Electrically heatable low-e glass

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Content:
thermal conditions in the vicinity of glass

- The importance of thermal conditions
- The effect of IGU structures to thermal conditions
- Heatable glass as a technical solution

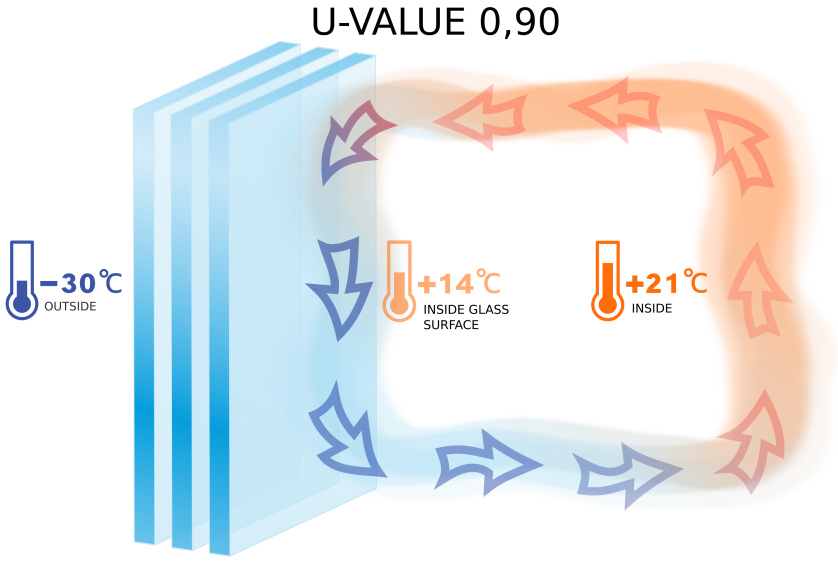
Cold climate challenges

- Thermal asymmetry
- Cold wall effect
- Convection → draft
- Condensation

Mercury tower Moscow, Customer Josef Gartner GmbH, Germany

The importance of thermal conditions – field studies

- Thermal conditions and acoustic conditions are the most significant source of discontent /4/
- Study in Canada, USA and Finland shows that thermal conditions are on a good level only in 11% of office buildings /5/



4. Hongisto, V. TOTI –Käyttäjälähtöiset toimistotilat. Toimistojen tyytyväisyystutkimus 2002-2008. Työterveyslaitos. 2012
5. Huizenga, C., Abbaszadeh, S., Zagreus, L., Arens, E. Air Quality and Thermal Comfort in Office Buildings: Results of a Large Indoor Environmental Quality Survey. Proceedings of Healthy Buildings 2006, Lisbon, Vol. III, 393-397

Work productivity aspect – field studies

- 2°C change from uncomfortable zone to thermal comfort boosted workers' performance by 5% /3/

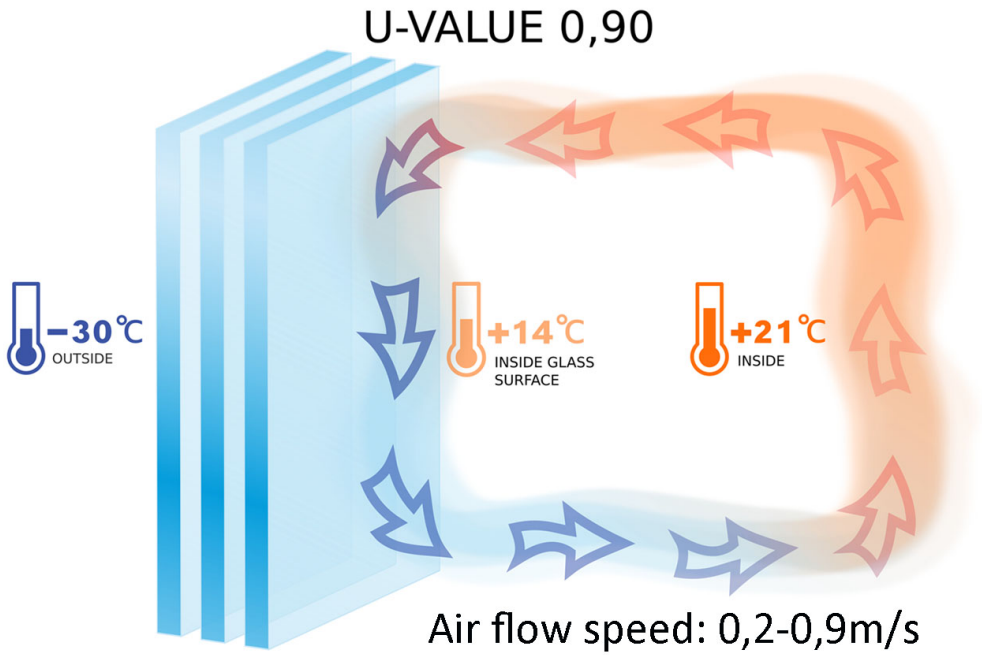
- Even 3,4% increase in office work productivity gives quick and good payback, by compensating the building costs /1/, /2/

