SMART WINDOWS
AND CANADIAN ENERGY CODES

SAINT-GOBAIN

BACKGROUND

Around the world, building energy codes and standards are driving future buildings to reduce energy consumption. In Canada, the Toronto Green Standard (TGS) and British Columbia Energy Step Code (BC ESC) are setting ambitious, mandatory targets that become more stringent with time (by moving up in “Tiers” or “Steps”). Projects seeking to dramatically reduce energy consumption are increasingly turning to Passive House (PH) standards. PH buildings typically consume about 75% less energy than standard comparable buildings.

All of these targets will increasingly require designers to employ new techniques and technologies, such as smart windows. Smart windows, also called dynamic glass, refer to glazing products that automatically modulate their visible light transmittance and solar heat gain. This technology improves occupant comfort by maximizing daylight levels and controlling glare, and it also offers significant energy saving potential. This prompted SageGlass to commission RDH Building Science[1] to examine a few key questions:

- How do smart windows help meet the requirements of TGS, BC ESC and PH targets in Toronto and Vancouver?
- How does smart windows help address cooling loads, and potential HVAC downsizing, in these climates?
- What other ECMs (Energy Conservation Measures) would need to be used to meet the requirements if traditional low-E windows were used instead of smart windows?

TOP 5 FINDINGS

1 BIG CHANGE IS COMING SOON

Meeting future requirements cannot be done with "business as usual" design approaches or design features.

2 THE CHANGES CAN HAVE AESTHETIC IMPACTS

In the past, meeting energy targets did not always have a significant impact on building design, specifically exterior aesthetics. This will not necessarily be the case for future requirements. This means early stage design ought to consider energy targets to create concept renderings that accurately depict future buildings.

3 SMART WINDOWS PREVENT TRADE-OFFS

Incorporating smart windows can help projects meet energy requirements without incorporating other costly features or reducing the amount of glazing. The report calls out two design features that would frequently need to be used if dynamic glass were not included:

EXTERIOR SHADING

Future office and multifamily buildings will often need to include these features for all glazed areas. This includes both fixed and operable solutions. Regardless of the exact solution employed, exterior shading has significant impacts on a building's aesthetics as well as upfront costs.

GREATLY REDUCED WINDOW-TO-WALL RATIO (WWR)

If exterior shading is not employed, frequently the only viable alternative is reducing WWR, sometimes cutting the amount of glazing in half. As the amount of glazing is tied to daylight and outdoor views, features that support wellness and provide significant occupant value, this trade-off may be unacceptable from a marketability standpoint.

4 SMART WINDOWS REDUCE PEAK COOLING LOADS

Across building types, standards and climate zones, smart windows were shown to significantly reduce peak cooling demand. This can allow for HVAC system downsizing and associated cost savings (subject to discussion with project mechanical engineers).

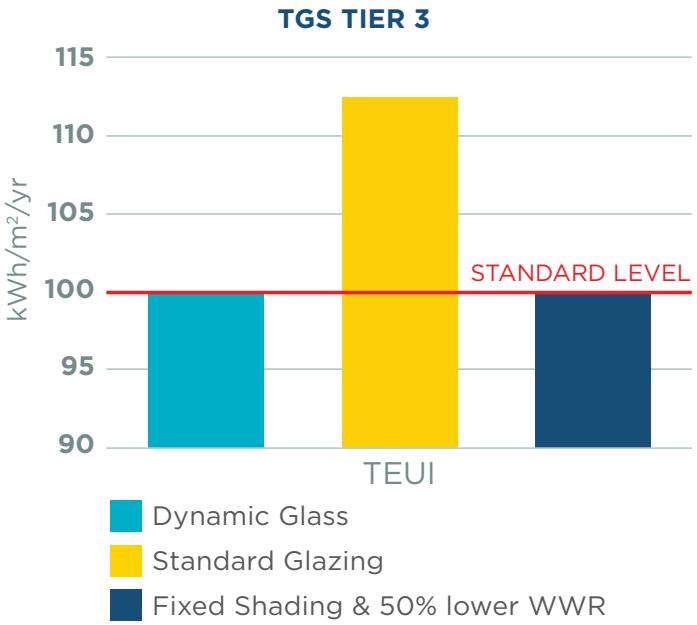
5 SMART WINDOWS CAN PROVIDE COMFORT WITHOUT MECHANICAL COOLING[2]

