The Summary Presentation of GPD Finland 2015
Jorma Vitkala GPD Chairman

GPD 2015 Summary Presentation is compiled from over 140 presentations
and from over 8000 slides.

GPD 25 Years In Brief 1992 – 2017

GPD is an independent forum dedicated to the development of the global glass industry supply chain through education.

Gpd history in numbers 1992-2016:

- Over 1000 spekers
- Over 12000 specialists visitors
- Over 100 different countries
- Over 40 media partners
- Over 8000 pages publish articles

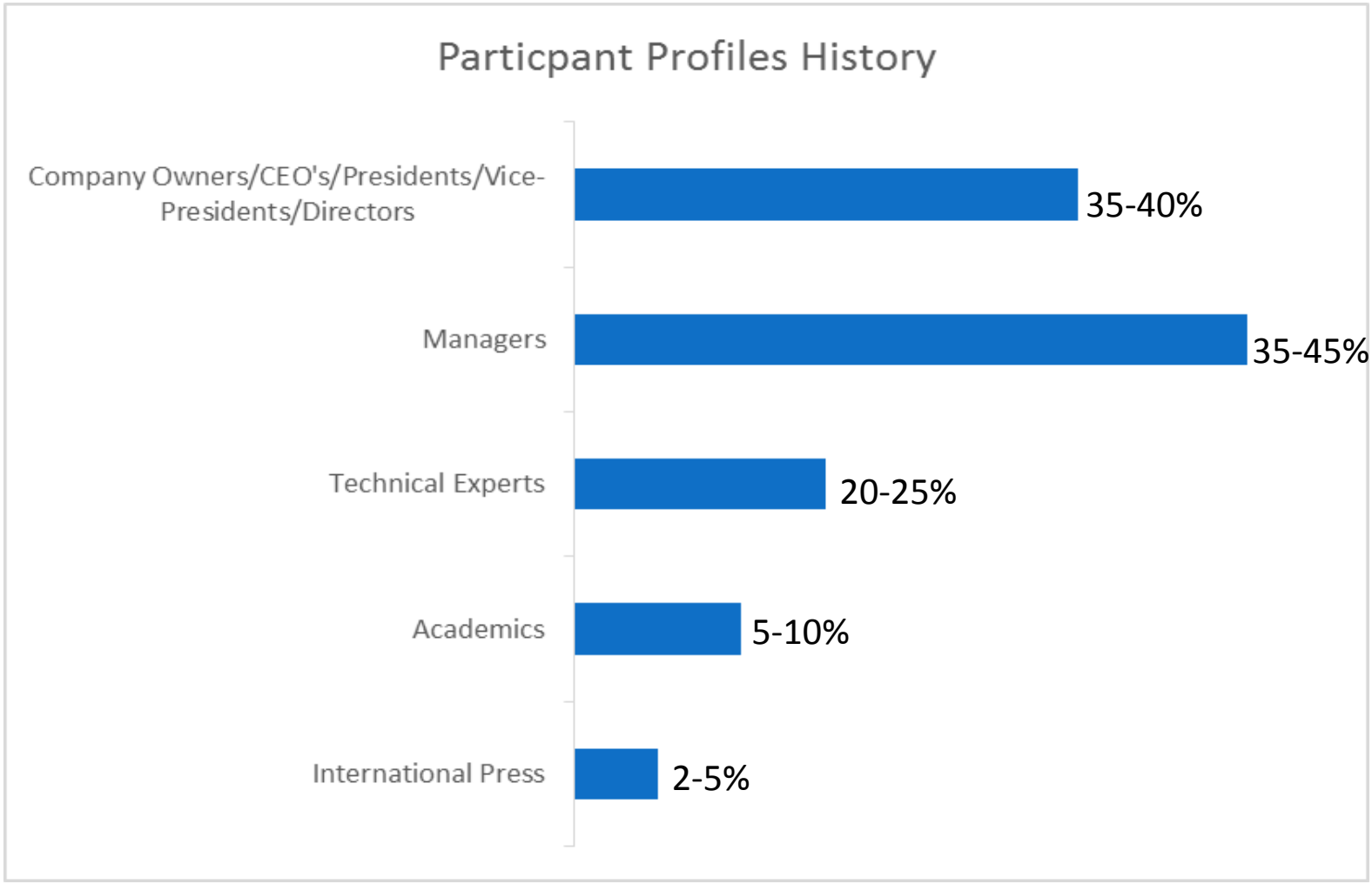
Conferences & seminars to the entire glass industry supply chain:

Finland, China, Brazil ,India, Turkey, Azerbaijan, Singapore ,UK and Cuba

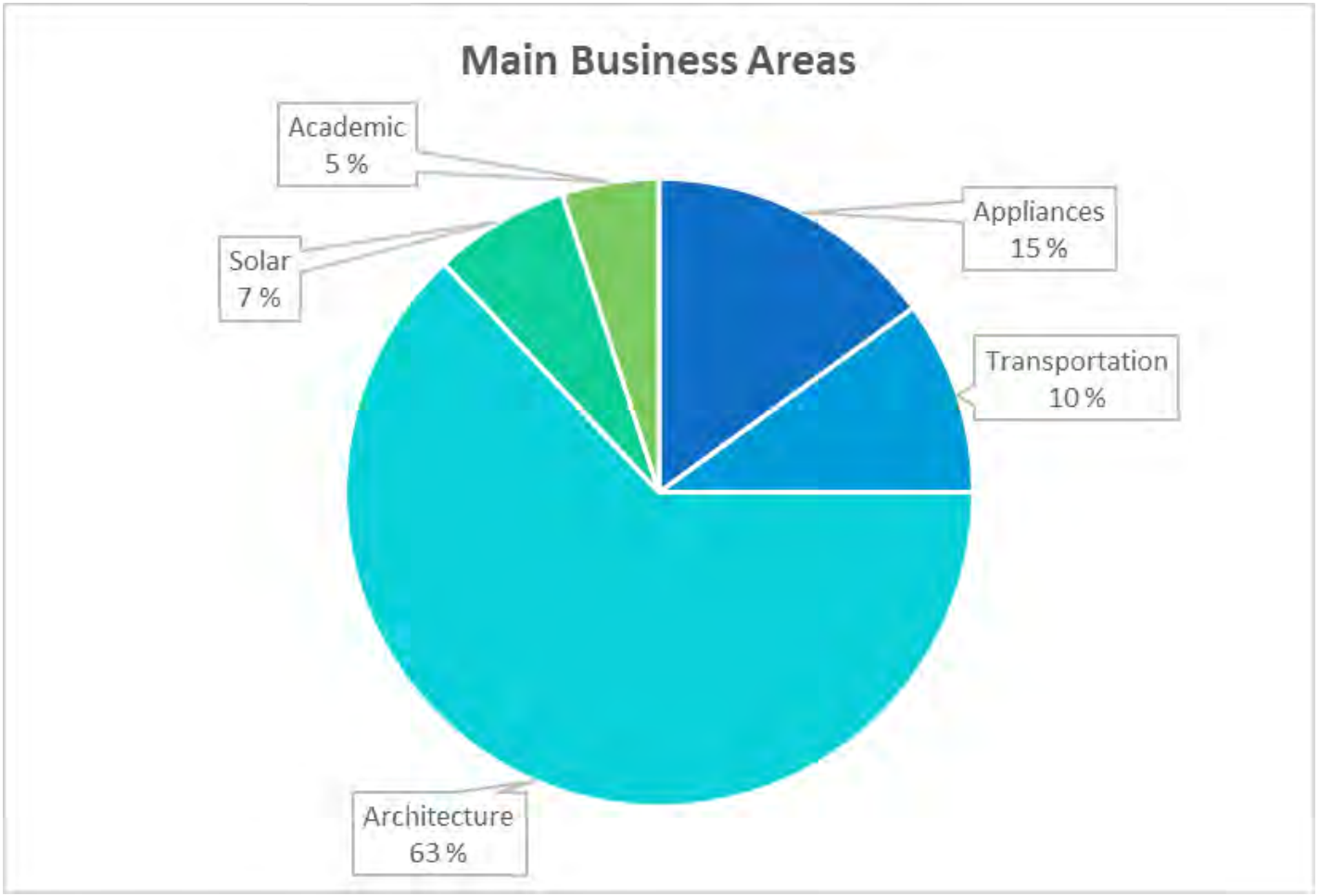
Participant History

- Since 1992
  - Over 12 000 participants since 1992
  - Over 1 000 speakers
  - Over 10 000 pages of technical papers published
- In 2017, the target is to get around 800 participants to attend, since GPD will be celebration its 25th anniversary

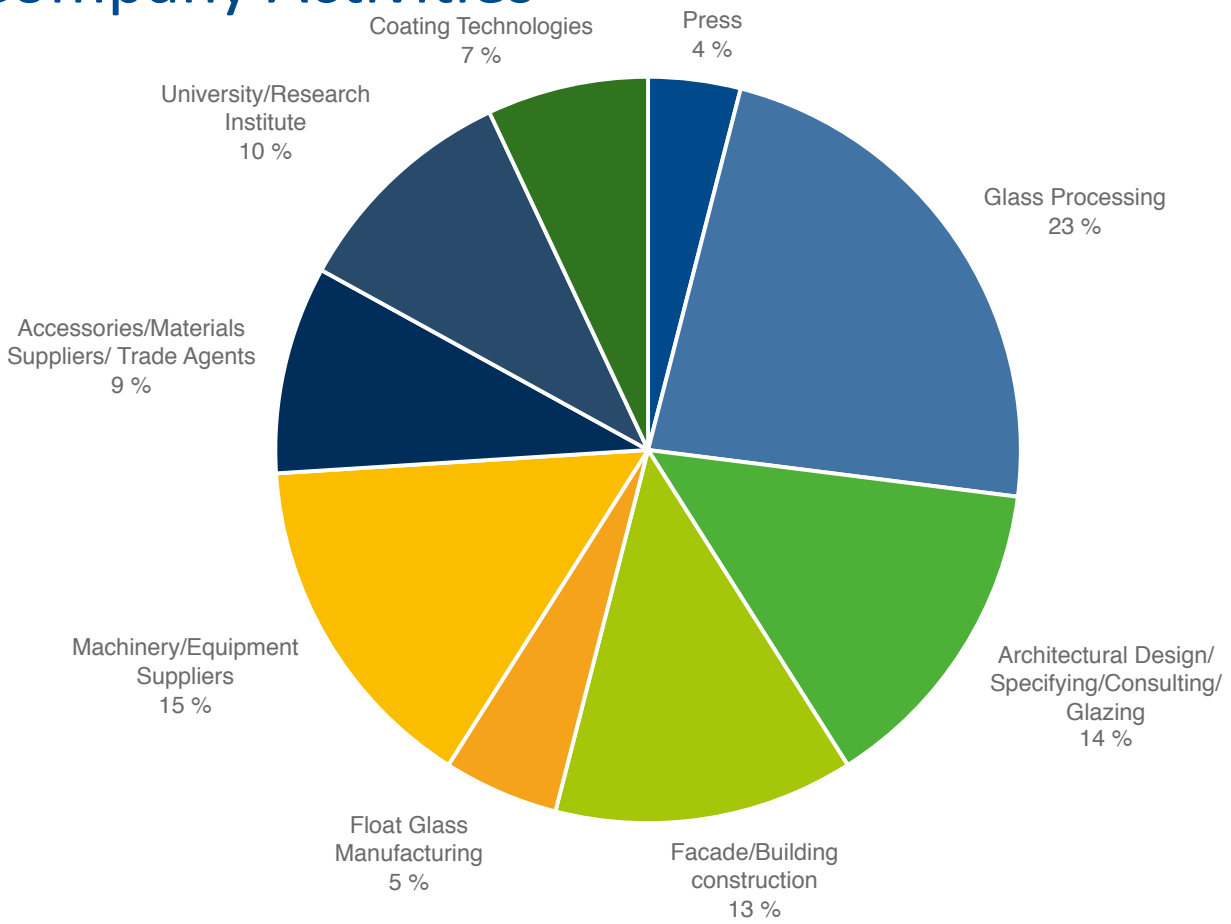
Participant Seniority Profiles



Participant Main Business Area



Participant Company Activities



A Summary Presentation of GPD Finland 2015: Market and Trends

	Flat Glass	Container Glass
Yearly production (world)	70 million tons	50 million tons
Business	80 billion US$	55 billion US$

New comers in the flat glass business

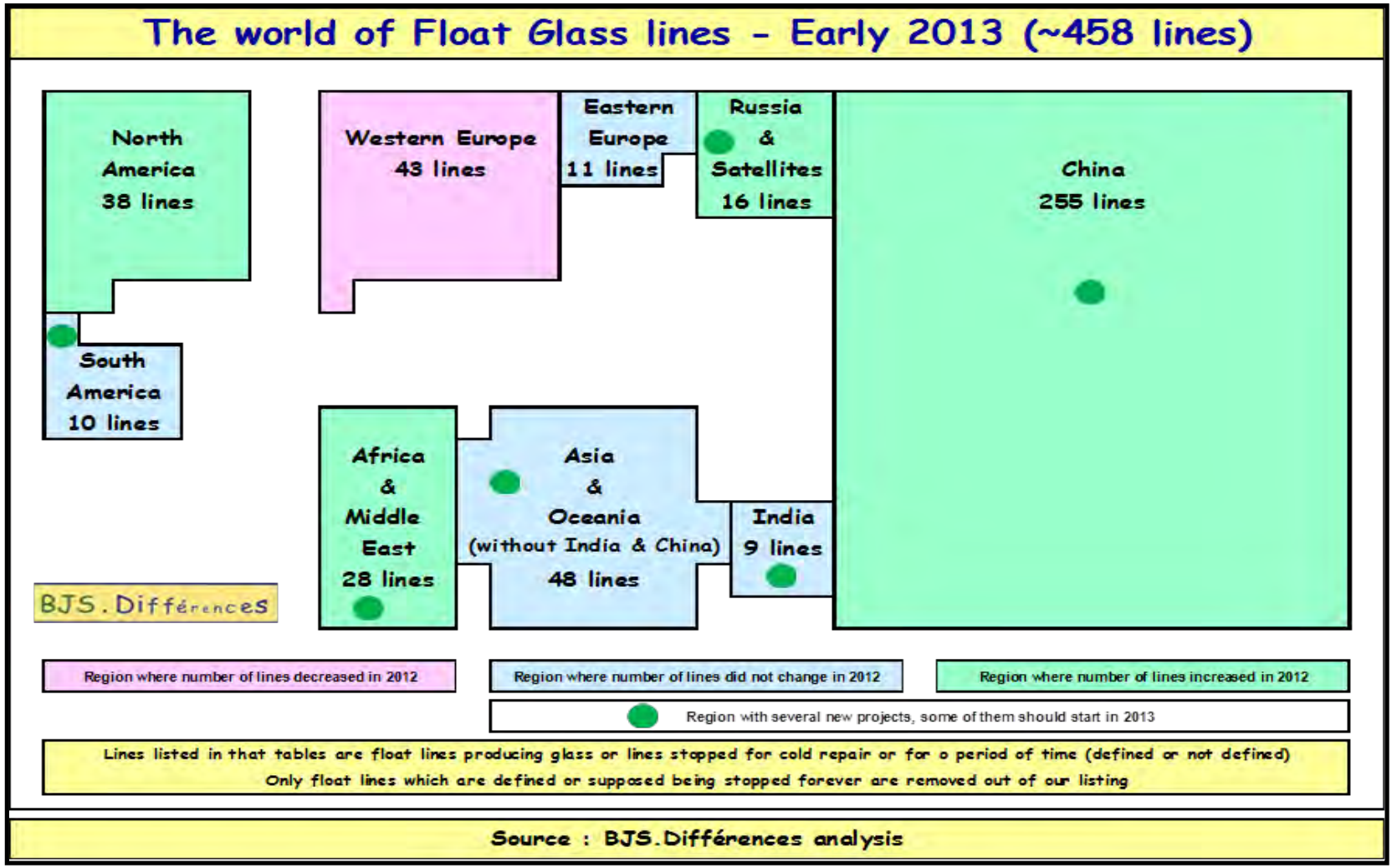
Extra thin glass for portable devices and LCD did bring new comers inside the flat glass business, such as:

- Corning
- LG Chem
- Avanstrate

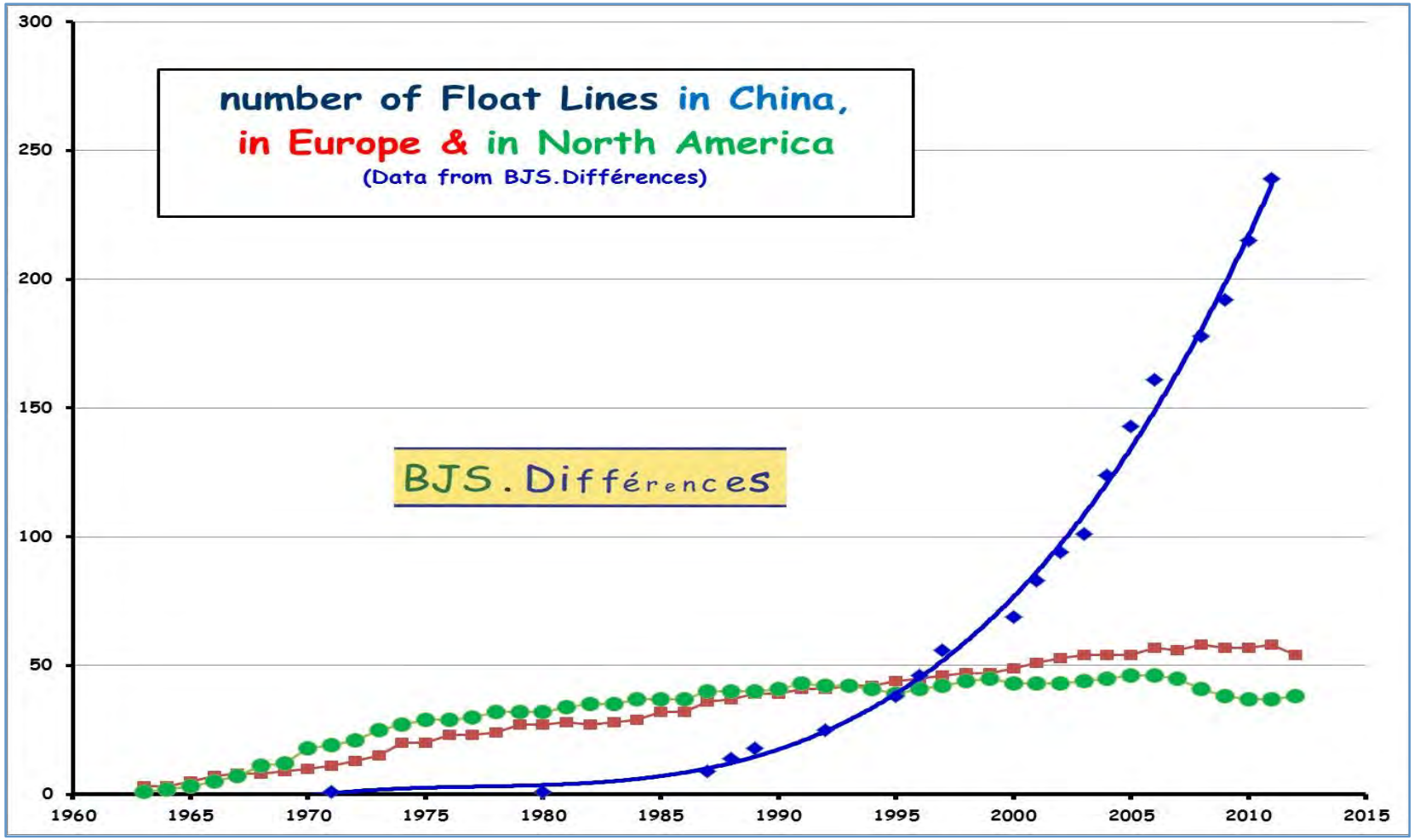
Main usages of flat glass			
Business		% (volume)	
Building	New building	35	
	Refurbishment	35	
	Interior	13	
	Total		83
Other	Solar energy	2,5	
	Other	7	
	Total		9,5
Automobile	Original equipment	6	
	Aftermarket	1,5	
	Total		7,5
Grand total		100	

GLASS PERFORMANCE DAYS 2015

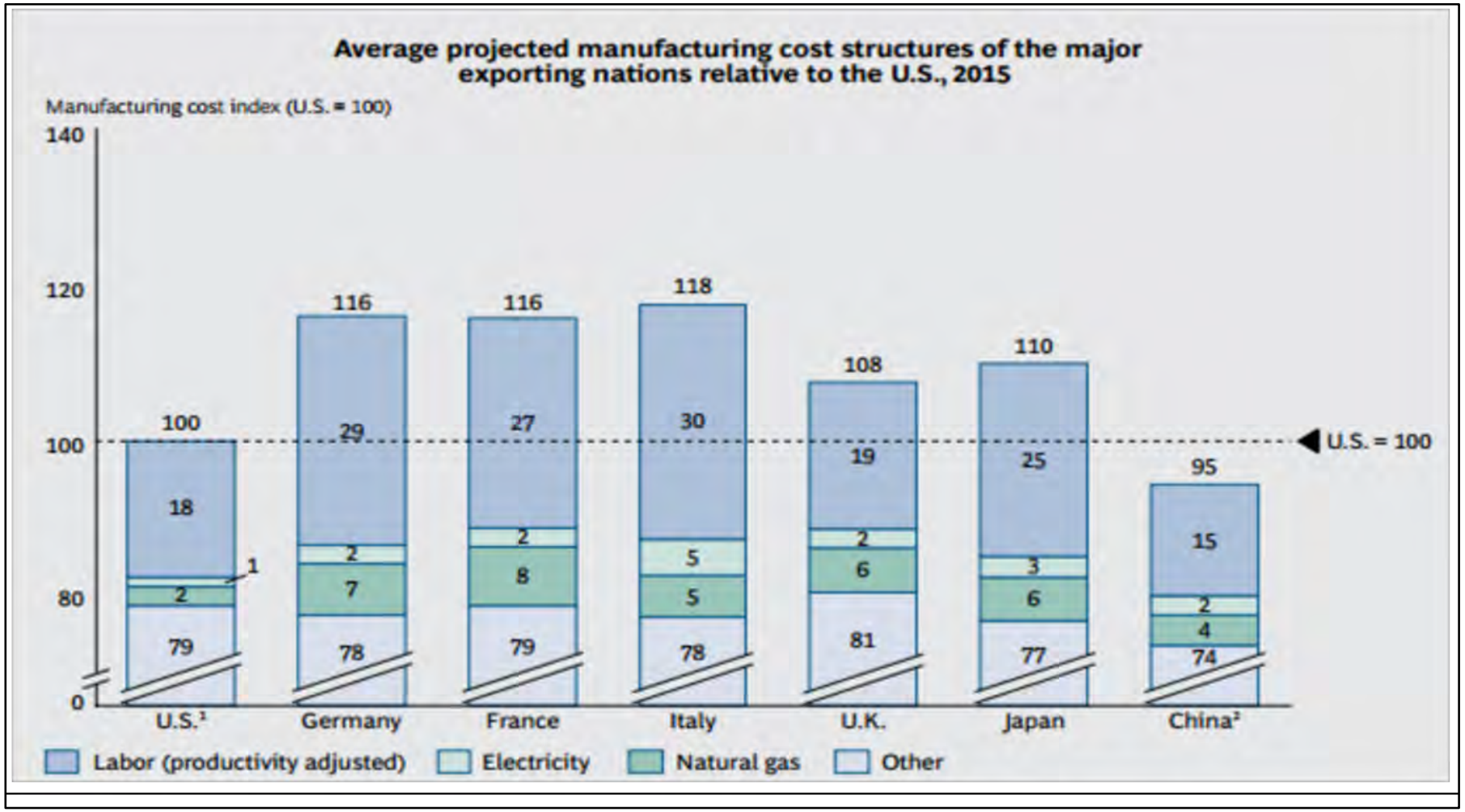
World map of float glass lines - status early 2013



Evolution of number of float lines vs. time (up to 2012)



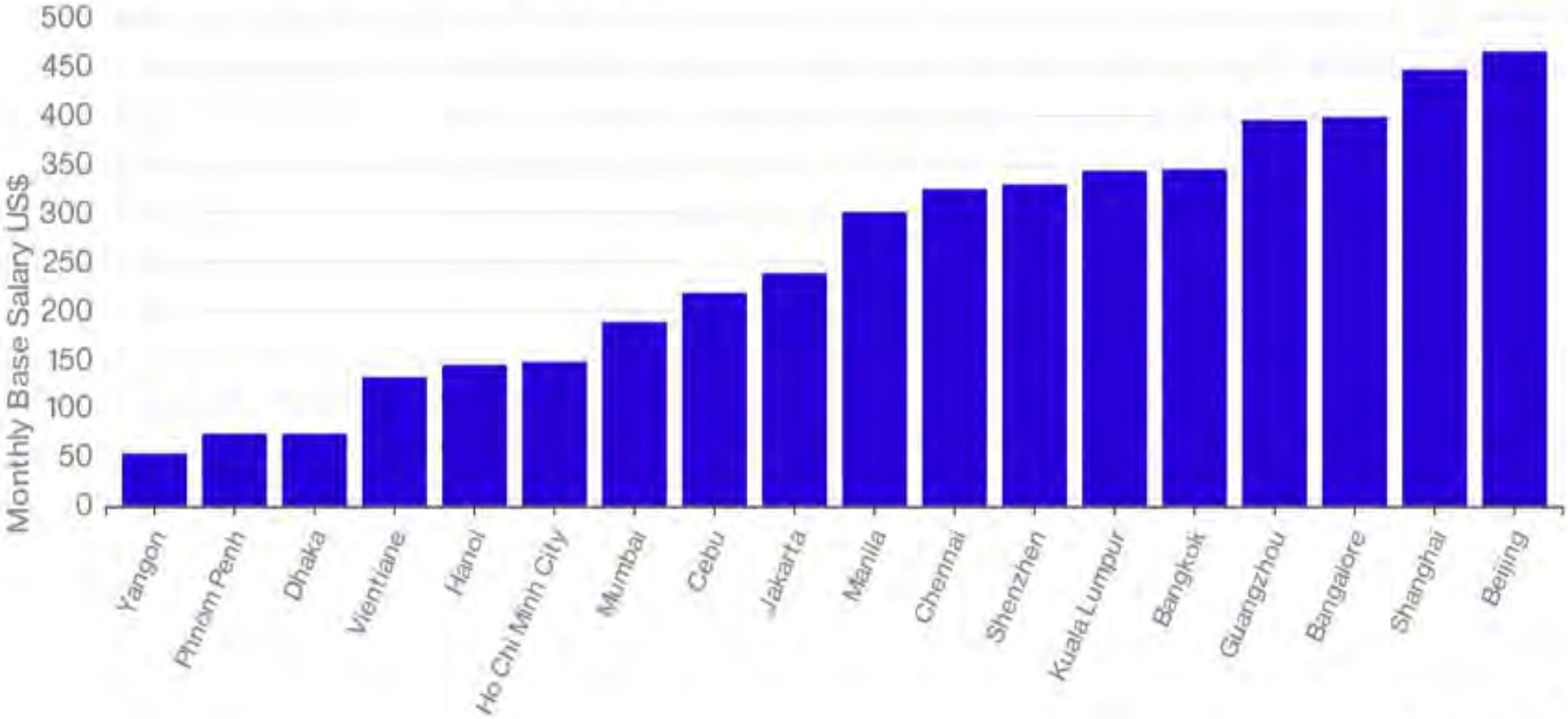
The US as one of the developed world's lowest-cost manufacturers



Selected 2013 & 2014 facts (24/31). Boston Consulting Group (08/2013)

Asian Labor Costs

Factory workers' wages in emerging Asia



From http://www.bloomberg.com/news/articles/2015-04-29/china-is-set-to-lose-manufacturing-crown

29 April 2015

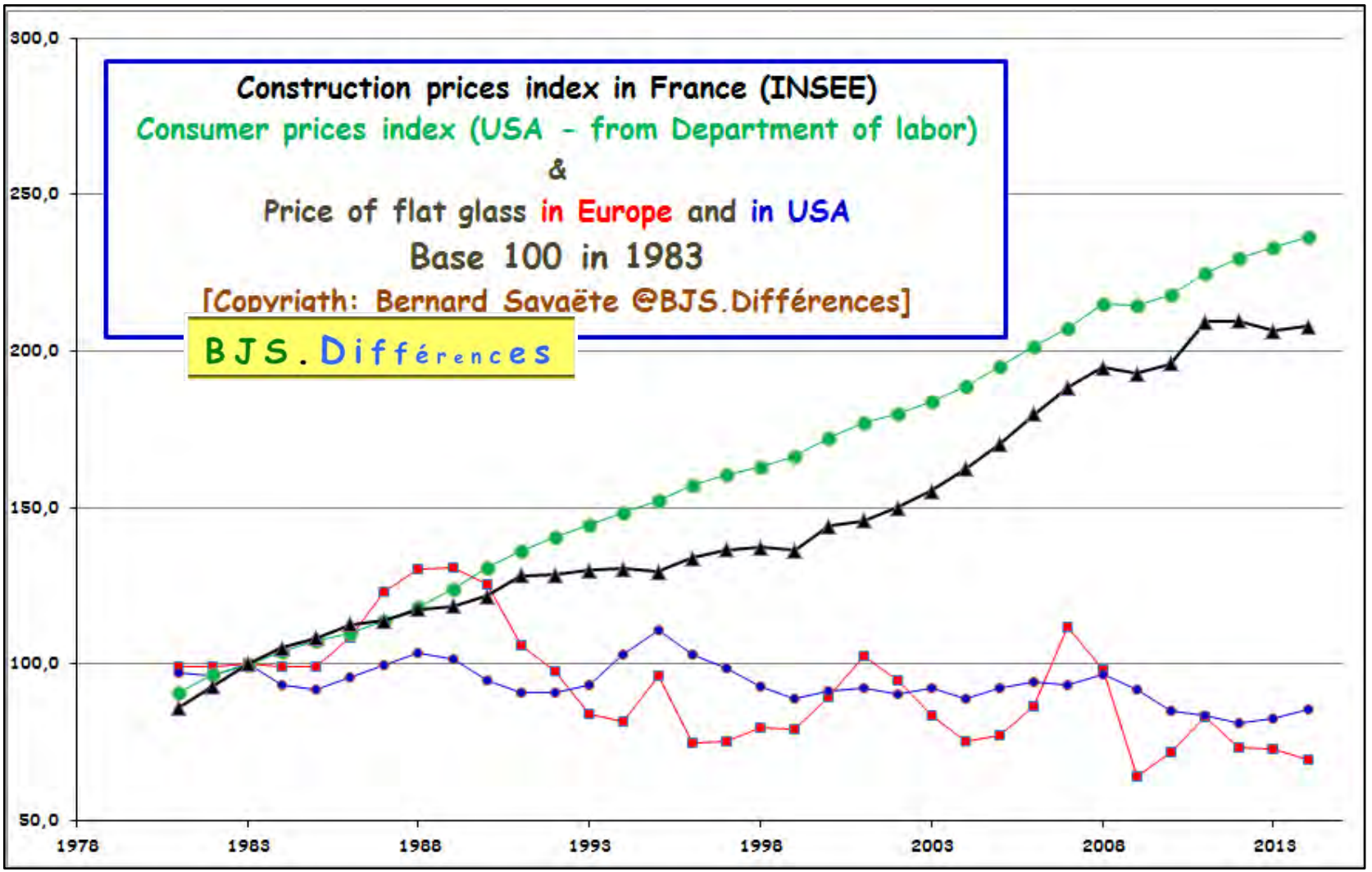
Bloomberg

	Electricity prices (per kWh)					
	Households (1)			Industry (2)		
	2012s2	2013s2	2014s2	2012s2	2013s2	2014s2
EU-28	0.195	0.202	0.208	0.116	0.118	0.120
Euro area	0.205	0.215	0.221	0.122	0.126	0.128
Belgium	0.222	0.222	0.204	0.111	0.110	0.109
Bulgaria(***)	0.096	0.088	0.090	0.078	0.073	0.084
Czech Republic	0.150	0.149	0.127	0.103	0.099	0.082
Denmark	0.297	0.294	0.304	0.099	0.100	0.088
Germany	0.268	0.292	0.297	0.130	0.144	0.152
Estonia	0.112	0.137	0.133	0.082	0.097	0.093
Ireland	0.229	0.241	0.254	0.140	0.137	0.131
Greece	0.142	0.170	0.179	0.122	0.124	0.130
Spain	0.228	0.227	0.237	0.120	0.120	0.117
France	0.145	0.159	0.175	0.079	0.085	0.091
Croatia	0.138	0.135	0.132	0.094	0.094	0.092
Italy	0.230	0.232	0.234	0.178	0.172	0.174
Cyprus	0.291	0.248	0.236	0.234	0.201	0.190
Latvia	0.137	0.136	0.130	0.111	0.115	0.118
Lithuania	0.127	0.139	0.132	0.114	0.123	0.117
Luxembourg	0.171	0.165	0.174	0.101	0.100	0.099
Hungary	0.162	0.133	0.115	0.100	0.098	0.090
Malta	0.168	0.169	0.125	0.186	0.186	0.186
Netherlands	0.190	0.192	0.173	0.097	0.094	0.089
Austria	0.202	0.202	0.199	0.112	0.111	0.106
Poland	0.153	0.144	0.141	0.096	0.088	0.083
Portugal	0.206	0.213	0.223	0.115	0.114	0.119
Romania	0.108	0.128	0.125	0.076	0.082	0.081
Slovenia	0.154	0.166	0.163	0.094	0.095	0.085
Slovakia	0.172	0.168	0.152	0.127	0.127	0.117
Finland	0.156	0.156	0.154	0.074	0.075	0.072
Sweden	0.208	0.205	0.187	0.078	0.075	0.067
United Kingdom	0.179	0.180	0.201	0.119	0.120	0.134

