


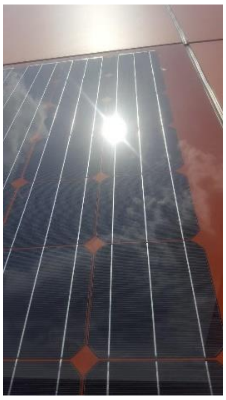

Q-Air – the innovation in glazing

With Q-Air solar heat-gain naturally changes with seasons. As it should be, it is highest in winter and lowest in summer. Solar gain is 30% lower in summer. As a result, no additional exterior solar shading is necessary.

Afraid of sitting at the window in winter?

Q-Air offers a U value so low that there can be no perceptible cold air movement at the panoramic window even in coldest winter. In the summer there will be no discomforting heat radiation from the glass despite not having any exterior sunshades.

Since there are no moving parts or openable enclosures, there is a reduced need for maintenance. And all that with an additional benefit of the extra net-floor area.

REFLEX

Q-Air

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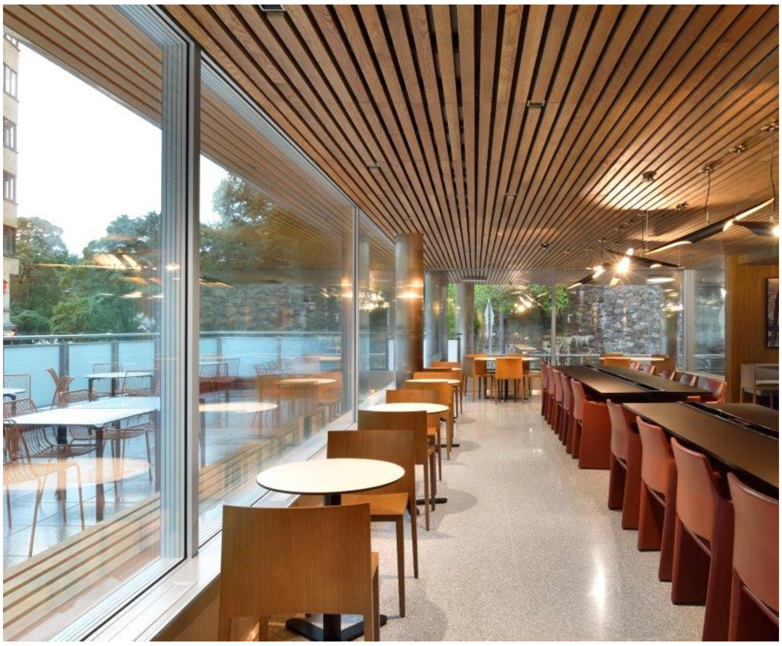
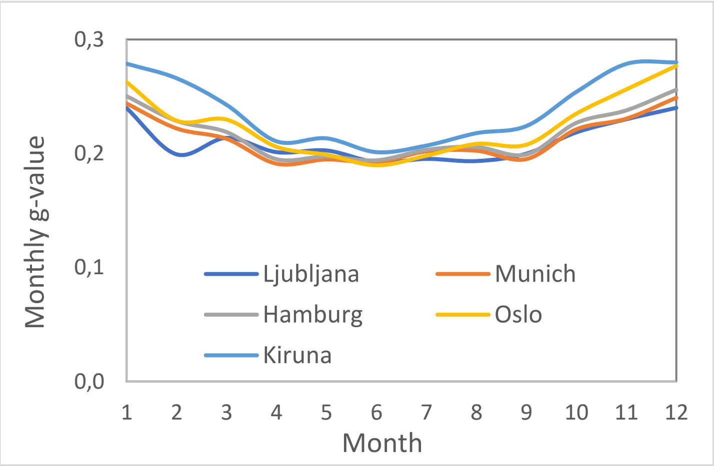
No exterior sun shading

The heat-trapping capacity of modern, low U-value glazing, causes a substantial increase in time duration where the shading is shut. In many cases, this means that a building's occupants cannot see outside if a part of the building is insolated. Recent improvements in glazing U-value have caused the shading device to be closed most of the sunny daytime throughout the year.



On the other hand, it was shown[1] that solar gain modulation no longer benefits energy requirements of a building if the glazing U value approaches 0.4 W/m^{2}K. This means dynamic exterior shading could be harmlessly discarded in exchange for a low U-value glazing with a modest solar gain.

