MORRISON HERSHFIELD

Façade Techtonics – Simulation vs. Reality

Session 1 – New Energy Codes

May 6, 2021

Old Energy Codes

- ASHRAE 90.1, NECB, etc.
- Prescriptive, Trade-off, Performance
- Un-addressed or compliance neutral elements
  - Building shape
  - Infiltration
  - Most thermal bridging
  - Occupant behaviour
  - Building operating schedules, room temperature, etc.
  - Over-ventilation, sometimes

Old Energy Codes

- Performance Path pitfalls
  - Code/Reference gaming
  - Energy vs energy cost
  - Fuel switching

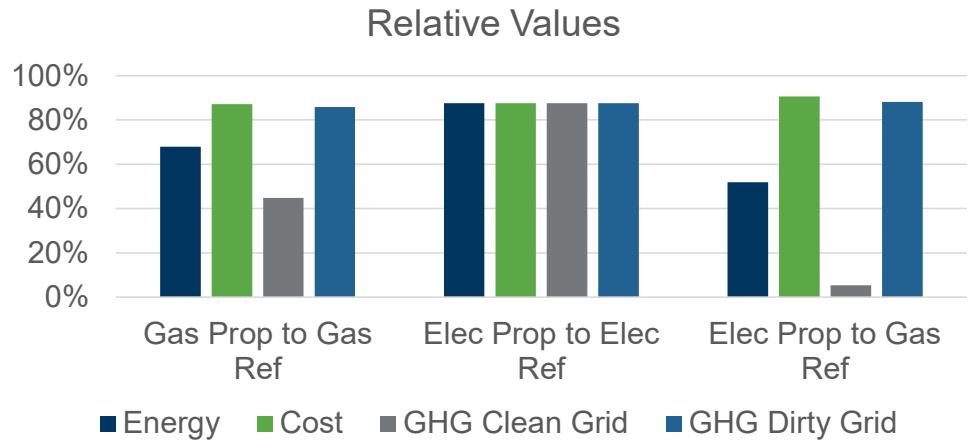
80 kWh/m^2 reference heating load

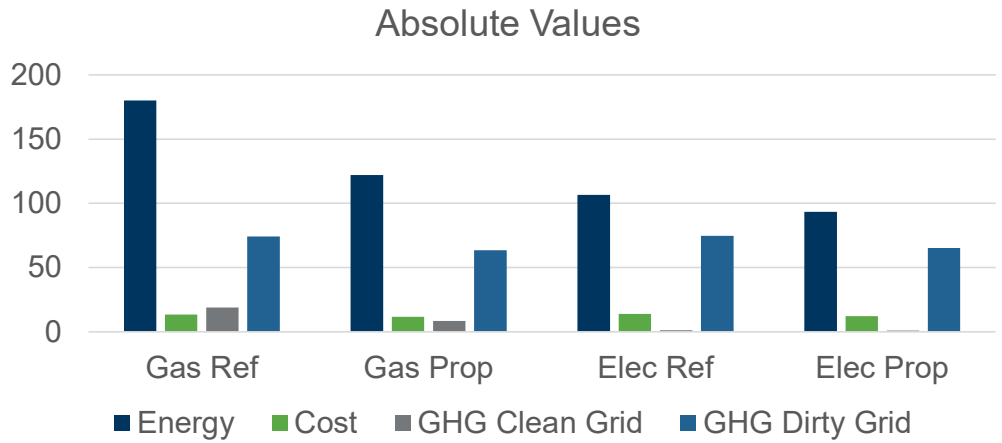
40 kWh/m^2 proposed heating load

80 kWh/m^2 other electrical load

Gas – atmospheric vs condensing boiler

Elec – heat pump vs heat pump





New Energy Codes and Standards

- Passive House, Vancouver Building Bylaw, Toronto Green Standard, BC Energy Step Code, CaGBC Net Zero, and others
- Absolute performance metrics
- Energy Use Intensity (EUI, kWh/m^2)
  - All energy on project is in
- Thermal Energy Demand Intensity (TEDI , kWh/m^2)
  - Annual heating requirements of the building, generally reflective of BE performance and ventilation system performance
- Greenhouse Gas Emissions Intensity (GHGI , $kgCO_{2e}/m^2$), some codes
- Metrics determined by energy modelling, modelling requires inclusion of all thermal bridging, most require air tightness testing
- Building type and climate dependent targets