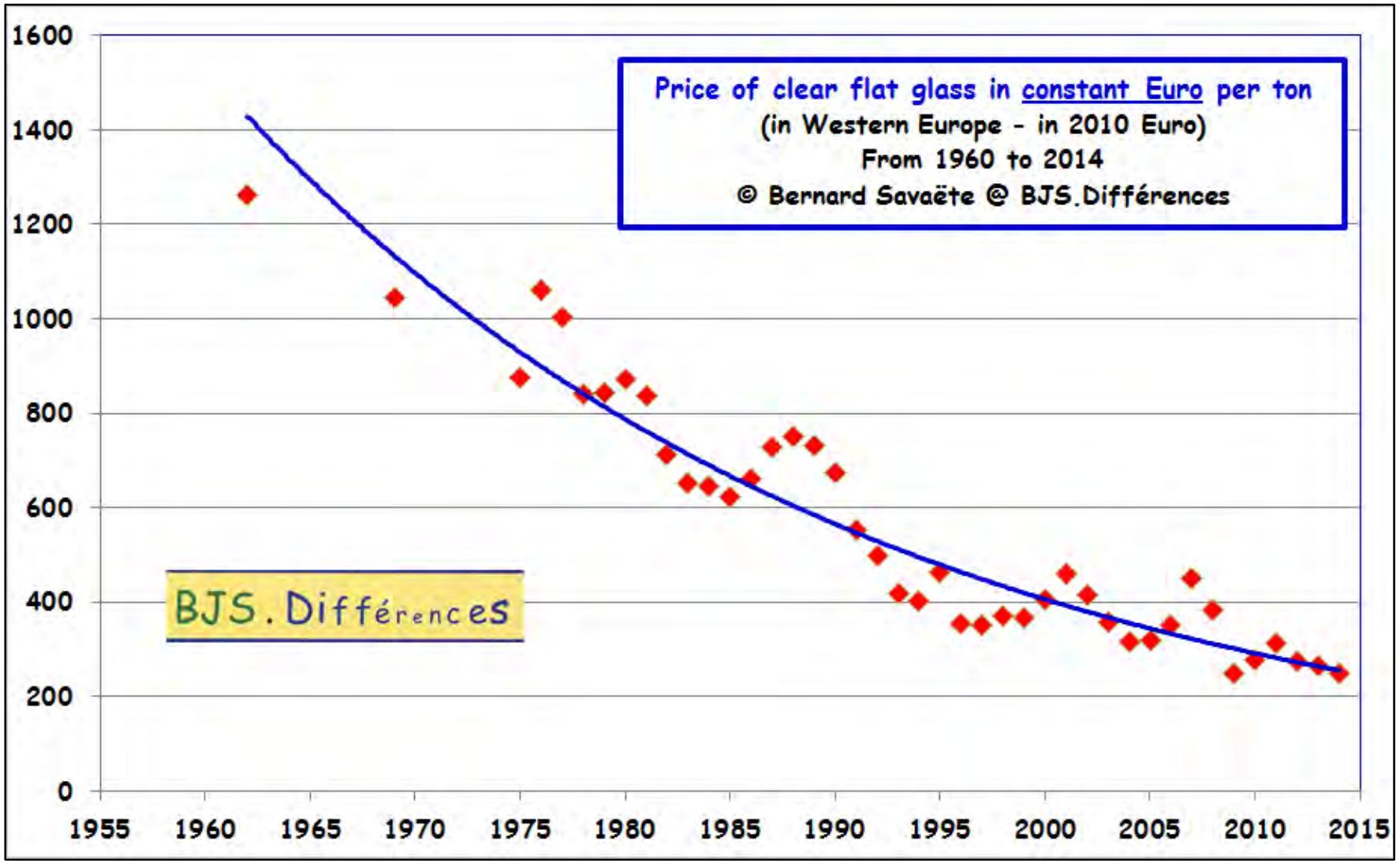
Electricity prices in Europe (Euros per Kwh)

Source : Eurostat

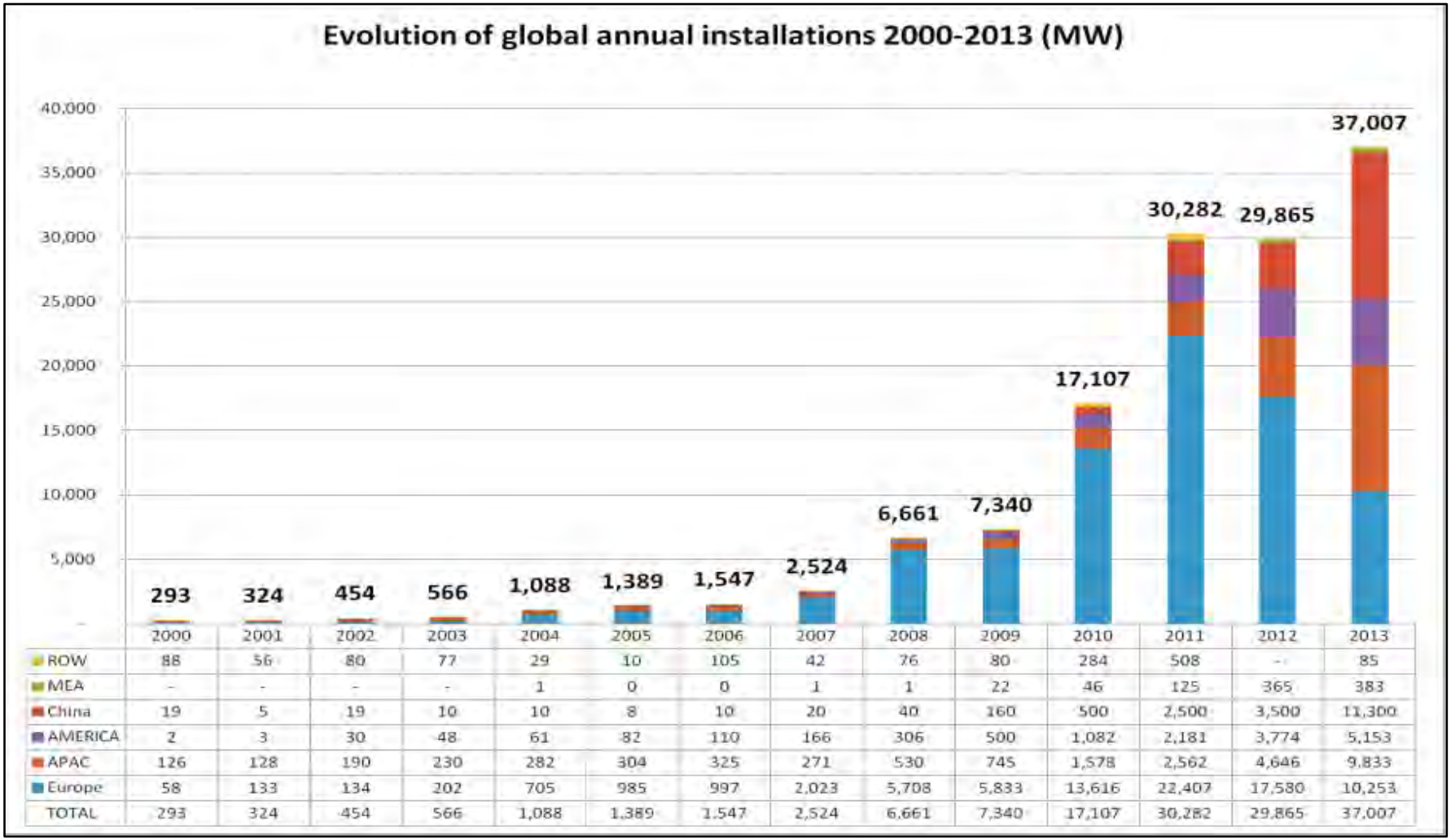
Selling prices of clear glass in USA & Europe (1981-2015) vs. consumer prices & construction index prices



Selling prices of clear glass in Europe (1960-2015)



World solar capacity



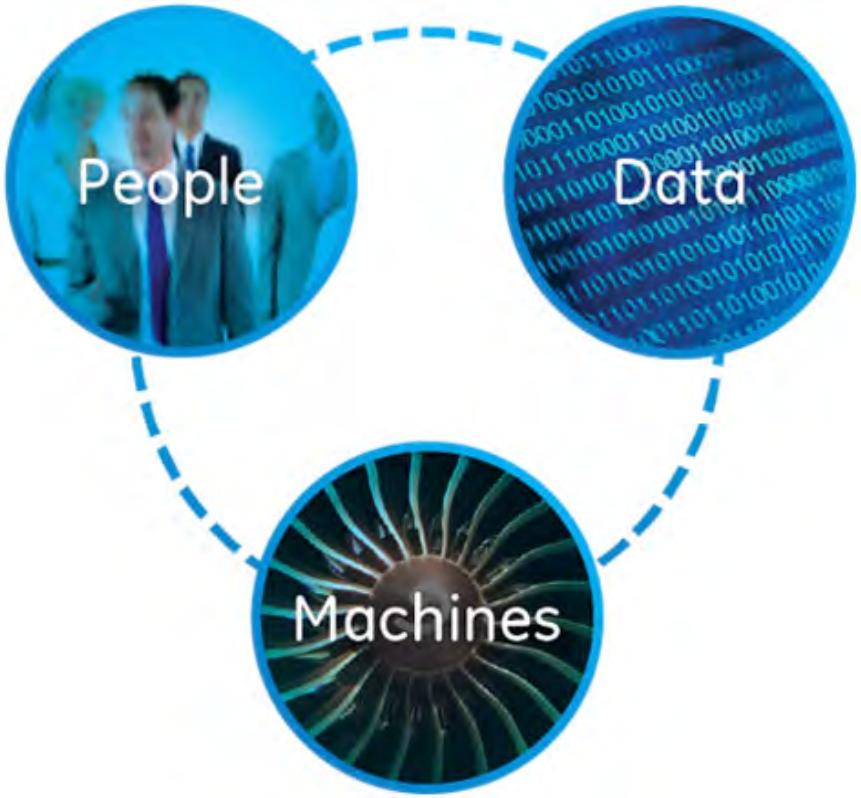
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
ROW	88	56	80	77	29	10	105	42	76	80	284	508	-	85
MEA	-	-	-	-	1	0	0	1	1	22	46	125	365	383
China	19	5	19	10	10	8	10	20	40	160	500	2,500	3,500	11,300
AMERICA	2	3	30	48	61	82	110	166	306	500	1,082	2,181	3,774	5,153
APAC	126	128	190	230	282	304	325	271	530	745	1,578	2,562	4,646	9,833
Europe	58	133	134	202	705	985	997	2,023	5,708	5,833	13,616	22,407	17,580	10,253
TOTAL	293	324	454	566	1,088	1,389	1,547	2,524	6,661	7,340	17,107	30,282	29,865	37,007

Selected 2013 & 2014 facts (23/31).

Potential weight savings

Lightweight option / Current glazing	1.6 mm Glass 0.76 mm New Interlayer 1.6 mm Glass	1.3 mm Glass 0.76 mm New Interlayer 1.3 mm Glass	Additional Benefit
	Weight Savings		
4.0 mm Glass	13% (1.3 kg/m²)	28% (2.8 kg/m²)	Greatly improved acoustic properties
2.0 mm Glass 0.76 mm PVB 2.0 mm Glass	19% (2.1 kg/m²)	33% (3.6 kg/m²)	

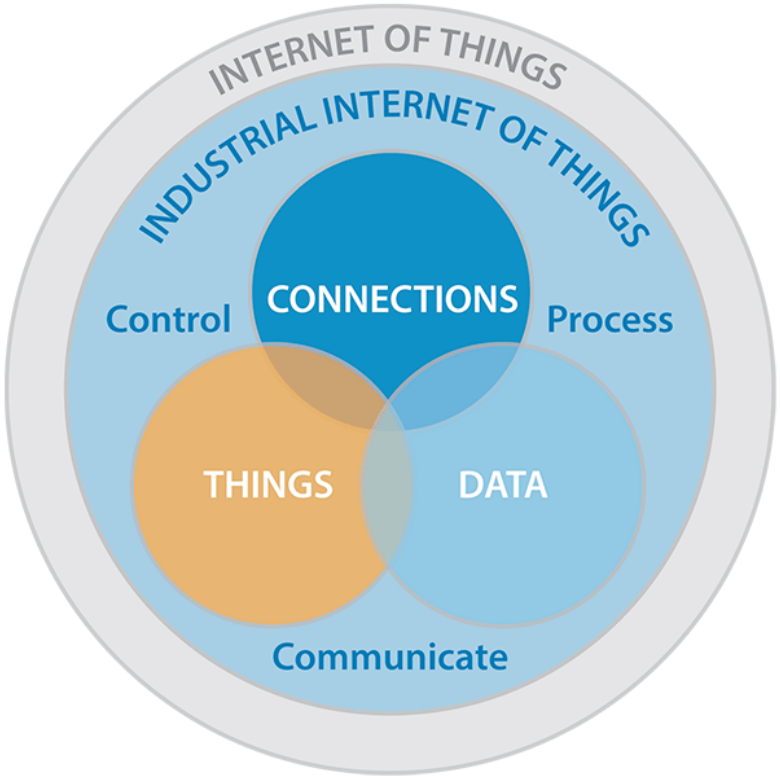
Internet of Things – What is it?



Tieto Corporation defines IoT following way:

Internet of Things will put customer demand, production and supplier data in context at a rate that is faster and more accessible. This in turn will lead to lower costs, increased efficiency and faster response times.

Internet of Things – Future



In the next generation glass processing factory:

- All machines from cutting all the way to final shipment are connected together **(Also to ERP system)**
- Machines can automatically schedule "their" maintenance brakes and spares
- Machines can inform ERP systems to reserve production breaks accordingly
- ERP system can automatically inform CRM system to modify lead times accordingly

NEW DESIGN

“Treat each and every project as if it the last one you will ever do. The project should respond to its use, respect its climate, achieve the highest level of craft possible, utilize innovative and appropriate technology and reflect how you want to be remembered”

