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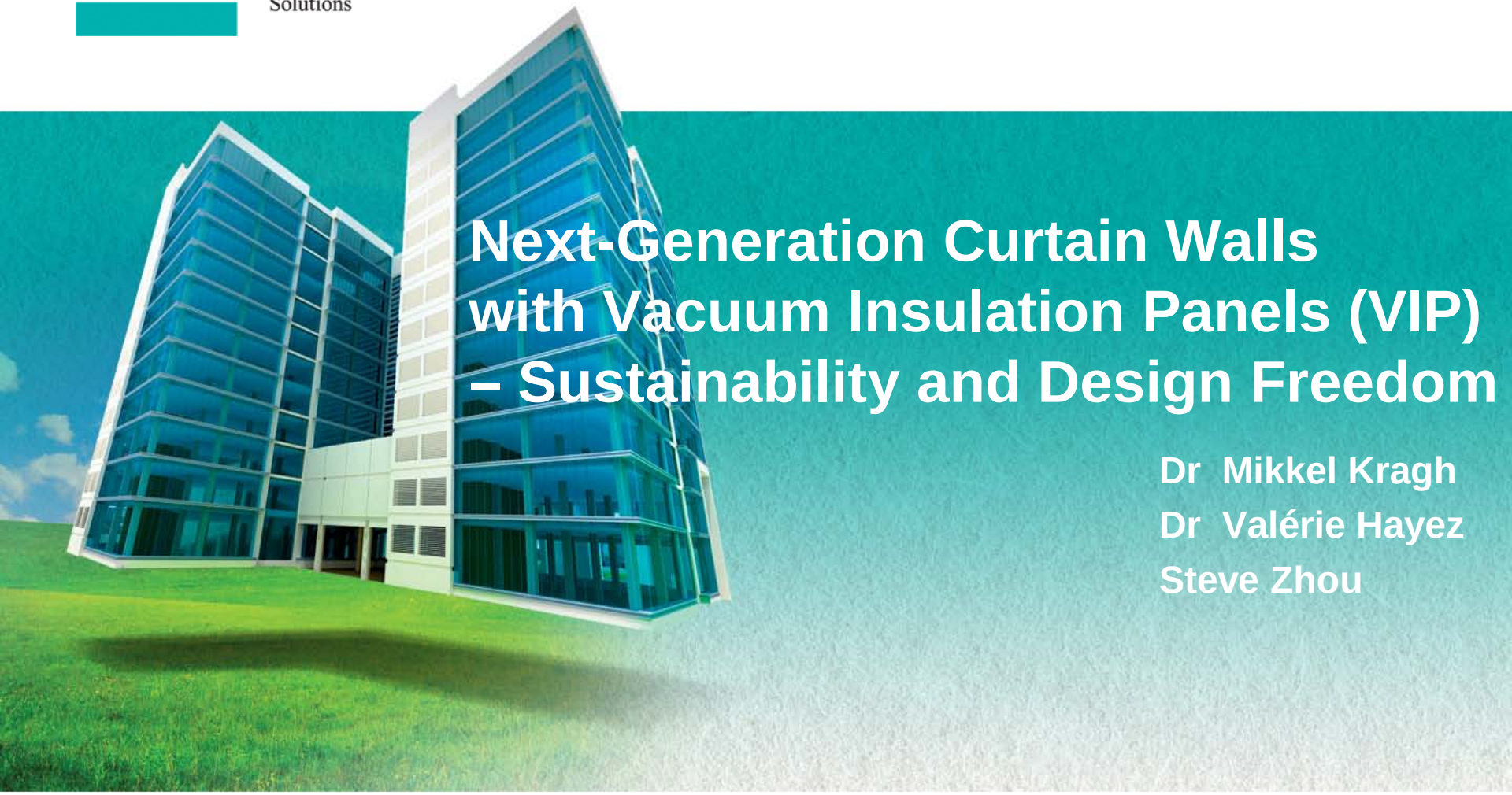
High Performance Building Solutions