1. Fisk, W. J., Rosenfeld, A. H., Potential Nationwide Improvements in Productivity and Health From Better Indoor Environments. Energy Efficiency in a Competitive Environment. American council for an Energy-Efficient Economy. August 23-28, Asilomar, CA. 1998.
2. Evans, R., Haryott, R., Haste, N., Jones, A. The long term costs of Owning and Using buildings. Royal academy of Engineering. 1998
3. Tham, K.W., Willem, H.C., Sekhar, S.C., Wyon, D.P., Wargocki, P., Fanger, P.O. Temperature and ventilation effects on the work performance of office workers (study of a call centre in the topics). Healthy Buildings 2003 – Proceedings 7th International Conference (7th-11th December 2003) – National University of Singapore – Vol. 3, pp 280-286

Heat radiation

- Cold surfaces create asymmetries
- Asymmetries reduce thermal comfort
- Temperature difference between glass surface and indoor air

There are several studies on cold convection:



1. Shillinghaw, J. A., Cold Window Surfaces and Discomfort. Building Services Engineering; 45(1977), July, 43-51
2. Fanger, P.O., Ipsen, B. M., Langkilde, G., Olesen, B. K. Christensen, N. K., Tanabe, S. Comfort Limits for Asymmetric Thermal Radiation, Energy and Buildings, 8 (1985) 225-236
3. Christensen, K. E., Jeppesen, J., Overby, H., Reduktion af traekgener i opholdszonen ved motering af sprosser i vindueskonstruktioner., Dansk VVS, June 1994, Vol 30, s. 42-46
4. Topp, C., Heiselberg, P. Reduktion af kuldenedfald ved hoje glasflader, Dansk VVS, 2/1996, Vol 32, s32-36
5. Heiselberg, P., Stratified flow in rooms with a cold vertical wall. ASHRAE Transaction 100 (1994):2, 1155-1162
6. Heiselberg, P., Draught risk from cold vertical surface. Building and Environment 29 (1994):3, 297-302
7. Heiselberg, P., Overby, H., Bjorn, E., Energy-efficient measures to avoid downdraft from large glazed facades. ASHRAE Transaction 101 (1995):2, 1127-1135

