Natural Resources Canada | Ressources naturelles Canada

LEEP Windows

Energy, Carbon, HVAC, Thermal Comfort, and Cost

2025

Canada

Agenda

7:00-8:00	**Arrival and Breakfast**	
8:00-8:50	The Science of Good Window Design and Selection	SME
8:50-9:50	Window Selection Tools: Energy, Carbon, HVAC, Thermal Comfort Analysis and Cost	SME
9:50-10:05	**Break (15 min)**	
10:05-11:00	Design Detailing & Installation for Durability: New CSA A440	SME
11:00-11:40	VIDEO Spray Rack Test Results & Commentary	Video
11:40-12:00	Q&A, Wrap Up & Summary	
12:00-12:15	Survey	

The Science of Good Window Design and Selection

Subject Matter Expert

Window Selection Tools: Energy, Carbon, HVAC, Thermal Comfort Analysis and Cost

Subject Matter Expert

Overview

- Modelling Tools
- Case Study Archetype Home
- Energy Performance
- HVAC loads
- Carbon
- Comfort and Climate Adaptation
- Partner Challenge questions

Modelling Tools

Hot2000:

Energy modelling software

CBAT:

Cost Benefit Analysis Tool

HVAC Tools:

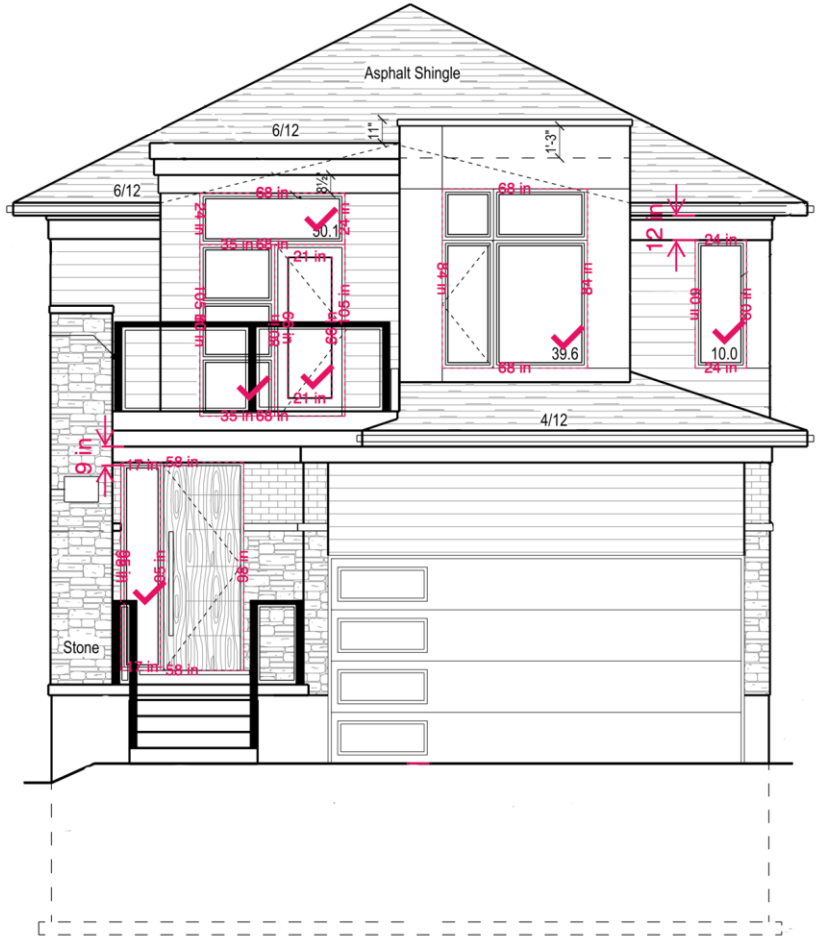
LEEP ASHP Sizing Tool

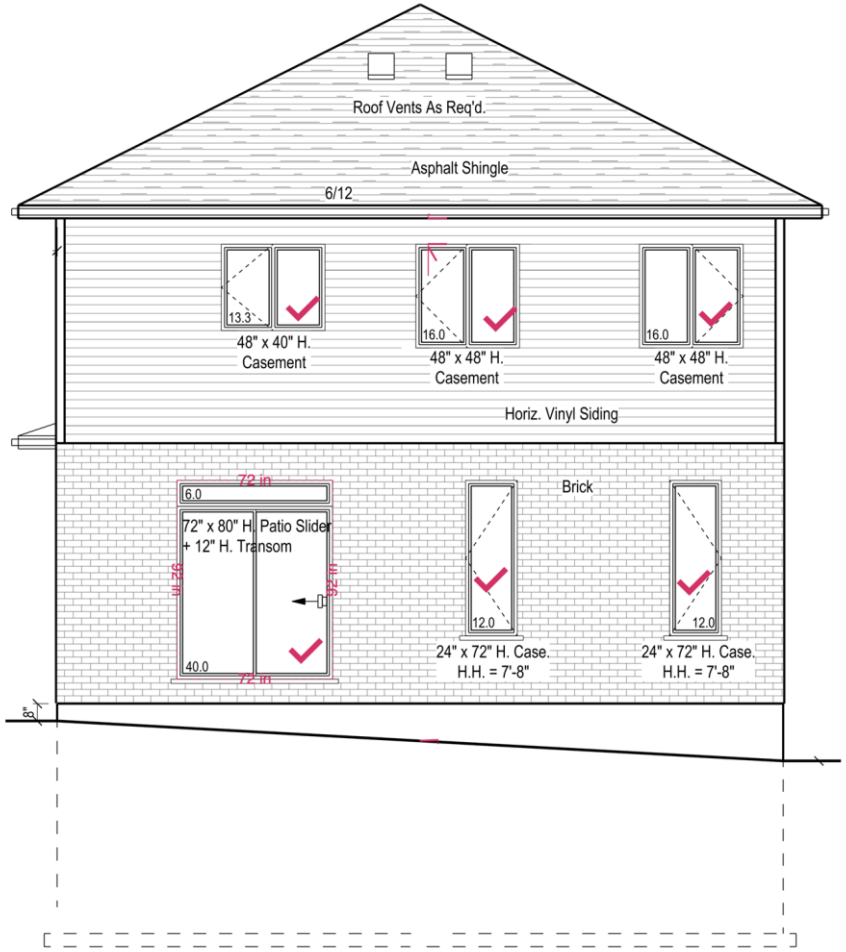
MCE2:

Material Carbon Estimator

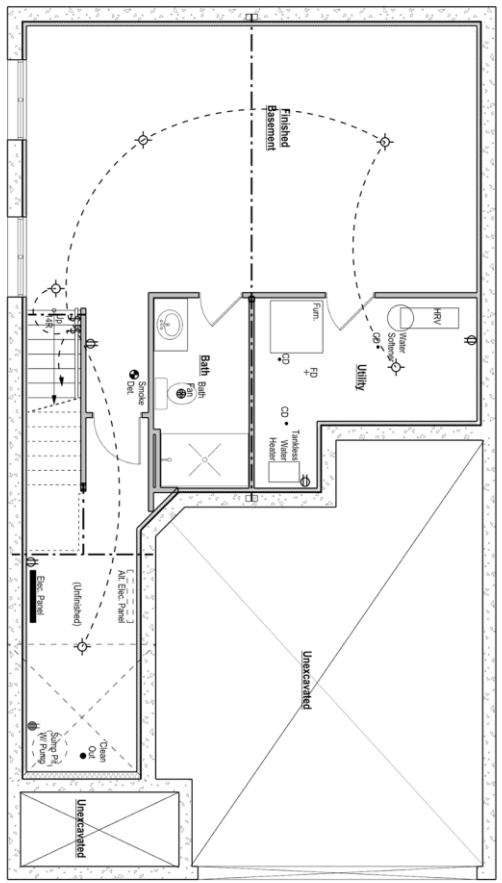
Archetype Home

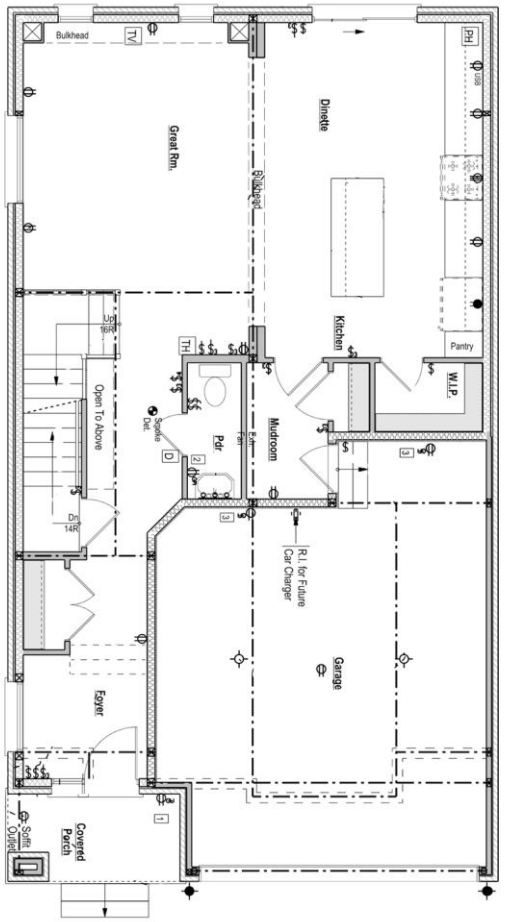
Archetype Home: 2-Storey, ~2700sf

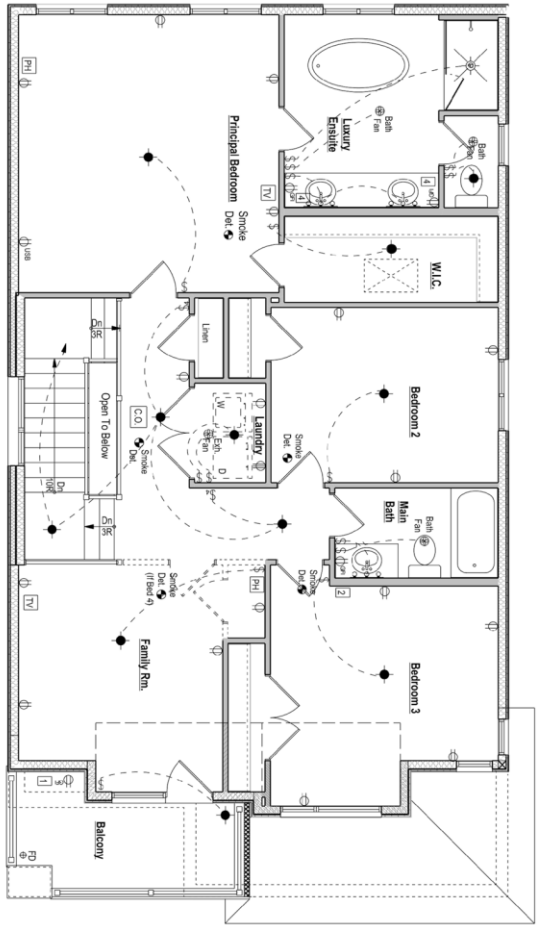




Archetype Home: 2-Storey, ~2700sf

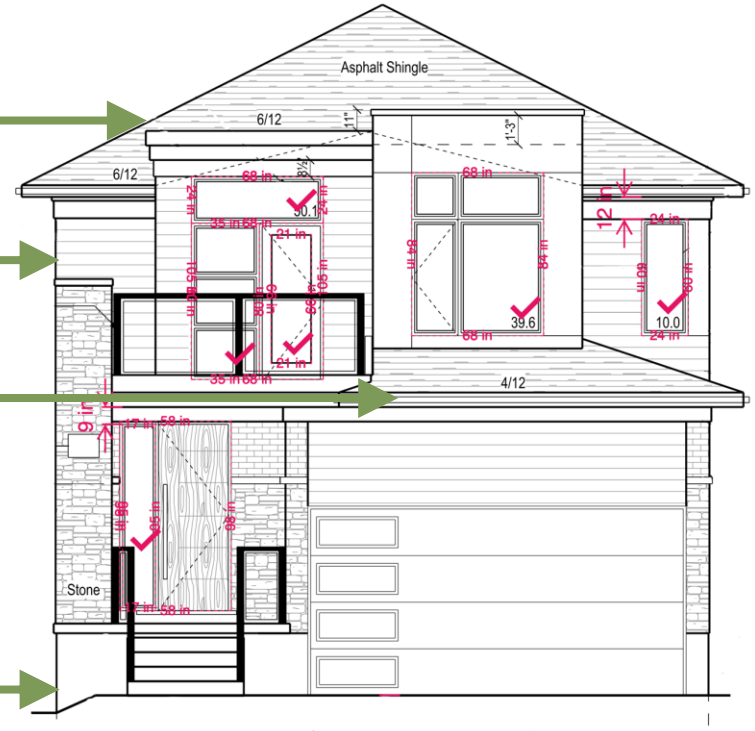






Reference House – NBC Zone 5

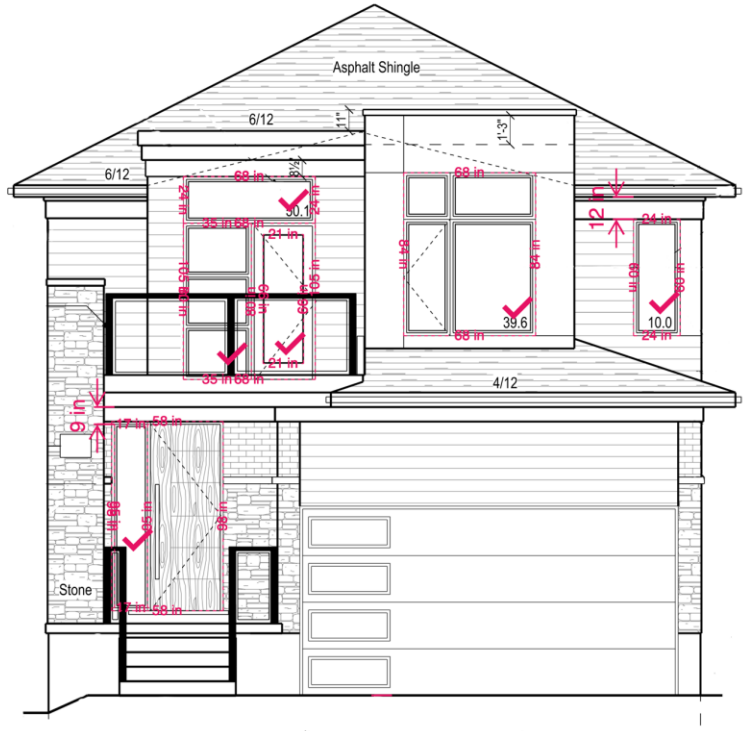
- Ceilings with Attic Space: R_{eff} = 49.2
- Above Grade Walls: R_{eff} = 17.5
- Exposed Floors: R_{eff} = 26.5
- Foundation Walls: R_{eff} = 16.9
- **Windows: 1.84 U-Value, ER 21, 0.26 SHGC**
- Air Tightness: 3.0 ACH @ 50 Pa



20% FDWR
Climate Zone 5 (London)

Reference House – NBC Zone 5

- Principle Ventilation: Exhaust Only
- Space Heating: 95% AFUE Gas Furnace + ECM
- Space Cooling: 14.5 SEER
- Domestic Water Heater: Gas Tank 0.67 EF
- No Drain Water Heat Recovery



20% FDWR
Climate Zone 5 (London)

Glass Orientation and FDWR*

***Fenestration and Door to Wall Ratio**

Front Glass Orientation – Total Energy

1. **North**

   114.3 GJ (lowest)

2. **East**

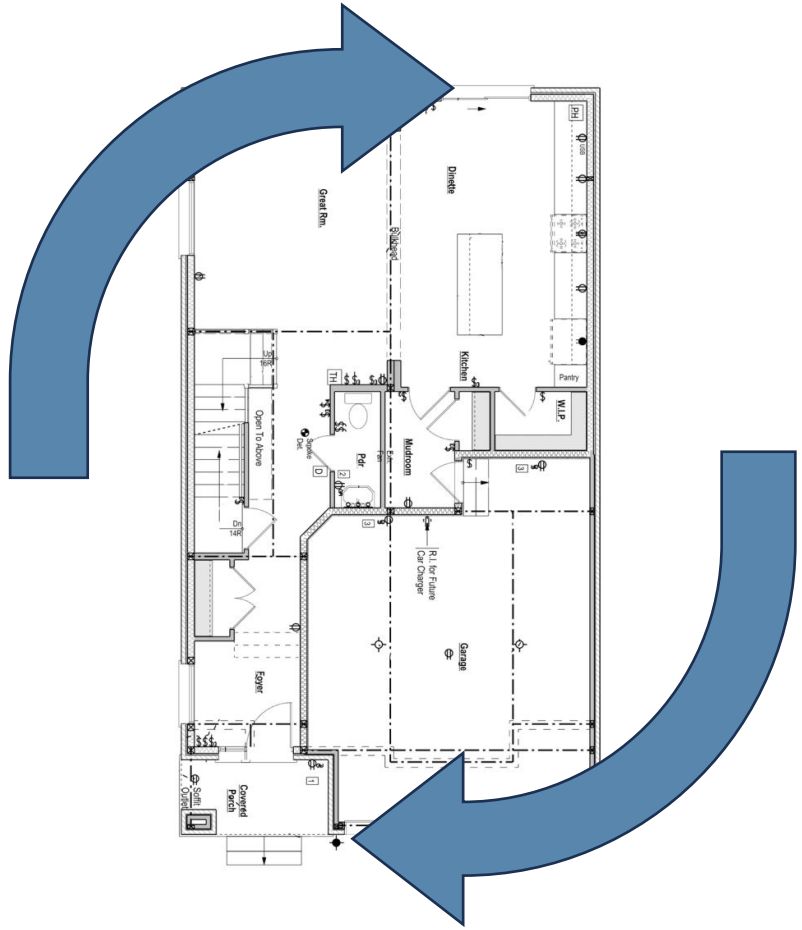
   115.1 GJ (0.7% More Energy)

3. **South**

   114.7 GJ (0.4% More Energy)

4. **West**

   115.8 GJ (1.3% More Energy)



Glass Orientation + FDWR Analysis (Zone 5 – London,ON)

Energy Consumption (GJ) for Each Orientation

Orientation	16% FDWR	20% FDWR	23% FDWR
North	110.9	114.3	64GJ (56%) Heating Energy and 5GJ (4%) Cooling
South	111.3	114.7	
West	112.5	115.8	
East	111.7	115.1	

* The maximum difference is 1.4%.

Conclusion: Window area has a much larger impact on energy consumption than orientation with this archetype.

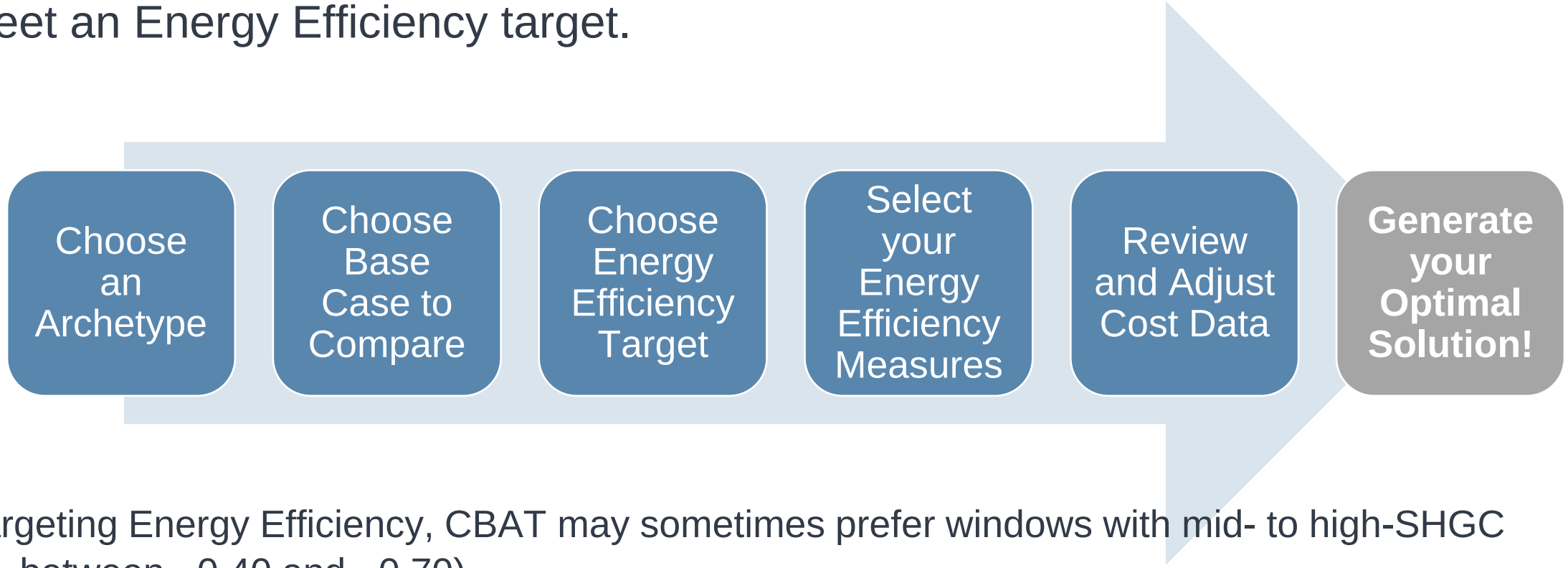
In colder climate zones with more sun, the FDWR would have more of an impact.

CBAT*

*Cost Benefit Analysis Tool

Cost Benefit Analysis Tool (CBAT) Overview

CBAT offers a good starting point to quickly assess suggested spec packages that meet an Energy Efficiency target.