Next-Generation Curtain Walls with Vacuum Insulation Panels (VIP) – Sustainability and Design Freedom

Dr Mikkel Kragh
Dr Valérie Hayez
Steve Zhou

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- Introduction
- Product Concept
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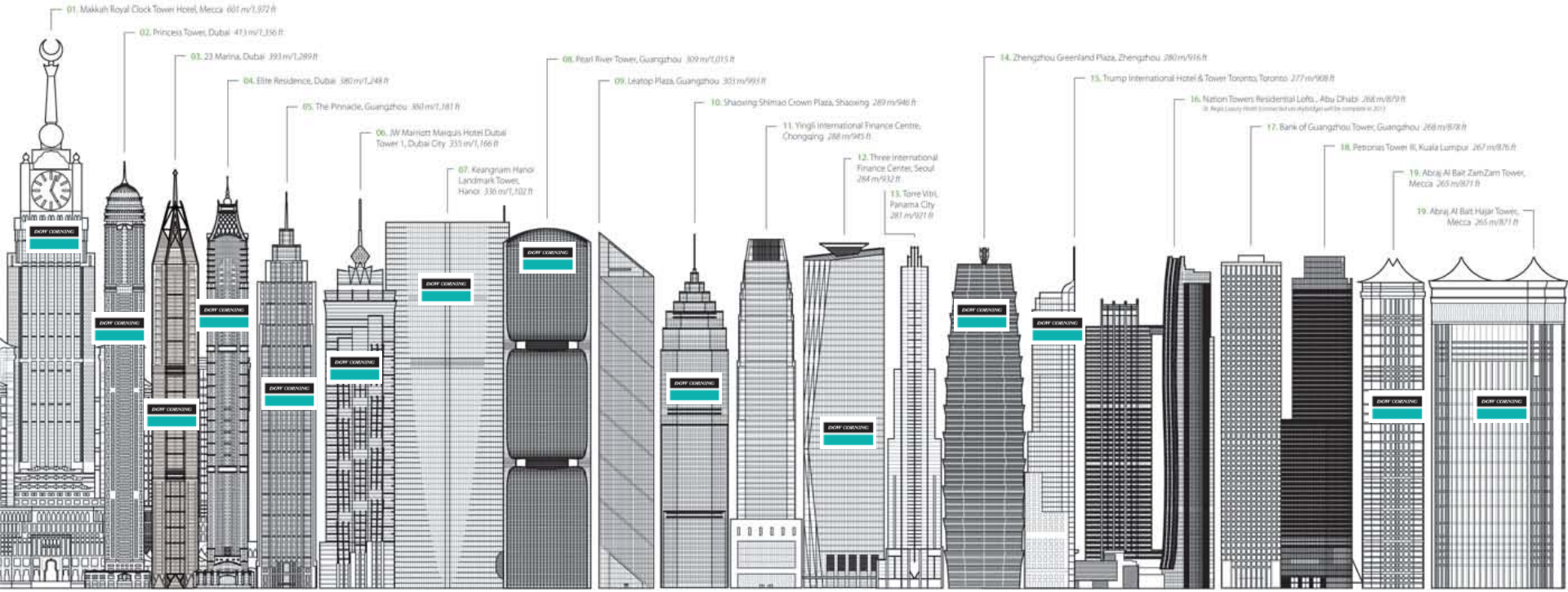
Dow Corning

- A global leader in silicones and high purity silicon
  - More than 7,000 products/services
  - Approx. 25,000 customers
  - Approx. 11,000 employees
- $6.12 billion sales in 2012
- Investing in our future and our customers' futures: geographic, manufacturing, innovation
- Transforming our business to deliver:
  - Efficiency, Innovation and Sustainability
- Focused on sustainability and *Responsible Care*®

Dow Corning

Tallest Buildings completed in 2012



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A Brighter Shade of Green

Silicone-based innovations to help increase energy efficiency.