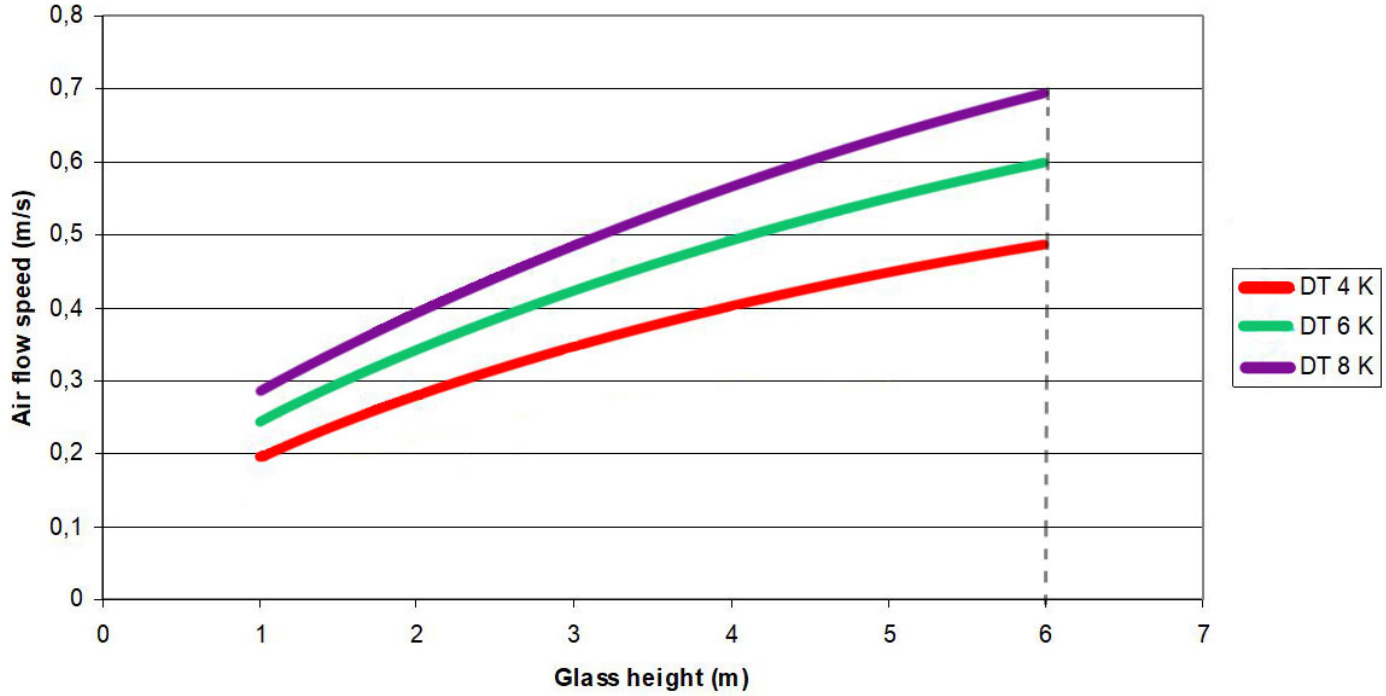
Convection

$$V = k \times \sqrt{h \text{ x } \Delta T} \text{ m/s}$$

- k varies 0,05-0,1
- h is height of glass surface (m)
- Δ T is thermal difference between glass and indoor air (K)
- Currently there are presented higher values /1/

1. Karumaa, K. Jäähdytyspalkit ja sekoittava ilmanvaihto. Fläkt Woods. Tekninen ohje. 2012.

ΔT is the temperature difference between glass surface and indoor air.



During normal winter day flow speeds are 0,2-0,5 m/s!

K-value used 0,1 in this graph[1].

The effect of IGU structures to thermal conditions

The effect of IGU structures to thermal conditions

- Glass surface temperatures in accordance of EN673 standard[1]

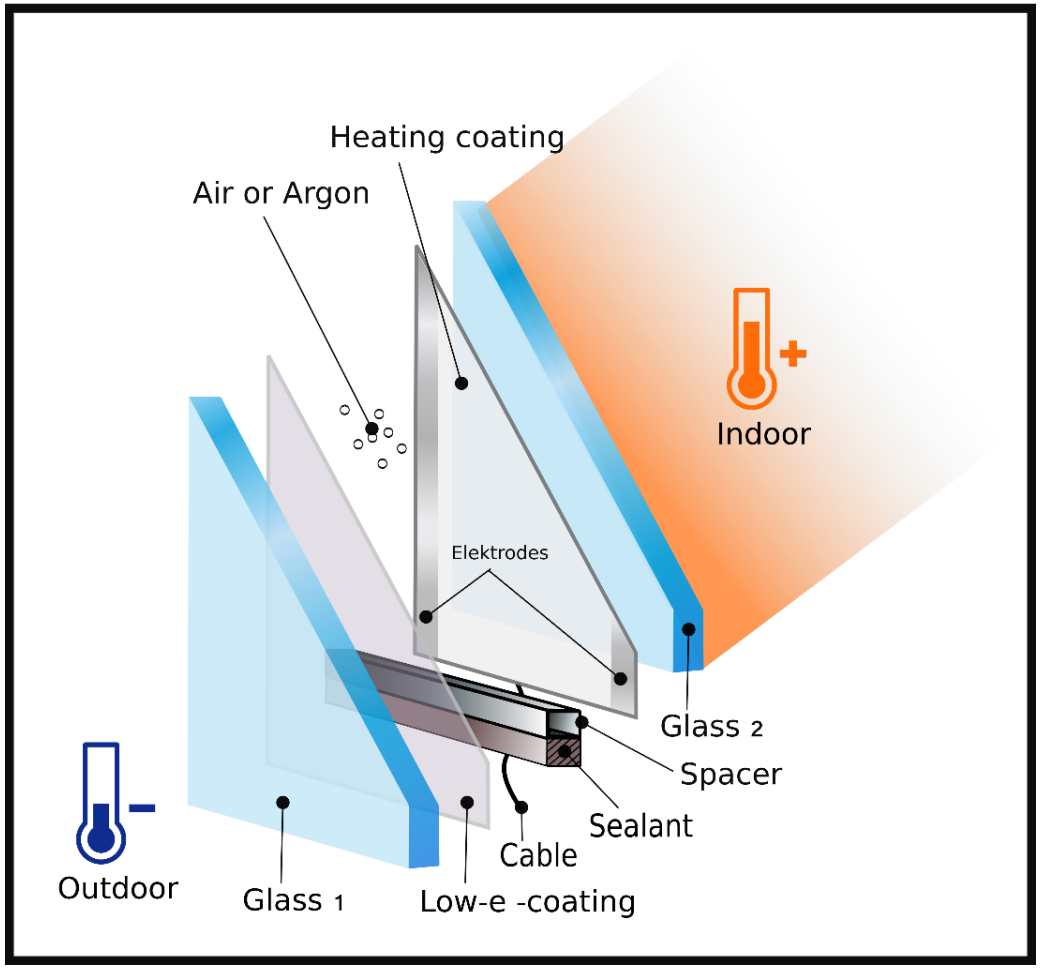
Glass U-value W/m^2K	Outdoor temperature °C		
	-30	-20	-10
	Glass surface temperature °C, inside		
0,6	16,0	17,0	17,7
1,1	13,0	14,3	15,7

