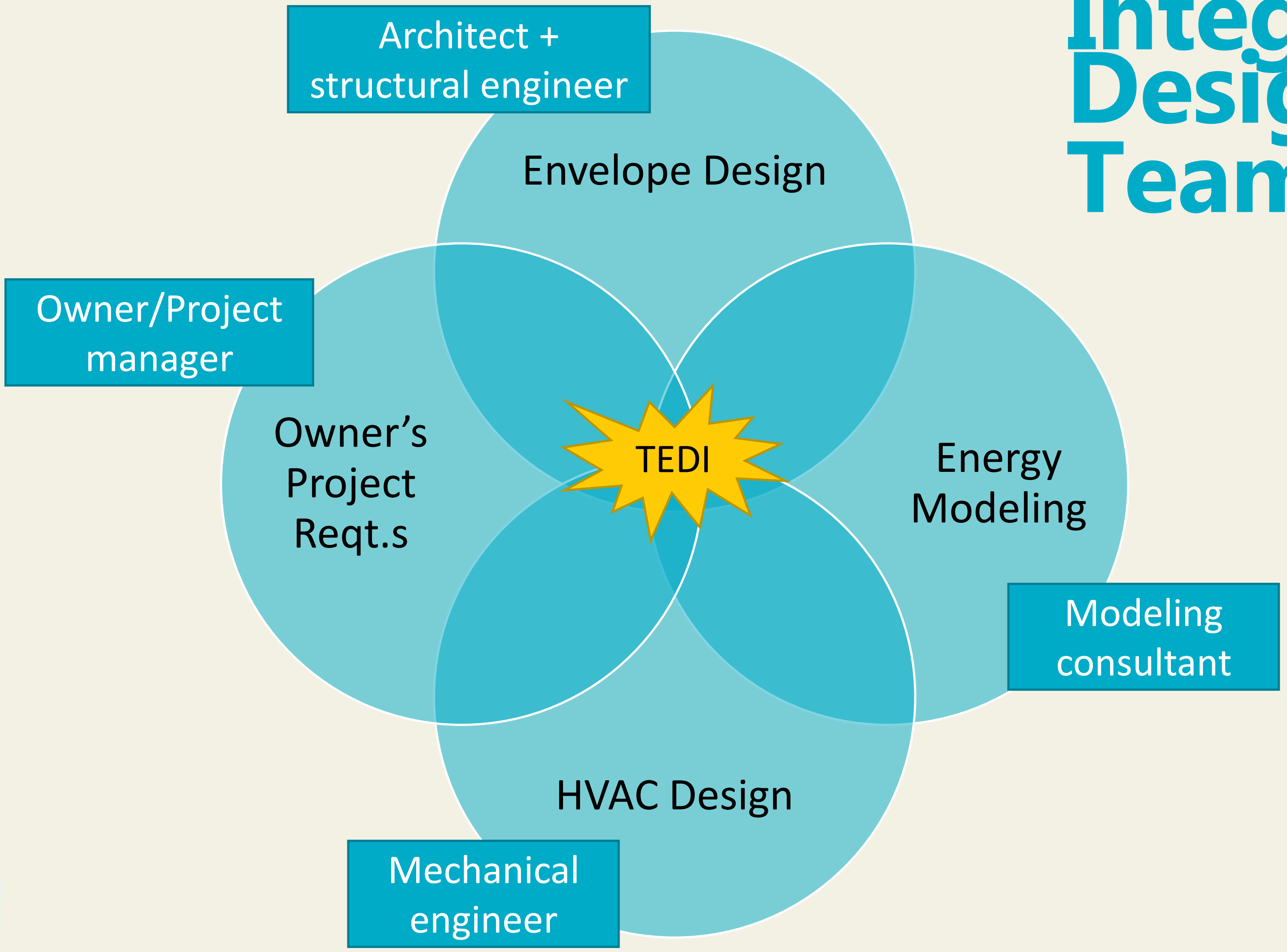
Integrated Design Team



+ others including:

- Electrical engineer
- General contractor
- Cost consultant
- Interior designer
- Renewables consultant

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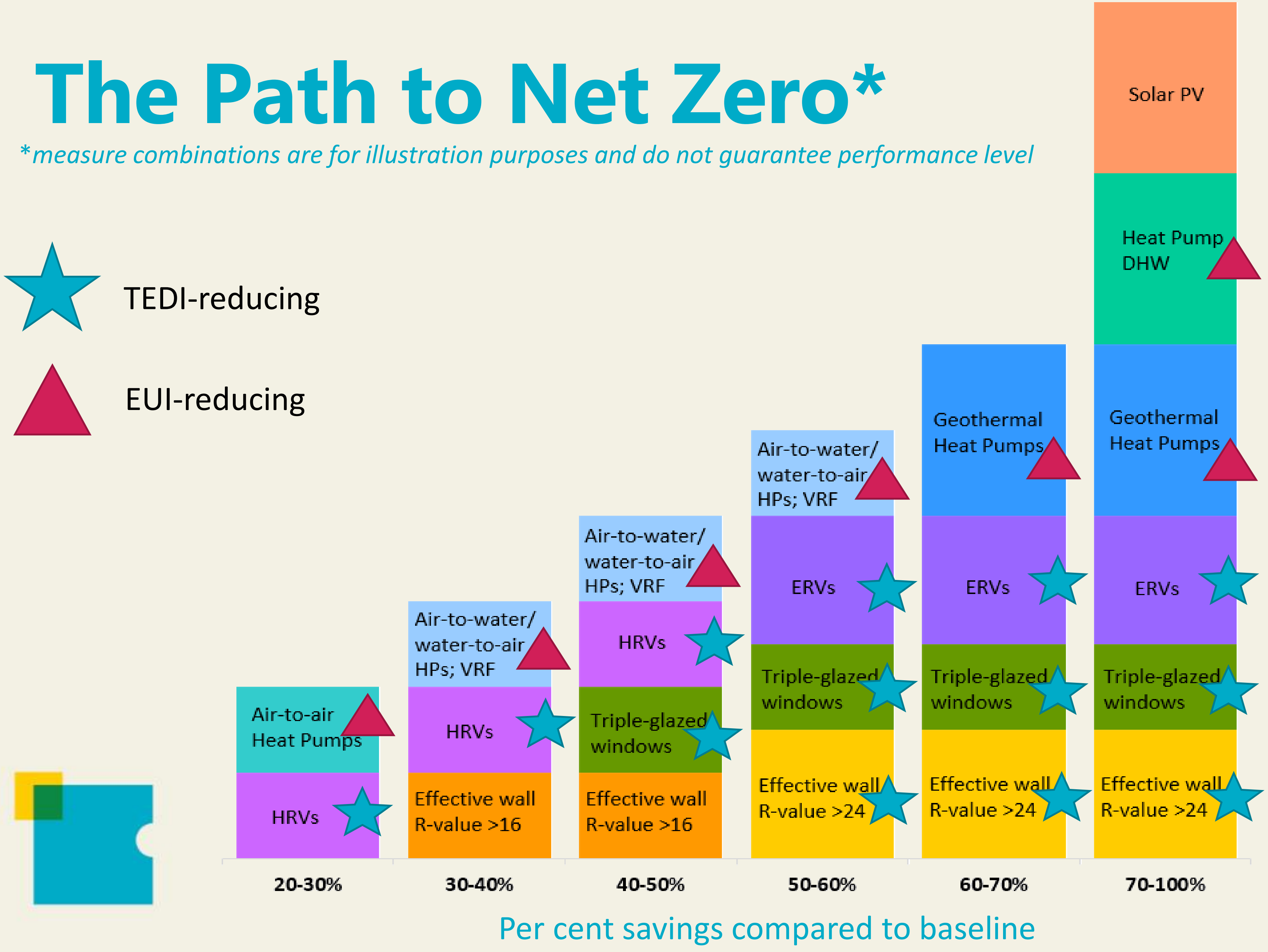

But what *is* TEDI?