Toronto Green Standard, v3

Building Type	Total Energy Use Intensity (KWh/m²)		Thermal Energy Demand Intensity (KWh/m²)		Greenhouse Gas Intensity (kg/m²)		Total Energy Use Intensity (KWh/m²)		Thermal Energy Demand Intensity (KWh/m²)		Greenhouse Gas Intensity (kg/m²)	
	Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2	Tier 3	Tier 4	Tier 3	Tier 4	Tier 3	Tier 4
Multi-unit Residential Buildings (≥4 Storeys)	170	135	70	50	20	15	100	75	30	15	10	5
Multi-unit Residential Buildings (≤ 6 Storeys)	165	130	65	40	20	15	100	70	25	15	10	5
Commercial Office Buildings	175	130	70	30	20	15	100	65	22	15	8	4
Commercial Retail Buildings	170	120	60	40	20	10	90	70	25	15	5	3
Mixed Use Buildings (90% residential, 5% retail, 5% commercial)	170	134	70	49	20	15	100	74	29	15	10	5
All Other Building Types	Tier 1: ≥15 per cent improvement above SB-10, 2017 Tier 2: ≥25 per cent improvement above SB-10, 2017											

Vancouver Building Bylaw

- Base Code

Table 10.2.2.5.A
Maximum Energy Use and Emissions Intensities
Forming part of Sentence 10.2.2.5.(2)

Occupancy Classification [1]	Total Energy Use Intensity (kWh/m^2a)	Thermal Energy Demand Intensity (kWh/m^2a)	Greenhouse Gas Intensity ($kgCO_{2e}/m^2a$)
Group C *occupancies* in *buildings* up to 6 *Storeys*	110	25	5.5
Group C *occupancies* in *buildings* over 6 *Storeys*, except Hotel and Motel	130	45	14
Hotel and Motel *occupancies*	170	30	14
Group D and E *occupancies*, except Office	170	30	5
Office *occupancies*	130	30	7
All other *occupancies*	Comply with ASHRAE 90.1, Section 11 (ECB) or Appendix G performance paths in accordance with Article 10.2.2.2., or NECB Part 8 performance path in accordance with Article 10.2.2.3.		

- Rezoning

Performance Limits
Buildings Not Connected to a City-recognized Low Carbon Energy System

Building Type	TEUI (kWh/m^2)	TEDI (kWh/m^2)	GHGI ($kgCO_2/m^2$)
Residential Low-Rise (< 7 storeys)	100	15	5
Residential High-Rise (7+ storeys)	120	30	6
Office	100	27	3
Retail	170	21	3
Hotel	170	25	8
All Other Buildings	EUI 35% better than Building By-law energy efficiency requirements, Section 10.2, in effect at the time of rezoning application		

BC Energy Step Code

- Only multi-unit residential shown
- Targets adjusted for climate zone
- Step 1 available for a broader range of building types, NECB performance path compliance + thermal bridging accounting + air-leakage testing

