



Quality Differences in tempered, bent and laminated glass (quality makes a difference)

Glass for Architects and Designers

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Do we want our buildings to look like they were designed to, or?

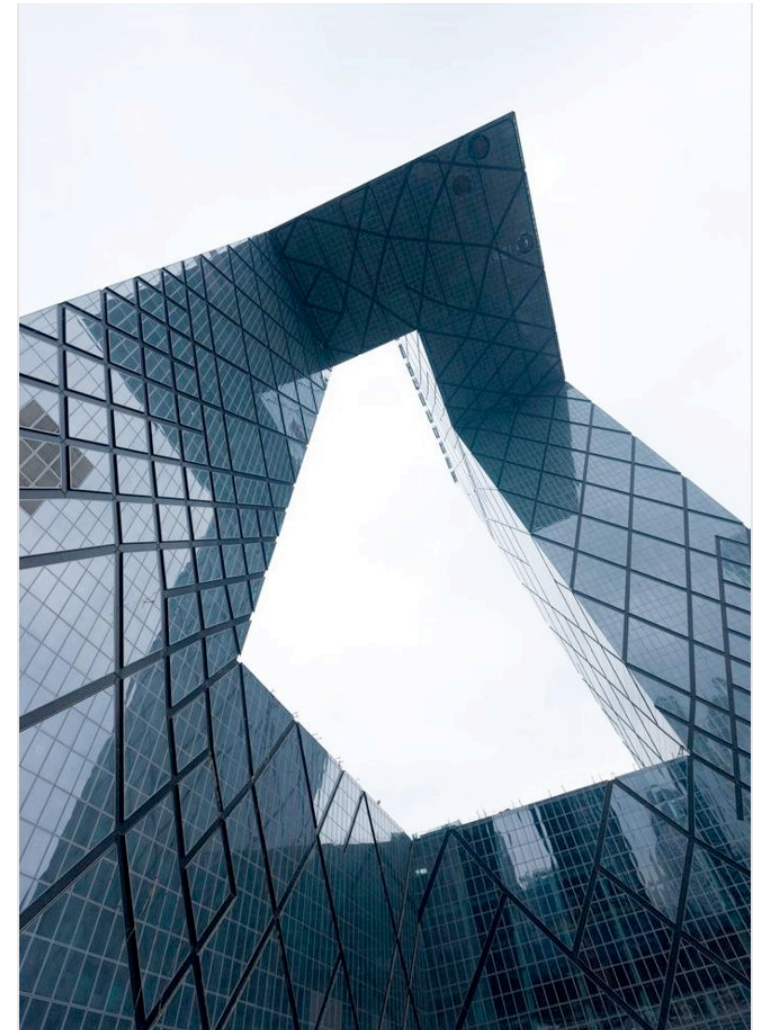
If you can't hide it, exploit it!



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Content

- Glazing examples: current/future challenges
- Causes for distortion (and other defects)
- Technology solutions to increase facade quality
- Your checklist



Quality challenges



Picture source: www.gpd.fi © M. Elstner, Interpane Glasgesellschaft GmbH

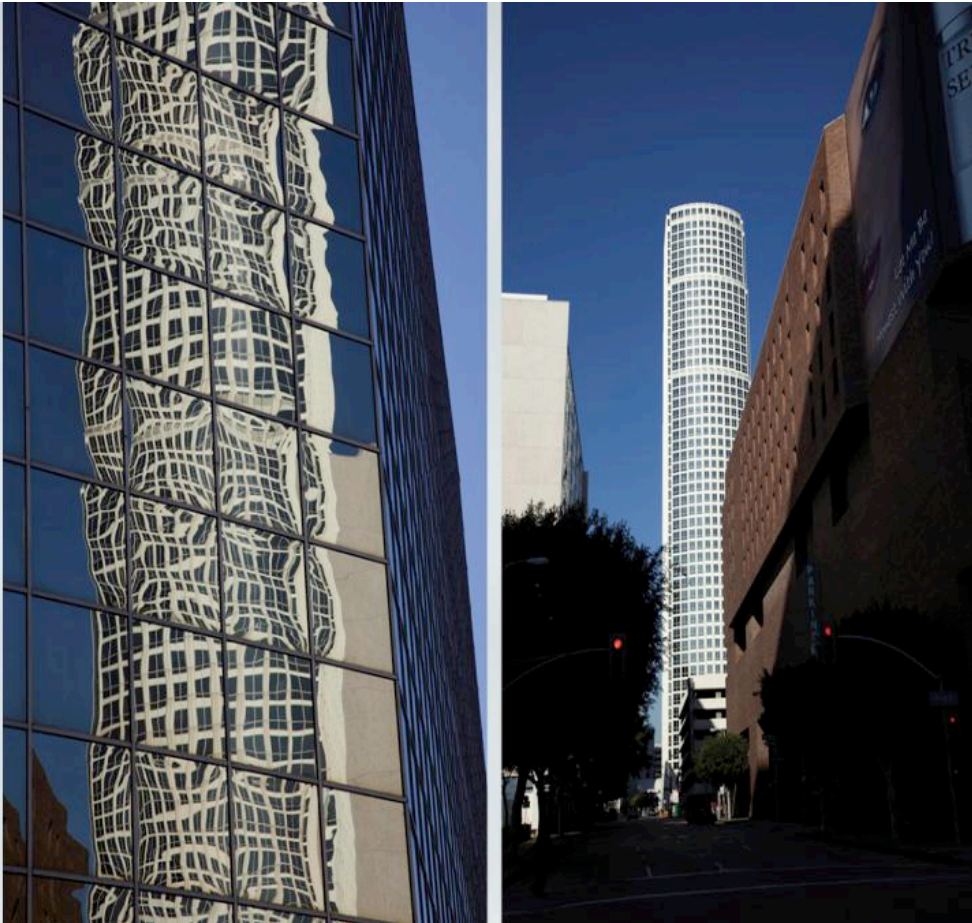
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Quality challenges



Quality challenges

Intent or Accident?