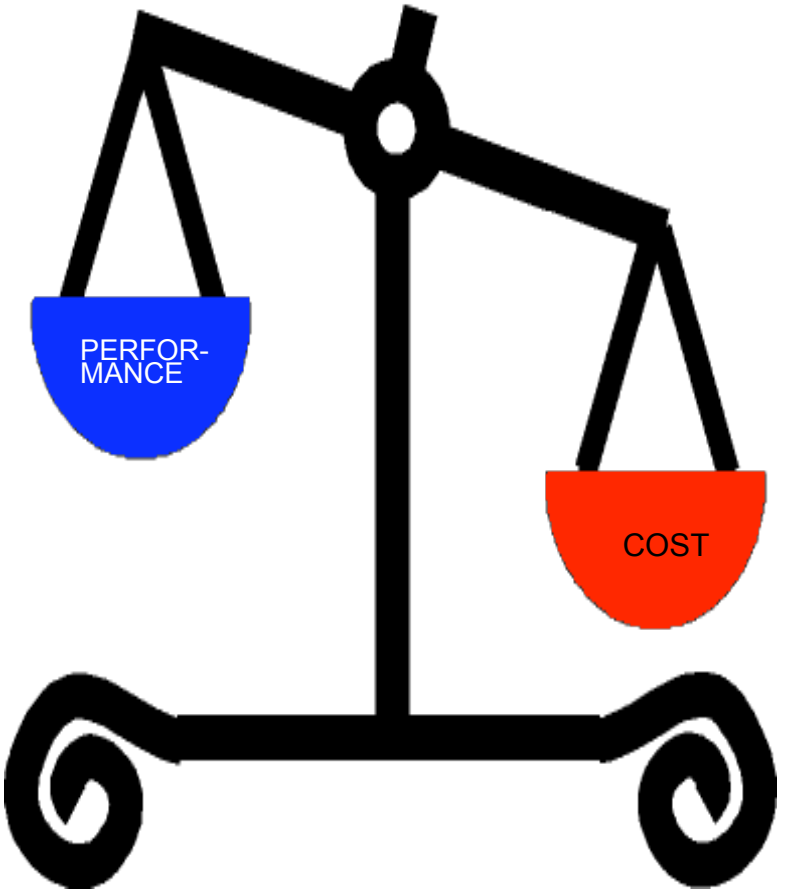
C. Keith Boswell

SOM

Summary of GPD – 2015, J.Vitkala

Source: www.gpd.fi

HIGH PERFORMANCE DESIGN - An Architects Perspective



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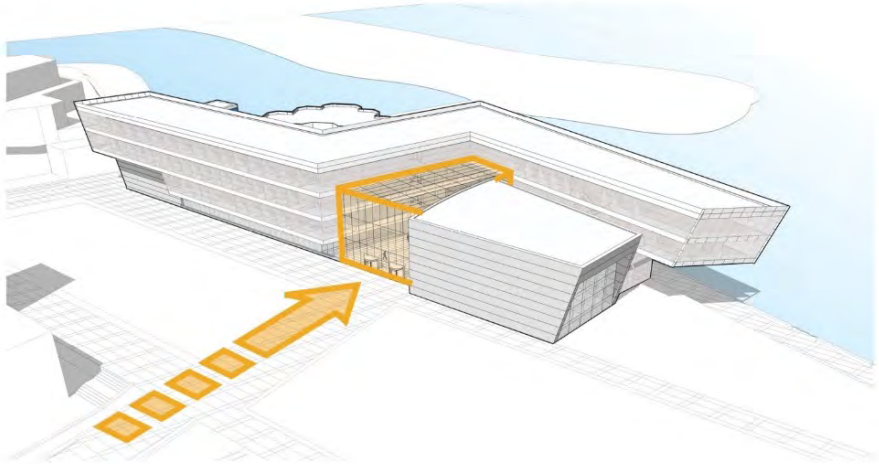
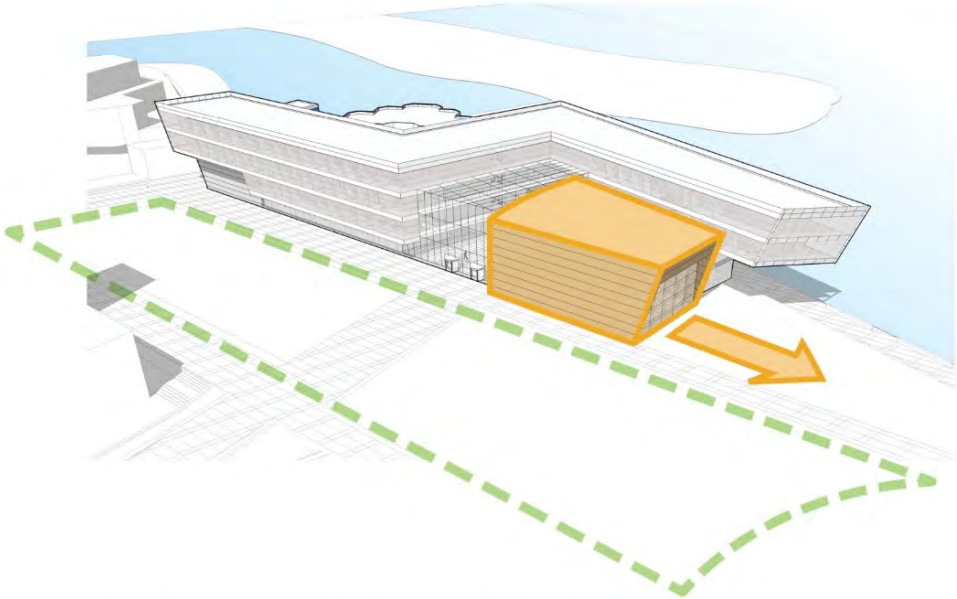
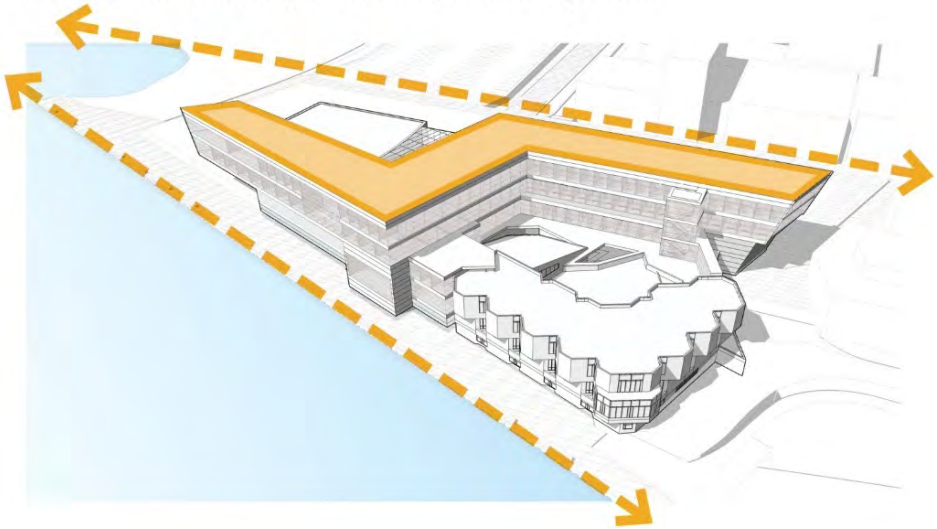
Dynamic building entry sequence with main vehicular access drive



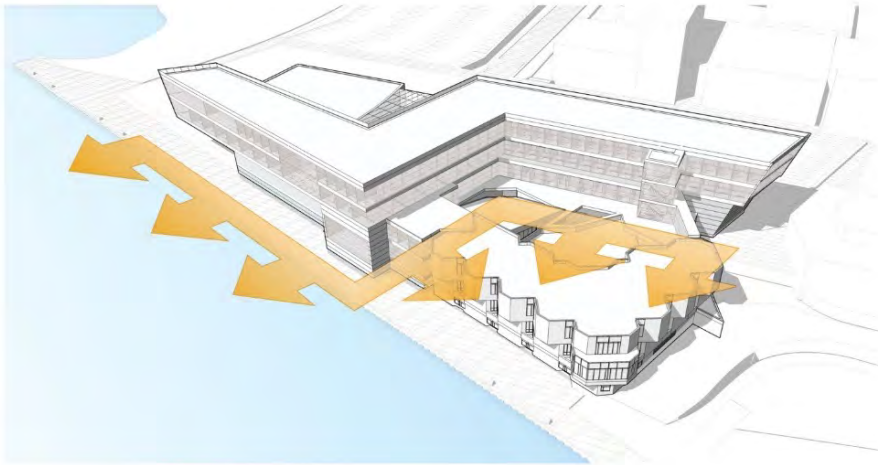
Prominent recital hall with dramatic views to Lake Michigan and Chicago skyline



Building orientation shape with strong relationship to site



Maximize occupant's view towards Lake Michigan



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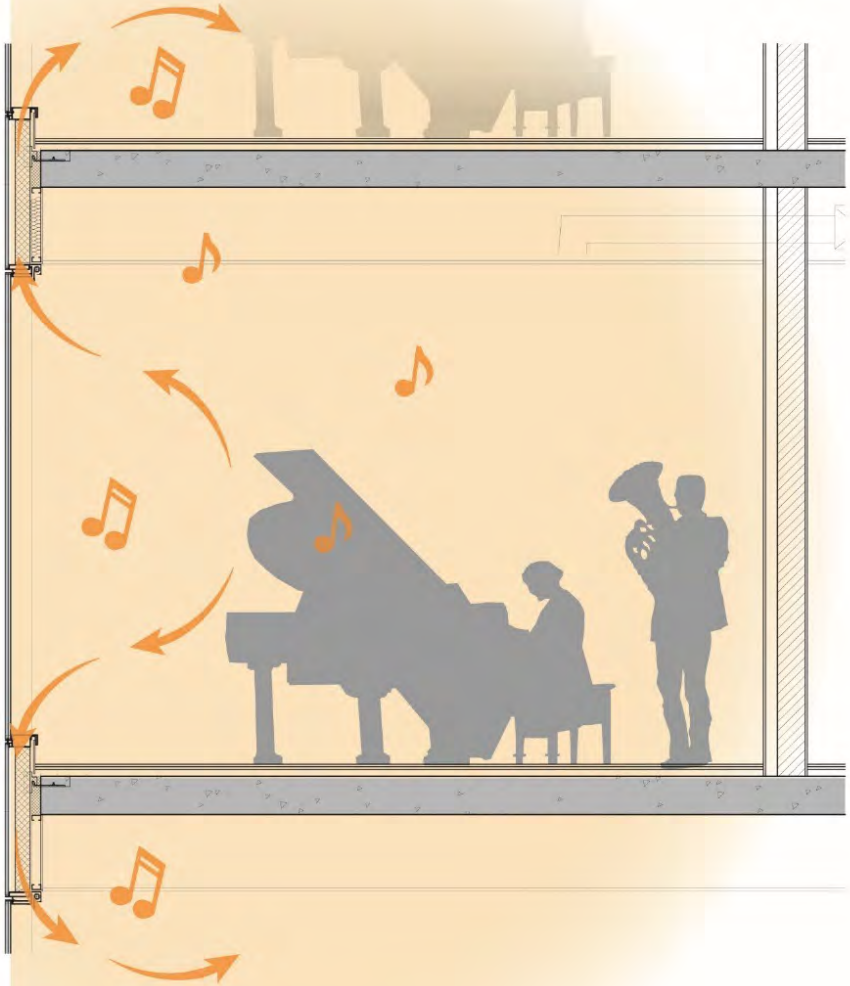

TRADITIONAL CURTAIN WALL

DOUBLE WALL

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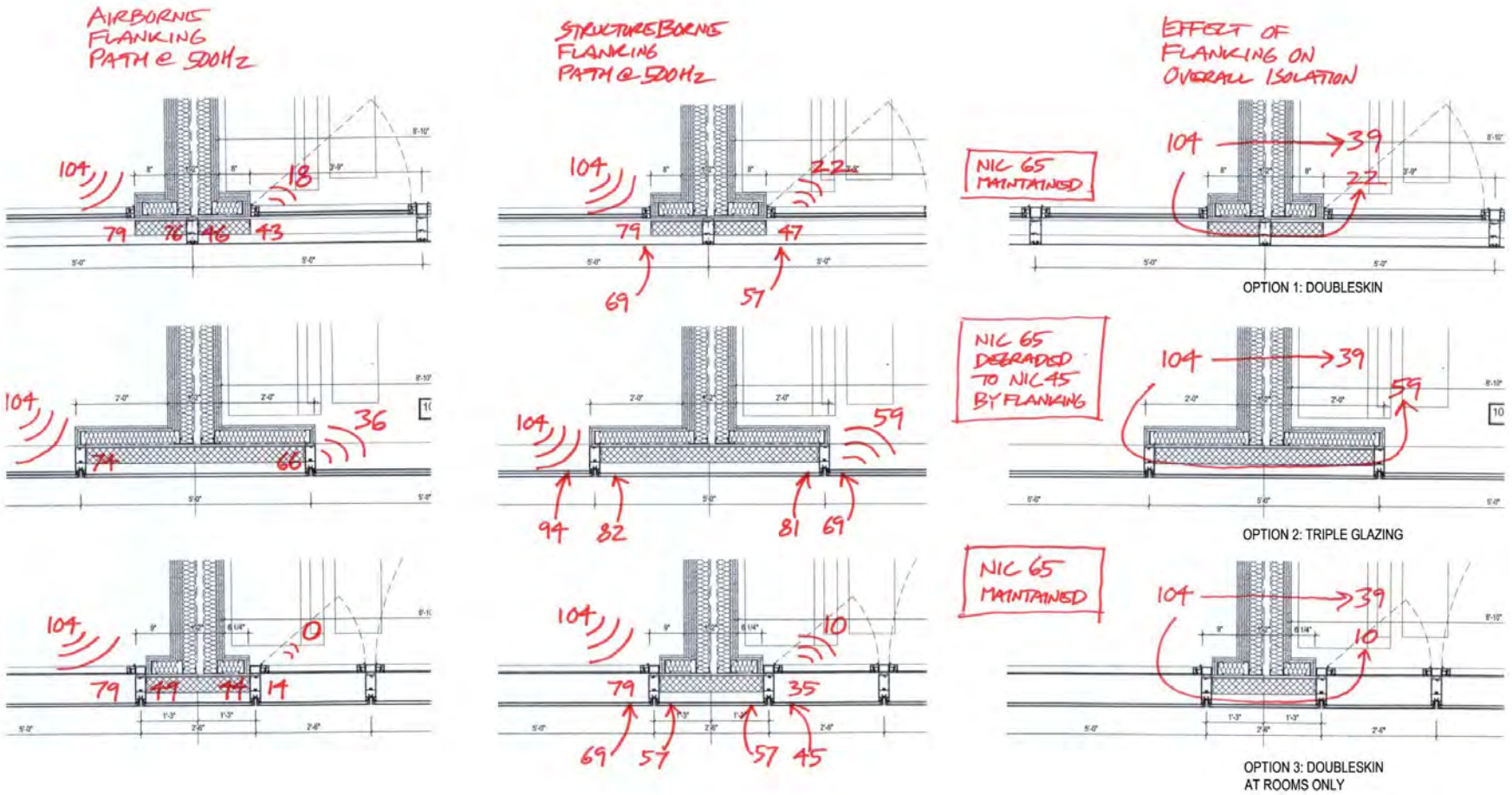
NIC Design Goals = 75 faculty teaching, 65 practice room, 50 office



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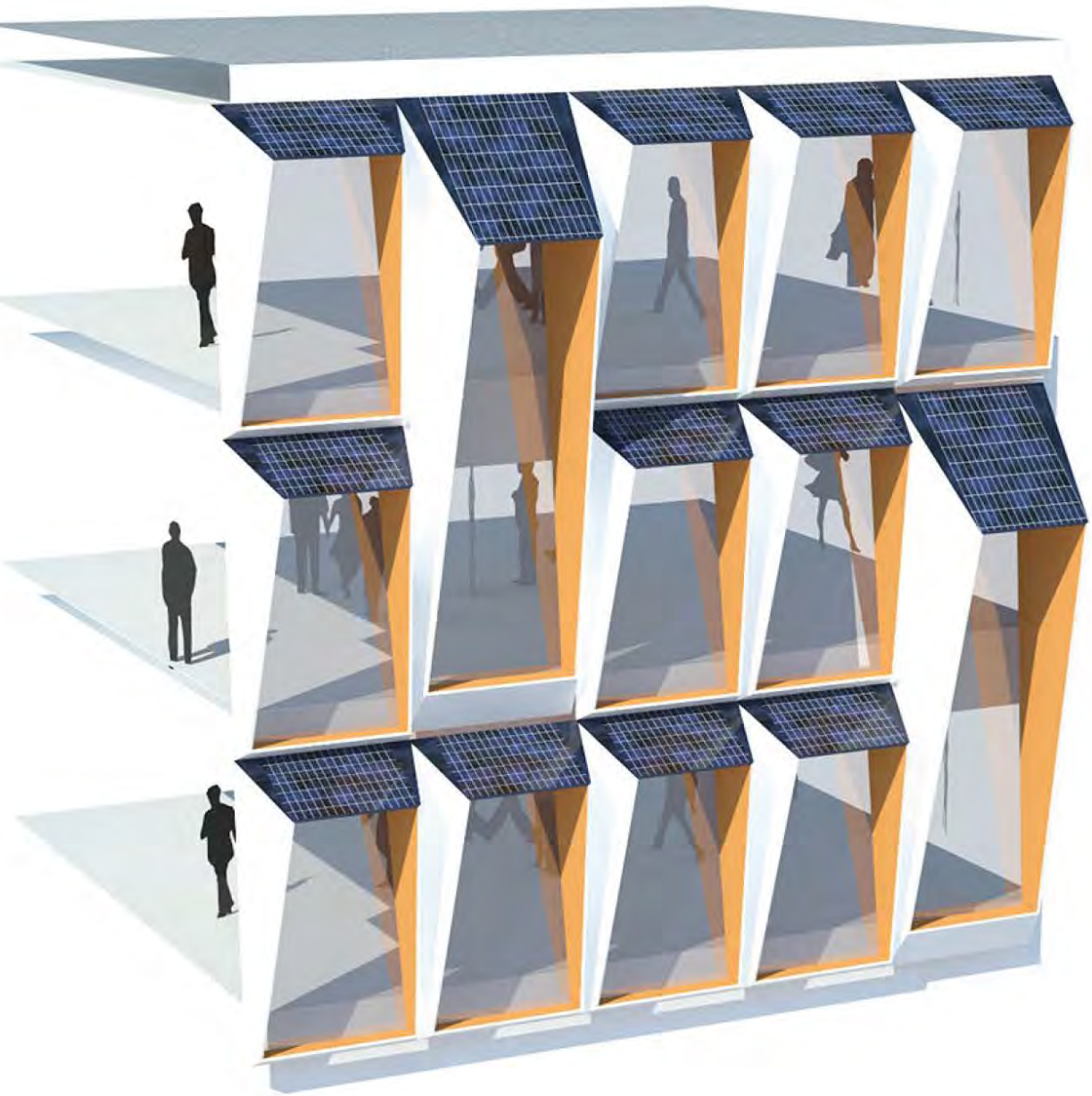

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Thorvald Ellegaard Arena, Odense

GLASS PERFORMANCE DAYS 2015

INNOVATION • BUSINESS • DESIGN

Photo by James Ewing

- 325,160 m² (3.5 million gsf) Class A office tower with Concourse retail, Observation Deck, Digital Broadcast Antenna, Parking, Plazas and Public Space
- Over 1800 construction workers on site at peak times
- Enhanced security and life safety
- LEED CS Gold
- 1.2 MW fuel cell plant
- Below grade concourse with direct access to subways, PATH, retail, and World Financial Center
- 104 floors, office floors 20-90
- 422m (1386') to top of parapet, 541m (1776') to top of spire
- Approximately 122m (448') spire
- First Move-ins fall 2014