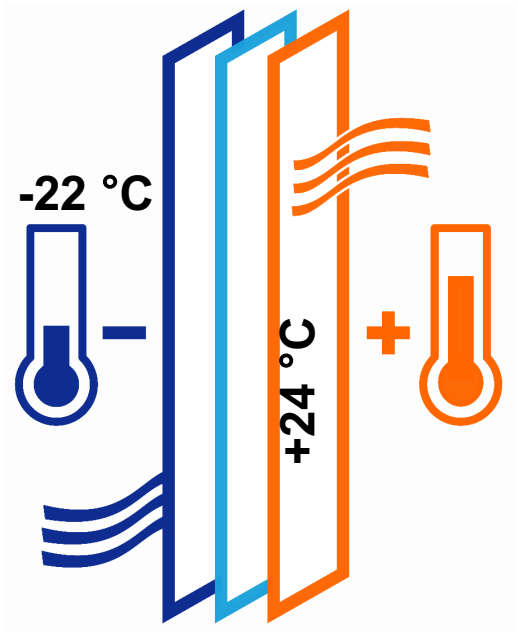
OBS! Whole glass construction U-value is normally ca. 0,2W/m²
K more than in the glass U-value itself. Glass edge temperatures are colder!

1. Dioup, A. Study Report – FSG. Saint-Gobain Chantereine R&D Centre, Saint-Gobain Glass France. Internal Report, not published. Paris, France. 2012.

Heatable glass as a technical solution

Heatable glass structure





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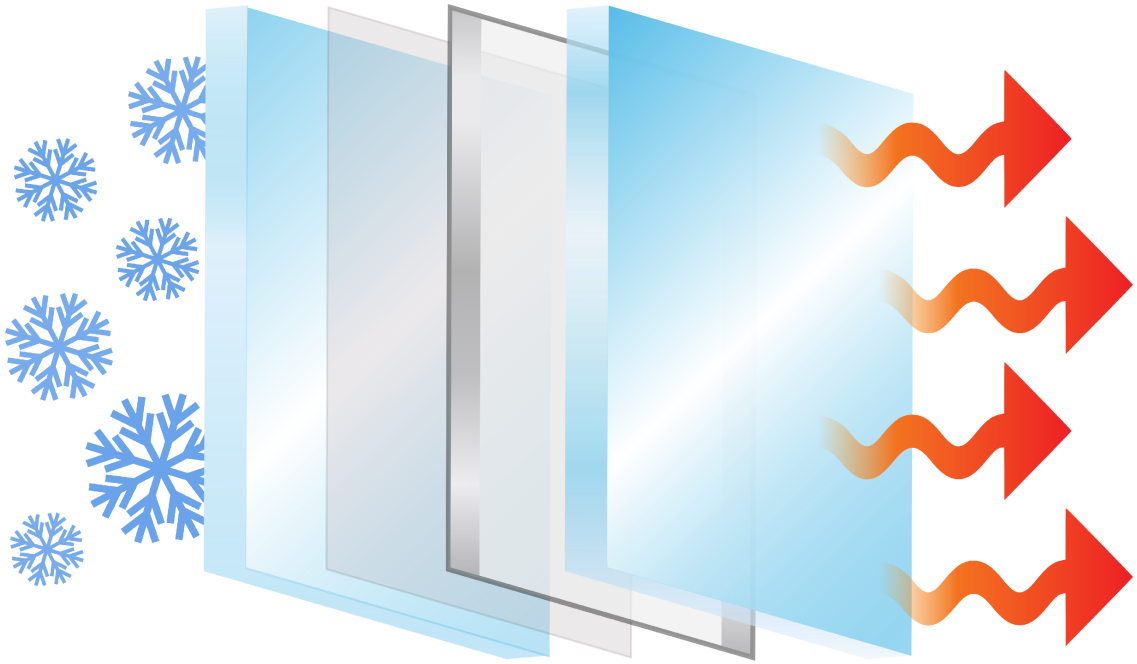
Heatable glass as a technical solution

Benefits of heatable glass:

- Optimized thermal comfort: enables to lower the room temperature
- Heatable glass thermostate reacts quickly and independently to different conditions

Efficiency

- According to VTT study on energy efficiency, η >90%
- Heat is directed inside
- Typically 20-30 W / m²
- <u>Enables to lower the room temperature</u>