SOURCE: www.gpd.fi © M. Patterson, Enclos

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Quality challenges



© Eric Segarra

<https://theglassblog.wordpress.com>

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Picture source: www.gpd.fi © M. Elstner, Interpane Glasgesellschaft GmbH

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New Shapes - Future Challenges



Source: GPD Finland 2011

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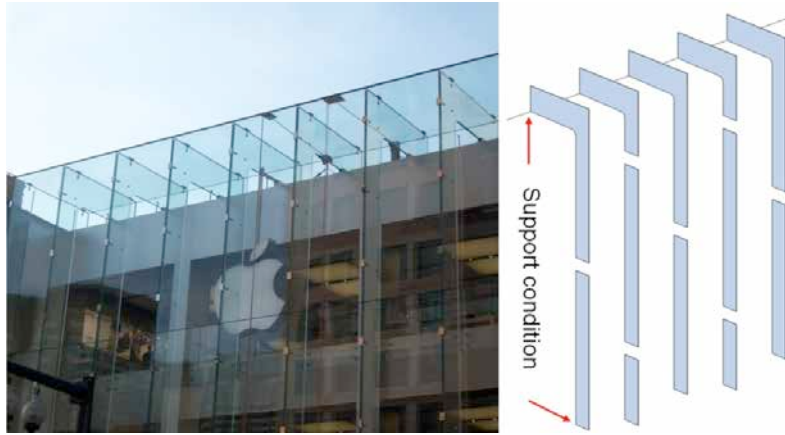
Printed Glass Façade



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Source: GPD Finland 2011

Structural Glass Design



Source: GPD Finland 2011

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Complex shapes

Source: GPD Finland 2011



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A photograph of a modern building with a dark, vertically-slatted facade and large glass windows, set in a snowy winter landscape. The building has a unique, angular design. In the background, a large green dome structure is visible on a hill. The foreground is covered in snow with some small trees and dark posts. A semi-transparent teal banner is overlaid across the middle of the image, containing the text.

Causes for distortion and other quality defects

Sources for distortion

(for tempered, bent and laminated)

**Heat treatment /
tempering** can cause
distortion

Distortion can be
multiplied in
lamination

Thickness variation
along the glass

**IG unit pressure level
and environment
condition**

Reflective coatings
add the visibility of
distortion

**Pressure on the
glazing** will cause
distortion

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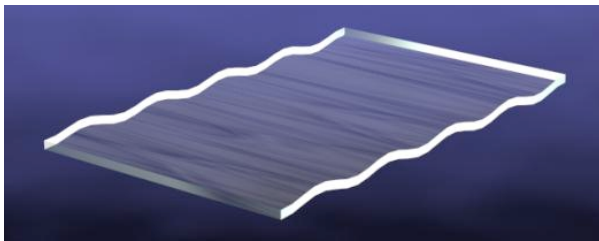
**Reflective coating
quality** add the
visibility of distortion

**Pressure on the
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distortion

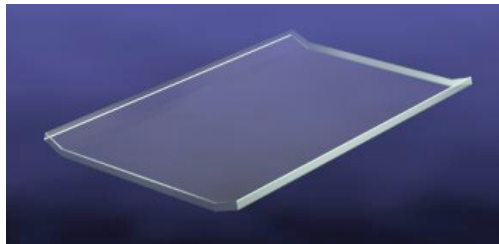
Most common heat-treatment glass quality indicators