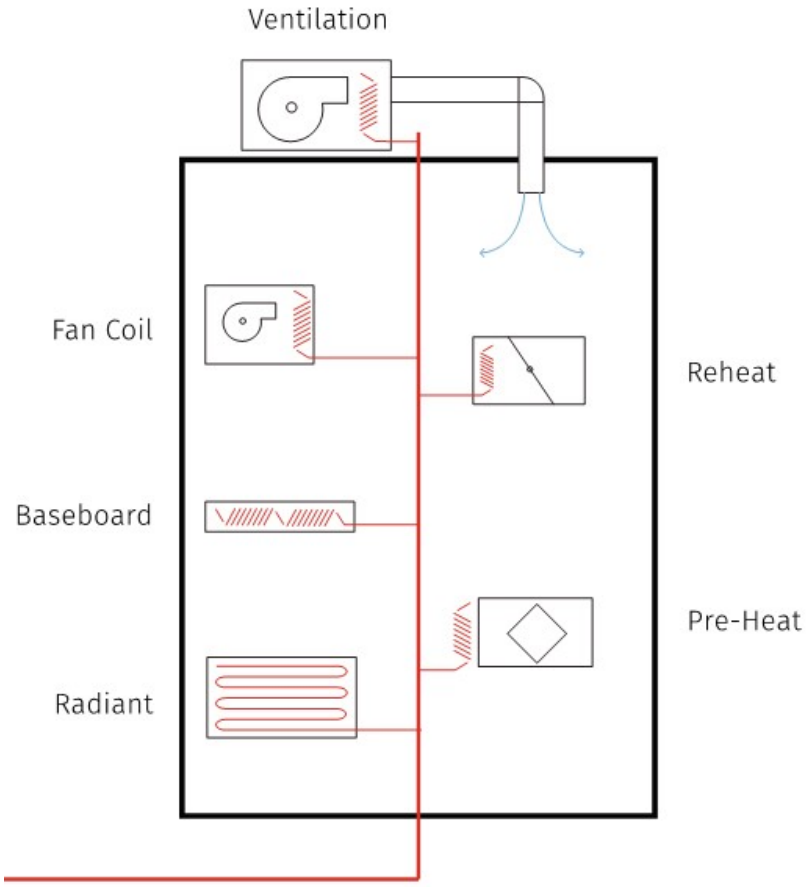
Table 10.2.3.3.-H
Energy Performance Requirements for Other Residential Occupancies
Forming part of Sentences 10.2.3.3.(1) and (2)

Degree-Days Below 18°C	Step	Equipment and Systems – Maximum Total Energy Use Intensity, kWh/(m²·year)	*Building* Envelope – Maximum Thermal Energy Demand Intensity, kWh/(m²·year)
Less than 3000	1	Conform to Part 8 of the NECB	
	2	130	45
	3	120	30
	4	100	15
3000 to 3999	1	Conform to Part 8 of the NECB	
	2	130	45
	3	120	35
	4	110	22
4000 to 4999	1	Conform to Part 8 of the NECB	
	2	135	50
	3	120	35
	4	110	22
5000 to 5999	1	Conform to Part 8 of the NECB	
	2	135	55
	3	120	40
	4	110	22
6000 to 6999	1	Conform to Part 8 of the NECB	
	2	150	60
	3	140	50
	4	125	35
Greater than 6999	1	Conform to Part 8 of the NECB	
	2	180	90
	3	160	75
	4	140	60

What is TEDI?

- Annual heating energy delivered for space conditioning and conditioning of ventilation air by mechanical heating systems.
- Impacted by massing, envelope, ventilation
- Internal gains, schedules, etc.

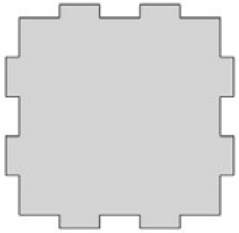
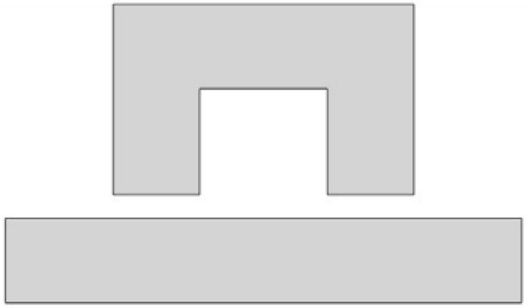
$$TEDI = \left[\frac{kWh}{m^2 a} \right]$$