Vacuum-insulated panel, Thin Insulation Module, Air barrier system, Advanced Insulated Glazing, Glazing and weatherproofing sealants,

Renewable energy solutions improve efficiency; BIPV, solar cell encapsulants, adhesives, coatings

HVAC lubricants, coatings and advanced materials enhance performance and energy efficiency

Dynamic Solar and Thermal control; light scattering, day lighting,

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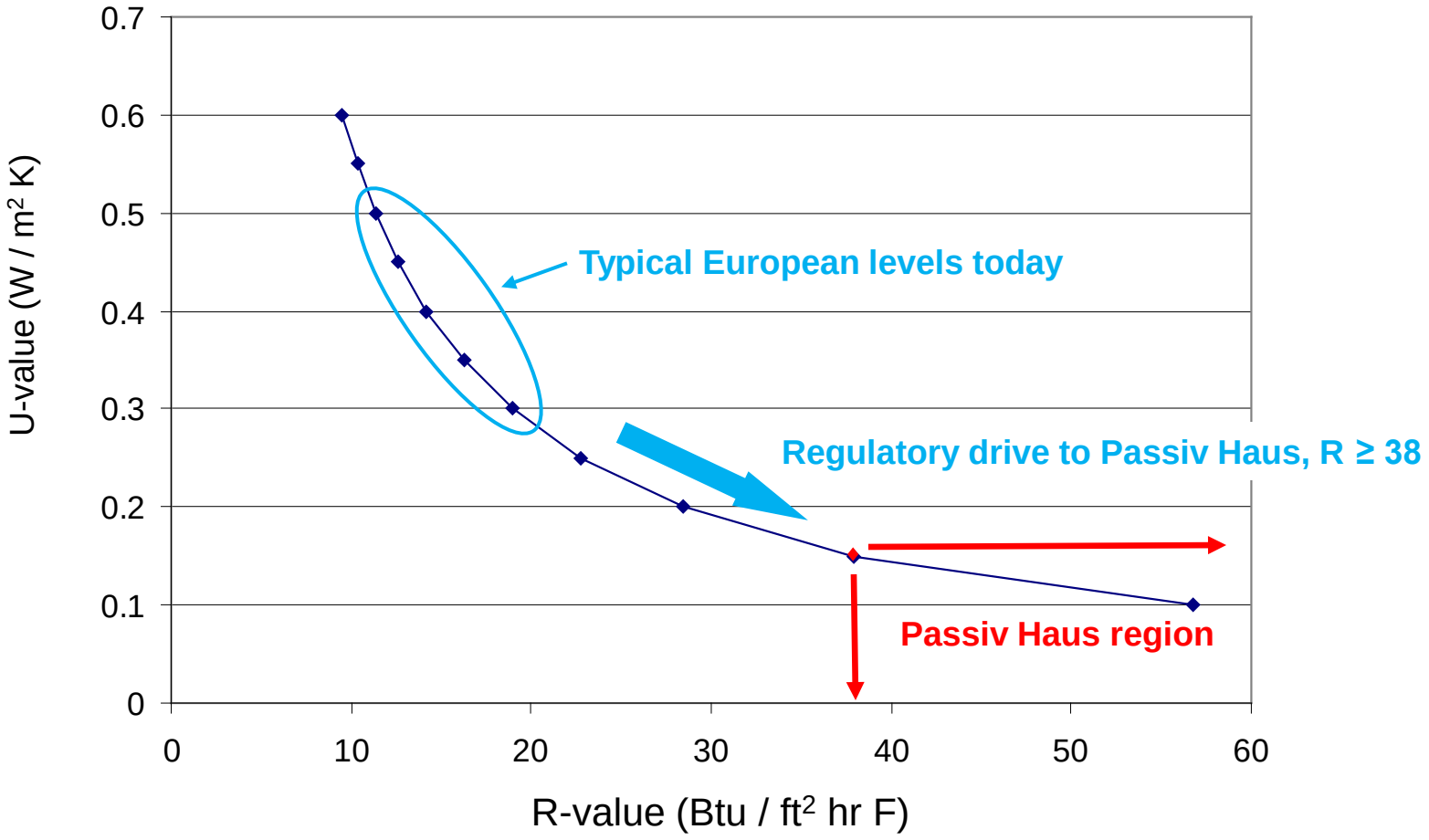
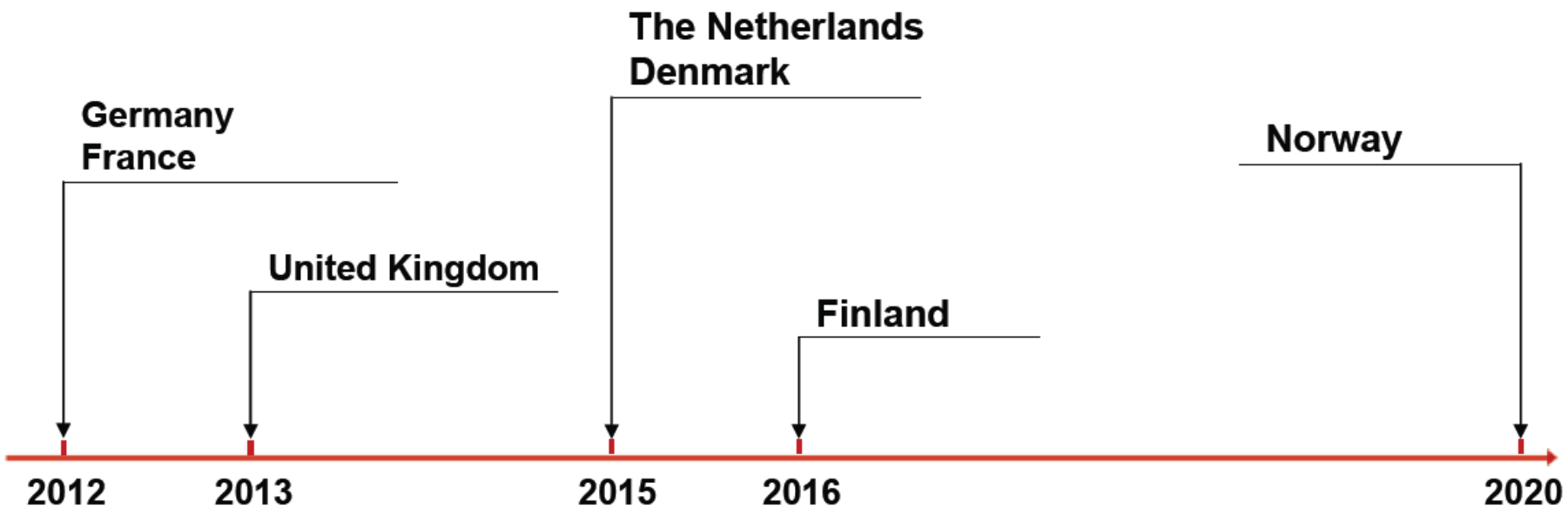
Today versus Tomorrow