What criterias we have for heat-treated glass

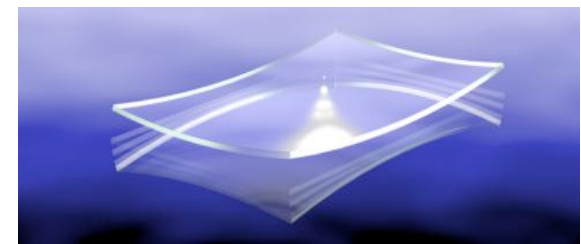
Rollerave / local bow



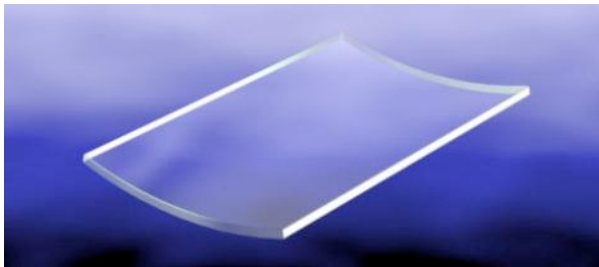
Edge lift



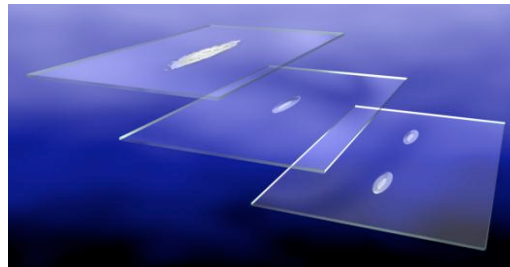
Bi-stable glass



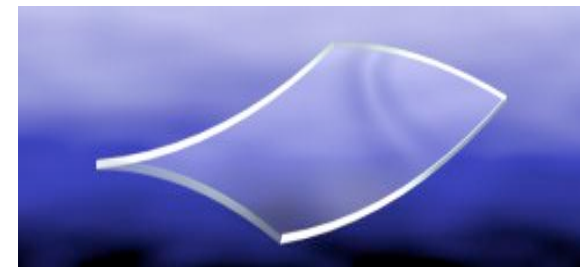
Overall bow



Local haze, local distortion



Saddle bow



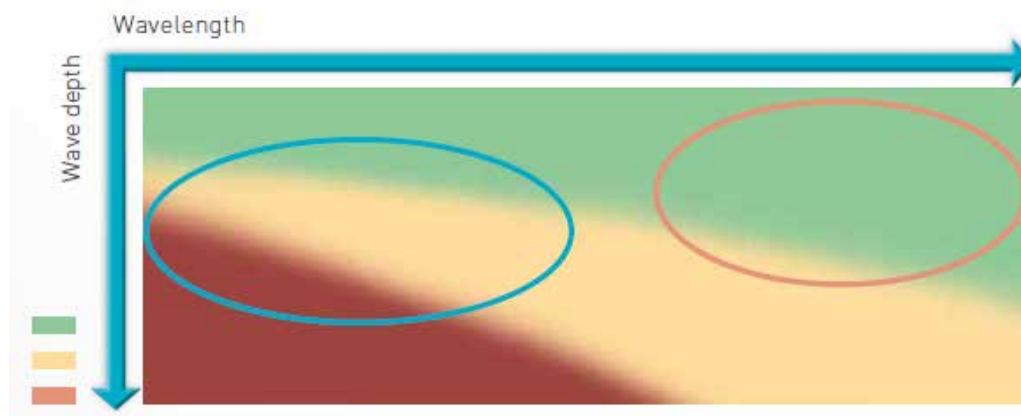
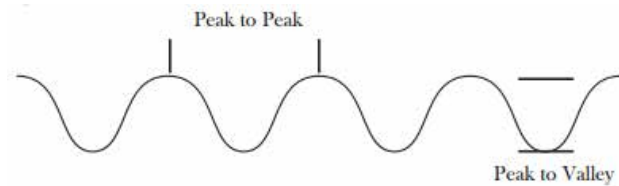
Proper reflection on the light board



Edge lift & Rollerwave



Measuring distortion: Millidipter vs mm



The impact on optical quality
from short roller waves



The impact on optical quality
from long roller waves

Pictures from: VitrumIndustries



Rollerwaver
Mpdt 0,2
~300



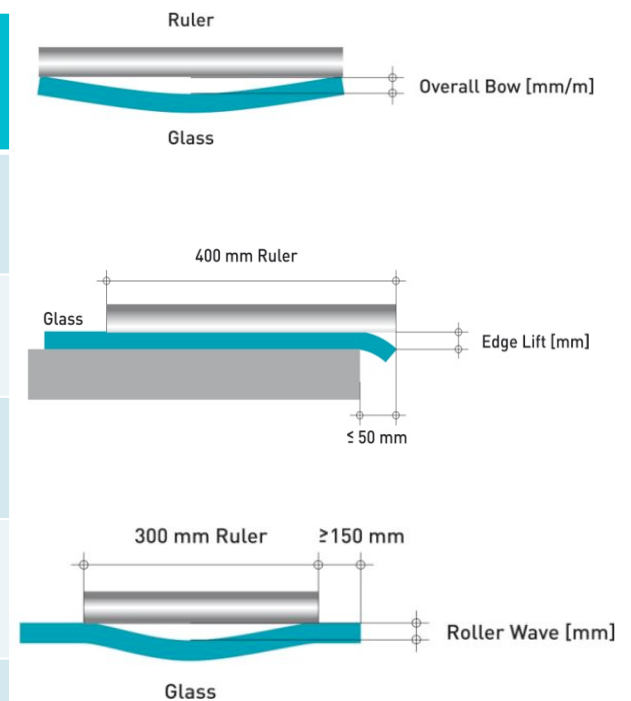
Rollerwave
Mpdt 0,1
~130



Rollerwave
Mpdt 0,07
~100

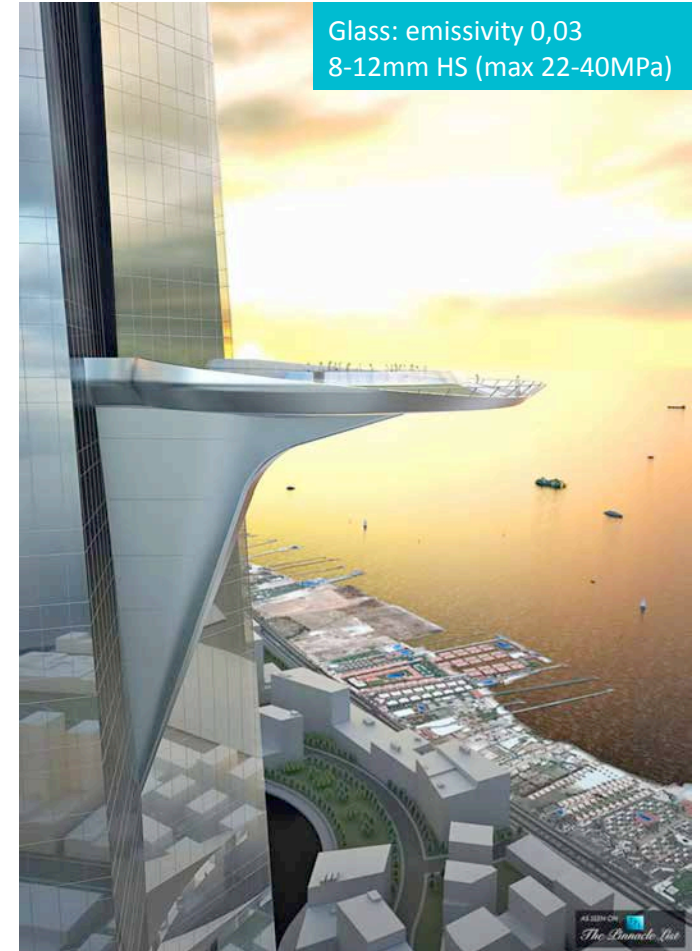
The market requirements in project business, 6mm and up

	Tightest specification	Average specification
Rollerwave	0,06	0,1-0,15
Edge lift	0,15	0,2
Overall bow	1,5%	2,0 – 2,5%
Visual quality evaluation	Hadamard	-
Rollerwave orientation	Horizontal	-



The market
requirements for
heat-treated glass

“at any peak to
valley the
deviation shall
not exceed
0,076mm”



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The market
requirements for
heat-treated glass

“rollerwave
maximum 0,06mm
and overall bow
max <0,001”



The standards for
heat-treated glass
are outdated

EN, ANSI and GB
quality specification
for rollerwave is
0,3mm...