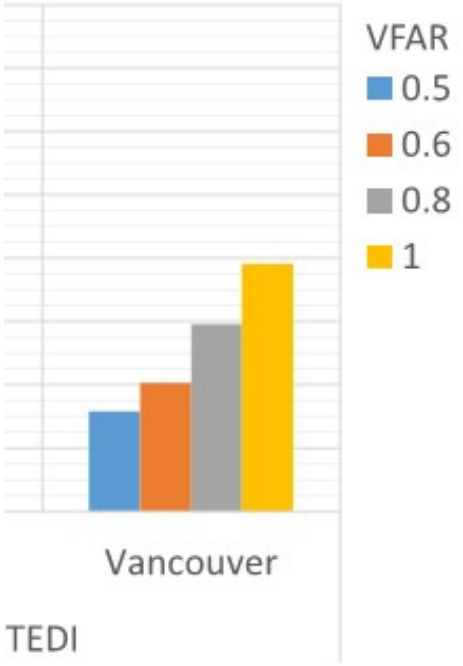


TEDI – Architecture Matters

- Addressing building shape

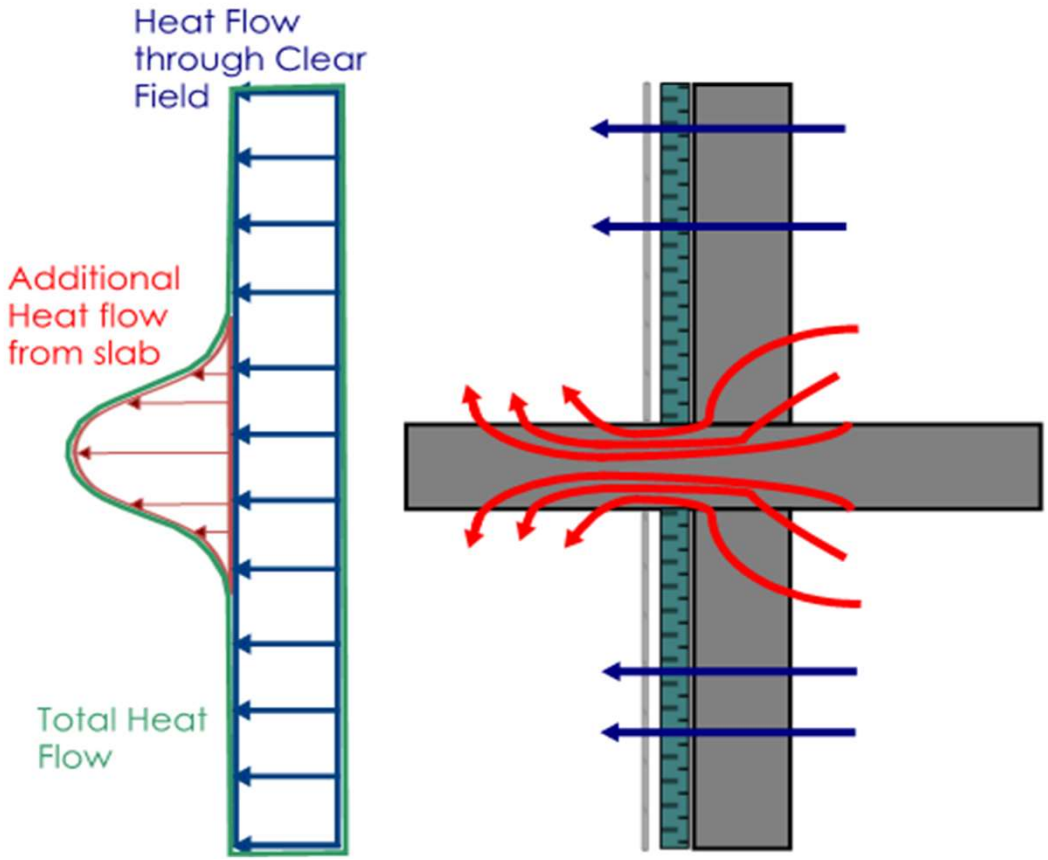
Table 4: VFAR for Example Building Shapes and Floor Plate Sizes

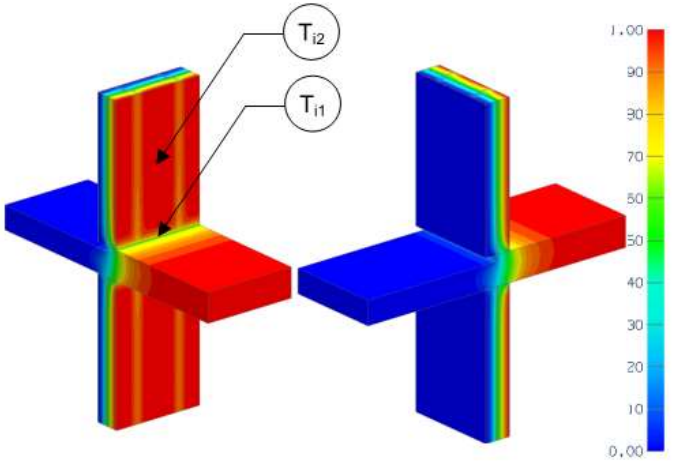
Floor Plate Size	Building Shapes		
	Square	Articulated	Narrow
			