Targeting Energy Efficiency, CBAT may sometimes prefer windows with mid- to high-SHGC (ie. between ~0.40 and ~0.70)

Cost Benefit Analysis Tool (CBAT): NBC Tiers 2-4

ECM	Tier 2	Tier 3	Tier 4
	NBC 9.36 Tier 2 - Capital Cost	NBC 9.36 Tier 3 - Capital Cost	NBC 9.36 Tier 4 - Capital Cost
Airtightness @ 50 Pa	2.5 ACH	1.5 ACH	1.5 ACH
Ceiling R-Value	R-40 Fiberglass Blow-in	R-40 Fiberglass Blow-in	R-40 Fiberglass Blow-in
Wall R-Value	R-22 Effective, Fiberglass Batt, Exterior Insulation	R-22 Effective, Fiberglass Batt, Exterior Insulation	R-22 Effective, Fiberglass Batt, Exterior Insulation
Window Type	Double Glazed, U=1.65, SHGC= 0.26, Vinyl Frame	Double Glazed, U=1.65, SHGC= 0.26, Vinyl Frame	Triple Glazed, U=1.08, SHGC= 0.26
Below Grade Wall R-Value	R-22 Effective, Fiberglass Batt, Exterior Insulation	R-22 Effective, Fiberglass Batt, Exterior Insulation	R-22 Effective, Fiberglass Batt, Exterior Insulation
Sub-Slab R-Value	Uninsulated Slab	Uninsulated Slab	Uninsulated Slab
HRV Efficiency	78% Efficiency HRV	78% Efficiency HRV	78% Efficiency HRV
DHW System	Electric Tank	Electric Tank	Electric Tank
Drainwater Heat Recovery	None	None	None
HVAC System	96% Natural Gas Furnace- 50,000 Btu, ECM Motor + AC - 2.5 ton, 14 SEER	Air Source Heat Pump, 3.66 COP	Air Source Heat Pump, 3.66 COP

ECM	Tier 2	Tie
	NBC 9.36 Tier 2 - Capital Cost	NBC 9.36 Tier 3
Airtightness @ 50 Pa	2.5 ACH	1.5 ACH
Ceiling R-Value	R-40 Fiberglass Blow-in	R-40 Fiberglass Blow-in
Wall R-Value	R-22 Effective, Fiberglass Batt, Exterior Insulation	R-22 Effective, Fiberglas Insulation
Window Type	Double Glazed, U=1.65, SHGC= 0.26, Vinyl Frame	Double Glazed, U=1.65, Frame
Below Grade Wall R-Value	R-22 Effective, Fiberglass Batt, Exterior Insulation	R-22 Effective, Fiberglas Insulation
Sub-Slab R-Value	Uninsulated Slab	Uninsulated Slab
HRV Efficiency	78% Efficiency HRV	78% Efficiency HRV
DHW System	Electric Tank	Electric Tank
Drainwater Heat Recovery	None	None
HVAC System	96% Natural Gas Furnace- 50,000 Btu, ECM Motor + AC - 2.5 ton, 14 SEER	Air Source Heat Pump, 3

	Tier 3	Tier 4
apital Cost	NBC 9.36 Tier 3 - Capital Cost	NBC 9.36 Tier 4 - Capital Cost
	1.5 ACH	1.5 ACH
	R-40 Fiberglass Blow-in	R-40 Fiberglass Blow-in
att, Exterior	R-22 Effective, Fiberglass Batt, Exterior Insulation	R-22 Effective, Fiberglass Batt, Exterior Insulation
GC= 0.26, Vinyl	Double Glazed, U=1.65, SHGC= 0.26, Vinyl Frame	Triple Glazed, U=1.08, SHGC= 0.26
att, Exterior	R-22 Effective, Fiberglass Batt, Exterior Insulation	R-22 Effective, Fiberglass Batt, Exterior Insulation
	Uninsulated Slab	Uninsulated Slab
	78% Efficiency HRV	78% Efficiency HRV
	Electric Tank	Electric Tank
	None	None
0,000 Btu, ECM ER	Air Source Heat Pump, 3.66 COP	Air Source Heat Pump, 3.66 COP

Volta Snap Tool

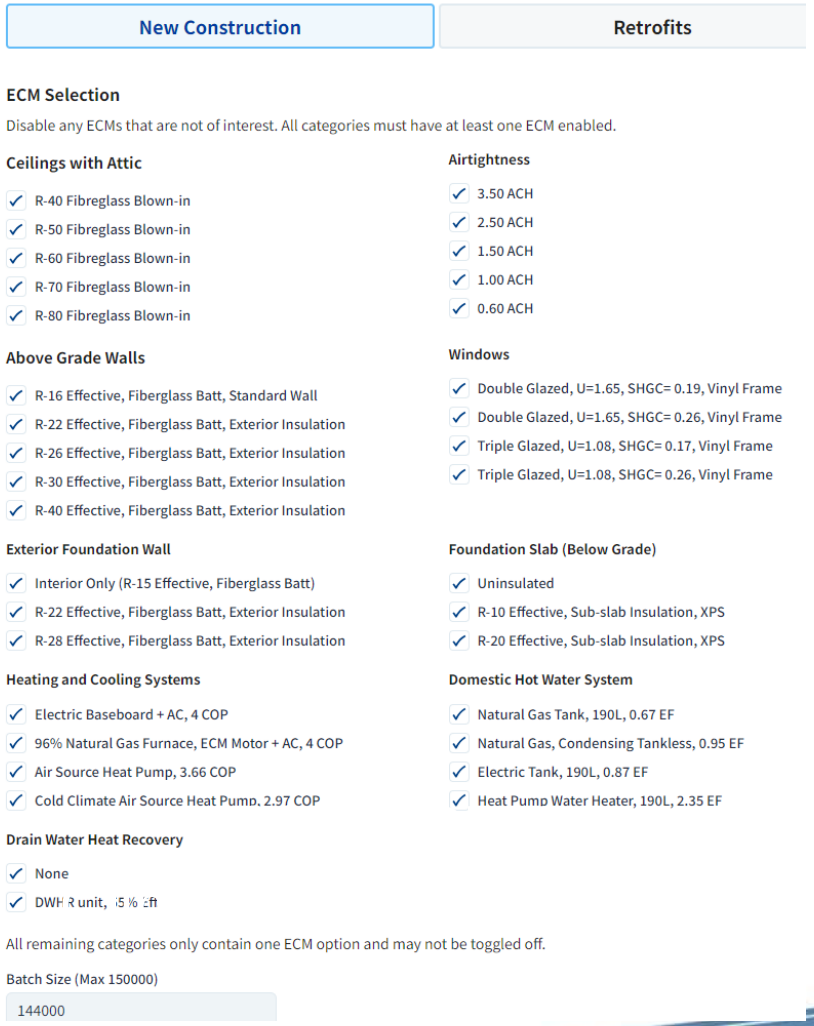
- A new user interface for Hot2000
- Additional features beyond Hot2000
- Easy for energy advisors to show packages (ie. SB12 A3, ENERGYSTAR, NetZero…)
- For new homes and retrofits

Upgrade Pathways Report **2024-04-16**

	House Components	Exisiting Home	Greener Homes Upgrades
ENVELOPE	**Ceiling with Attic Space**	*R31 batt*	R28 batt + (x2 layers)
	Cathedral / Vault / Flat	*None*	*None*
	Above Grade Walls / Garage Wall	*None*	3.5" medium density spray foam
	Exposed Floors	*None*	*None*
	Foundation Wall	*R0 (100%)*	R10 batt + R20 batt
	Under Basement Slab	*R0*	R10
	Windows & Sliding Glass Doors	*Single glazed (U-val=5.04, SHGC=0.60)*	Double glazed with 2 heat mirror 88s (U-val = 0.93, SHGC = 0.25)
	Doors	*Solid wood (R2.2)*	*Solid wood (R2.2)*
	Airtightness	*13.2 ACH*	10.6 ACH
HVAC	**Principle Ventilation**	*None*	*None*
	Space Heating	*77.0% AFUE furnace*	9.57 HSPF mini-split ductless air source heat pump, ENERGY STAR certified, baseboards backup
	Cooling & Heat Pumps	*13.00 SEER A/C*	21.50 SEER mini-split ductless air source heat pump, ENERGY STAR certified
DHW	**Domestic Water Heater**	*0.54 EF natural gas conventional tank*	3.5 EF heat pump water heater
	Drain Water Heat Recovery	*None*	None
	On-site Generation and Storage	*None*	5 kW Solar PV
	Bathroom Faucets	*None*	*None*

Volta Snap Tool – Parametric Analysis

- Can consider thousands of options in short order (ie. Parametric Analysis)
- Much easier than HTAP (Housing Technology Assessment Platform)
- Provides the inputs for costing with CBAT (Cost Benefit Analysis Tool)



Volta Snap Tool – Parametric Analysis

New Construction | Retrofits

ECM Selection

Disable any ECMs that are not of interest. All categories must have at least one ECM enabled.

Ceilings with Attic

- ✓ R-40 Fibreglass Blown-in
- ✓ R-50 Fibreglass Blown-in
- ✓ R-60 Fibreglass Blown-in
- ✓ R-70 Fibreglass Blown-in
- ✓ R-80 Fibreglass Blown-in

Above Grade Walls

- ✓ R-16 Effective, Fiberglass Batt, Standard Wall
- ✓ R-22 Effective, Fiberglass Batt, Exterior Insulation
- ✓ R-26 Effective, Fiberglass Batt, Exterior Insulation
- ✓ R-30 Effective, Fiberglass Batt, Exterior Insulation
- ✓ R-40 Effective, Fiberglass Batt, Exterior Insulation

Airtightness

- ✓ 3.50 ACH
- ✓ 2.50 ACH
- ✓ 1.50 ACH
- ✓ 1.00 ACH
- ✓ 0.60 ACH

Windows

- ✓ Double Glazed, U=1.65, SHGC= 0.19, Vinyl Frame
- ✓ Double Glazed, U=1.65, SHGC= 0.26, Vinyl Frame
- ✓ Triple Glazed, U=1.08, SHGC= 0.17, Vinyl Frame
- ✓ Triple Glazed, U=1.08, SHGC= 0.26, Vinyl Frame

Exterior Foundation Wall

- ✓ Interior Only (R-15 Effective, Fiberglass Batt)
- ✓ R-22 Effective, Fiberglass Batt, Exterior Insulation
- ✓ R-28 Effective, Fiberglass Batt, Exterior Insulation

Heating and Cooling Systems

- ✓ Electric Baseboard + AC, 4 COP
- ✓ 96% Natural Gas Furnace, ECM Motor + AC, 4 COP
- ✓ Air Source Heat Pump, 3.66 COP
- ✓ Cold Climate Air Source Heat Pump, 2.97 COP

Drain Water Heat Recovery

- ✓ None
- ✓ DWHR unit, 55% Eff.

Foundation Slab (Below Grade)

- ✓ Uninsulated
- ✓ R-10 Effective, Sub-slab Insulation, XPS
- ✓ R-20 Effective, Sub-slab Insulation, XPS

Domestic Hot Water System

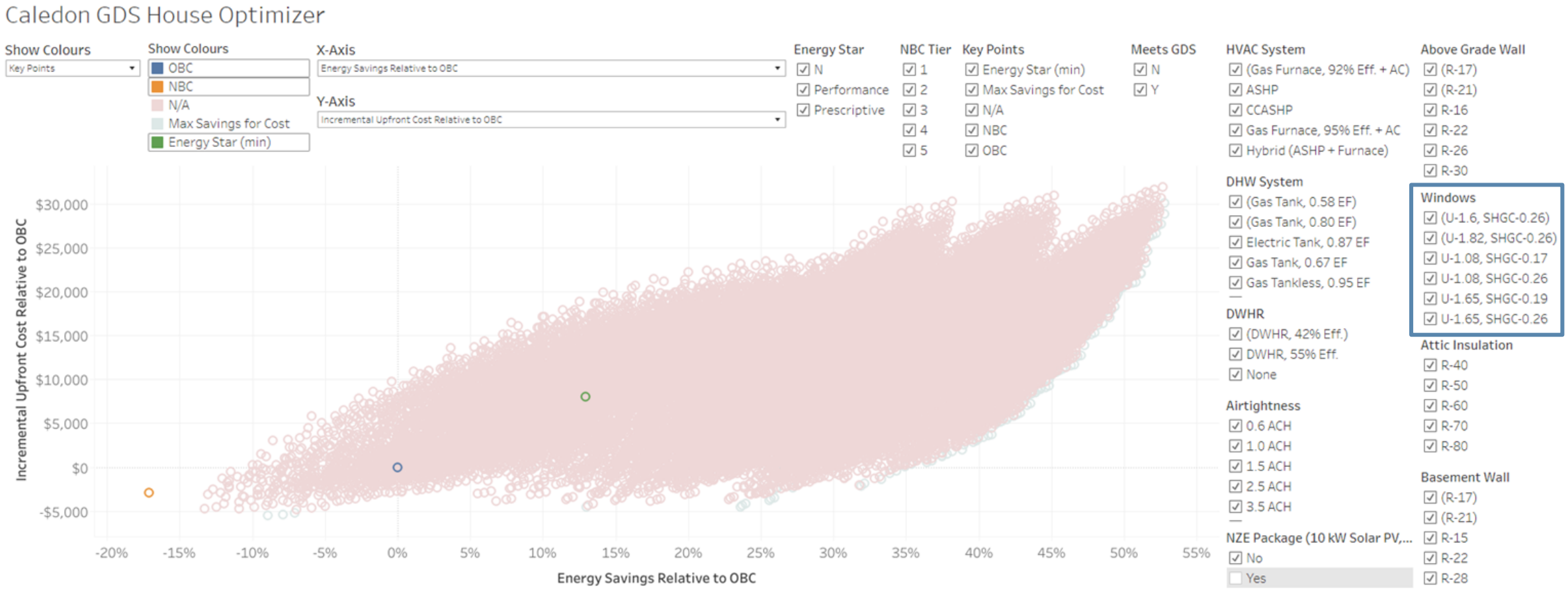
- ✓ Natural Gas Tank, 190L, 0.67 EF
- ✓ Natural Gas, Condensing Tankless, 0.95 EF
- ✓ Electric Tank, 190L, 0.87 EF
- ✓ Heat Pump Water Heater, 190L, 2.35 EF

All remaining categories only contain one ECM option and may not be toggled off.