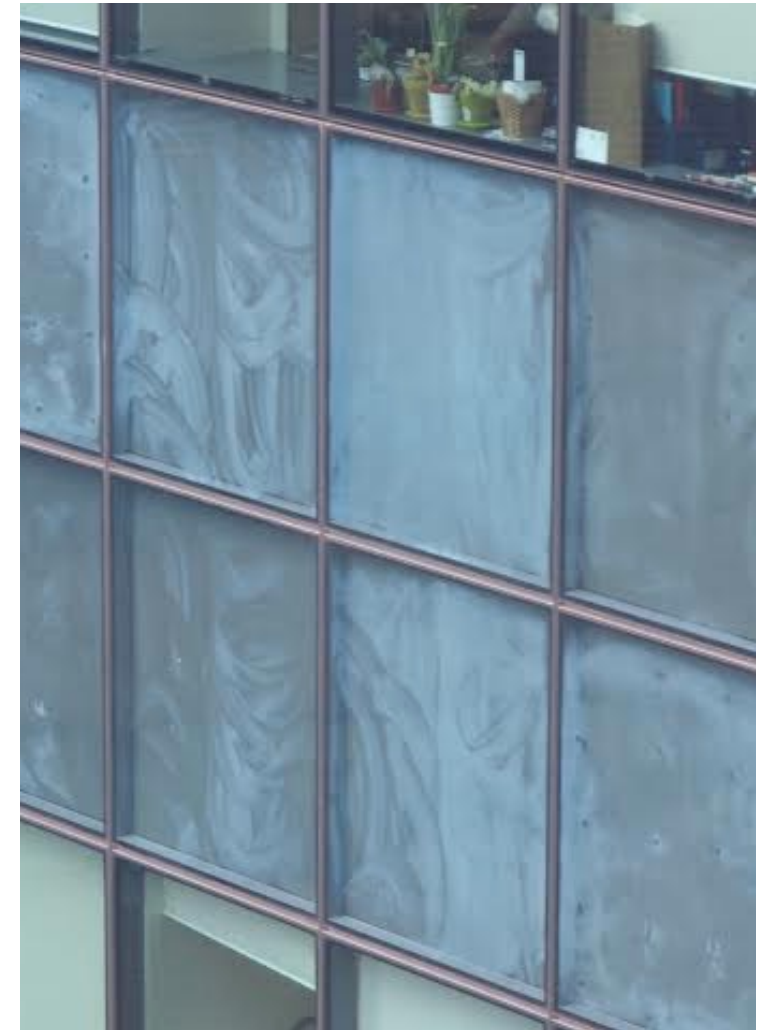


Picture source: www.gpd.fi © M. Elstner, Interpane Glasgesellschaft GmbH

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Other defects in addition to distortion

- Anisotropy
- Glass surface corrosion
- Hot spots / scratches / marks
- Coating burns
- Design faults

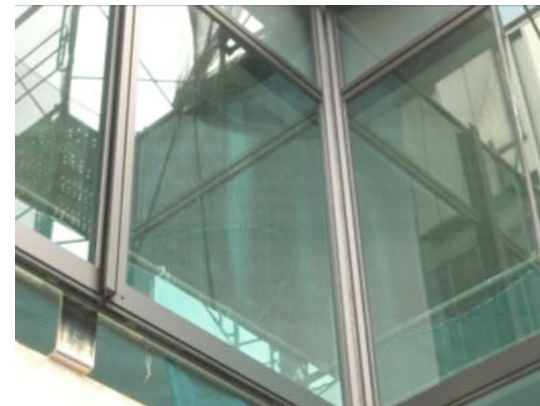


Summary of GPD – 2015, J.Vitkala
Source: www.gpd.fi © Peter Hartog,
Building Diagnostics Asia Pacific,
Chris Barry, Glass Consultant

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Anisotropy, iridescence, birefringence

- Bi-refrigent colour effect
- Characteristic for tempered glass, not (actually) a fault
- Caused by stress variations in glass (= variations in density, speed of light, refraction)
 - local unevenness of temperature during heating and quenching
- Intensity depends on amount of polarized light



What Is Anisotropy?



Summary of GPD – 2015, J. Vitkala
Source: www.gpd.fi ©Saverio Pasetto, Skanska UK

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Source: Vehmas, J., GLASTON

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No standards for anisotropy

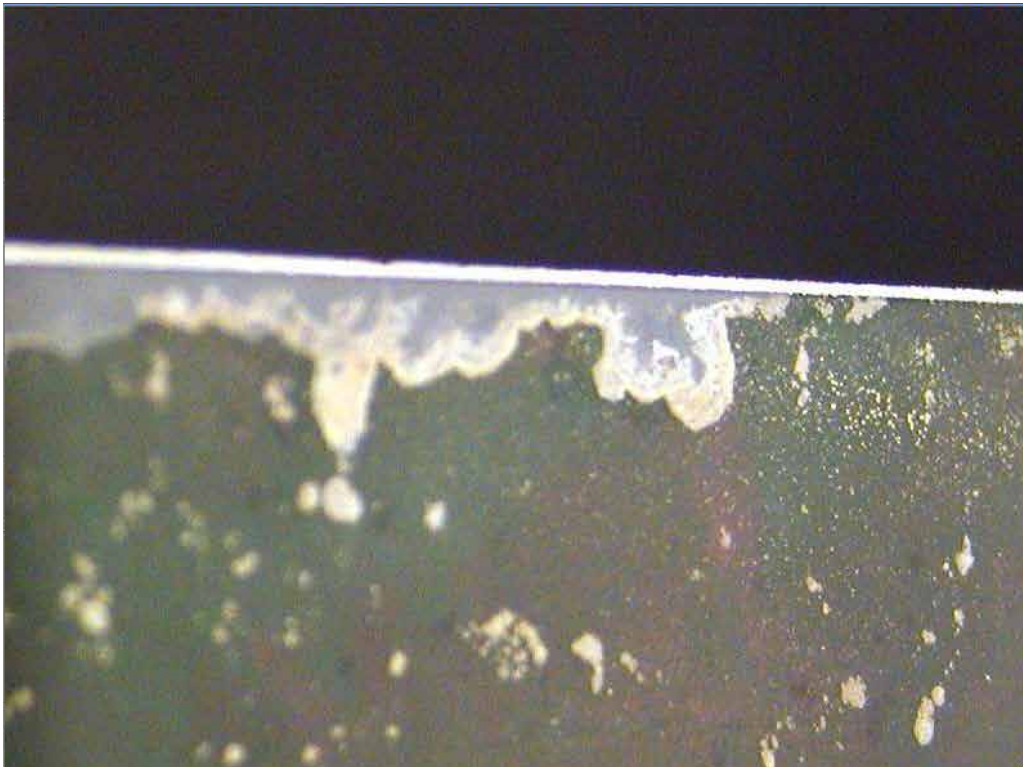


<http://lakhta.center/ru/>

Building owners
have created their
own standards for
anisotropy

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Coating burns / coating corrosion



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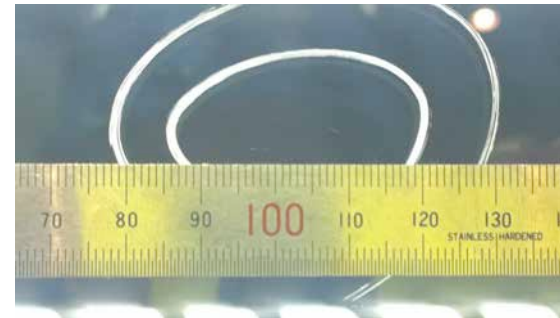
Coating Uniformity?