Helsinki Music hall

Fan coil: 1500-4000€/m²

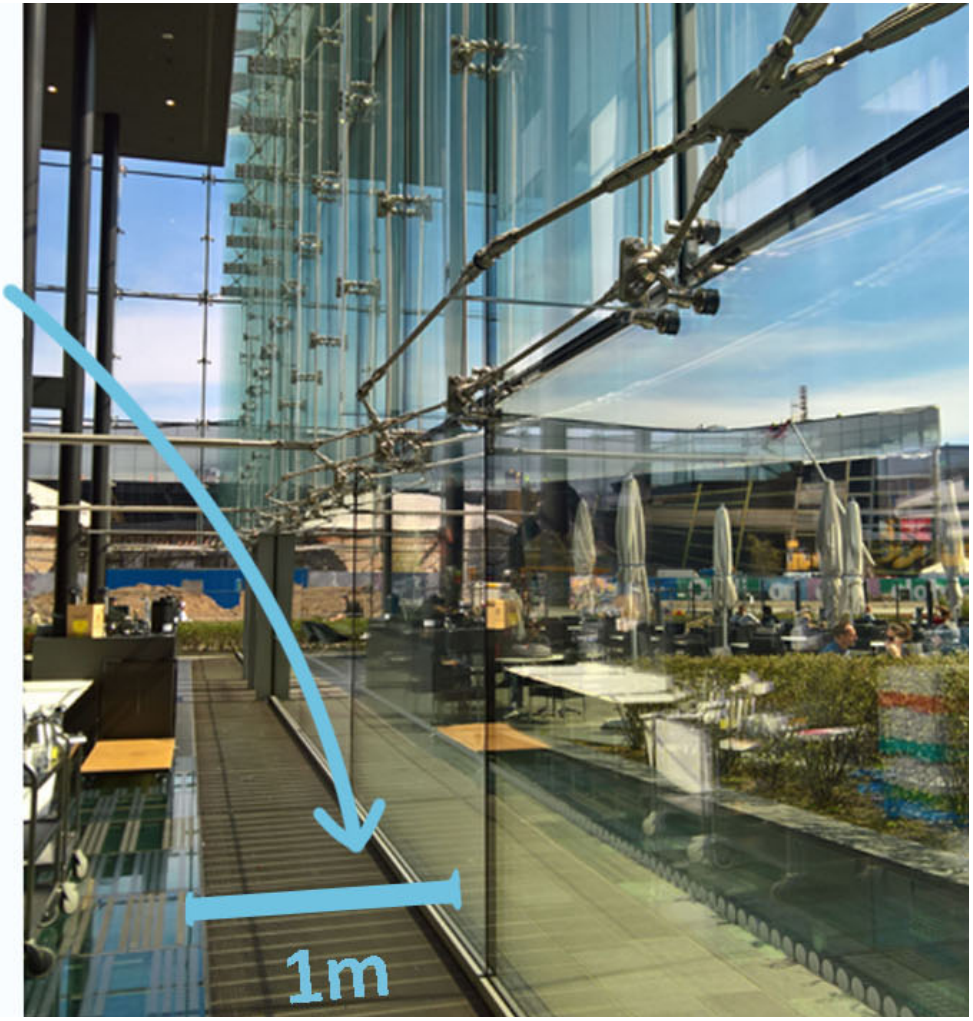
Unused floor area: 1m x 100m = 100m²

Building costs = 10 000€/m²

→ Costs can be even 1 000 000€

Extra costs with electrically heated glass: 200 000€