Batch Size (Max 150000)

144000

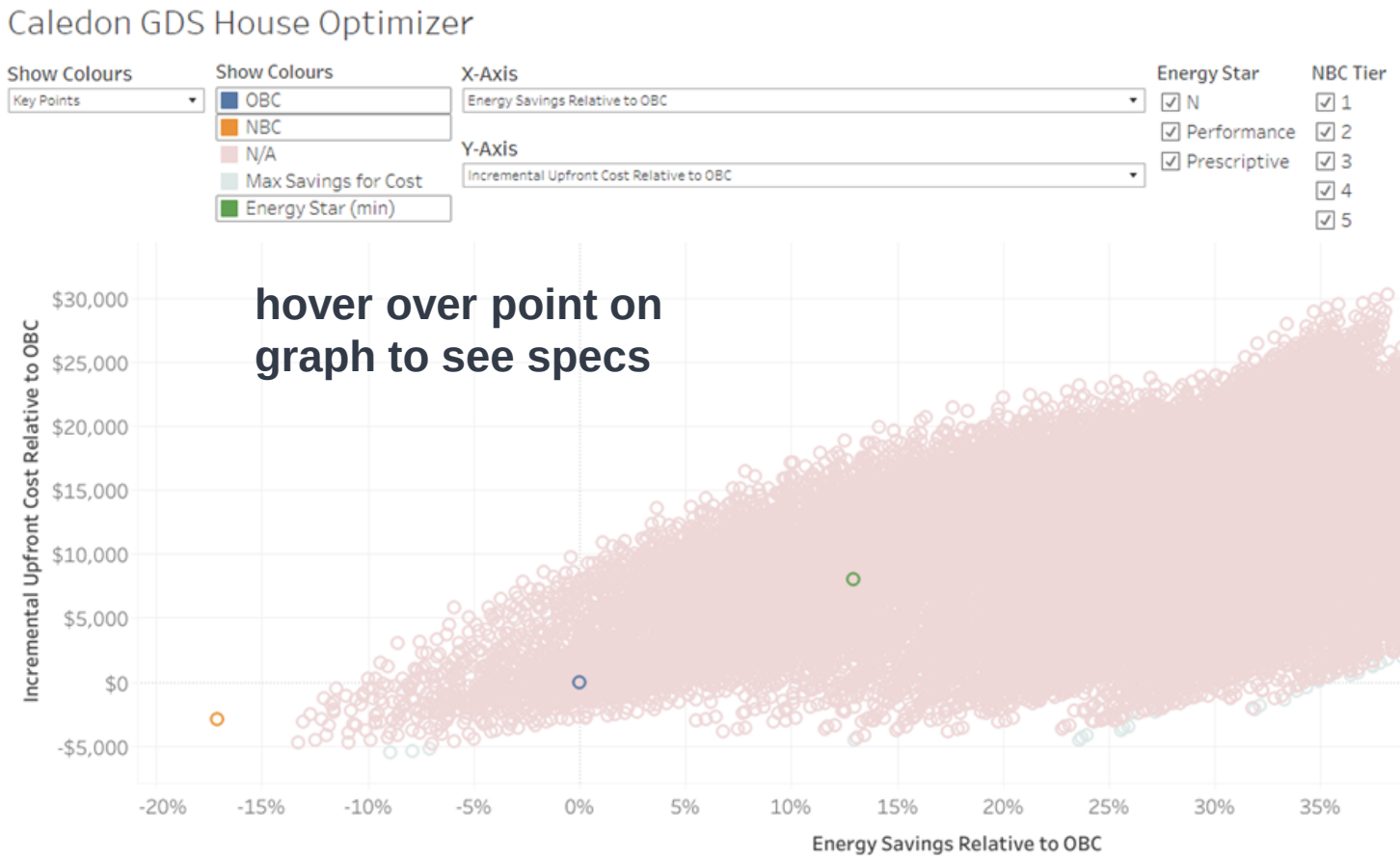
Tableau Dashboard for Window Comparison



Developed by the NRCan LEEP Team.

Disclaimer: Different house forms and modelling assumptions may produce different results than those displayed here.

Tableau Dashboard



Developed by the NRCan LEEP Team.

Disclaimer: Different house forms and modelling assumptions may produce different results than those

Heating and Cooling System:	Hybrid (ASHP + Furnace)
HRV:	HRV, 67% Eff.
DHW System:	Gas Tank, 0.67 EF
DWHR:	DWHR, 55% Eff.
Airtightness:	1.0 ACH
Above Grade Wall:	R-22
Windows:	U-1.65, SHGC-0.19
Attic Insulation:	R-70
Basement Wall:	R-22
NZE Package (10 kW Solar PV, All LED, HE Appliances):	No

Energy Star:	Performance
NBC Tier:	4
Qualifies for GDS:	N
Key Points:	N/A

GHG Savings Relative to OBC:	43.1%
Energy Savings Relative to OBC:	23.6%
Incremental Upfront Cost Relative to OBC:	$11,452
Annual Energy Cost:	$1,994

Annual GHG Emissions (kgCO2e):	1,788
GHGI (kgCO2e/m2/yr):	8.49
Electricity Consumption (kWh):	10,144
Gas Consumption (m3):	779
Total Energy Consumption (GJ):	65.50
Peak Heating Load (W):	6,338
TEDI (kWh/m2):	35.30

Energy Performance of Windows

Window Selection – Impact on Total Energy Consumption

Energy Consumption compared against the NBC Reference Case

	1.6 U-Value		**1.44** U-Value		**1.22** U-Value	
	0.40 SHGC	**0.19** SHGC	**0.40** SHGC	**0.19** SHGC	**0.40** SHGC	**0.19** SHGC
Energy Consumption (GJ)	105.3	114.2	102.5	109.4	98.8	105.6
% Energy Savings*	7.9% >	0.1%	10.3% >	4.3%	13.6% >	7.6%

* Relative to reference house

- **Lower U-Values** mean **lower** **Energy Consumption**
- **Lower SHGC** mean **higher** **Energy Consumption**

Energy Star Windows Searchable Product List

Energy Efficiency Ratings: Search

ENERGY STAR HIGH EFFICIENCY HAUTE EFFICACITÉ

Windows (Select a New Product)

Windows and doors are eligible for ENERGY STAR® based on their U-factor that measures their overall heat loss, or, their Energy Rating (ER) that combines their passive solar heat gain (SHGC) through the glass with their overall heat loss and air leakage. Models must have a U-factor of 1.22 W/m2 or lower, or, an ER of 34 or higher.

To find models that are the most efficient, select the ENERGY STAR Most Efficient checkbox in the "Energy Efficiency Criteria" section below. Models must have a U-factor of 1.05 W/m2 or lower, or, an ER of 40 or higher.

Caution is advised when selecting windows and sliding glass doors with passive solar heat gain (SHGC) values above 0.45 that will face south or west, especially if there is more glass area than exterior wall area (high window to wall ratio), as this could cause uncomfortably warm room temperatures and higher cooling costs.

Seeking advice from a qualified Energy Advisor can help ensure that you choose the right windows and doors to lower your energy bills and have optimal thermal comfort in all seasons.

Products contained on this list may be different from the Greener Homes program list.

Models: 210,677 **ENERGY STAR®:** 210,677

Energy Efficiency Criteria

ENERGY STAR Most Efficient 2020 - 2024: ☐

U-factor (W/m² - K):
Range: 0.57 to 1.98
Minimum: **Maximum:**

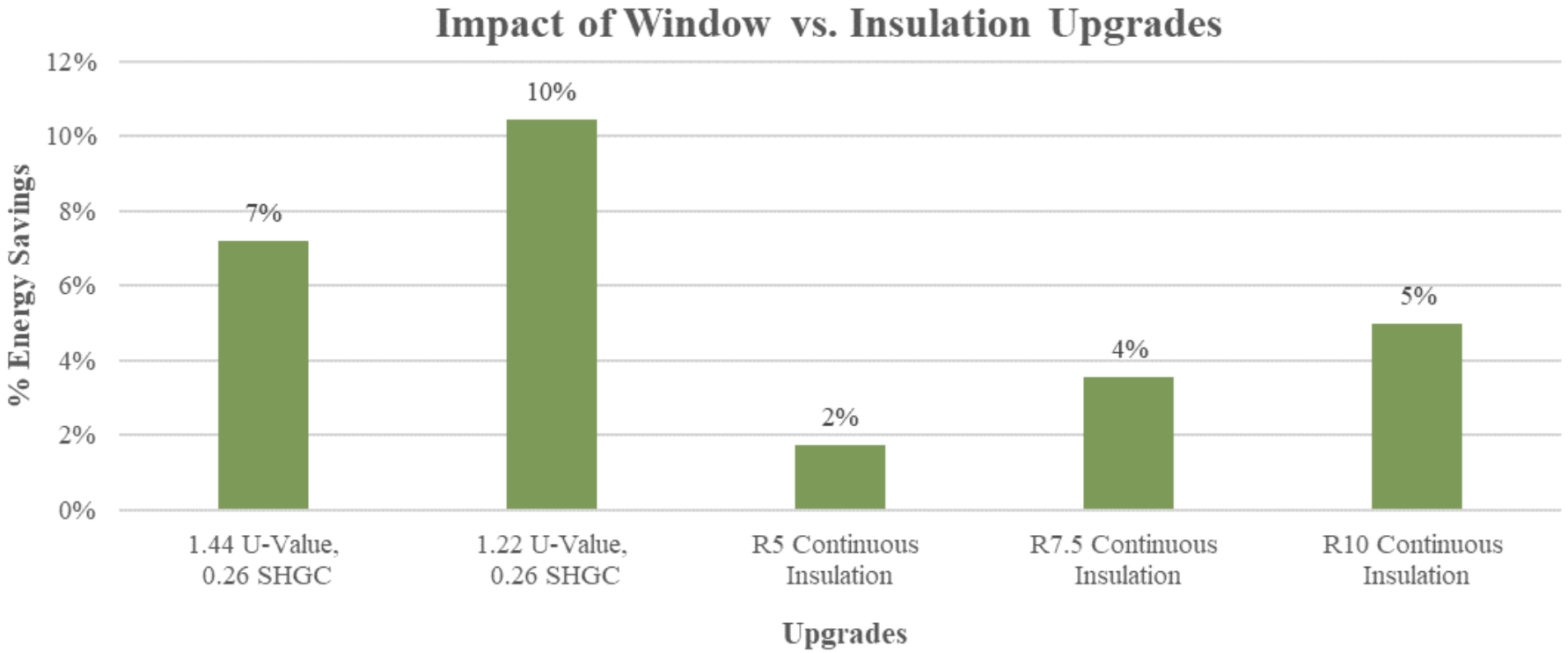
Solar Heat Gain (SHGC):
Range: 0 to 0.76
Minimum: **Maximum:**