C.Barry GPD 2011

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The market requirements for heat-treated glass



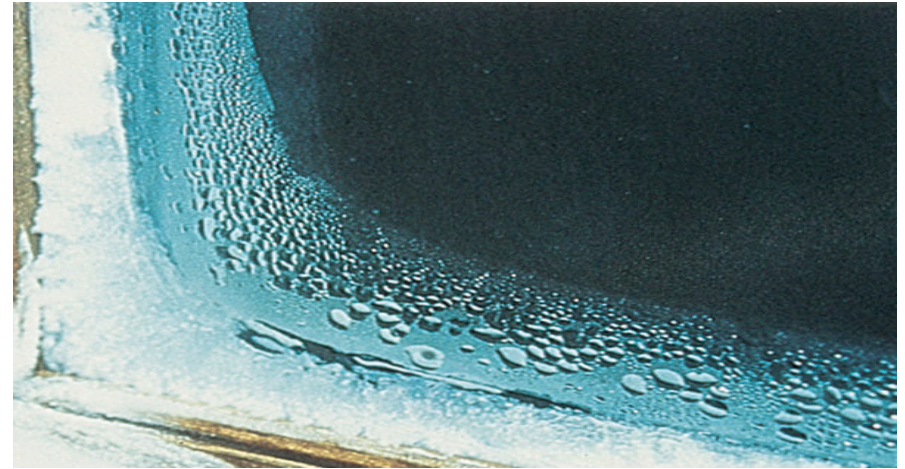
It's not only about
distortion

U-Factor vs. Condensation

Can lead to moisture or even frost formation on fenestration systems with otherwise very good U-factors



Source: GPD China 2012 ©



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**Glass
business
is
Global –
there is
no local
quality
anymore**

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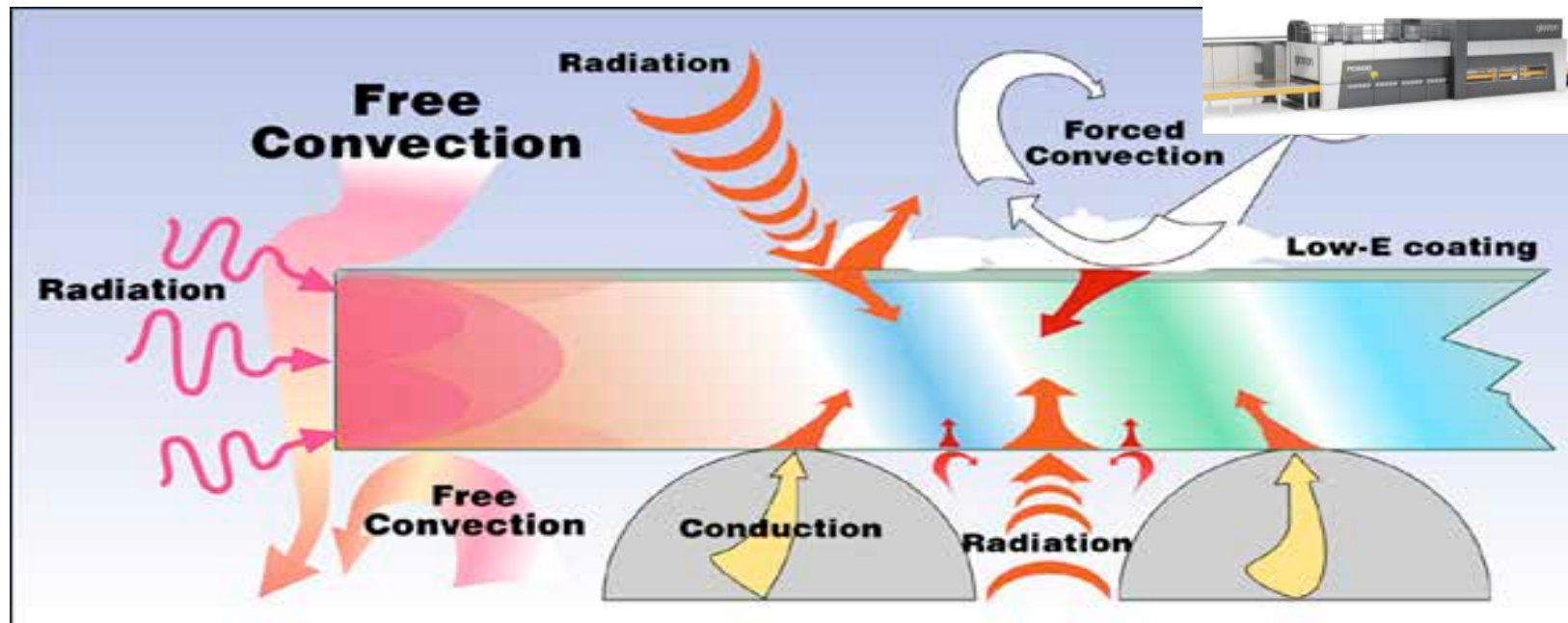