Further, glazing having four or more glass panes exhibits strong seasonal selectivity[2]. In the summer, solar hear gain (g-value) is about 30% less than its nominal, standard calculated value due to direct sunlight reflecting from multiple glass panes more intensely at a higher average angle of incidence. Of course, full year-around weather data and geographical latitude are accounted for.



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[1] Vanhoutteghem, Lies, Gunnlaug Cecilie Jensen Skarning, Christian Anker Hviid, and Svend Svendsen. "Impact of façade window design on energy, daylighting and thermal comfort in nearly zero-energy houses." *Energy and Buildings* **102** (2015): 149-156.

[2] Kralj, Aleš, et al. "Investigations of 6-pane glazing: Properties and possibilities." *Energy and Buildings* **190** (2019): 61-68. Click HERE to see the Open access article.

Winter cold downdraught prevention

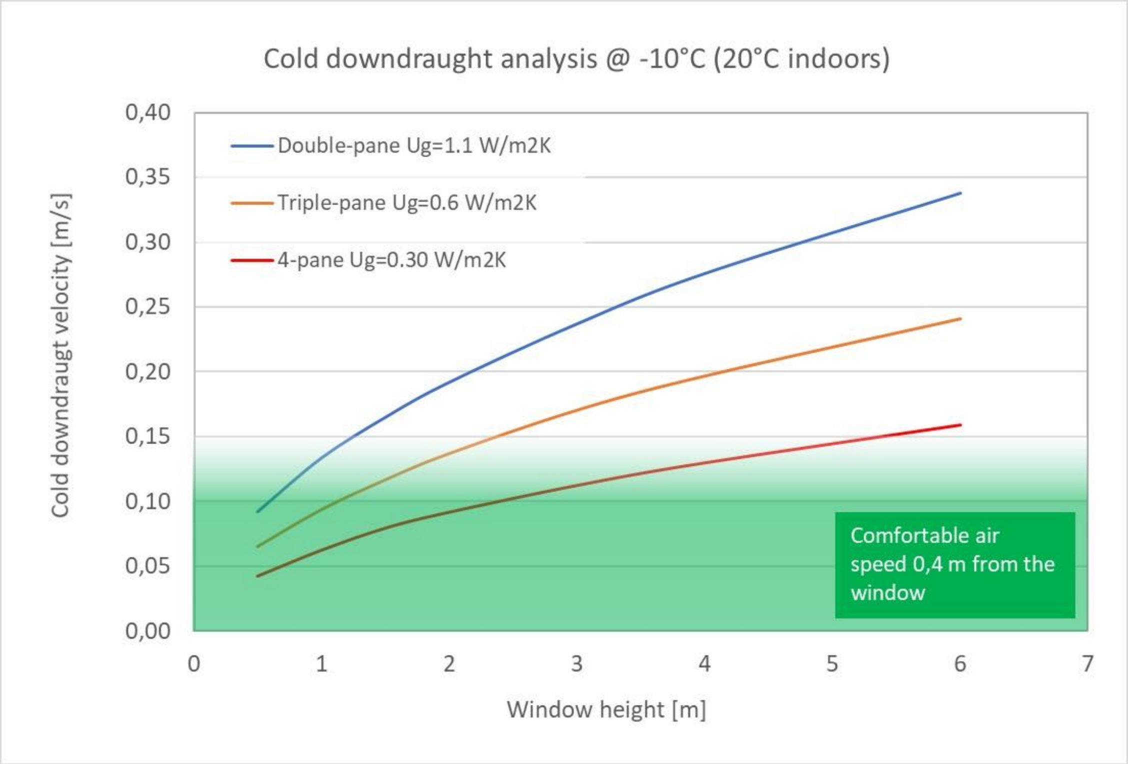
Have you ever experienced winter discomfort sitting at a tall window? The cold downdraught pouring from the inner glass surface enveloped your feet?

Cold downdraught becomes sensible when creeping air velocity reaches 0.15 m/s.

The taller the glass, the more the problem. The lower the U-value, the better.

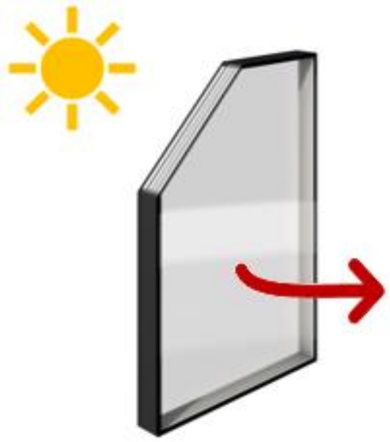
Q-Air can reach a low enough U-value to remove the cloud draught sensation for up to 4 m tall glass units.