Energy Rating:
Range: 16 to 53
Minimum: **Maximum:**

https://oee.nrcan.gc.ca/pml-lmp/index.cfm?action=app.search-recherche&appliance=WINDOWS

Impact of Window vs Insulation Upgrades

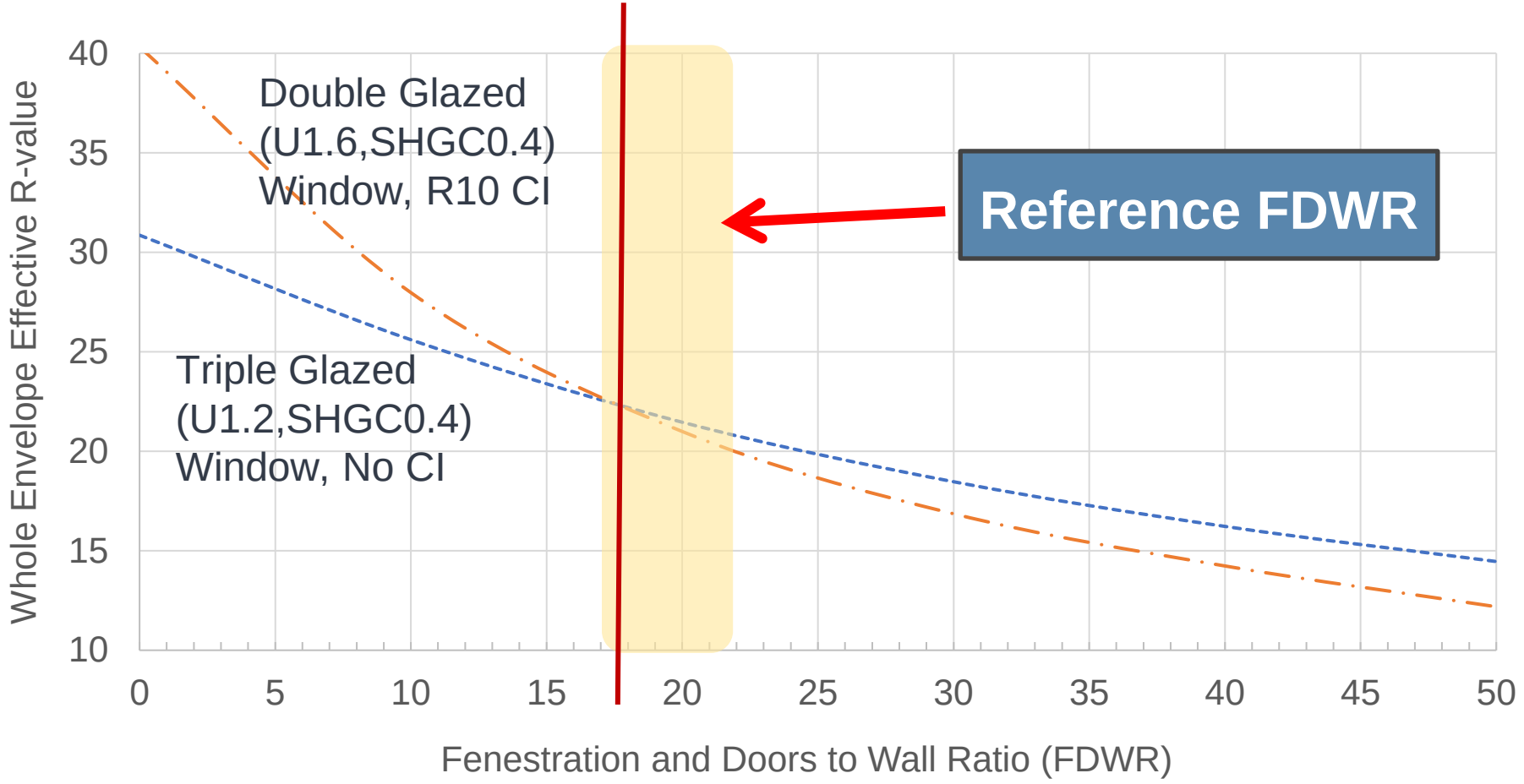
% Energy Savings for Each Upgrade Relative to Reference House



- For a home with a high FDWR (20%)
- Reference house window specifications: 1.84 U-Value

Whole Envelope Effective R-Value

Triple Glazing vs R10 CI Sheathing



SHGC and HVAC

Cooling Equipment Sizing – Impact of SHGC

CSA F280-12 Design Heat Loss Heat Gain (btu/h) for Various U-Values & SHGC

CSA F280-12 Design Loads	1.6 U-Value		1.44 U-Value		1.22 U-Value	
	0.40 SHGC	0.19 SHGC	0.40 SHGC	0.19 SHGC	0.40 SHGC	0.19 SHGC
Heat Loss (btu/h)	39,544	39,899	38,348	38,052	36,701	36,555
Heat Gain (btu/h)	30,185	> 20,653	29,952	> 20,293	29,631	> 20,001

- **Lower U-Values** mean **lower Heat Loss** (ie. Heating demand)
- **Lower SHGC** mean **lower Heat Gain** (ie. Cooling demand)

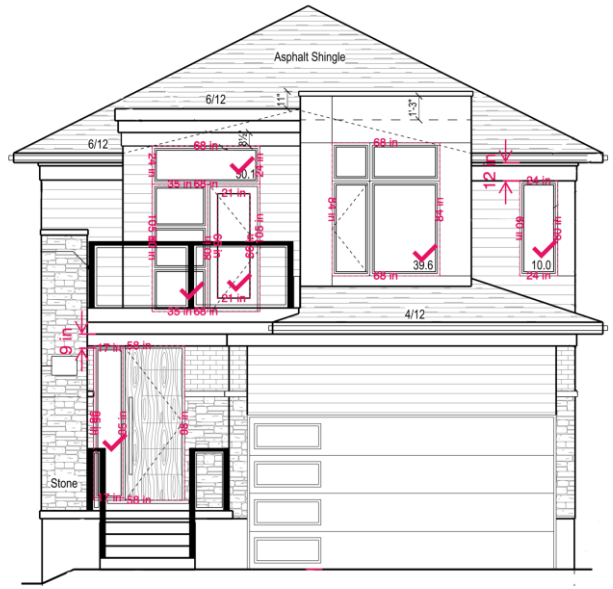
Impact of Solar Heat Gain – Cooling Load

Early decision to limit windows to low solar gain helps control cooling loads

U 1.6 Low Gain

0.19 SHGC

20,653 btu/h



U1.6 Mid Gain

0.4 SHGC

30,185 btu/h

Almost 1 ton of cooling load difference!

Impact on Cooling and Duct Sizing

Base (Typical) Window
(U1.6, ER 25, SHGC~0.45)

Design Heat Loss = 41,821 BTU/hr
Design Heat Gain = 44,382 BTU/hr

Duct Size: 28x10

4 Ton ASHP / AC

High Performance Window Product
(U0.9, SHGC 0.20)

Design Heat Loss = 34,791 BTU/hr
Design Heat Gain = 25,561 BTU/hr

Duct Size: 24x8

2.5 Ton ASHP / AC

Carbon Emissions

Operational Carbon Emissions

Annual Operational Carbon Emissions (tonnes CO_2e/yr) for Various U-Values

Code Window 1.84 U-Value, 0.26 SHGC	1.6 U-Value, 0.4 SHGC	1.44 U-Value, 0.4 SHGC	1.22 U-Value, 0.4 SHGC
4.6	4.0	3.9	3.7

Double Glazed

Triple Glazed

Upfront Embodied Carbon Emissions

54.9 m² Window Area and 20% FDWR

Impact of frame material selection

Frame Material	Vinyl	Wood	
Embodied Carbon (Tonnes CO_2e)	4.72	3.95	-16.3%

Upfront Embodied Carbon Emissions

- Frame material does not define energy performance
  - Data from manufacturer is required
  - Choice also impacts aesthetics and cost