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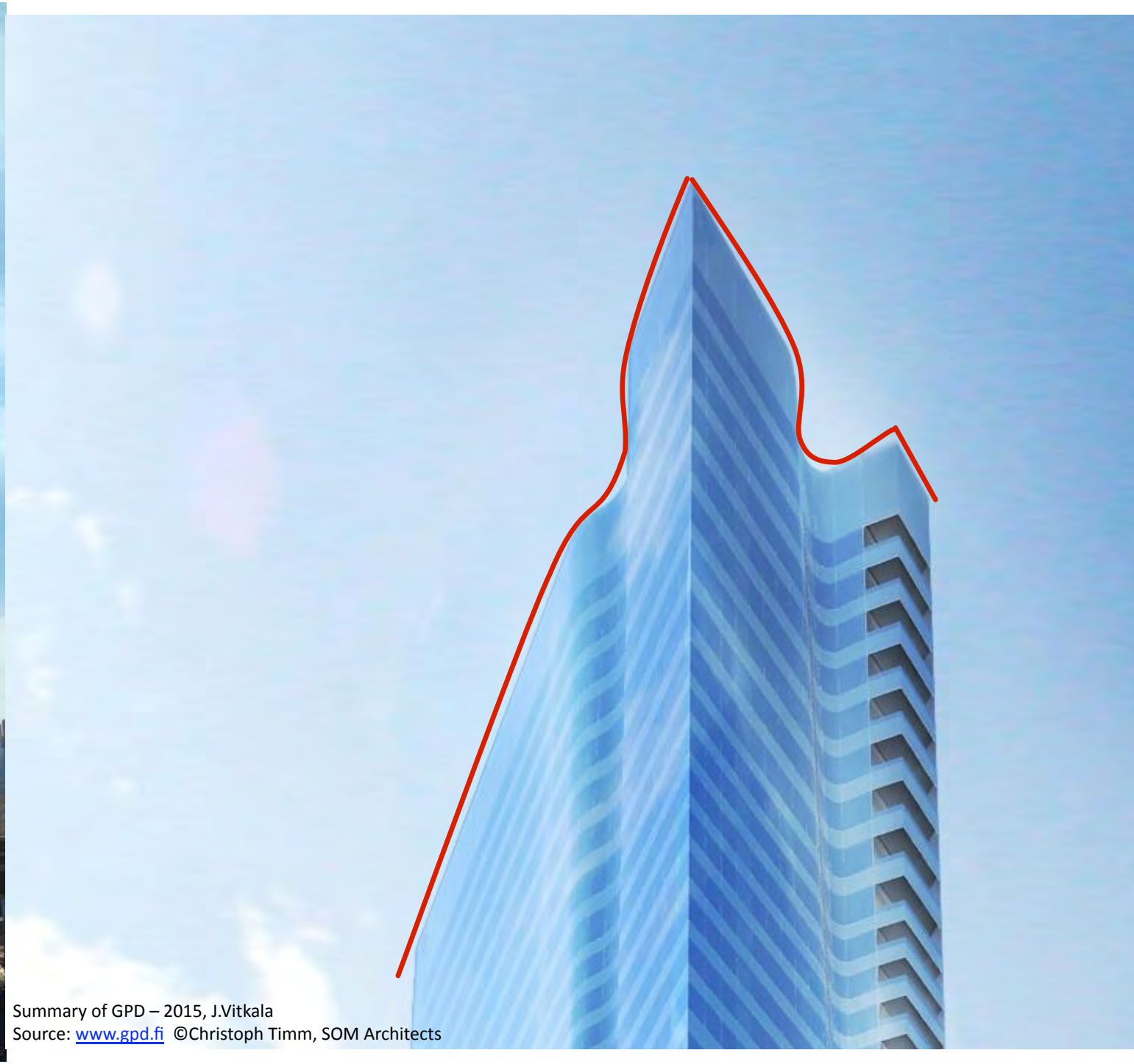

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Aquaria Grande residential tower Mumbai India

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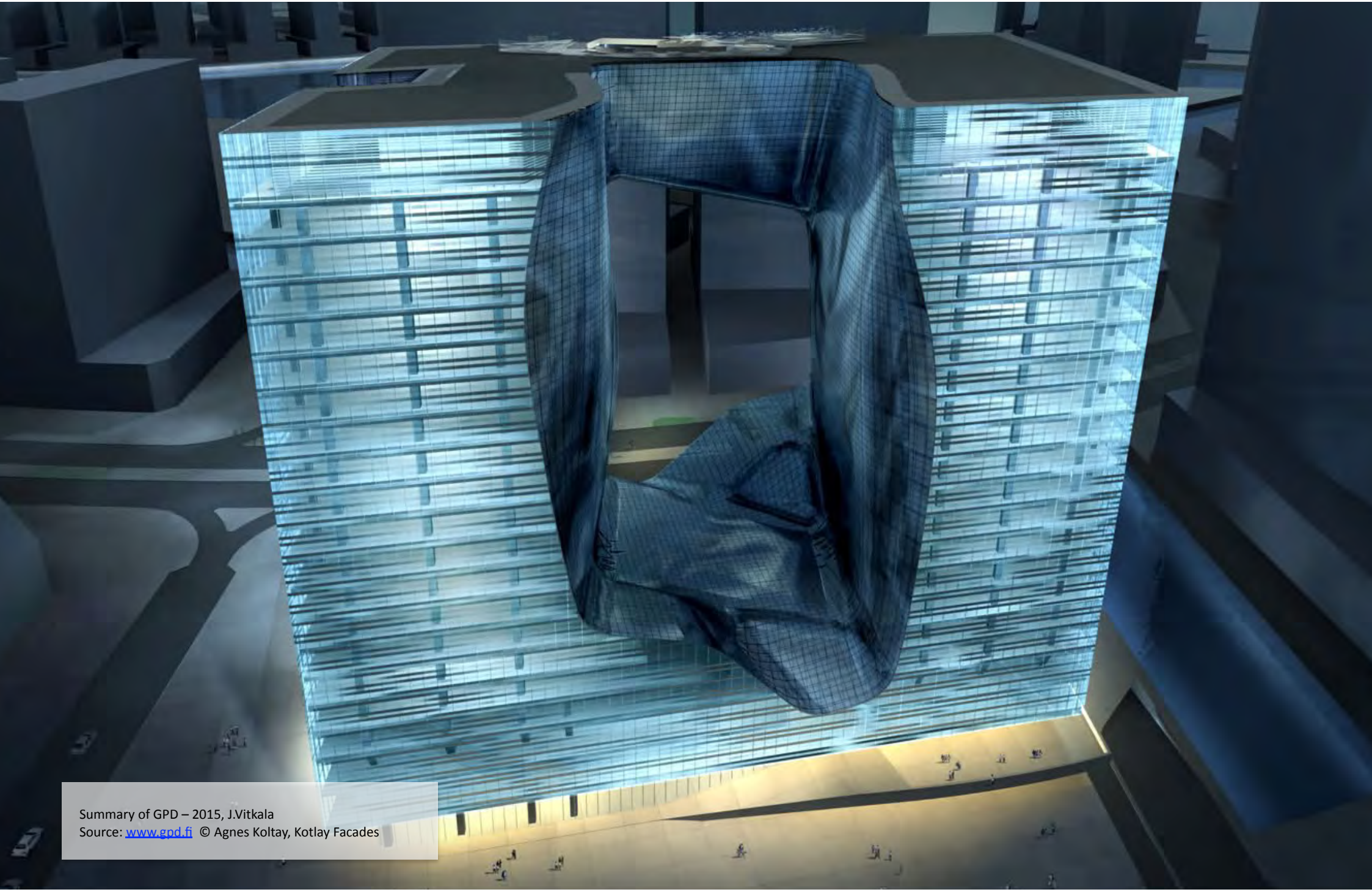

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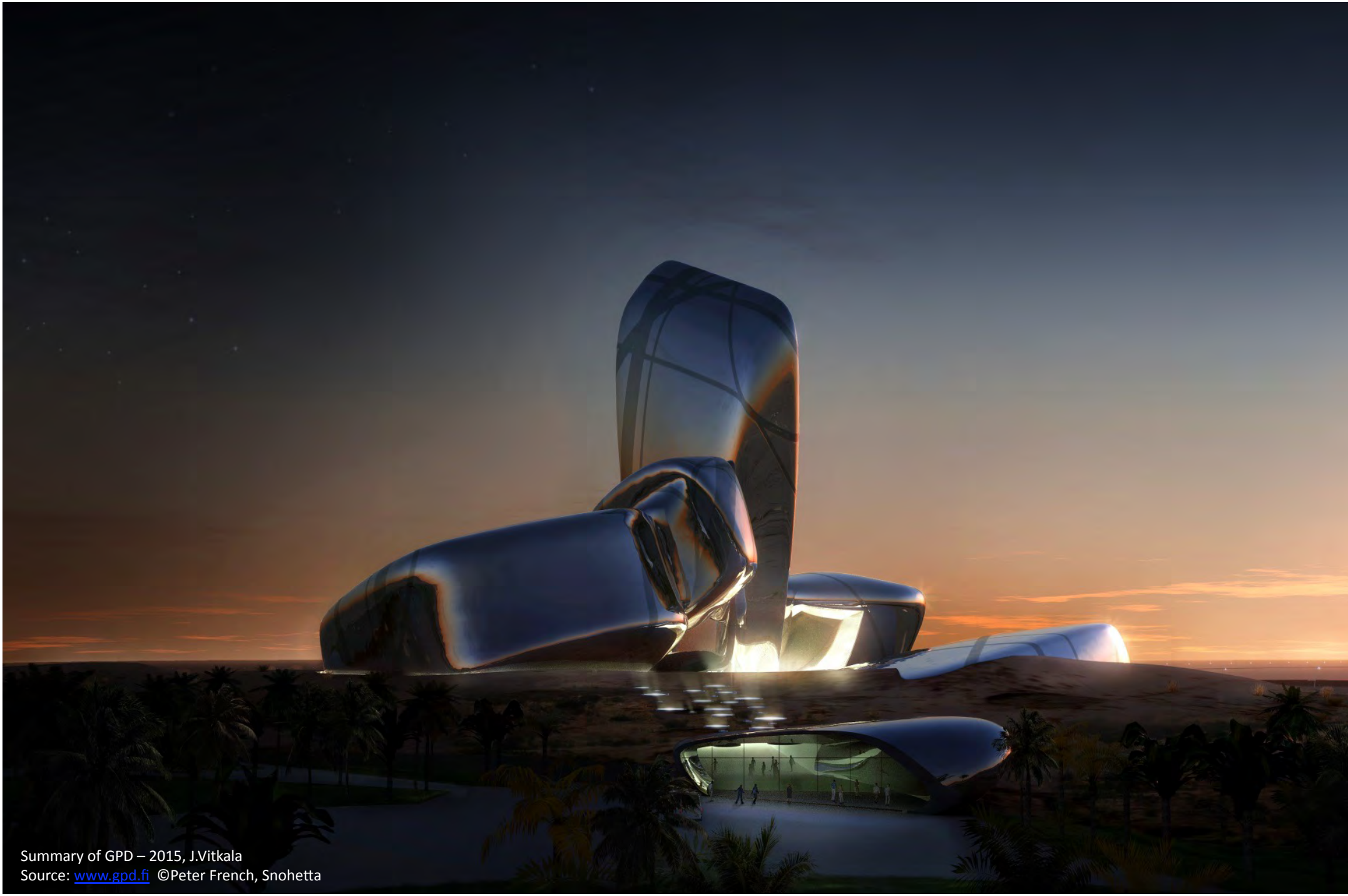

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R129 Future Housing Concept
Prof. Werner Sobek

Floating Housing Project Concept For Uncertain Climate Future
Alexander Remizov

White Sky iHouse
Lindemann Architects

Farmscrapers – Housing of the Future
Vincent Callebaut Architectures

Source: www.gpd.fi ©Benjamin Beer, Meinhardt Façade Technology

“YOU ARE ONLY AS GOOD AS WHAT YOU DID TODAY!”

C. Keith Boswell

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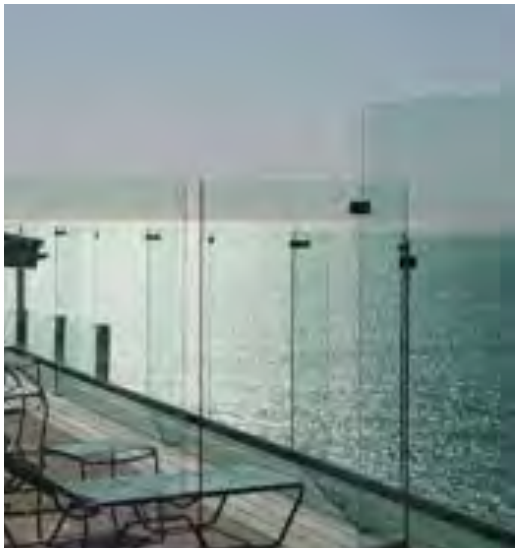
TRANSPARENCY

Glass Railing Systems - Examples





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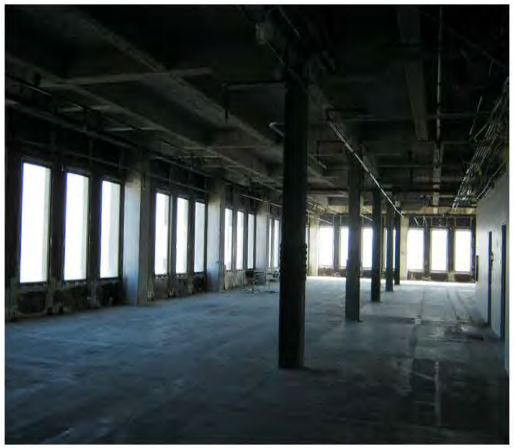
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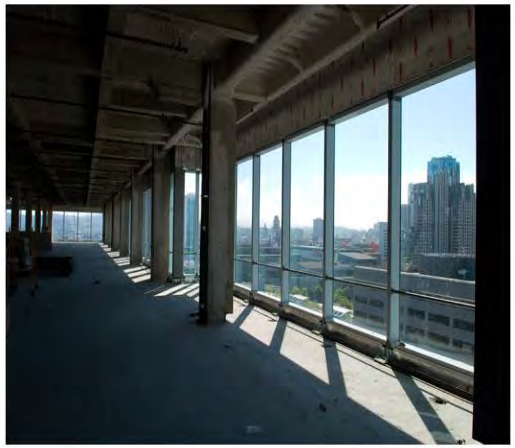

After

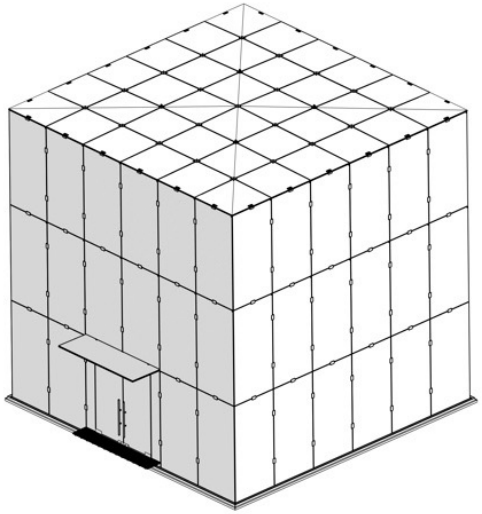

Before


After

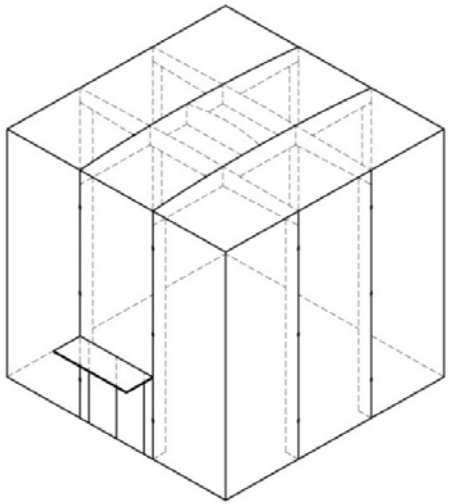
Renovate / transparency
San Francisco, California

680 Folsom

2006



2011



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STRUCTURAL GLASS

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Glass Light and Special Structures Limited

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National Bank of Denmark

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Glass beams as structural elements

Supporting floors/roofs

Glass frames

Fins for glazed façades

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Laminated glass panels

Victoria & Albert Museum, London

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Glass finns 2010 after extension

Summary of GPD – 2015, J.Vitkala
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Solution: connected glass beams