Solutions by the new technology

Solutions provided by the new technology

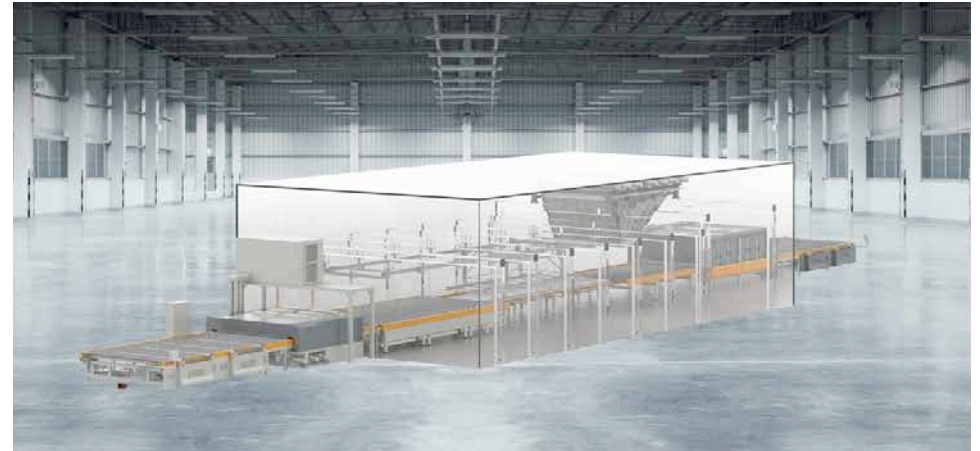
Tempering line has a huge effect on final façade outlook

Heat treatment / tempering can cause distortion	Distortion can be multiplied in lamination	Thickness variation along the glass
IG unit pressure level and environment condition	Reflective coating quality add the visibility of distortion	Pressure on the glazing will cause distortion



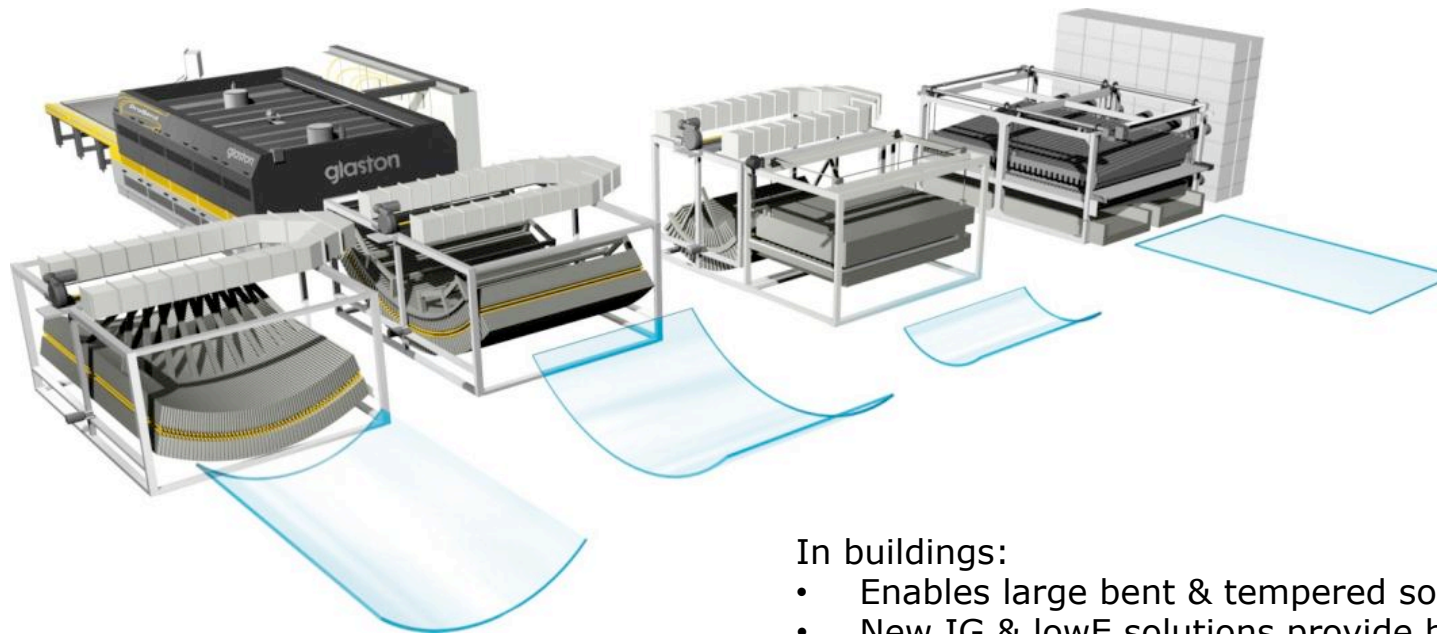
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Heat-treatment equipment has a big impact on final facade quality



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Curved shapes with laminatable quality are available



In buildings:

- Enables large bent & tempered solutions
- New IG & lowE solutions provide better energy efficiency compared to solid wall in flexible shapes

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Demand traceability for each glass – demand quality



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Automated solutions provide constant quality

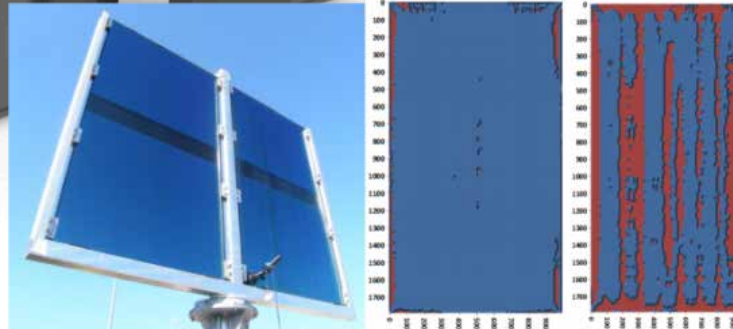
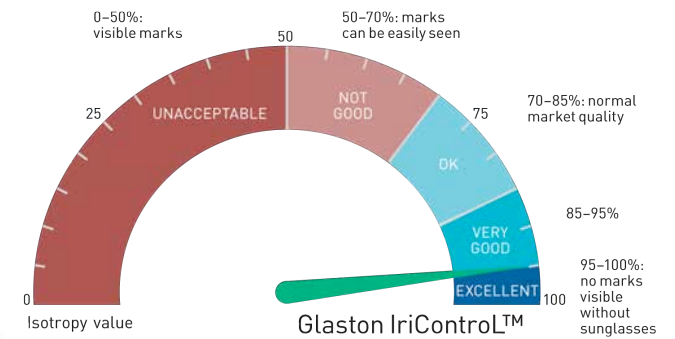
Glaston Assistant™ - Real-time automatic feedback on process optimization for better glass quality