Upfront Embodied Carbon Emissions

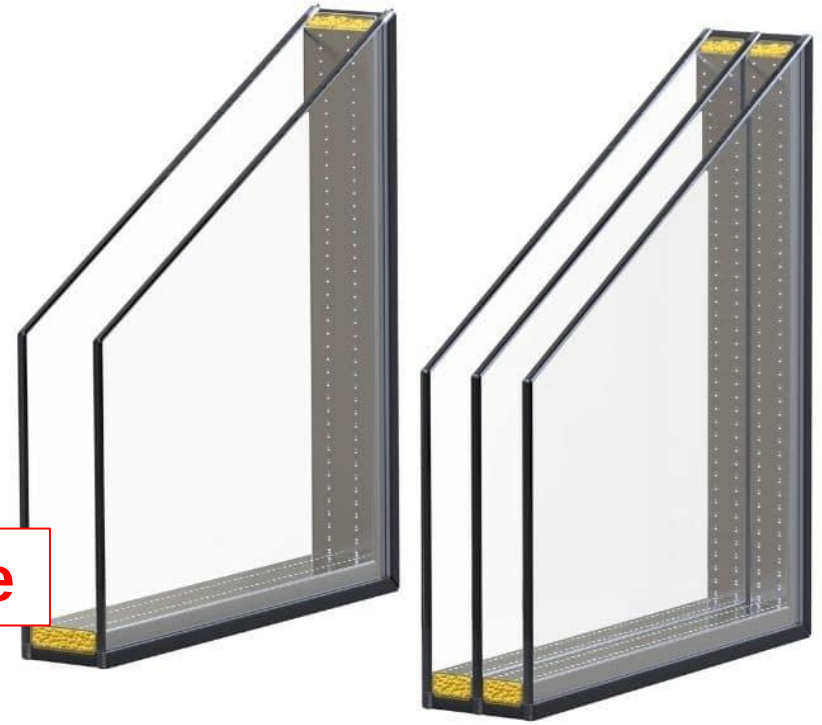
54.9 m^2 Window Area and 20% FDWR

Impact of glazing selection

Glazing (Vinyl Frame)	Double	Triple
Embodied Carbon (Tonnes CO_2e)	4.72	5.43

+15%

+0.71 tCO_2e

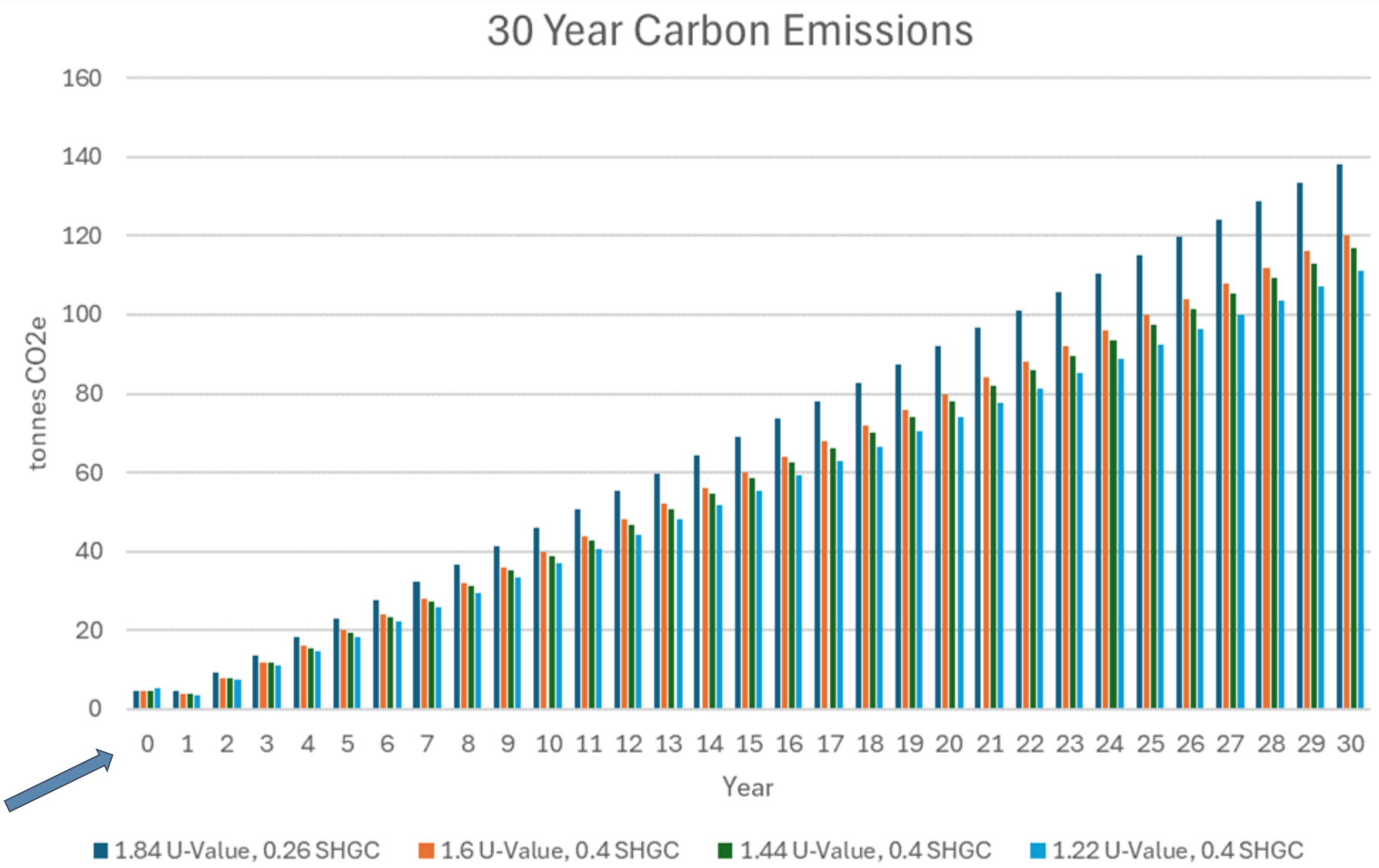


Carbon ROI: Operational vs Embodied

54.9 m^2 Window Area and 20% FDWR

Window Type	Embodied tCO_2e	Operational tCO_2e
Double glazed vinyl (U 1.61, 0.26 SHGC)	4.72	4.6
	+0.71 tCO_2e	-0.9 tCO_2e/yr
Triple glazed vinyl (U 1.22, 0.4 SHGC)	5.43	3.7

<1 year "return" on carbon investment



Year 0: Embodied carbon emissions of windows

Comfort

Comfort

- **Choice of windows can greatly impact the perceived comfort in the home.**

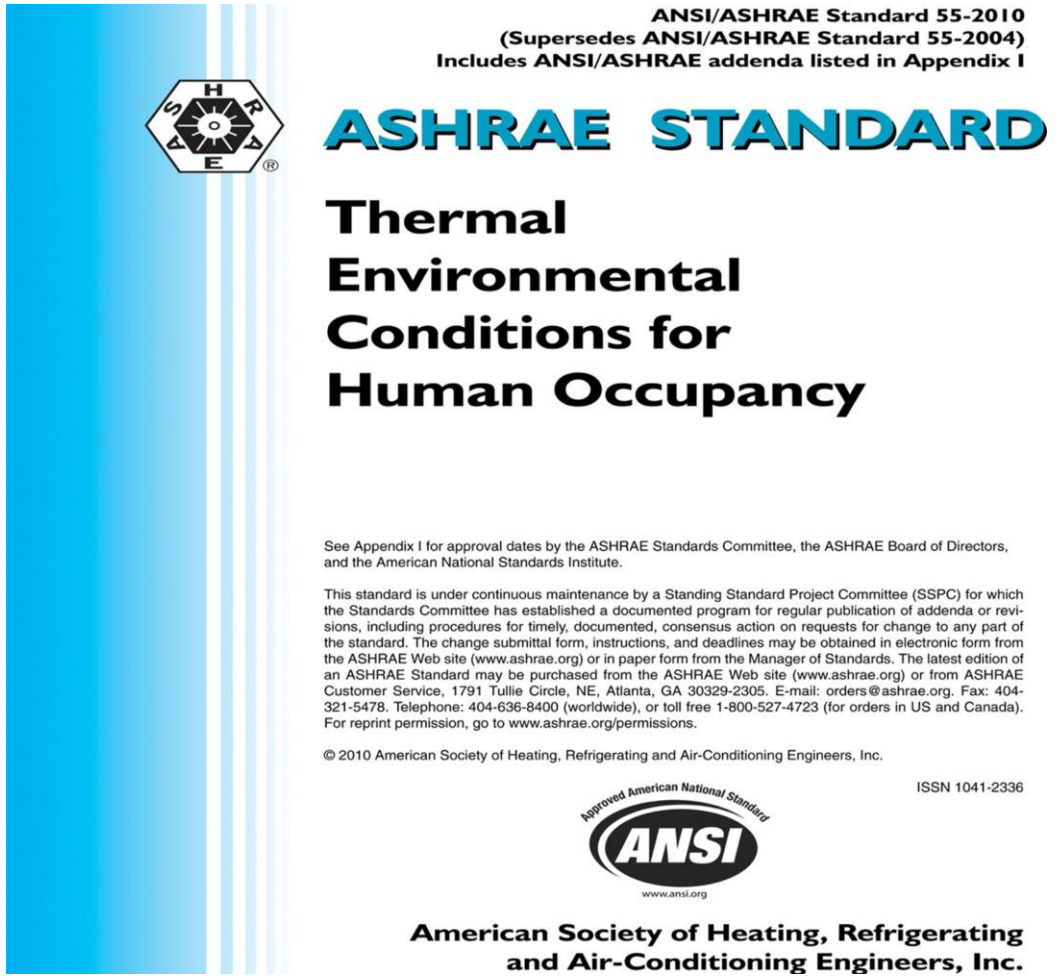
- **High U-value (lower energy performance) can make for more heat loss and discomfort in the winter**
  - Radiant heat loss causes the heat transfer from the occupant's skin to the cold surface, ‘pulling’ the heat away faster as you get closer to the surface

- **High SHGC allows much more heat from the sun through**
  - Causes overheating of surfaces
  - Combined with lots of insulation = Overheating in rooms/areas with lots of windows

Comfort ASHRAE 55

Let's Start with Defining Comfort

- Air temperature
- Humidity
- Air speed
- Surrounding surface temperature
- Gender, age
- Metabolic rate % clothing

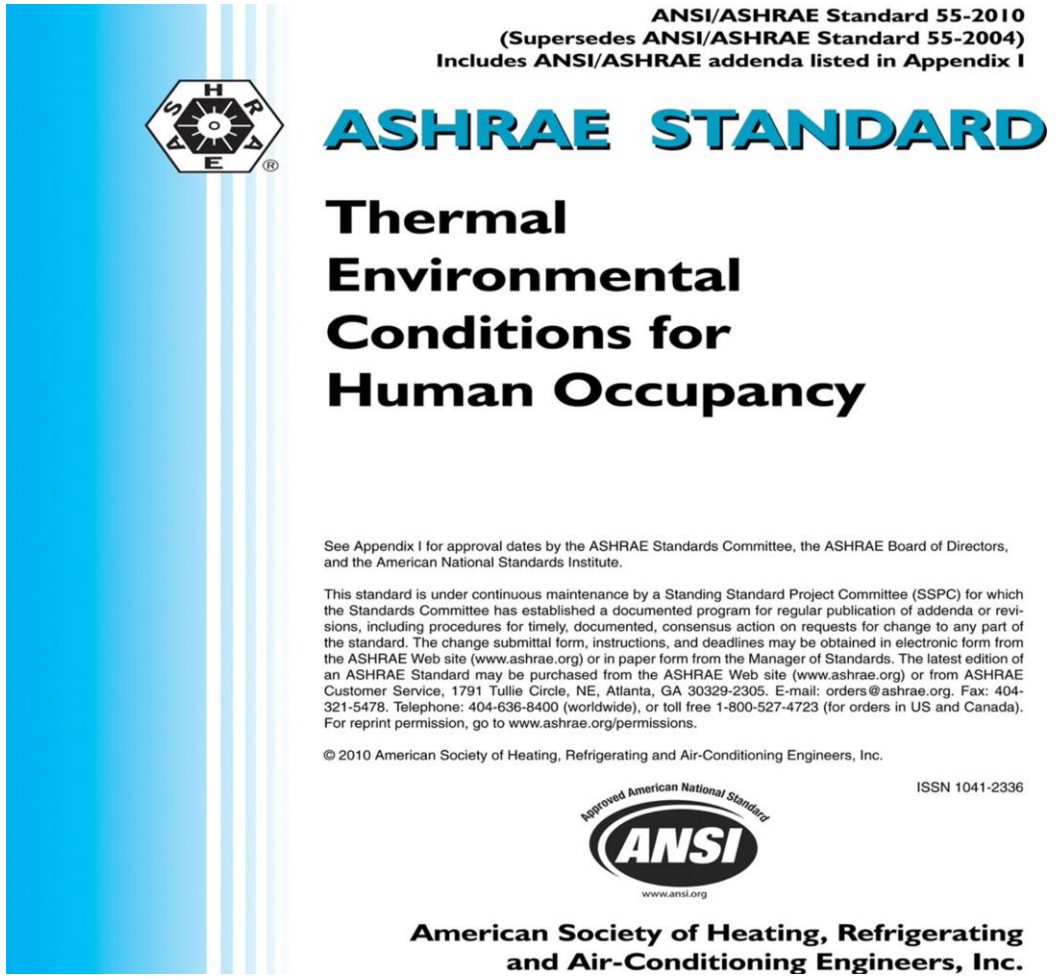


Comfort ASHRAE 55

Comfort Variables

The human body transfers energy (heat) by:

- 15% humidity / perspiration
- 35% convection / conduction to air
- 50% radiation to surrounding surfaces



ANSI/ASHRAE Standard 55-2010
(Supersedes ANSI/ASHRAE Standard 55-2004)
Includes ANSI/ASHRAE addenda listed in Appendix I

ASHRAE STANDARD

Thermal Environmental Conditions for Human Occupancy

See Appendix I for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, and the American National Standards Institute.