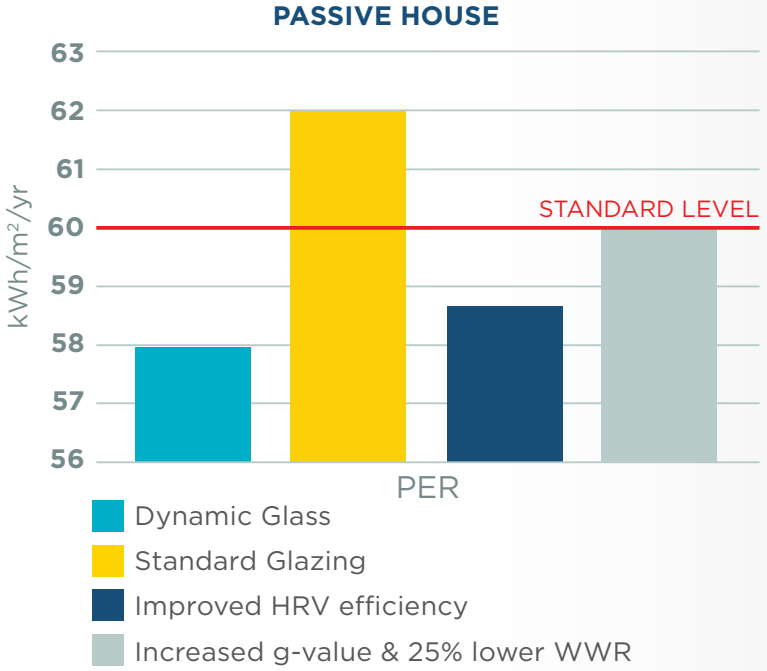
Vancouver requires buildings that don't include mechanical cooling to demonstrate that they will meet thermal comfort criteria. The data show that smart windows can help meet both thermal comfort and energy requirements.

THE DATA

The results below describe how smart windows help meet the performance targets identified. In addition, it examines what alternative compliance paths would be needed if smart windows were replaced with standard, low-E windows.

OFFICE BUILDING IN TORONTO[3]





TORONTO GREEN STANDARD:

- Cooling loads are driving overall Total Energy Use Intensity (TEUI), so strategies for reducing this are critical.
- Replacing dynamic glass with standard low-E glass would require the addition of fixed exterior shading, 3' deep, over all glazing, as well as reducing WWR from 50% to 25%.
- This approach could have significant cost, aesthetic and marketability impacts.

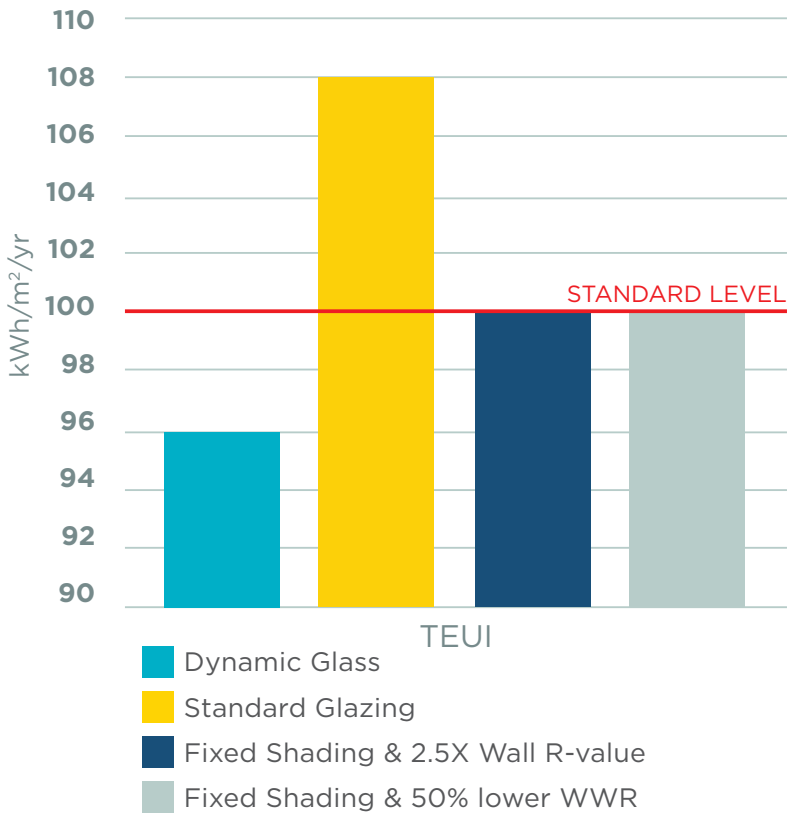
PASSIVE HOUSE:

- Heating load is the driver of Primary Energy Renewable (PER), which is the PH metric for total energy use.
- Increasing Heat Recovery Ventilation (HRV) efficiency from 84% to 91% is one path to compliance.
- The alternative compliance path would be increasing the g-value of the glass and reducing WWR from 40% to 30%.
- Increasing g-value would result in negative thermal comfort impacts in summer months by letting in more solar heat through glazing, and reducing WWR means less daylight for occupants.