→ Savings: 800 000€



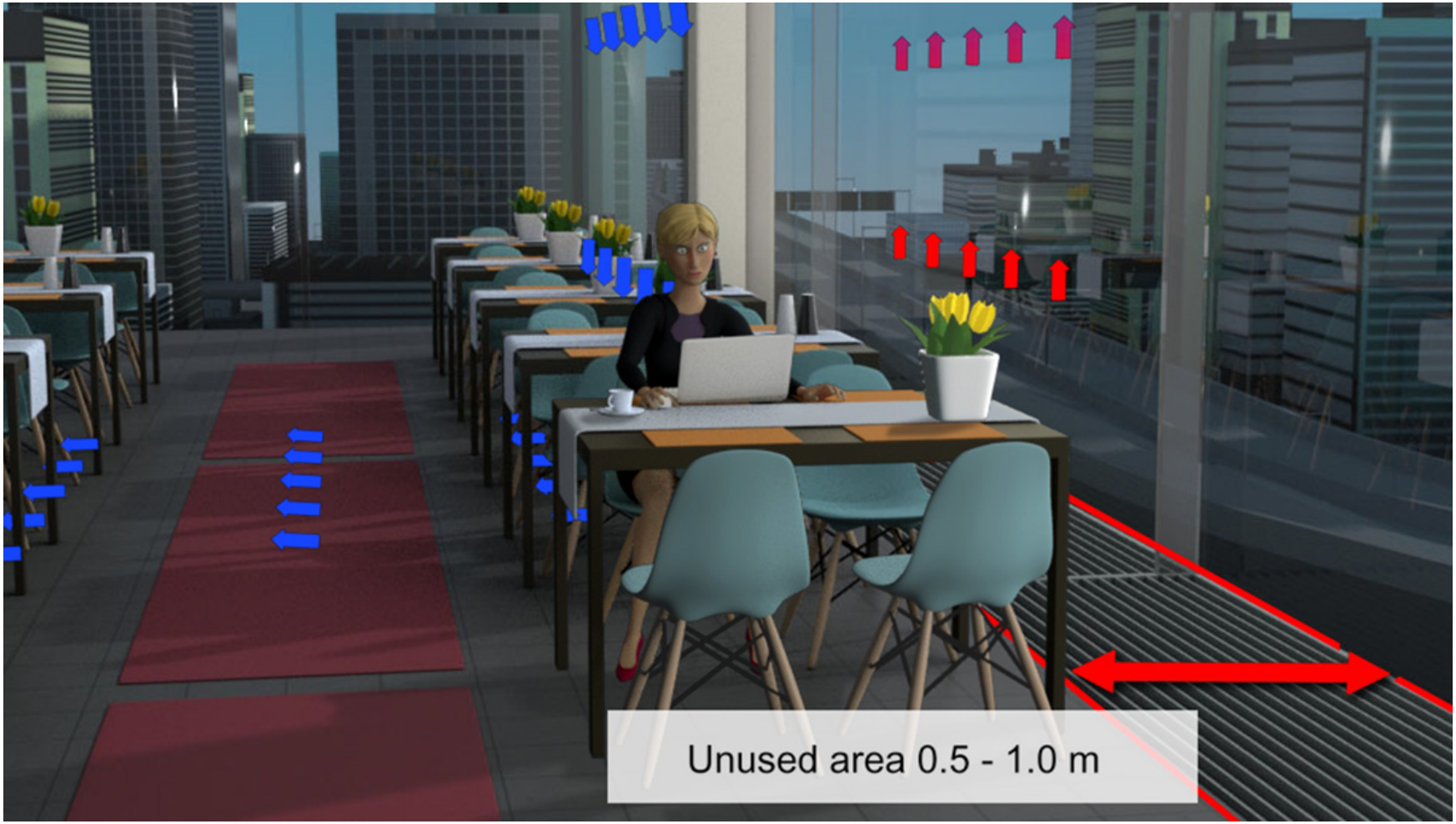
Investment costs

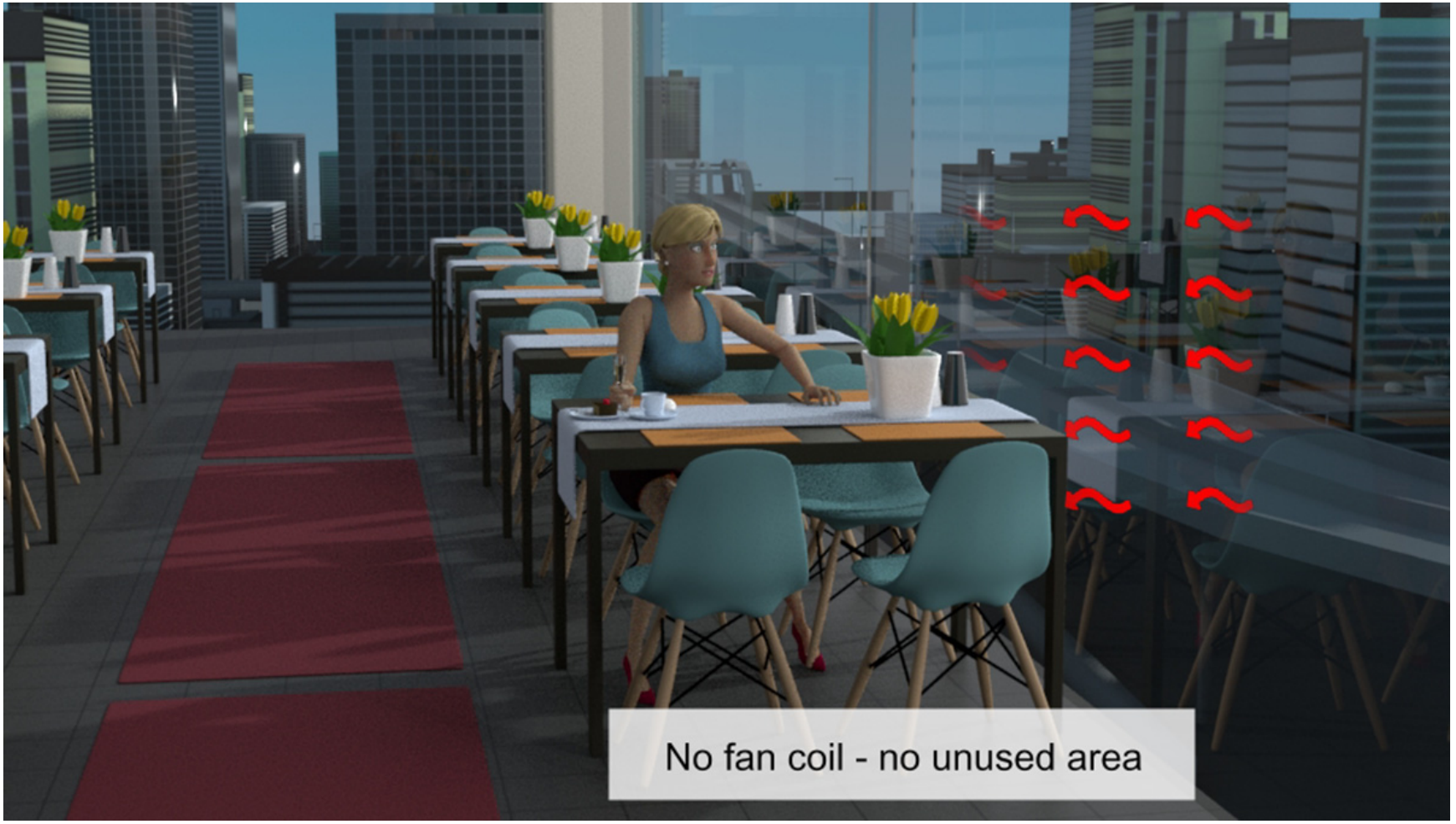
Table below shows the comparison between electrically heated glass vs. traditional fan coil system in facade of 10m in height.