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Thermal Comfort & Window Ratings

ASHRAE 55 and Windows Zone 5-6

- 1m from glass, patio door
- Winter: Acceptable room side glass/wall surface threshold temp= 57F or 14C
- Summer: Discomfort from any hour/elevation with solar gain greater than 70 btu/hr·ft²·°F

Single, metal frame

- Winter: 3000+ hrs of discomfort
- Summer: 300+ hrs of discomfort

Double 1.4 -1.6U, insulated, SHGC 0.55

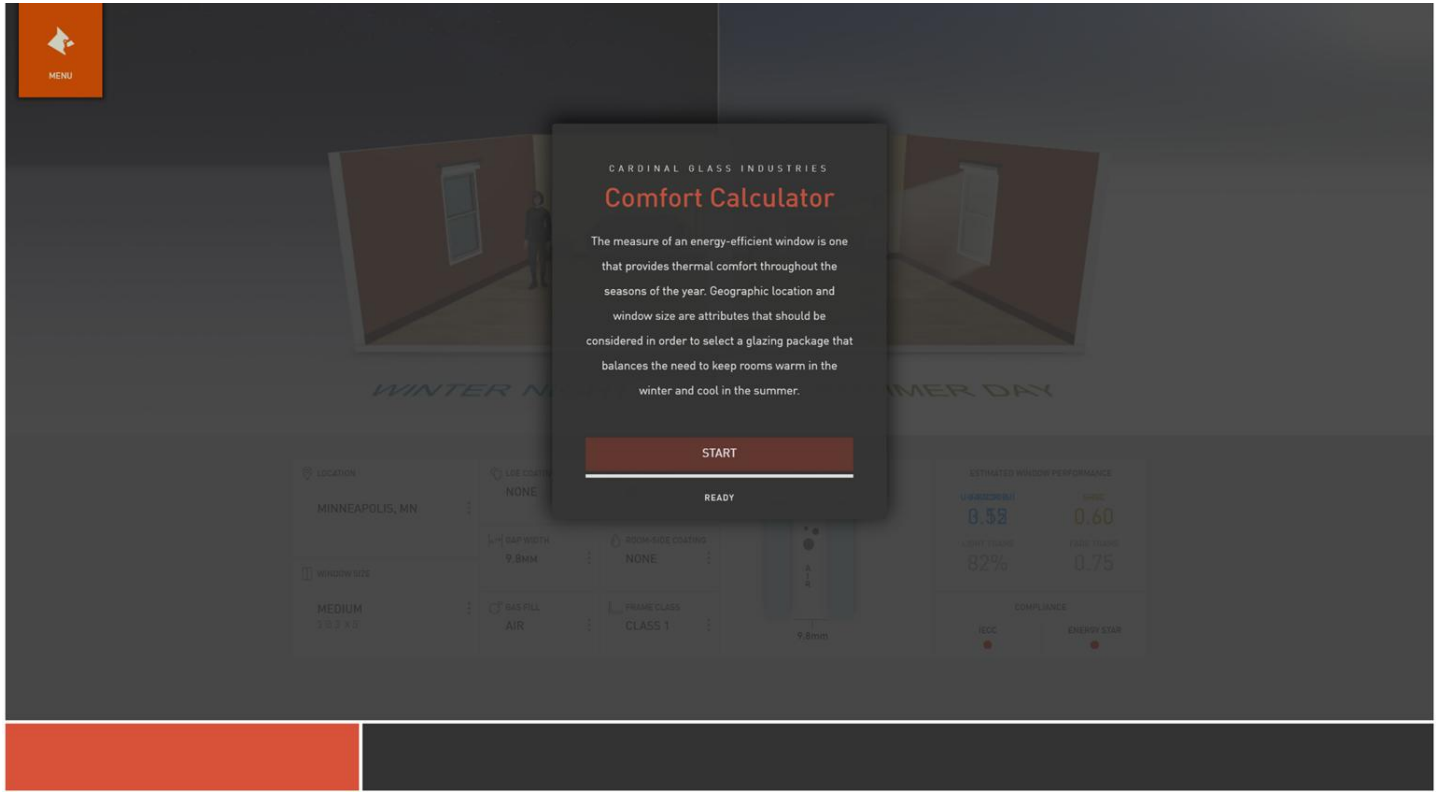
- Winter: 500+ hrs of discomfort
- Summer: 75+ hrs of discomfort

Triple 1.2>U, insulated, SHGC 0.22

- Winter: negligible
- Summer: negligible

Thermal Comfort & Window Ratings

Cardinal Glass Industries "Comfort Calculator"



www.cardinalcorp.com/technology/applications/comfort-calculator/

Comfort Demo – Winter with Code Windows

LOCATION LONDON, ON	LOĒ COATING E180	GLASS TYPE 2P
	GAP WIDTH 13.0MM	ROOM-SIDE COATING NONE
WINDOW SIZE LARGE 4 @ 3' X 5.8'	GAS FILL ARGON	FRAME CLASS CLASS 1

VISUAL SCENARIO

ESTIMATED WINDOW PERFORMANCE

U-FACTOR (SI)	SHGC
1.86	0.52
LIGHT TRANS	FADE TRANS
79%	0.63

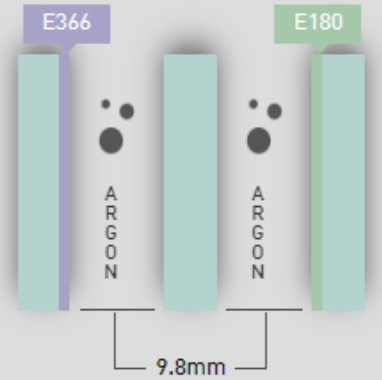
COMPLIANCE

CANADA MODEL	ENERGY STAR
●	●

Comfort Demo – Winter with Code Triples

LOCATION LONDON, ON	LOĒ COATING E366	GLASS TYPE 3P - 2E
	GAP WIDTH 9.8MM	ROOM-SIDE COATING NONE
WINDOW SIZE LARGE 4 ft 3" X 5.8"	GAS FILL ARGON	FRAME CLASS CLASS 3

VISUAL SCENARIO



ESTIMATED WINDOW PERFORMANCE

U-FACTOR (SI)	SHGC
1.18	0.19
LIGHT TRANS	FADE TRANS
57%	0.36

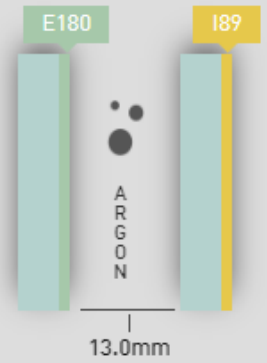
COMPLIANCE

CANADA MODEL	ENERGY STAR
●	●

Comfort Demo – Summer with High SHGC

LOCATION KELOWNA, BC	LOĒ COATING E180	GLASS TYPE 2P
	GAP WIDTH 13.0MM	ROOM-SIDE COATING I89
WINDOW SIZE LARGE 4 @ 3' X 5.8'	GAS FILL ARGON	FRAME CLASS CLASS 1

VISUAL SCENARIO



ESTIMATED WINDOW PERFORMANCE

U-FACTOR (SI)	SHGC
1.66	0.47
LIGHT TRANS	FADE TRANS
77%	0.61

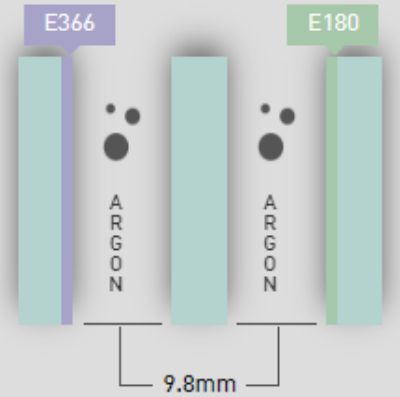
COMPLIANCE

CANADA MODEL	ENERGY STAR
●	●

Comfort Demo – Summer with Low SHGC

LOCATION KELOWNA, BC	LOĒ COATING E366	GLASS TYPE 3P - 2E
	GAP WIDTH 9.8MM	ROOM-SIDE COATING NONE
WINDOW SIZE LARGE 4 @ 3' X 5.8'	GAS FILL ARGON	FRAME CLASS CLASS 3

VISUAL SCENARIO



ESTIMATED WINDOW PERFORMANCE

U-FACTOR (SI)	SHGC
1.18	0.19
LIGHT TRANS	FADE TRANS
57%	0.36

COMPLIANCE

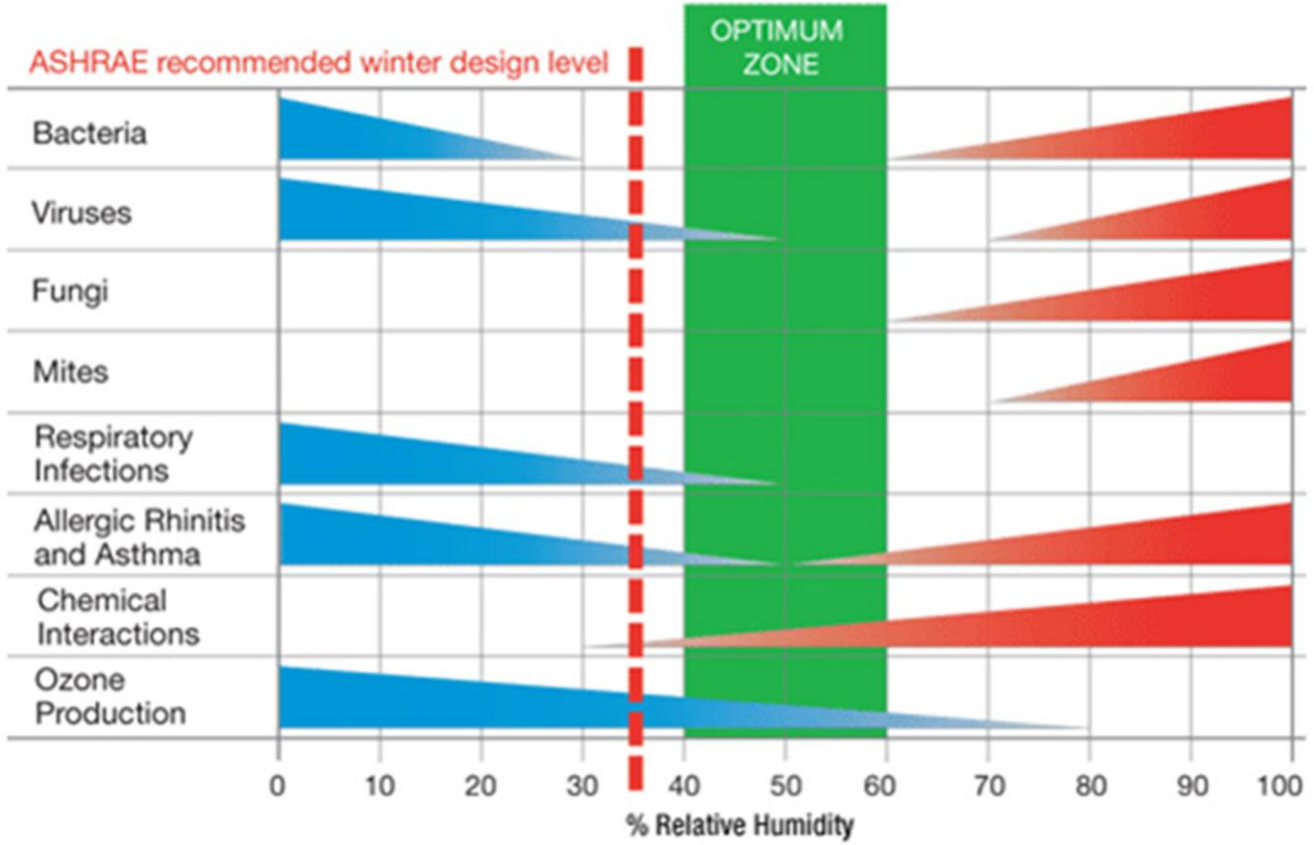
CANADA MODEL	ENERGY STAR
●	●

Windows & Humidity Optimization

Healthy Interior Humidity

- Summer 45% RH +-5%
- Winter 35% RH +-5%

Condensation resistance of window in cold climates ?