OFFICE BUILDING IN VANCOUVER

PASSIVE HOUSE

BC STEP 3



PASSIVE HOUSE:

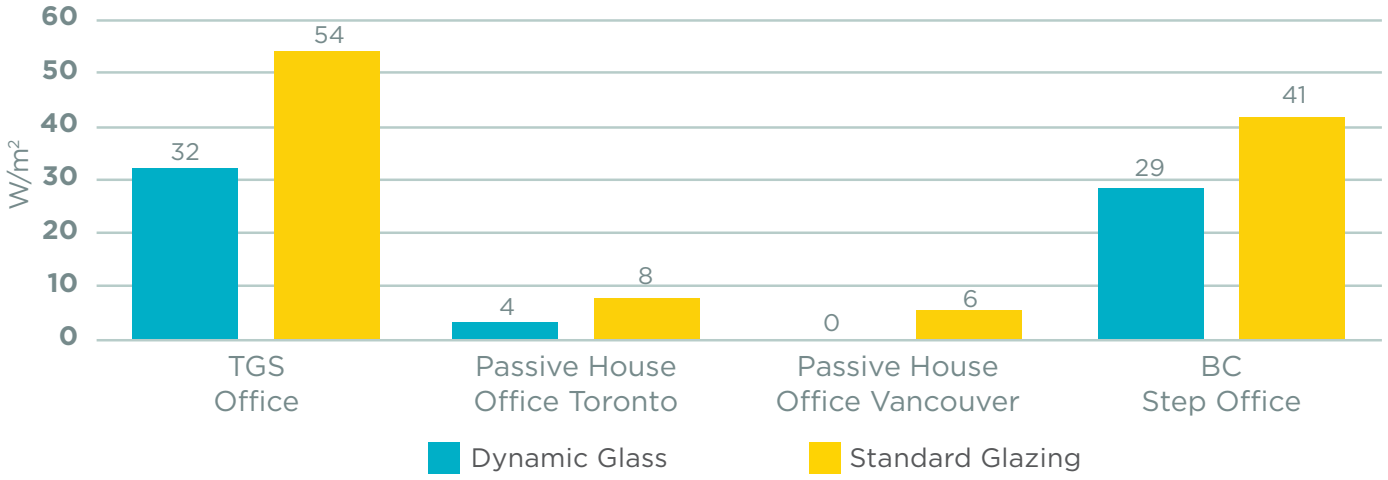
- Improving HRV efficiency from 80% to 87% is one alternative path to compliance.
- The other alternative compliance path would be increasing the g-value of the glass and reducing WWR from 55% to 45%.
- Increasing g-value would result in negative thermal comfort impacts in summer months by letting in more solar heat through glazing, and reducing WWR means less daylight for occupants.

BC STEP 3: OFFICE:

- The first alternative path to compliance is the addition of 2' deep fixed shading, above all glazed areas, along with improving wall performance from R-6 to R-15. This may be both costly and hard to achieve as it necessitates a spandrel panel system with very high performance and details to minimize thermal bridging.
- The second alternative compliance path would be the same 2' deep fixed shading but reducing WWR from 60% to 30%, greatly limiting daylight and outdoor views for occupants.

PEAK COOLING LOAD REDUCTION

Smart windows help to reduce peak cooling loads, which can result in cost savings from downsized HVAC systems, subject to consultation with a project's mechanical engineer.