Cold downdraught calculation[3] (0.4 m from the window):



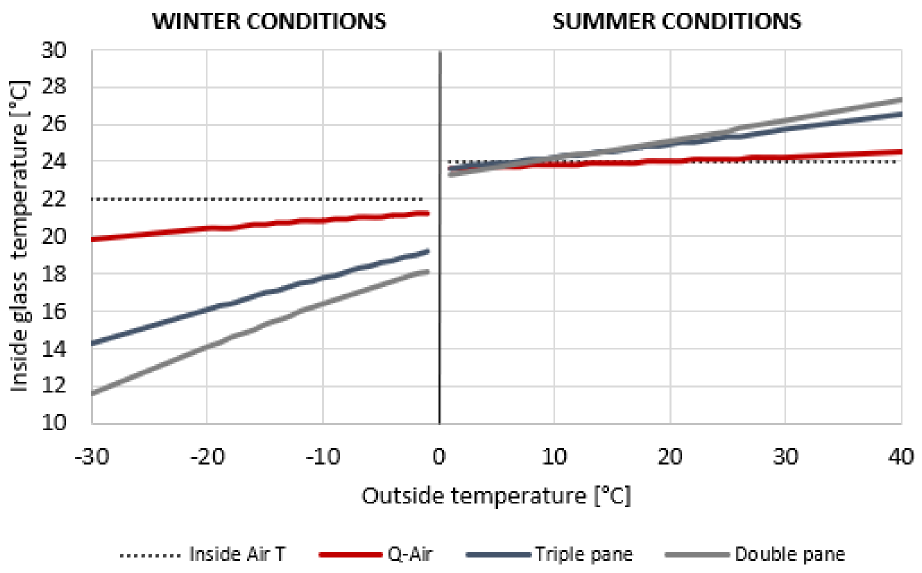
[3] Heiselberg P. Draught Risk from Cold Vertical Surfaces. *Building and Environment*, **29** (1994): 297-301.

Summer heat radiation from the glass



Experience teaches us that sitting behind the glass in the sunny summer day might bring discomfort from radiating heat. This phenomenon becomes apparent when the nominal calculated glass solar gain (g-value) exceeds 0.3. Basic glass units might pour heat inward through pure conduction.

Inner glass surface temperature is given for Q-Air 5 and several reference glazing.



With Q-Air 5:

- **Long wave radiant heat transfer in summer is reduced**
- **Reduced convection in winter**

	Winter (-30 °C)	Summer (40 °C)
Q-AIR5	19.8	23.6
TGU	14.3	25.1
DGU	11.6	26.0

Inner glass temperatures were calculated with Barkley Lab Window7.4 according to ISO 15099:

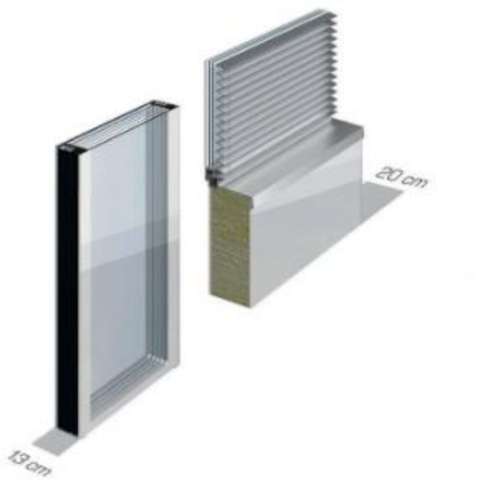
Environmental conditions	**Winter conditions**		**Summer conditions Direct Solar radiation 783 W/m²**	
	Inside	Outside	Inside	Outside
Air T	22°C	From -30 to 0 °C	24°C	From 0 to 40 °C
Convection coefficient	Fixed combined 7.5 W/m²K	Fixed combined 25.0 W/m²K	Fixed 7.5 W/m²K	Fixed 7.0 W/m²K
Radiation	/	/	ASHRAE/NFRC 24°C, Room ε=0.85	Sky T from 0 to 40 °C Sky ε=0.74