New connection prototype

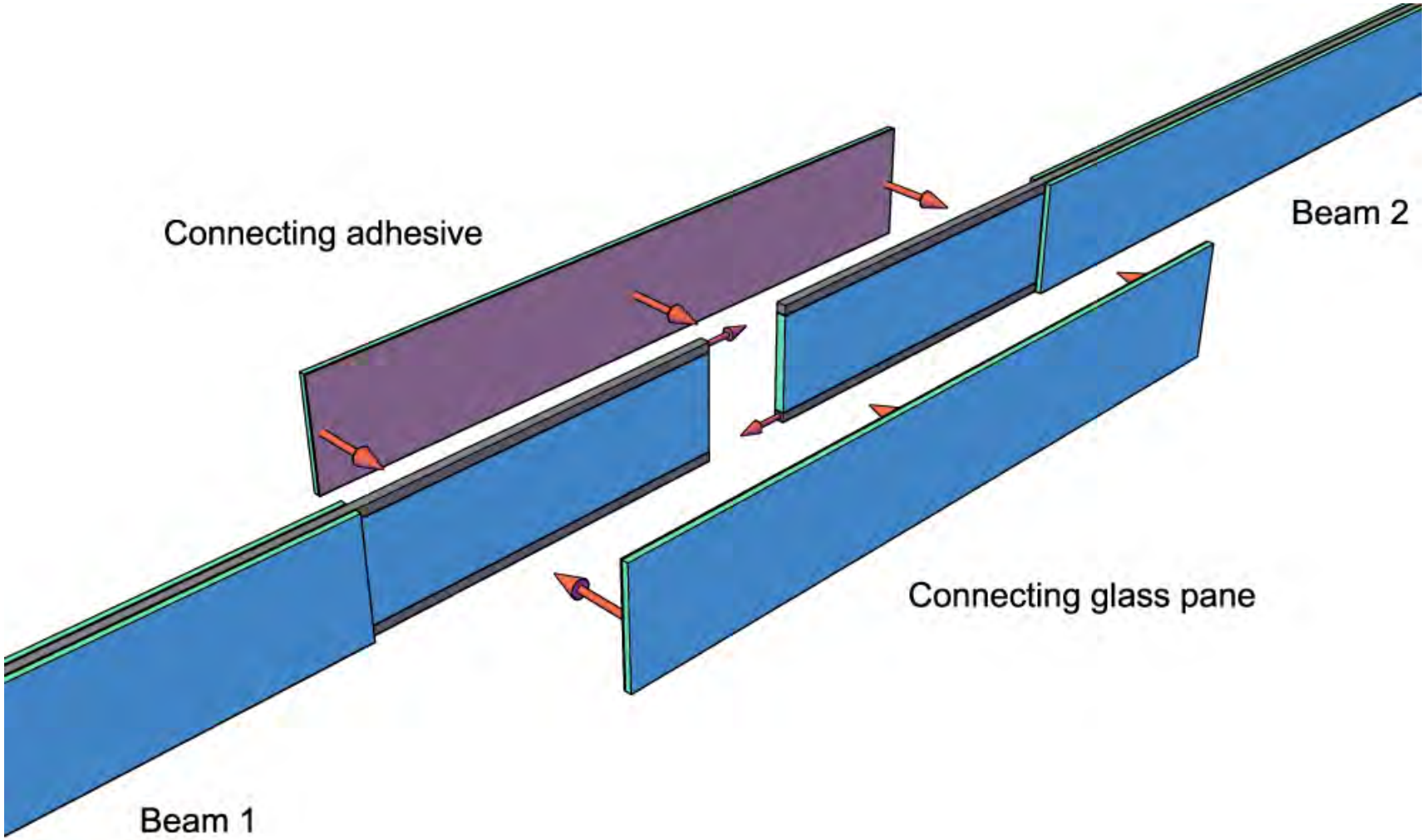
Reinforced laminated glass beams

Adhesively transparent connection

Source: www.gpd.fi © Kenny Martens, Ghent University

Solution: connected glass beams

New connection prototype



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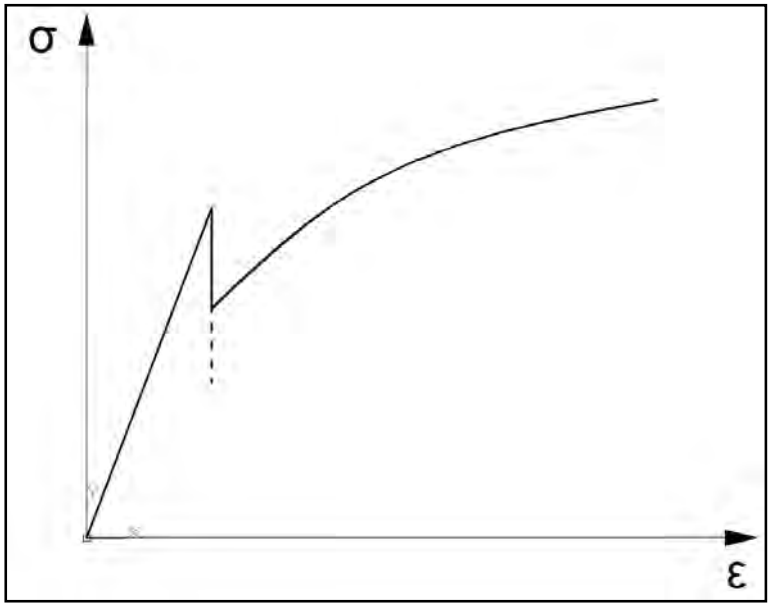
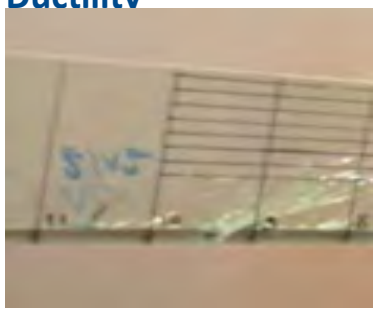
What about safety?

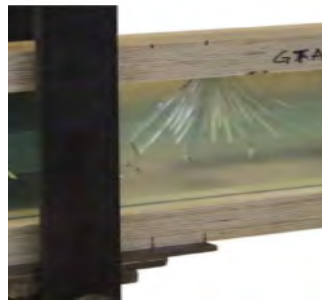
Hybrid glass beams → Safe failure behaviour

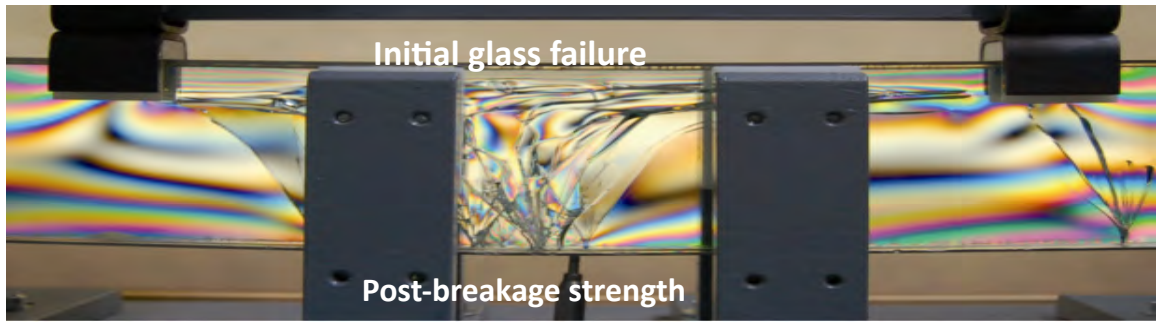


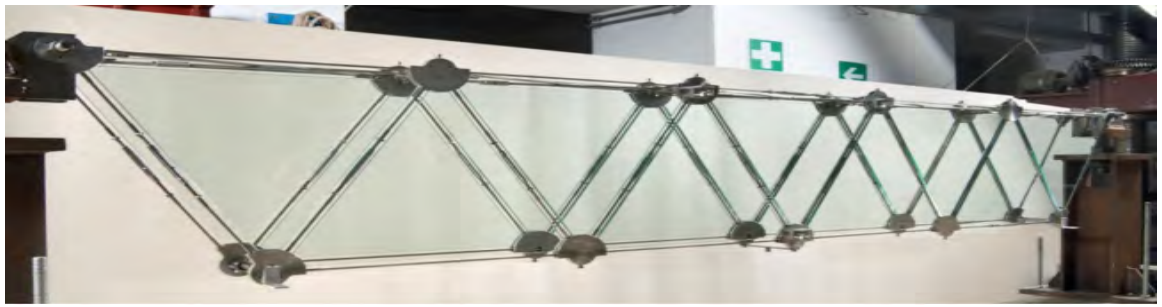
Ductility



Regular glass beam







Hybrid glass beam

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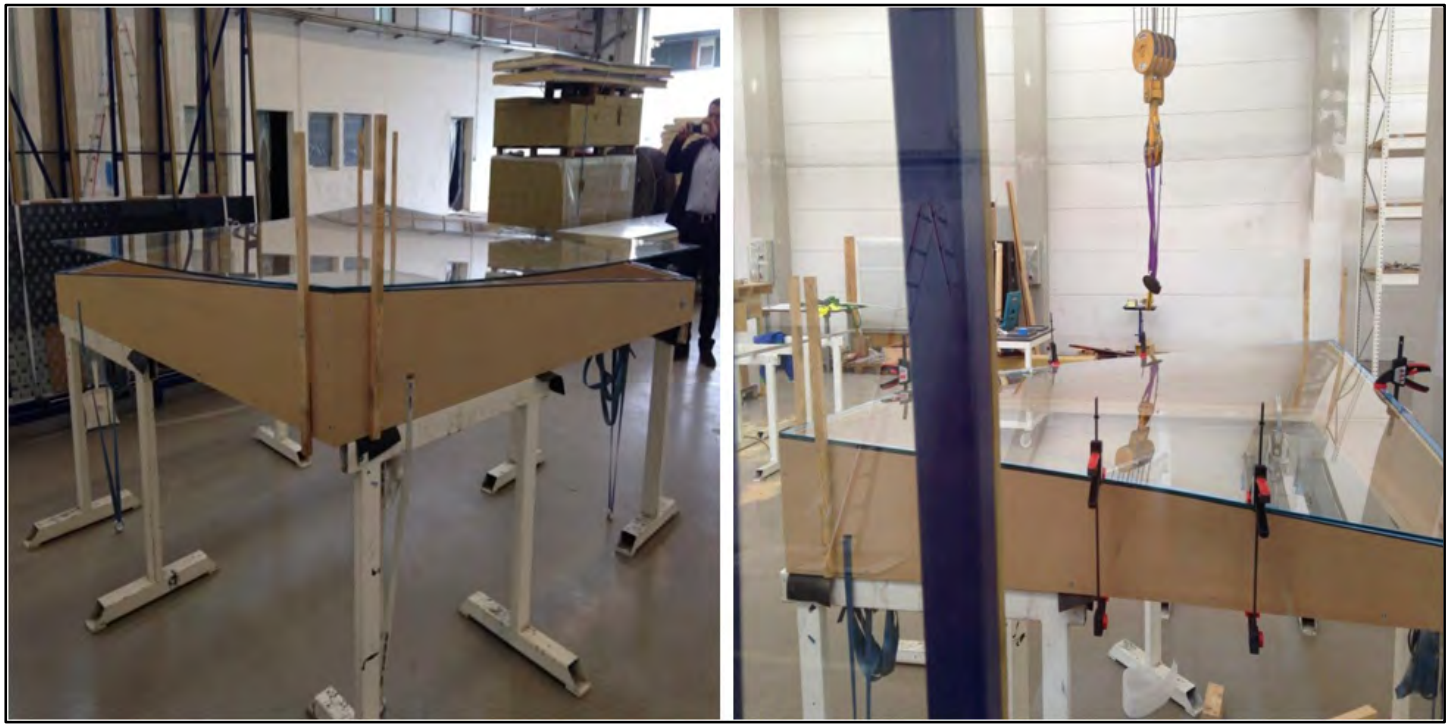
Source: www.gpd.fi © Kenny Martens, Ghent University

Summary of GPD – 2015, J.Vitkala
Source: www.gpd.fi ©James Ocallaghan Eckersley O'Callaghan

COLD BENDING

Transparent elements



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Source: www.gpd.fi © Lutz Schöne, LEICHT Structural Engineering & Specialist Consulting

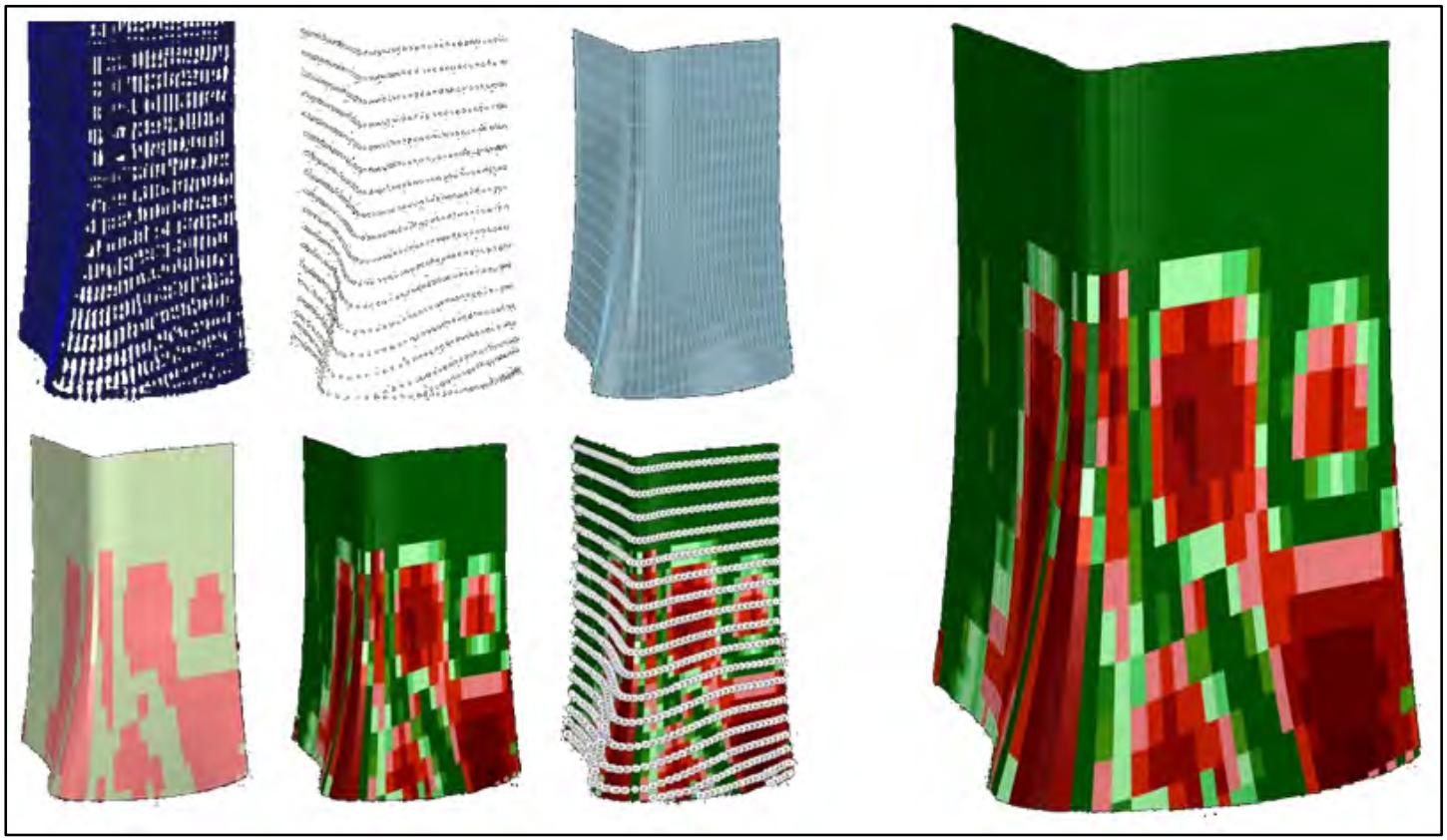
Cold bent glass in architecture

IAC headquarters, New York, Frank Gehry (2007)

Jinso Pavilion, Amsterdam, Cepezed (2009)

Main Train Station, Strasbourg, J.-M. Duthilleul, 2007

Parametric modeling. Freeform facade



Insulated glass panel. Cold bending assessment (gradient) according to established criteria

Summary of GPD – 2015, J.Vitkala
Source: www.gpd.fi ©Benjamin Beer
Meinhardt Façade Technology

GLAZING

History

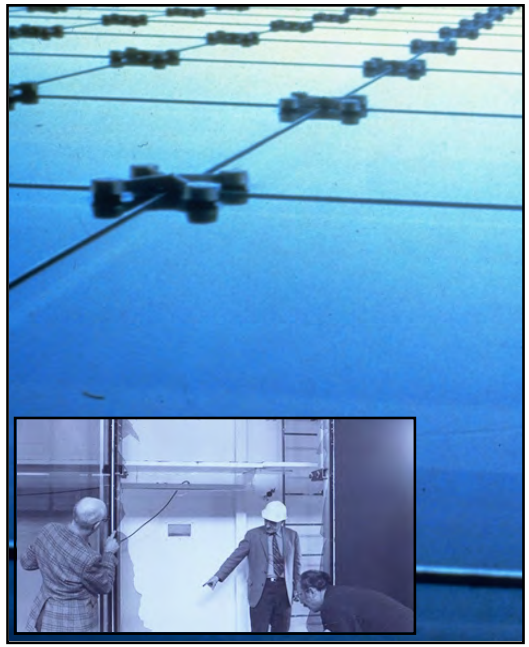
Origins of Structural Glazing

- 1971: First 4-sided SG – Detroit 1971
- 1980: Use of 1K neutral silicone
- 1984: In factory glazing with 2K silicone sealants

1983_Alaska

1984_Hong Kong

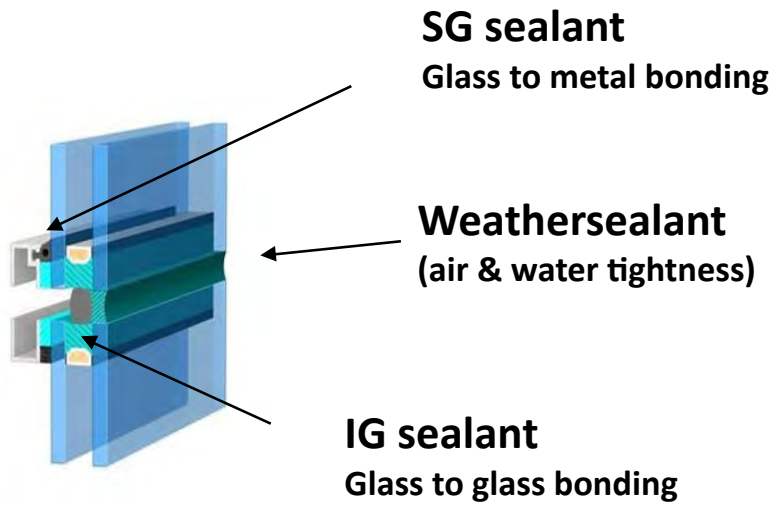
2009_Dubai



Source: www.gpd.fi © P. Vandereecken, Dow Corning

Structural Glazing

- Bonding of glass onto a metallic frame
  - Frameless façade
  - Improved aesthetics
  - Increase design possibilities
  - Air & water permeable
  - Energy efficient