- Thermal Energy Demand Intensity: **The net heating *demand* per unit area** (kWh per square meter, annually)
- Includes:
  - Heat loss through envelope
  - Heat gain from passive solar, occupants, etc.
  - Net ventilation heating load (including heat recovery)

Designing to reduce TEDI

- ✓Insulation
  - Account for, and minimize, **thermal bridges**
- ✓High performance glazing
  - Optimize gains, minimize losses
- ✓Air-sealing
  - Incorporate low-infiltration techniques in design
- ✓Energy recovery
  - Select high-performance ERVs/HRVs

Insulation and Thermal Bridging

Generally,

Net envelope insulation = Insulating materials – thermal bridges

Specifically,

$$U_T = \frac{\Sigma(\Psi \cdot L) + \Sigma(\chi)}{A_{Total}} + U_o$$

Where:

U_T =	total effective assembly thermal transmittance (Btu/hr·ft^2·°F or W/m^{2}K)
U_o =	clear field thermal transmittance (Btu/hr·ft^2·°F or W/m^{2}K)
A_{total} =	the total opaque wall area (ft^2 or m^2)
Ψ =	heat flow from linear thermal bridge (Btu/hr·ft °F or W/mK)
L =	length of linear thermal bridge, i.e. slab width (ft or m)
χ =	heat flow from point thermal bridge (Btu/hr· °F or W/K)

For another presentation…

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Insulation and Thermal Bridging

Insulating materials:

- Mineral wool
- Spray foam
- Cellulose
- Fiberglass
- Rigid foam
- Etc.

Thermal bridges:

- Stud/framing
- Floor slabs
- Corners
- Balconies
- Window-wall transitions
- Parapets

The energy code in NS (NECB 2017) requires that these are accounted for in all buildings

If thermal bridges are not accounted for, heat loss (and therefore heating load) is not accurately modeled
…which is a problem

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Why we need to care about thermal bridging

- Thermal bridging can reduce envelope assembly R value by **up to 80%**
  - R-40 to R-8
- Thermal bridging **must** be addressed in architectural design
- Can’t be solved by just adding more insulation (unfortunately)

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Addressing thermal bridging

Important thermal bridges for MURBs:

- Corners
- Balconies
- Window-wall transitions

- **Assess window size and quantity**
  - 1 large window is better than 3 small windows
  - 25% glazing is better than 50% glazing
- **Reduce corners/bump-outs**
  - A rectangular building can have as few as 4 corners!
  - Many are closer to 50 corners (because of bump-outs)
- **Reduce balcony length**
  - & avoid full-span balconies
  - Consider alternatives to balconies
- **Add thermal breaks**
  - At balconies, corners, parapets, windows, girt systems
  - Especially balconies though

Air-sealing and Infiltration

- Difficult to model (accurately), challenging to measure
  - And post-construction is too late to make corrections, usually
- Air infiltration can result in *significant* heat loss
  - + moisture issues
- Best practice:
  - Design air-tightness into the envelope
  - e.g. spray foam, Aerobarrier

Energy Recovery

- Heat Recovery Ventilators
  - Recover sensible energy only (heat)
- Energy Recovery Ventilators
  - Recover sensible + latent energy
  - Net effect is higher recovered energy
- High-performance ERVs can be 85%+ effective!
  - **This means the ERV could raise the temperature of outside air by up to 30 degrees (-15 to +15)**

This significantly reduces the ventilation load component of TEDI

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HVAC Options

Contributes to EUI, not TEDI

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Heating and Cooling Equipment