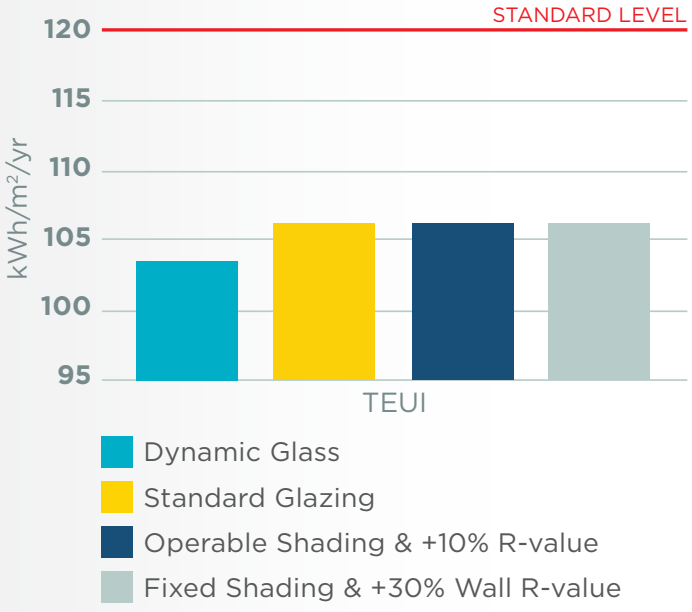


- For TGS Office and BC Step Office, peak cooling load is **reduced by 41% and 29%** respectively.
- For Passive House, the percentage **reductions (50-100%)** are more dramatic but loads are already quite low due to the greatly improved envelope performance of PH buildings.
- While the PH Office in Vancouver shows smart windows can reduce cooling load to 0, that does not eliminate the need for mechanical cooling, as dehumidification and internal heat loads (e.g., computers, lighting, people, etc.) need to be managed.

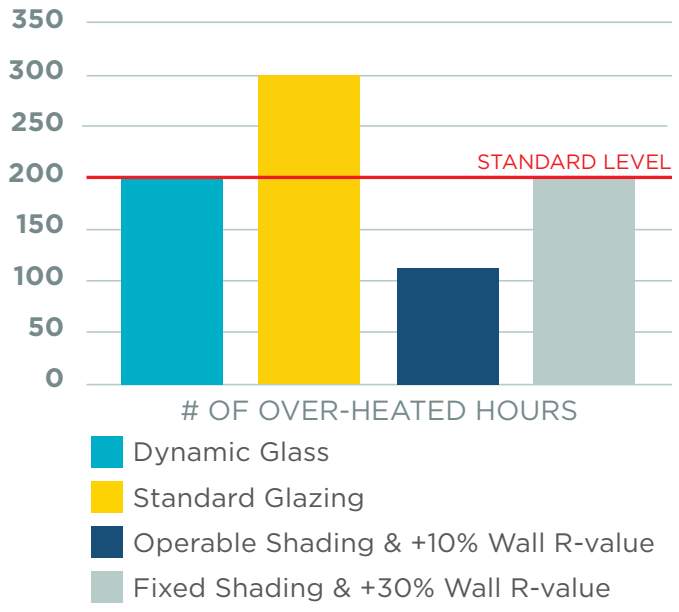
THERMAL COMFORT & SMART WINDOWS

A multifamily building in Vancouver without mechanical cooling was examined to understand both the energy and comfort impact of different design options. Vancouver has a mandatory threshold of "over-heated hours" that multifamily buildings without mechanical cooling must stay below.

BC STEP 3: MULTIFAMILY



BC STEP 3: MULTIFAMILY



- By eliminating mechanical cooling, multiple approaches are able to meet the TEUI standard, including a building with standard low-E windows.
- However, a building with standard windows goes over the "over-heated hours" threshold by 50%.
- The use of smart windows can help a building meet both the TEUI and thermal comfort targets without the need for exterior shading or increased wall R-values.

APPENDIX

[1] The full report prepared by RDH can be found here (www.sageglass.com/sites/default/files/canadianenergycodes.pdf). Data and findings are based on specific building archetypes analyzed in certain locations. Changes to archetypes or locations would impact the data. The report contains all relevant details and assumptions.

[2] This finding was limited to multifamily projects in the Vancouver climate. However, it may be extrapolated to other projects with similar characteristics in similar climate zones and serves to demonstrate the positive comfort impacts of smart windows.

[3] Specifics on baseline building features can be found in the full report from RDH.

SageGlass® is the pioneer of the world's smartest dynamic glass. Electronically tintable SageGlass tints or clears automatically to optimize daylight levels while preventing heat and glare without the need for blinds or shades. SageGlass delivers superior comfort, enhances occupant well-being and saves energy. As part of Saint-Gobain, SageGlass is backed by more than 350 years of building science expertise that only the world leader in sustainable environments can provide.

Contact your local SageGlass representative at:

Jordan Doria
Eastern Canada Territory Manager
jordan.doria@saint-gobain.com

Olivier Corbeil
Western Canada Territory Manager
olivier.corbeil@saint-gobain.com

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sageglass.com / marketing@sageglass.com / +1.877.724.3321