Source: www.gpd.fi © P. Vandereecken, Dow Corning

Bolted point-fixings to increase transparency

In facades and in canopies

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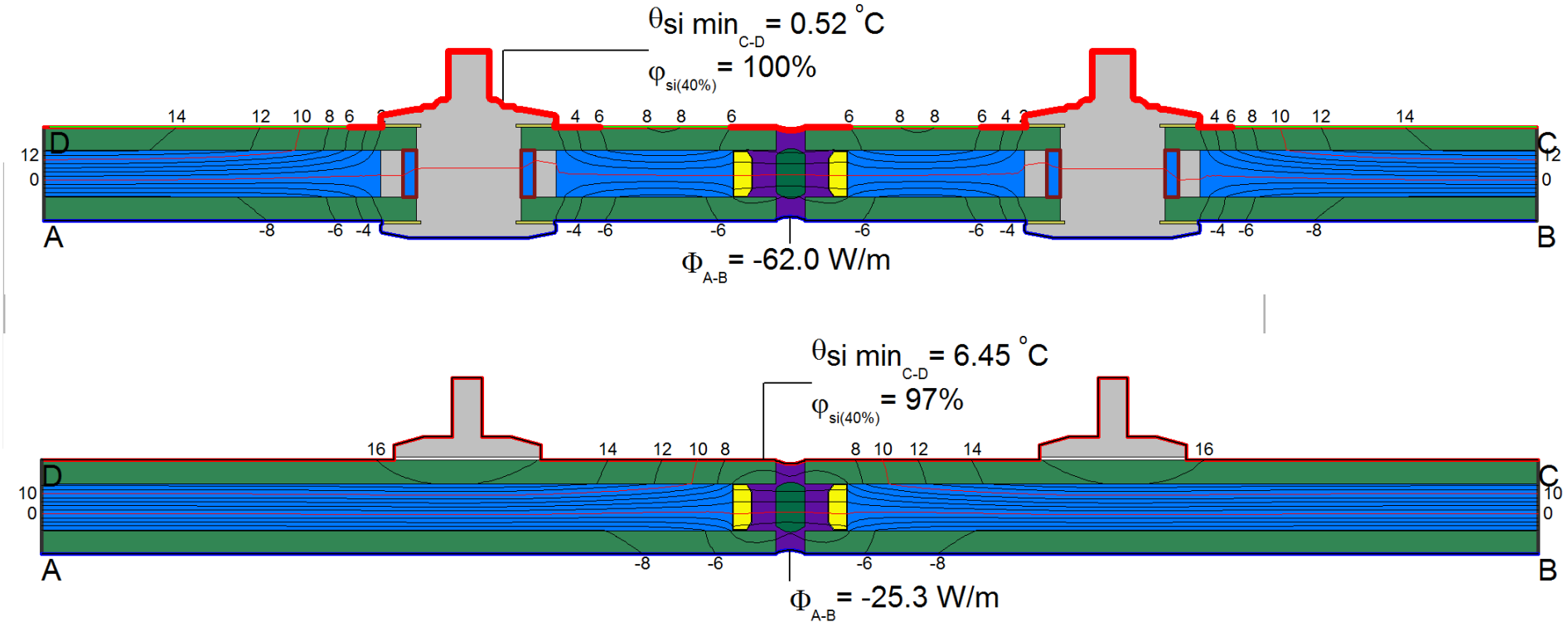
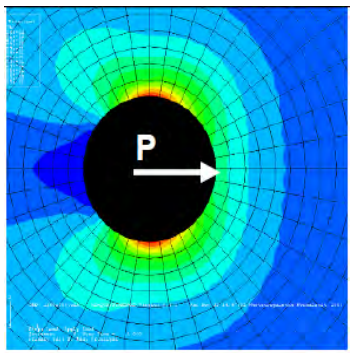
Source: www.gpd.fi © Kenny Martens, Ghent University

Point Fixing Condensation

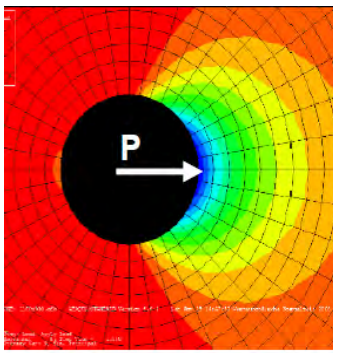


Source: www.gpd.fi

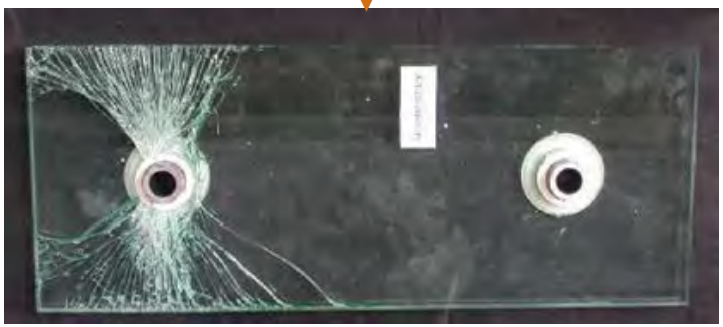
However stress-concentrations arise



Tension

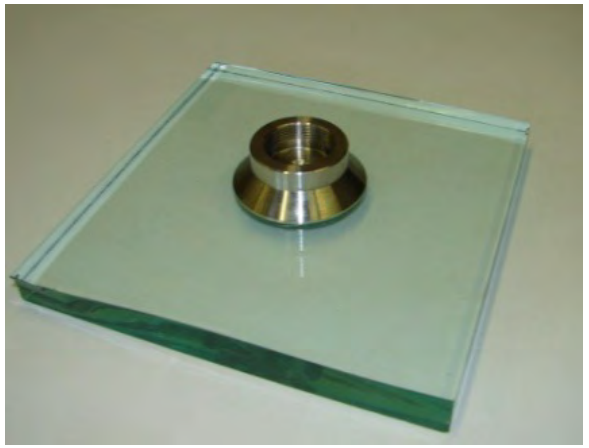


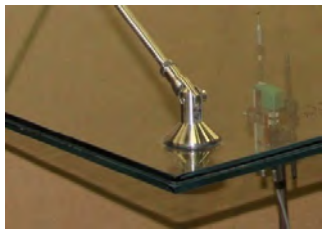
Compression



Solution

Adhesive point-fixings





Mocibob, D., & Belis, J. (2010). Coupled experimental and numerical investigation of structural glass panels with small slenderness subjected to locally introduced axial compression. *Engineering Structures*, *32*(3), 753–761.

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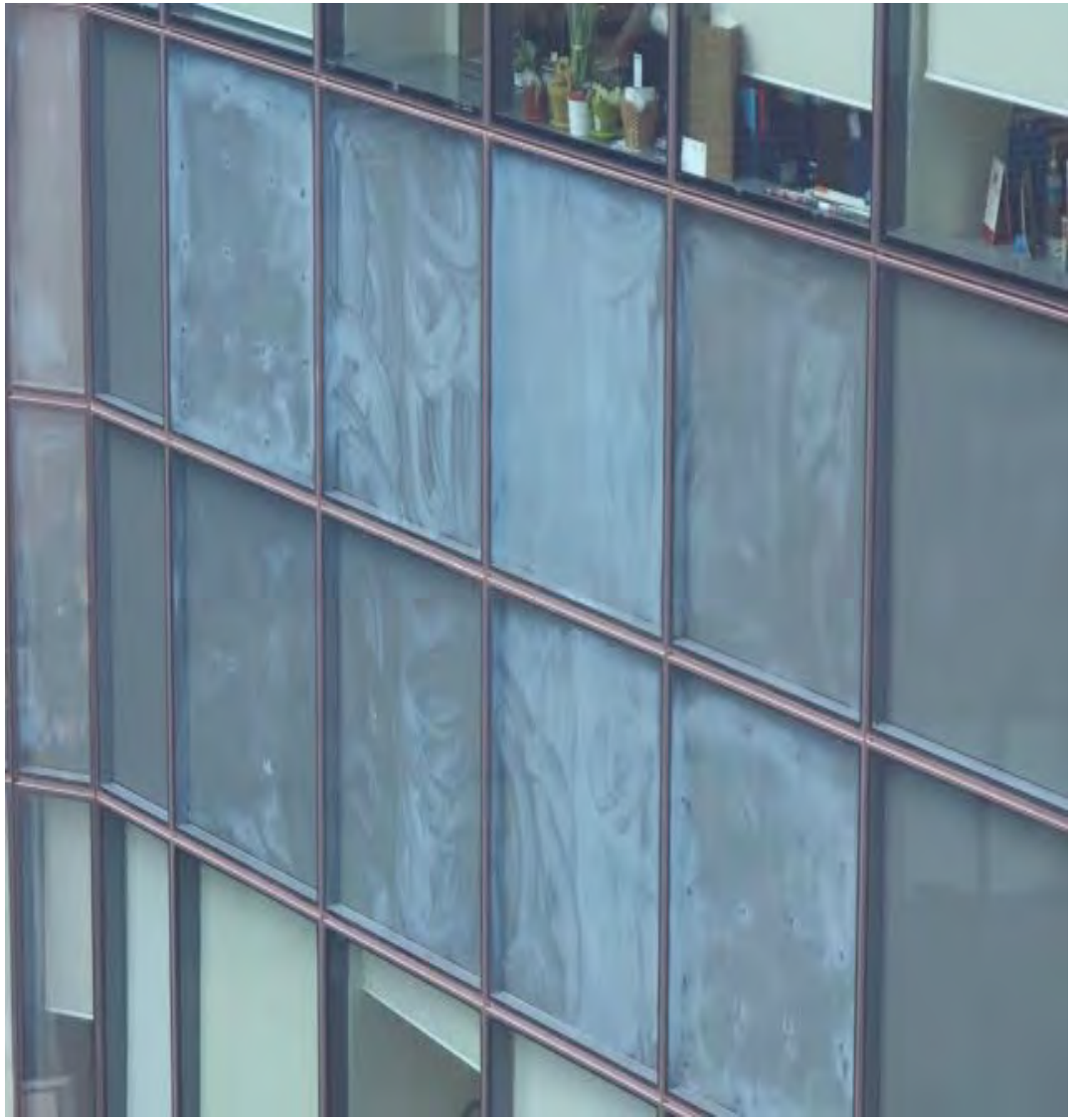
DESIGN PROBLEMS



Glass Surface Corrosion

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Source: www.gpd.fi © Peter Hartog, Building Diagnostics Asia Pacific,
Chris Barry, Glass Consultant

Distortion of reflected sunlight from wrinkles and areas of non-uniform thickness in combinations of PVB and PET laminating films

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The number and visibility of moiré fringes are functions of the magnitude of thermal deformation of sheet metal back-panels

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32nd floor of office building (Melbourne)

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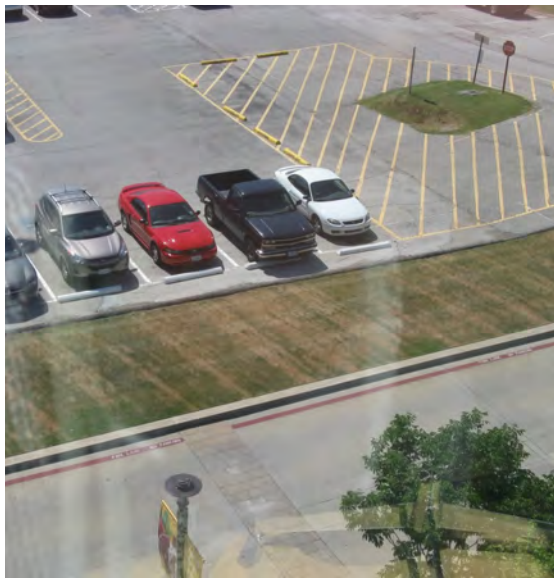
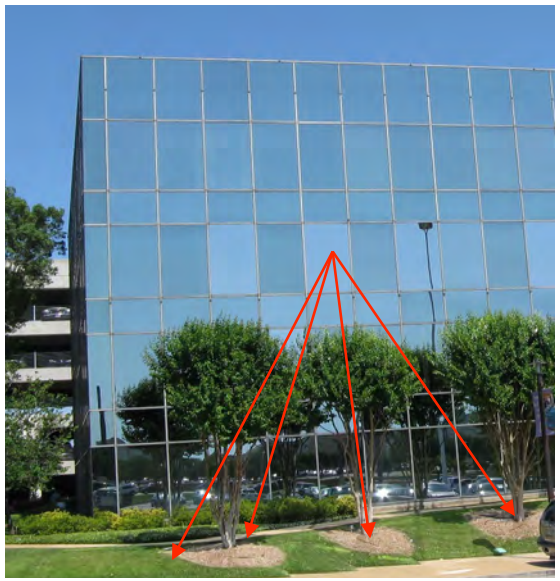
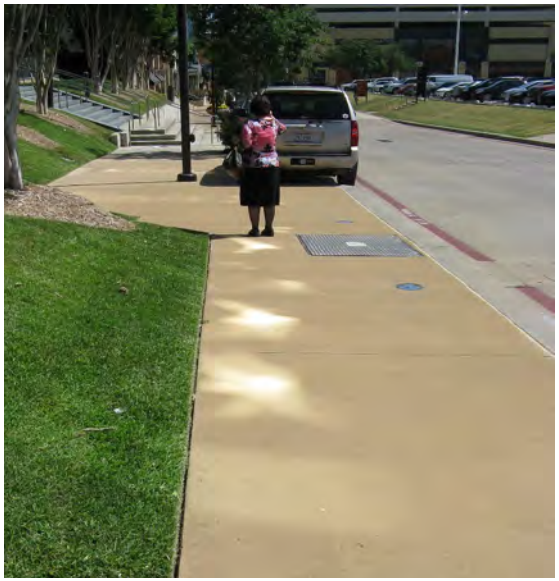
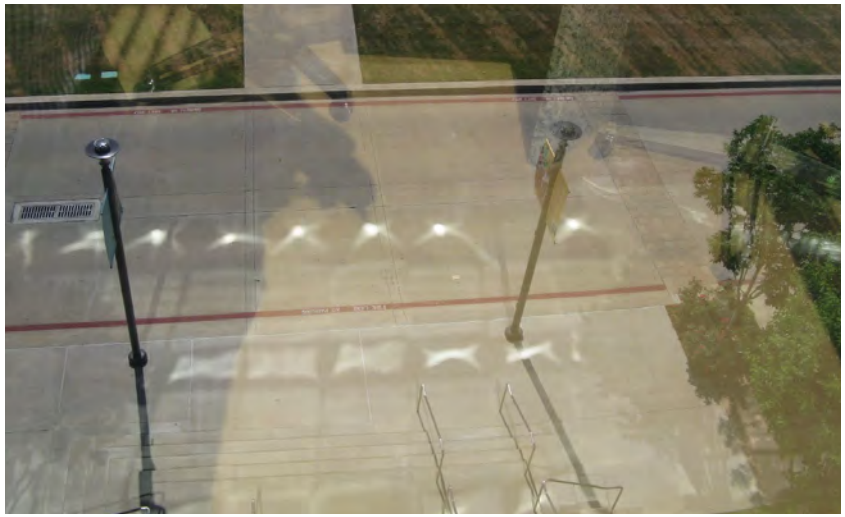
When Buildings Attack Their Neighbors









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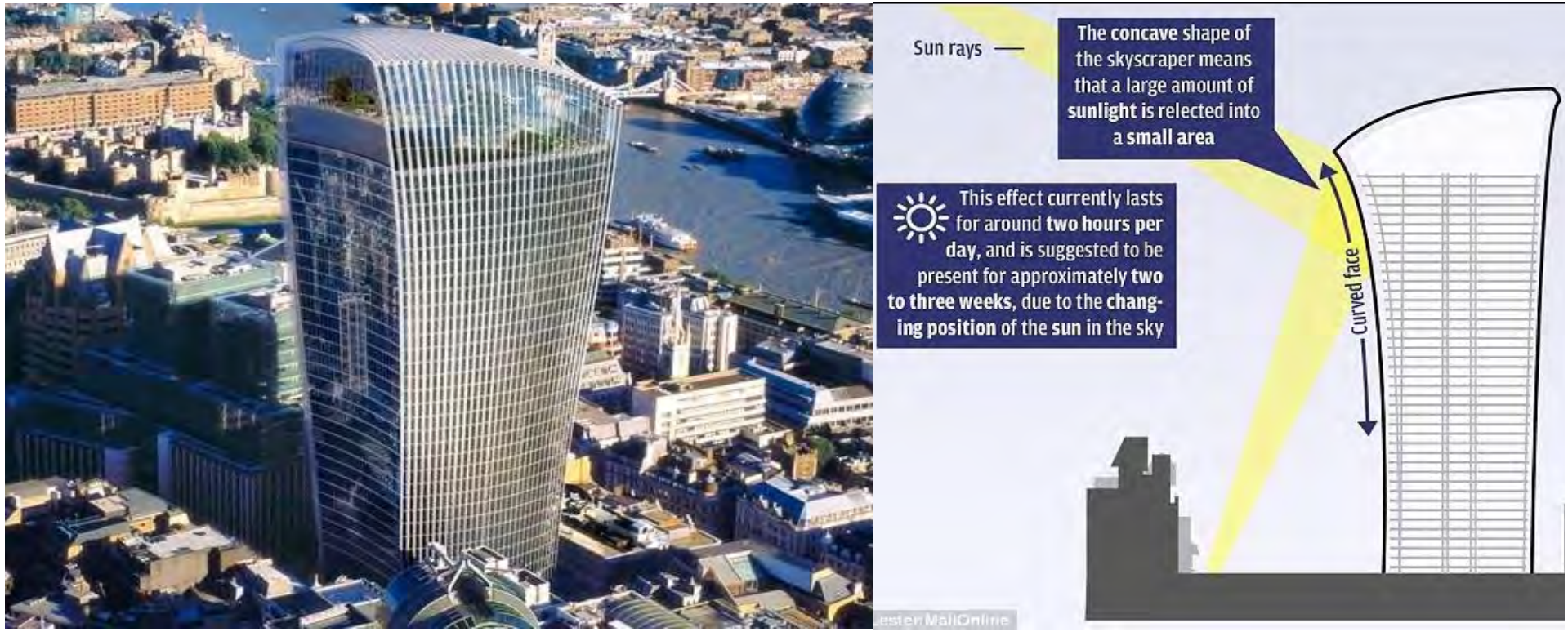
The Death Ray Strikes Back