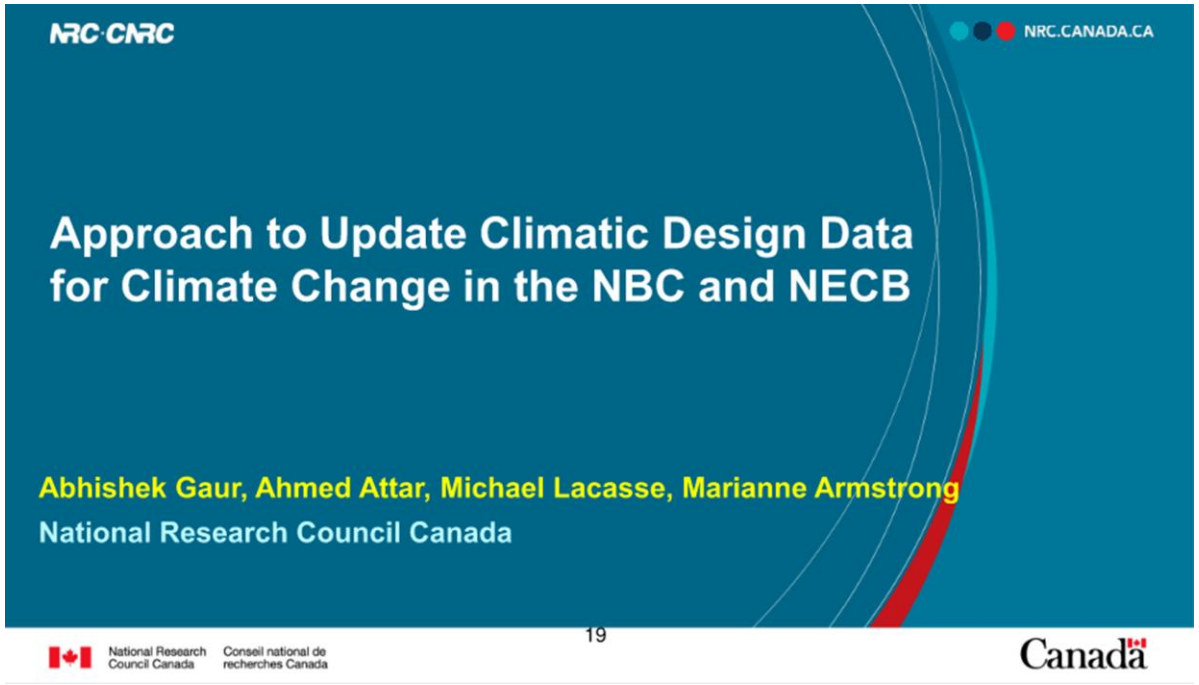


Climate Adaptation & Windows

Changes to

- Driving Rain Wind Pressures 1/5
- Moisture Index
- 1 Day Rain (1/50): 15 minute
- Heating degree Days
- January Design Temps 1%/2.5%

"Approach to Update Climatic Design Data for climate change in the NBC and NECB " National Research Council 2023



Climate Adaptation & Windows

Potential Design Implications

- CSA A440.4/.6 updates e.g. height of back dam
- Required use of Capillary break between 1st and 2nd plane of protection (increased drainage space depth and coverage)
- Reduce window / glazing Solar Heat Gain SHG through use of additional LowE coating and/or exterior shading devices
- Mechanical systems that provide life-safety cooling (AC/ASHP) of both sensible and latent (dehumidification) loads

"Approach to Update Climatic Design Data for climate change in the NBC and NECB " National Research Council 2023

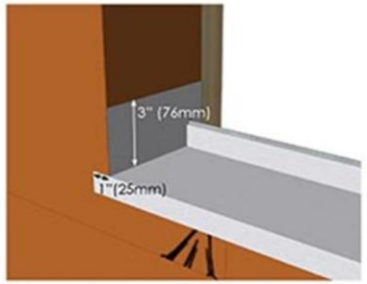
Driving rain wind pressure Increases in future projected values

CSA A440.4 Window, Door, And Skylight Installation

CSA A440.6 High Exposure Fenestration Installation

- Consideration of height of back dam of flashing in wall assembly

Option 1: Sill Flashing with Back Dam Angle



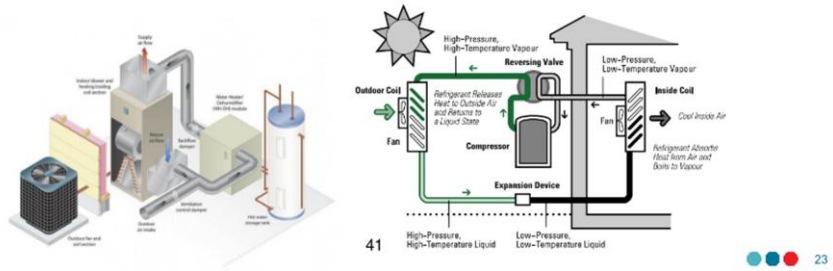
Increases in future projected values of July design temperatures

Increased occurrence of overheating events – extreme heat events

Extreme heat: Temperature of ≥ 30°C & humidex ≥ 40 | Extreme heat event: > 4 days

To alleviate risk of overheating in buildings consideration given to use of:

- **Larger capacity cooling & dehumidifying systems; e.g. heat pump + dehumidifier**

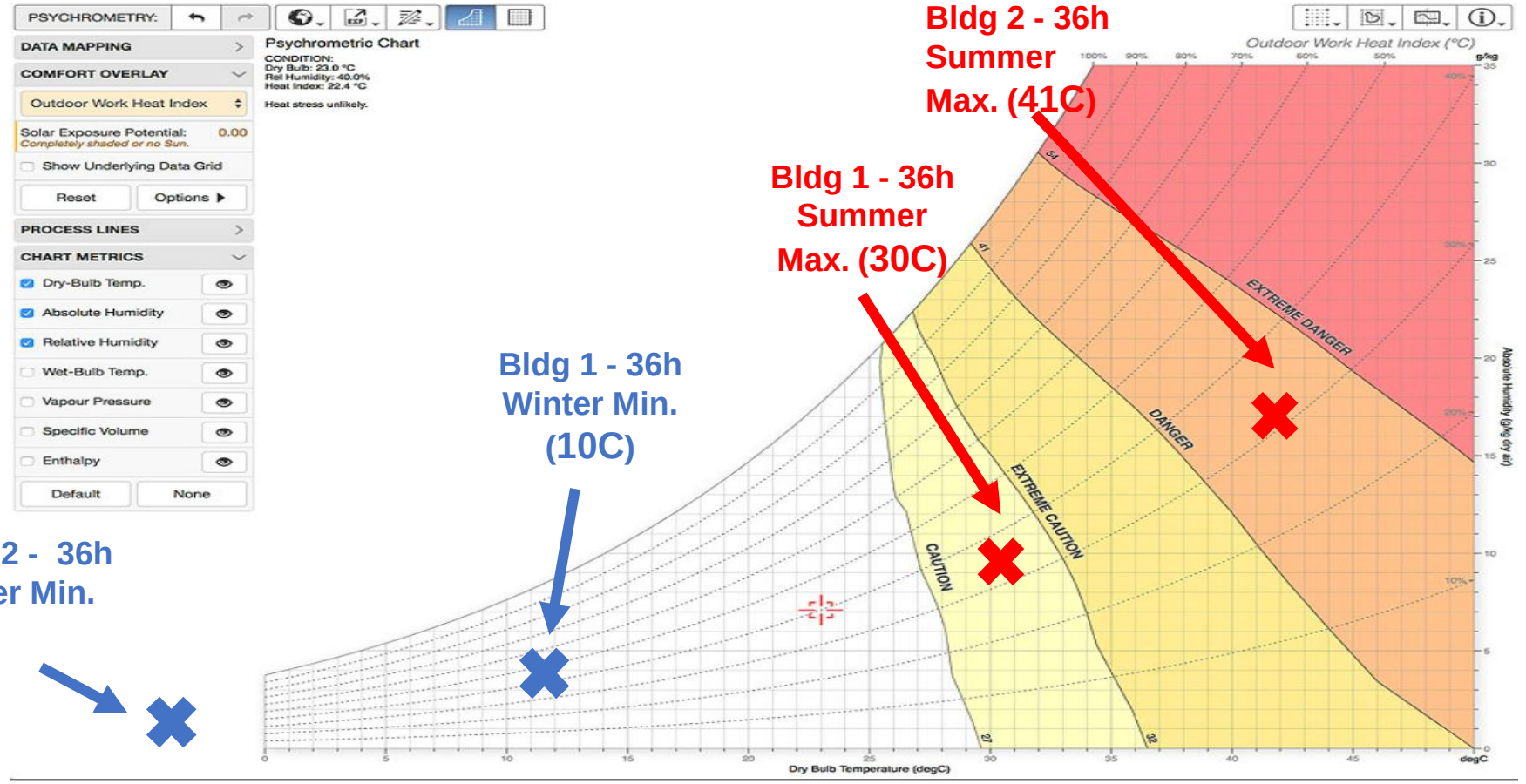


Climate Adaptation

- All of these strategies we've been discussing will help us to adapt our buildings to more extreme weather
  - Better enclosures including windows to keep the heat in/out
  - Low solar heat gain windows to keep the heat out
- We may have to think about more strategies to maximize the **passive survivability***
  - Overhangs
  - Operable windows
  - Passive ventilation
- Performance simulations to determine 'hours of safety'

Passive Survivability: A buildings ability to maintain critical, life support systems and interior conditions wherein occupants can survive during operational power outages that coincide with extreme temperature conditions e.g. heat "dome".

Difference in Building Design and Climate



Window Selection for Homes

SCENARIO: Window selection for 2 storey 2700 ft2 home with 20% FDWR in climate Zone 5

1. Performance

Building Code

- ❑ WWR
- ❑ U value or ER Occupant Comfort
- ❑ Orientation / WWR
- ❑ SHGC (high/mid/low)
- ❑ R value(U) Warm surface
- ❑ Condensation resistance HVAC Right Sizing Equipment and Delivery
- ❑ U + SHGC
- ❑ Orientation + Overhangs/shading

2. Energy + Carbon

Consider

- ❑ Energy Model Building-Whole-home impact
- ❑ Air tightness/Blower Door Test impact –Slider vs casement
- ❑ Operational Carbon Impact
- ❑ Embodied Carbon Impact

3. Total Cost +Availability

Total Cost

- ❑ Install Cost – Including opening prep and flash
- ❑ Impact on HVAC equipment size and duct system size
- ❑ Impact on customer satisfaction and warranty e.g. condensation or comfort calls
- ❑ Other...

Design Detailing & Installation for Durability: New CSA A440

Subject Matter Expert

VIDEO: Installation Demonstration and Test

Subject Matter Expert

Video Overview

- **Installation of a flanged window into a rough opening**
  - Demonstration of flashing sequencing and materials
- **Window installation demo using 2 methods:**
  - CSA A440 (minimum base)
  - Modified AAMA 100A (higher exposure alternative)
- **Windows subjected to ASTM E331 Applied Wind and Water test**
  - Brief overview of any observed failures or weaknesses.

VIDEO: Installation Demonstration and Test

Video Summary

- **Confidence in CSA A440**
  - Demonstration of flashing sequencing and materials
- **Consideration of augmentations for improved performance**
  - Good/better/best materials
  - Cost-benefit of additional materials & time vs. warranty call-backs/risks

Feedback

Please take a few minutes to provide some feedback that is valuable to improving this session in the future. Please scan this QR code and answer the survey questions on your phone or tablet. Thank you!

Thank You