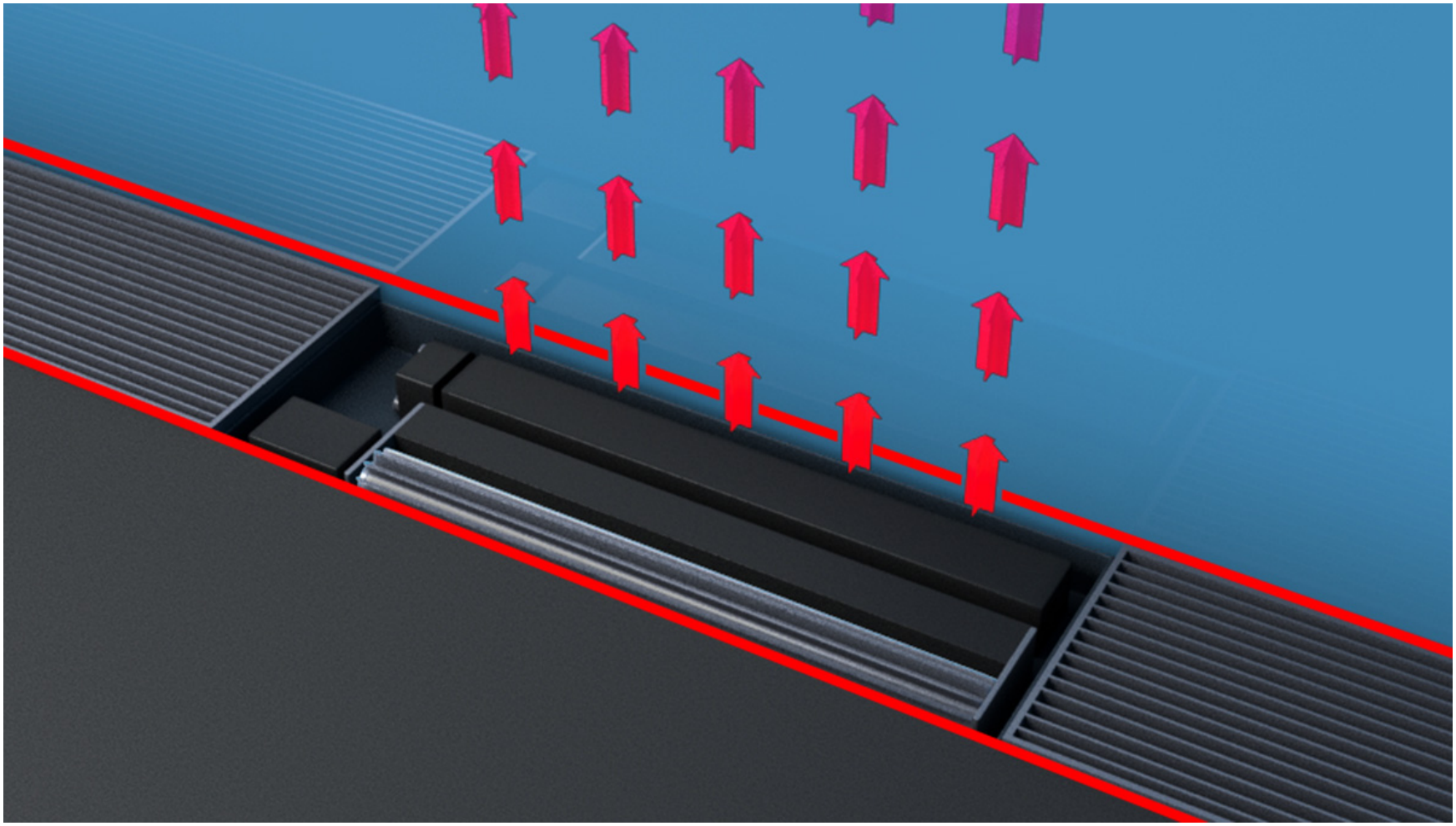
Investment cost (Eur/m)		Cost of floor area (Eur)	Total investment cost (Eur)
Electrically heated glass	2000	0	2000
Fan coils	1500-4000	1500-10000	3000-14000