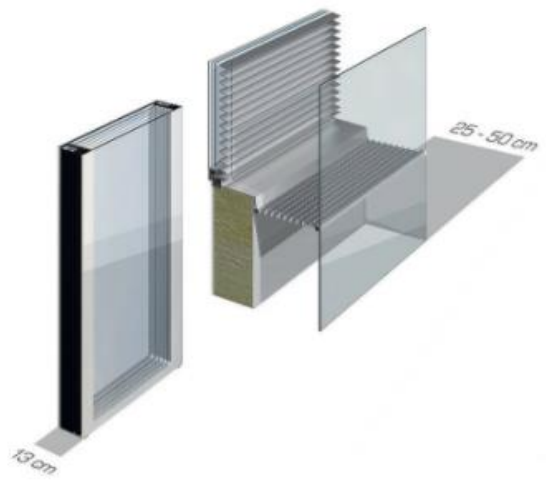
By maintaining radiant asymmetry and reducing convective air movement the inhabitants feel more comfortable at a lower room temperature thereby saving energy!

Costs, reduced maintenance and extra floor space

From a return on investment (ROI) perspective reduced maintenance, and extra floor space are the most significant direct value contributors of the Q-Air on top of savings made by omitting exterior sun shading.

The investment cost of the Q-Air is typically located in between that of systems such as a Closed cavity, Double skin glass facades and standard Triple-pane glazing.





Q-Air facades are usually less than 15 cm thick. Conventional solutions with comparable performance such as triple-pane glazing with parapets could easily reach 40 cm thickness of mineral wool insulation. In such cases, Q-Air façade saves 20-25 cm space. In some cases, this is sufficient to pay-back the extra investment cost into the Q-Air[4].

Exterior shading devices require maintenance. Mechanical louvres are maintenance heavy. All too often, dynamic shading systems require building occupants to receive training on how to operate them or else users will use shades as glare control, which seems to be the only intuitive use of such devices.

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[4] Kralj, Aleš, et al. "Investigations of 6-pane glazing: Properties and possibilities." *Energy and Buildings* **190** (2019): 61-68. Click HERE to see the Open access article.

The zero-heating building

Zero-heating building or nearly zero-heating building (nZHB) is a building having essentially zero heating demand, defined as having heating demand, Q'_{NH}, less than 3 kWh/(m^{2}a). The zero-heating building is intended for use in heating-dominated areas. The purpose of the zero-heating building is to supersede net-zero energy buildings now proposed as a standard in the EU. Zero-heating buildings address flawed net-zero energy buildings: the requirement for seasonal energy storage, in some cases poor comfort of living and narrow design options.

Seasonal energy storage problem. In areas where there is substantial heating demand, it is hard to fill this demand with renewable power as in heating season, solar power is in short supply. This means heating in highly urbanized areas is directly or indirectly powered by, in a large part from fossil sources. About 2000 TWh of seasonal energy storage is needed to meet EU's winter heating demand[5], should it be alleviated from fossil fuel dependency. The zero-heating building overcomes the need for seasonal energy storage required by the net-zero energy buildings and thus addresses major concerns.

Design freedom. Due to the exceptionally low U-values of glazing used, glazed areas are not limited in size due to energy requirements. nZEB building can be realized with 100% glazed walls[6]. This removes some constrains imposed on the building design by the double and triple-pane glazing. Most notably, a zero-heating building does not need to be purposefully built as a passive solar building.

Further developments of the Zero-heating building

Abandoning now common modulated external shades and switching to more cost-efficient multipane glazing with built-in solar control glass somewhat increases cooling demand. The zero-heating building should be designed to keep cooling demand, Q'_{NC}, less than 20 kWh/(m^{2}a) for office buildings and less than 15 kWh/(m^{2}a) for all other types. After capitalizing on the effects made by nearly zero-heating building one can further equip such a building with PV, to obtain something of a winter positive energy building[7]. The remaining cooling and ventilation demand can thus be favourably synchronized with solar radiation, where maximum photovoltaic generation nearly coincides with the maximum power needed for cooling.

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[5] "Energy consumption in households, Eurostat 2018". Energy consumption in households, Eurostat 2018. Retrieved 24 December 2020.

[6] Domjan, Suzana; Arkar, Ciril; Begelj, Žiga; Medved, Sašo (August 2019). "Evolution of all-glass nearly Zero Energy Buildings with respect to the local climate and free-cooling techniques". Building and Environment. 160: 106183. doi:10.1016/j.buildenv.2019.106183

[7] Drev, M., and B. Černe. "M. Žnidarši c, A. Geving, A. Kralj, Nearly independent, near-zero energy building." *PHN17 8th Nord. Passiv. House Conf., Helsinki, Finland*. 2017.