Summary of GPD – 2015, J.Vitkala
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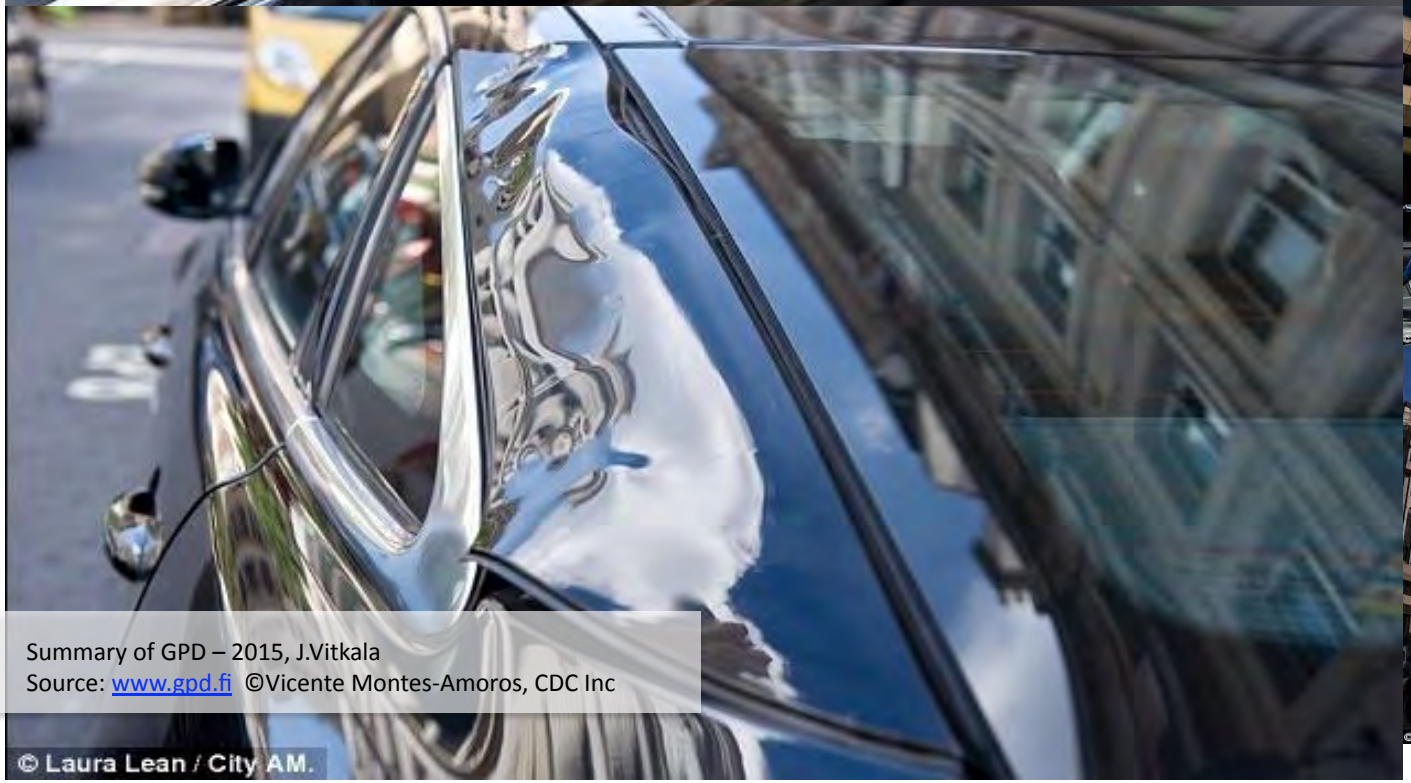

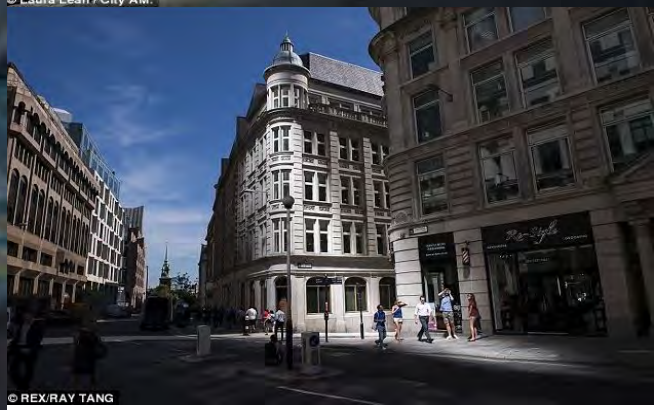

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The Death Ray Strikes Back

Summary of GPD – 2015, J.Vitkala
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What Is Anisotropy?

Summary of GPD – 2015, J.Vitkala
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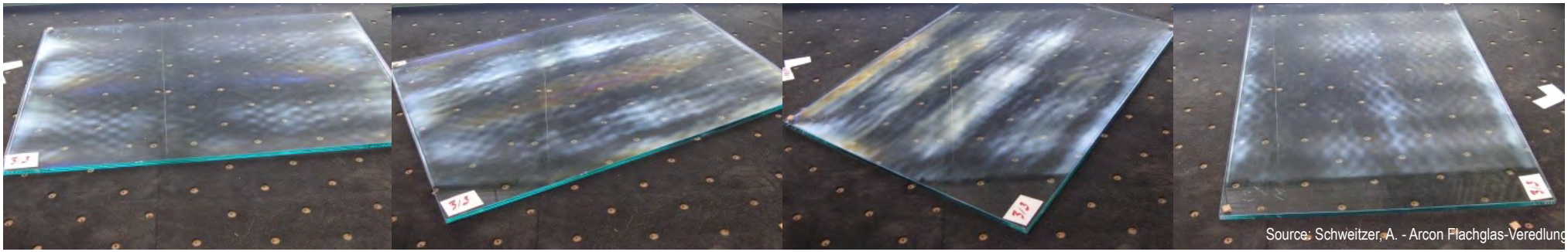
What causes anisotropy?

- **Stresses in glass plate due to heat treatment**
- Polarised light: reflection & scattering
- Viewing Angle & Conditions

Controllable?



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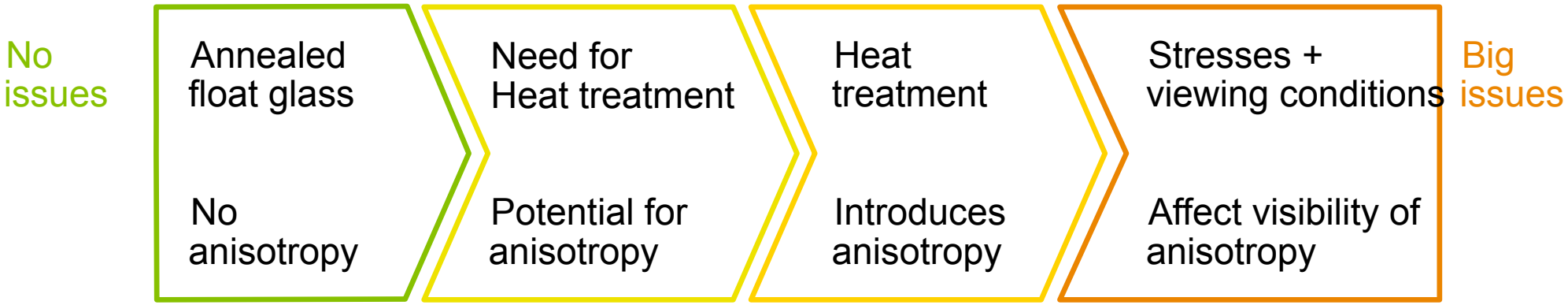
What causes anisotropy?



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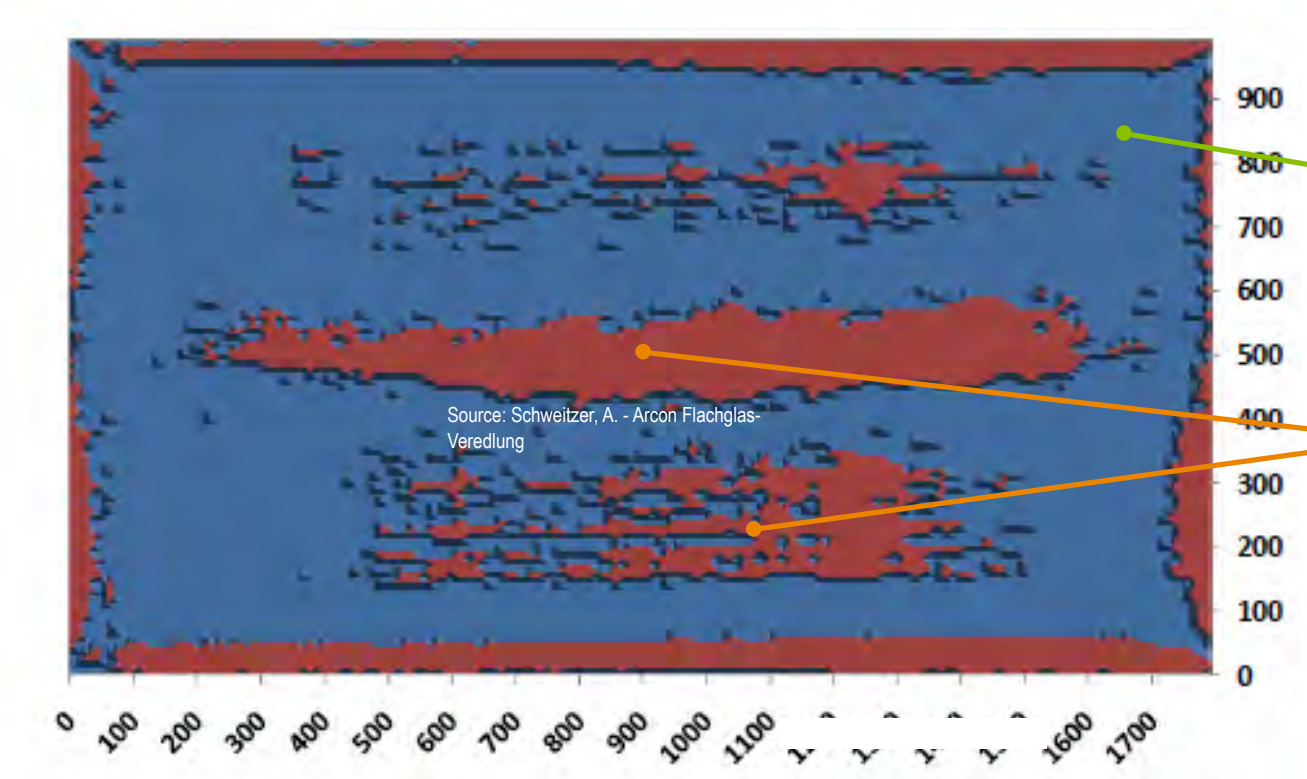
State of the art: Acceptance/Rejection



Area with non-critical Anisotropy level

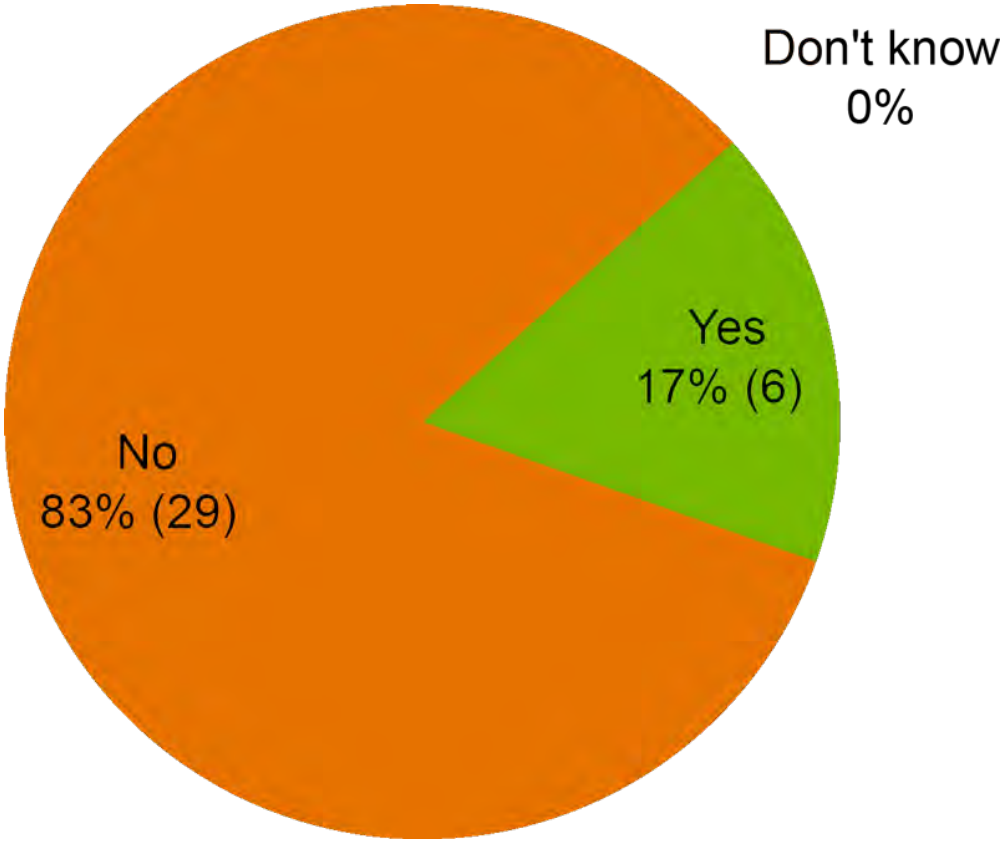
Area with critical Anisotropy level

State of the art: Acceptance/Rejection

Source: Vehmas, J., Glaston

Isotropy-value:
Percentage of the surface of the glass which does not show **critical** **Anisotropy** level

Standards vs. specifications



Do agreed specifications clearly address anisotropy acceptance and rejection criteria?

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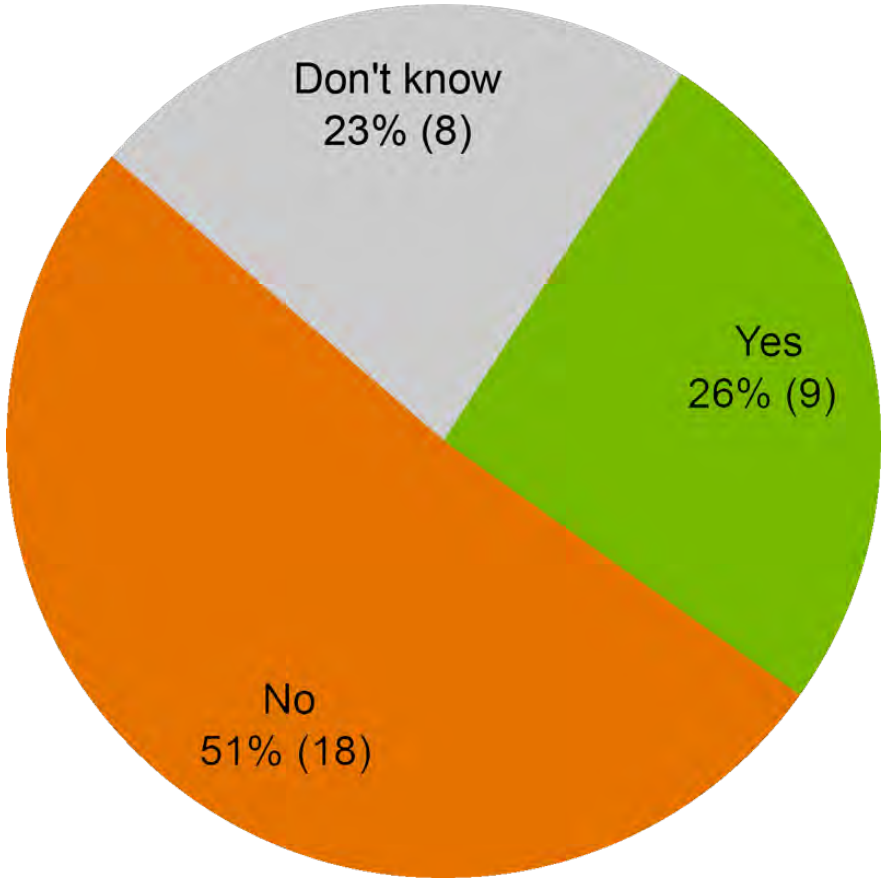
Standards vs. specifications



… a glass supply chain problem?

Are clients prepared to pay more to avoid issues associated with anisotropy or to take the risk?

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