- Savings can be achieved in investment costs
- The biggest savings come from space.


Fan coils vs Electrically heated glass


Unused area 0.5 - 1.0 m


No fan coil - no unused area



Electrically heated glass - Snow melting applications

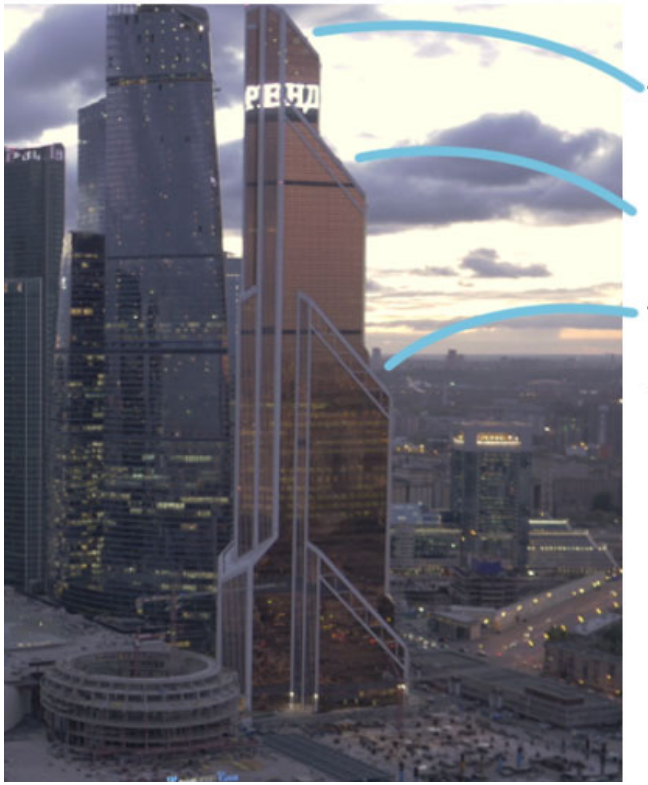
- Gostiny Dvor, Moscow
- Heated insulated glass with snow melting
- Solar control, laminated and tempered safety glass

Preventing snow load

- Finnglass project 1998: Gostiny Dvor
- 12 500m²
- Automatic snow recognizing & melting
- Fully automatic switching area and power circulation of 12 parts

Case study – snow melting and thermal conditions

Mercury tower, Moscow



Thermal conditions

Electrically heatable glass

Triple-glazed safety glass
2500m²

Condensation

- Heated glass prevents also condensation risks
- Condensation can be eliminated by heating the glass above the condensation point.
- The glass stays see-through and clear from snow, ice or condensation.

New ideas create new business

Heatable glass as a technical solution

- 20-25W/m^2 power is enough to keep the glass in room temperature /1/
- Can also be used to heat the room with higher power

/1/ Calculated according EN673 standard, in normal winter day (-10 °C, +20 °C, U-value 0,6)

New ideas create - new business

- Arctic resorts, Kakslauttanen, Finland
- Payback time less than 2 years

- Sales €20 million
- Profit € 10 million before income tax

- No cold feelings!

Summary

- To guarantee good thermal conditions inside it is justified to use heatable glass with adequate solar control
- Savings from floor space and investment costs
- No thermal differences, cold wall effect or condensation.

Summary

- Heated glass is economical, long-lasting and efficient solution in cold climate
- To achieve the best results, glass specification should be made already in project planning state.
- Energy is not wasted due to modern controlling systems.
- Business potential

Thank you!

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