600m²	0.49 VFAR	0.59 VFAR	0.7 VFAR
400m²	0.6 VFAR	0.72 VFAR	0.86 VFAR



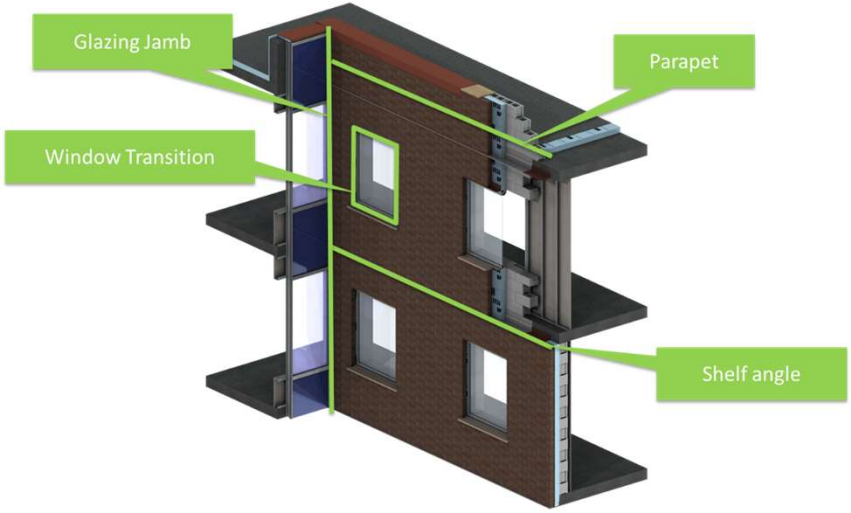
Source: 2017 Metrics Research Full Report, BC Housing

TEDI – Thermal Bridging





Thermal Bridging – The Whole Picture



Total Heat loss	=	heat loss due to clear field	+	Heat loss due to interface details

Building Envelope Thermal Bridging Guide www.BETB.ca

TEDI – Architecture Matters

- Quantity of thermal bridging

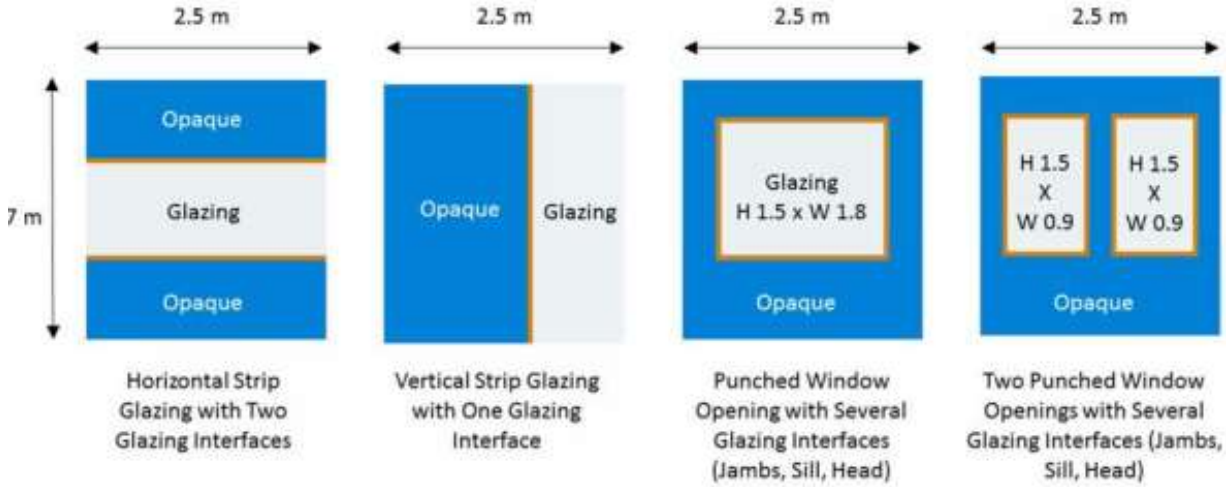


Figure 4.4: Example Window Orientations and Layouts

Table 4.4: Effects of Window Arrangement on Thermal Transmittance

	Horizontal Strip Glazing	Vertical Strip Glazing	Punched Window Opening	Two Punched Window Openings
Interface Length (m)	5	2.7	6.6	9.6
U-value (W/m² K)	**0.566**	**0.467**	**0.617**	**0.733**
Effective R-Value	10.2	12.2	9.2	7.8