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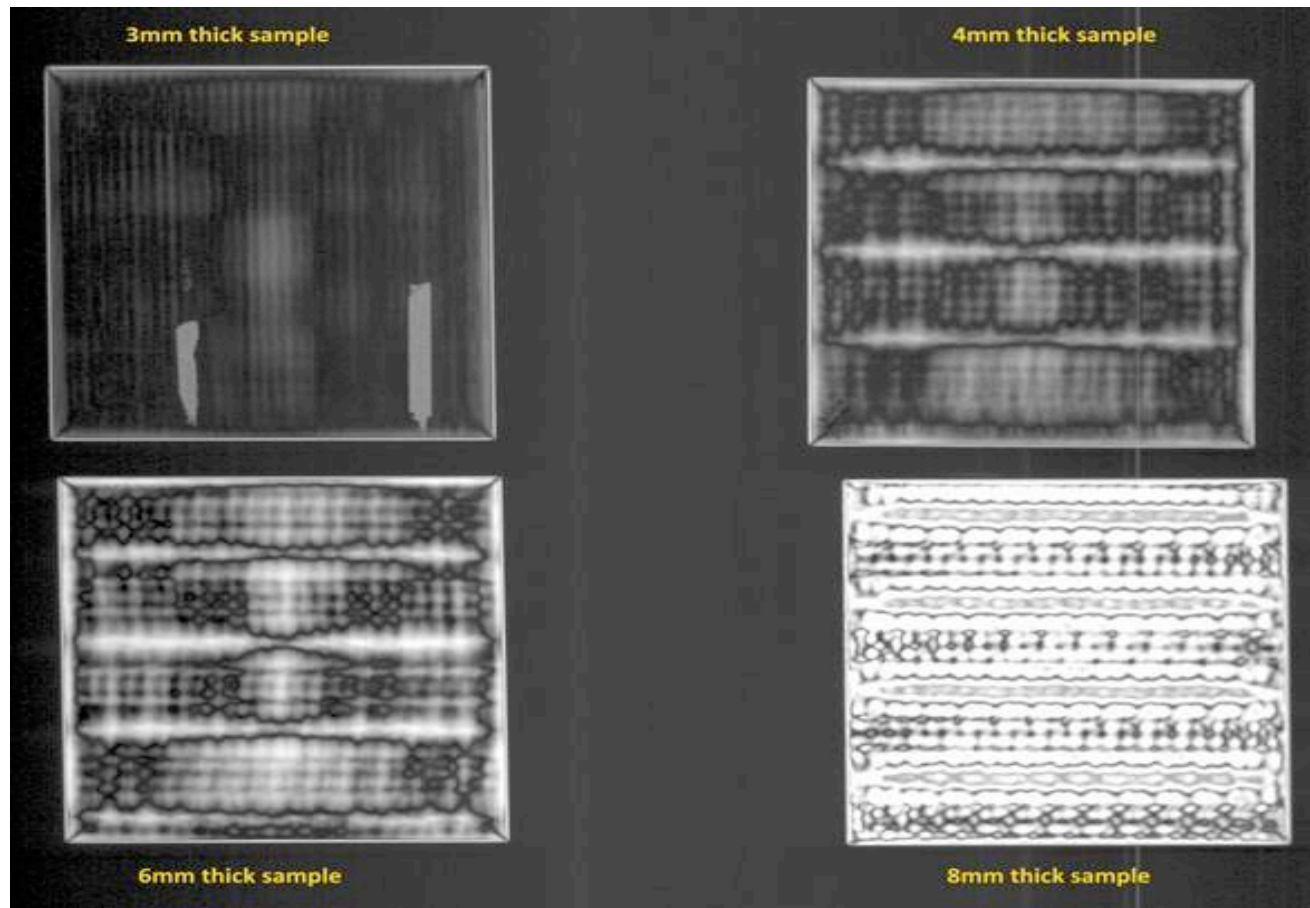
Solutions provided by the new technology