- Inverter-duty air-source heat pumps
- Variable refrigerant flow (VRF) heat pumps
- Water loop heat pumps
- Central air-to-water heat pumps
- ★ Geothermal water loop heat pumps
- ★ Seawater/Geothermal central water-to-water heat pumps

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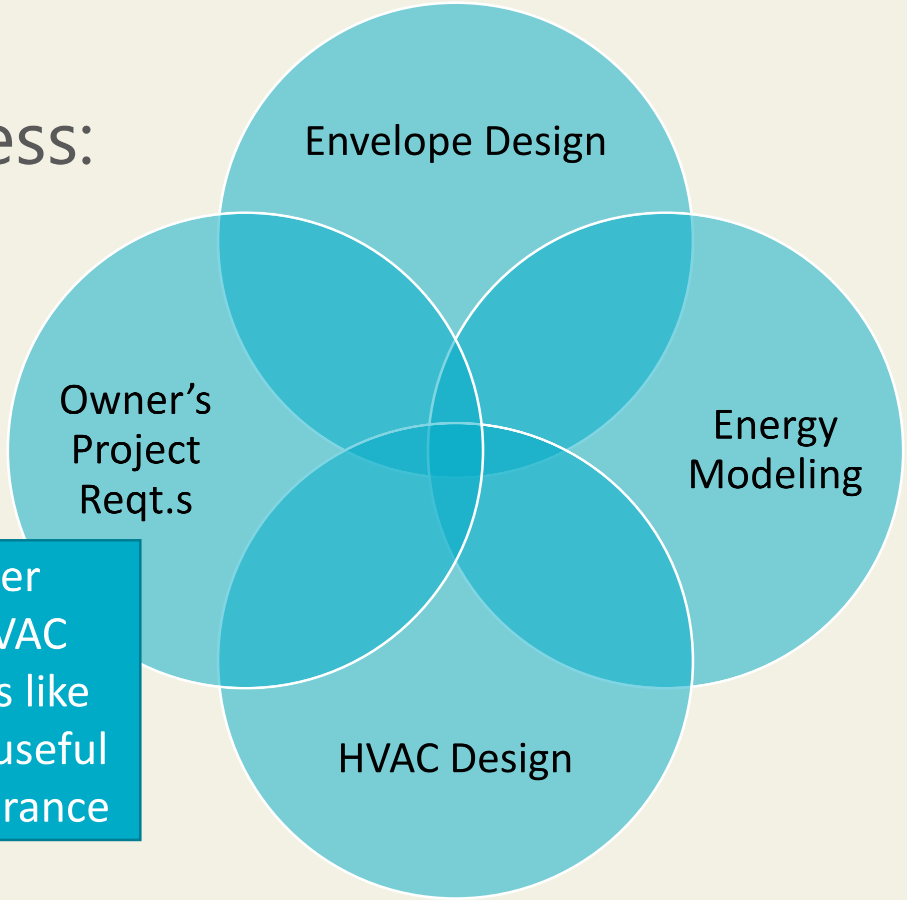
Selecting HVAC

Continue this process:

(i.e., it's actually okay to change the envelope design after selecting a preferred HVAC system)



Include other important HVAC considerations like maintenance, useful life, size/appearance

What about Renewables?

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Options

On-site renewables

Off-site renewables

Sizing Renewables

- Renewables are sized based on modeled annual energy consumption
  - Some building modeling software includes PV sizing tools
  - Otherwise, system sized using additional software
- Sizing includes all relevant system parameters
  - Weather, shading, placement, panel efficiency, etc.

This is, arguably, the easiest part of net zero design

Remember thermal bridging!

Summary: Net Zero for MURBs

REDUCE – REUSE/RECOVER - RENEWABLES

- Reduce TEDI (really, really reduce)
- Select efficient HVAC
- Size renewables

And use Integrated Design!

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P.S.

Efficiency NS offers customized incentives for Net Zero new construction (or major renovation) projects – up to **40% higher than standard project incentives**

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Questions?

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