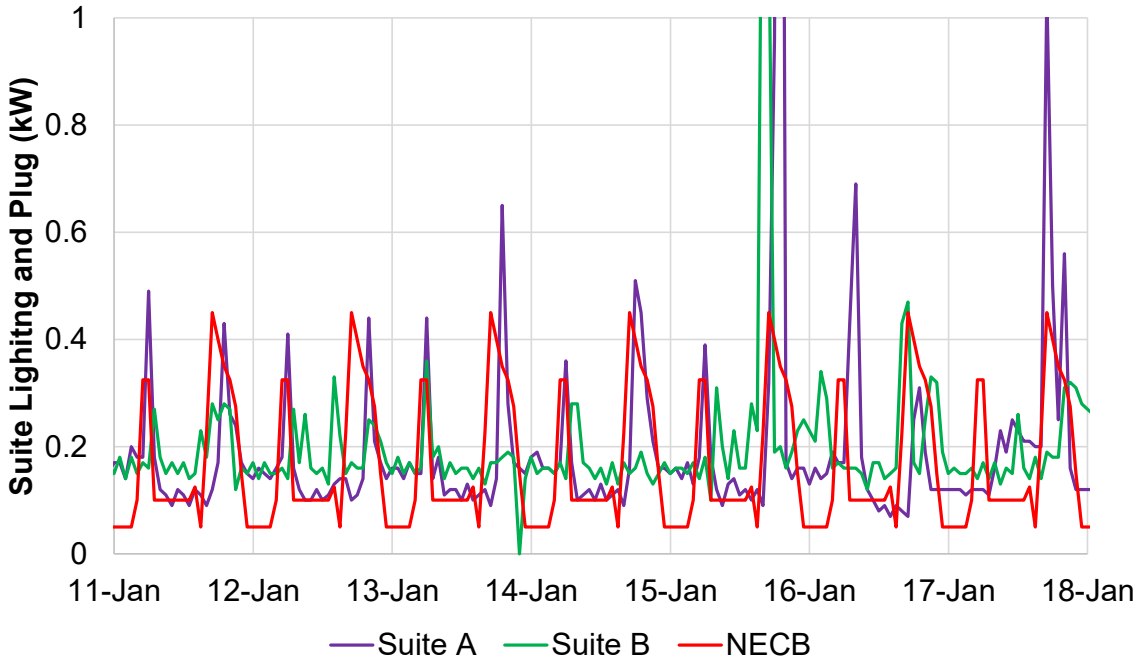
Source: 2018 Guide to Low Thermal Energy Demand for Large Buildings, BC Housing

TEDI – Infiltration

- Whole Building Air Leakage testing required
- Currently largely a data gathering initiative, to determine current industry performance.
- Higher levels of code, targets set assuming higher levels of air-tightness. Can be accounted for in energy modelling, especially if the design + construction teams have a plan to achieve an air-tight envelope

Energy Modelling Guidelines

- Some things still need to be standardized for fair comparison!
  - Plug loads, DHW loads, operating schedules – NECB Appendix A
  - Occupant behaviour
- Otherwise, models typically reflect the actual proposed design and operating intentions
  - Room temperature setpoints
  - Ventilation volumes (MURB Corr pressurization allowance in BC/VBBL)



Performance Code Outcomes – So Far

- Focus on the proposed design only, it's the only building that will be built
- GHGs are the problem, measure the problem
- GHGs typically tied to fossil fuel heating – TEDI and DHW load
- Lower TEDI still makes electric heat pumps more feasible, sizing and operation cost

- Can still work on:
  - Not suitable for all building types, high diversity in building uses, very high internal loads, other goals can outweigh energy performance
  - Building industry consensus and best practices around corridor pressurization practices, infiltration tied to HVAC system operation, hospital ventilation

Questions?

Ruth McClung, M.A.Sc., BEMP
Principal, BPA Practice Lead
Morrison Hershfield
rmcclung@morrisonhershfield.com

MORRISON HERSHFIELD