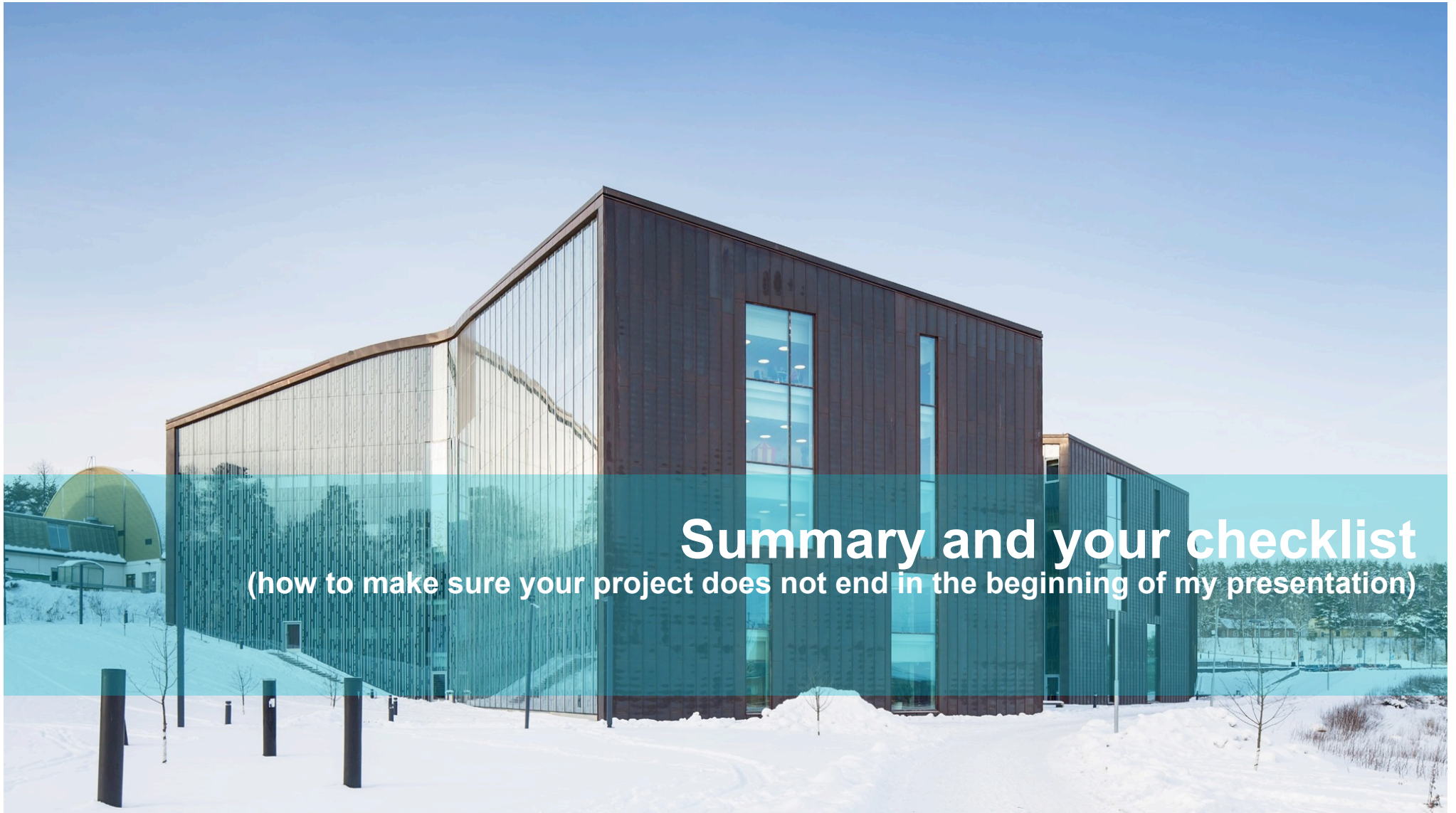
Glaston IriControl™ - a unique technology to minimize and measure the iridescence



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Online anisotropy measurement





Summary and your checklist

(how to make sure your project does not end in the beginning of my presentation)

How to ensure your project glazing does not end up in the beginning of my presentation

- Demand mock-up
- Right specification for the application
- Is the heat treatment technology up-to-date for today's requirements?
- How is the quality control arranged?
- See reference projects

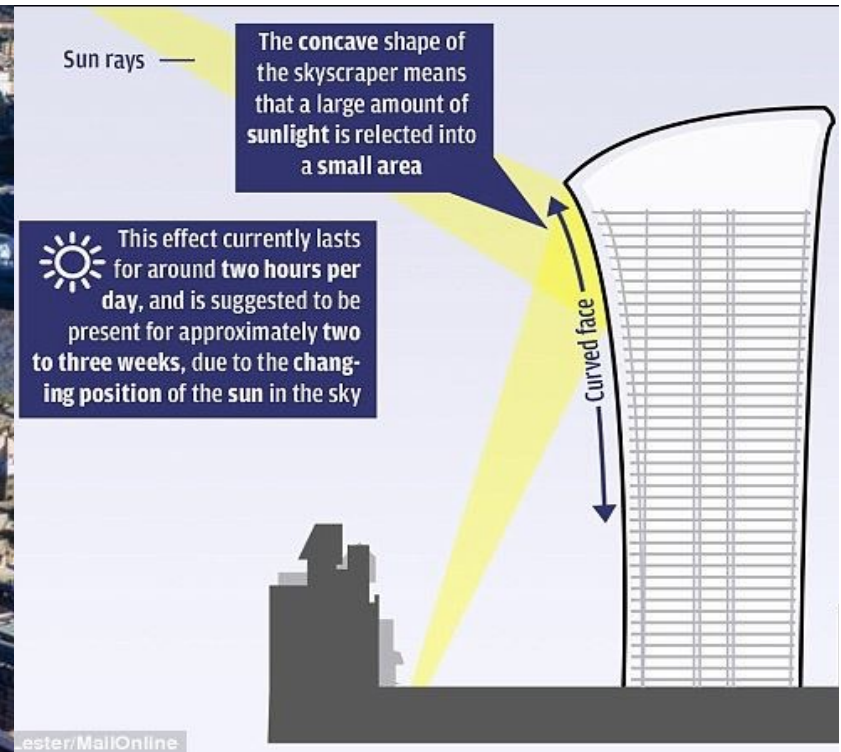


Thank you!

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The Death Ray Strikes Back



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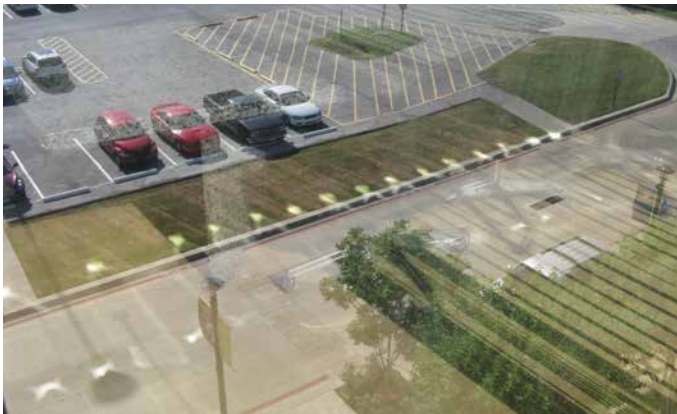
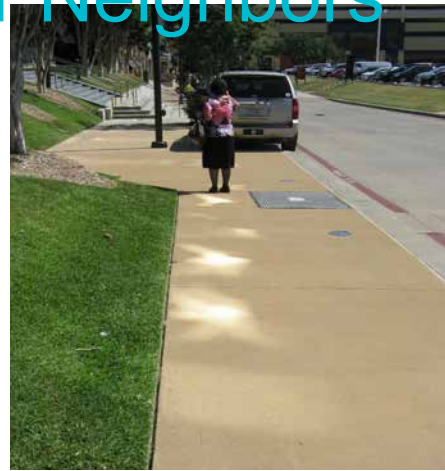
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When Buildings Attack Their Neighbors



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