Today versus Tomorrow

Timing for *Passiv Haus* or *Zero Energy* principles in efficiency levels for new buildings.

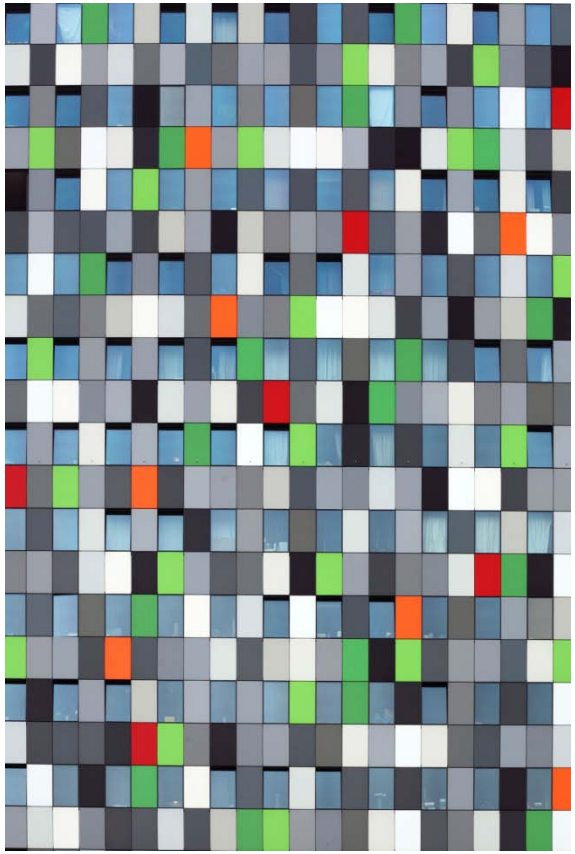


Trend to *Passiv Haus* standard is clear. Infrastructure investments and technology developments are already underway.

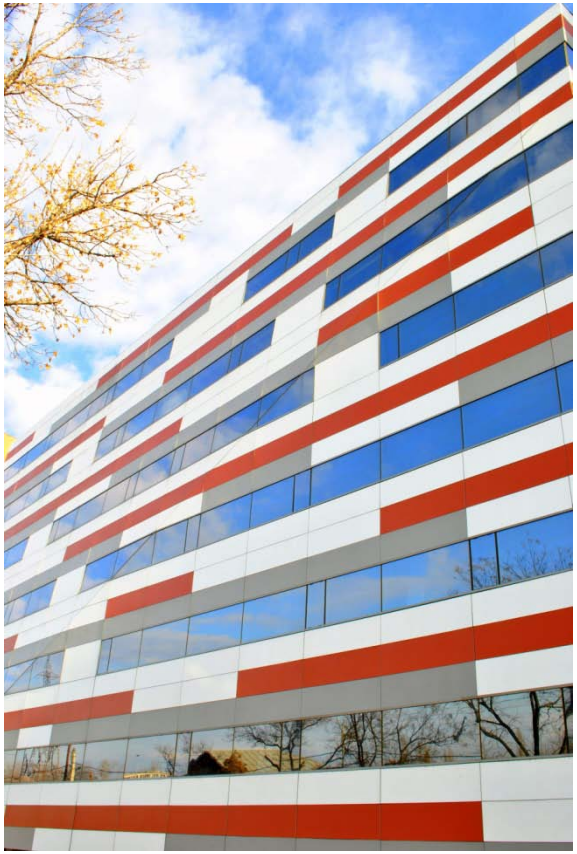
Sustainable Buildings in Hong Kong And China

	Hong Kong	Shanghai	Beijing
Energy Saving Requirement for Public Building	**OTTV** Tower: 24W/m2; Podium: 56W/m2 **Overall Facade** (based on experience) U ≤ 1.8 W/m2K SC ≤ 0.40	**Local Standard** 65% Energy Saving **Vision Area** 0.5< WWR ≤ 0.7 U ≤ 2.2W/m2K SC ≤ 0.3(E,S,W)/0.4(N) **Non-vision Wall** U ≤ 0.7W/m2K	**Local Standard** 65% Energy Saving **Vision Area** 0.5< WWR ≤ 0.7 U ≤ 2.2W/m2K SC ≤ 0.45(E,S,W) **Non-vision Wall** U ≤ 0.8W/m2K
Energy Saving Requirement for HK-BEAM/ China Green Building 3-star	**Commercial Building** (Credits 1~10) 10~45% Energy Saving	**Mandatory Requirement** 65% Energy Saving **Advanced Option** Overall Energy Consumption to be lower than 80%*government approved energy saving standard value (another 5~10% saving)	
Incentive Programs for Green Building	Eligible to exempt of green and innovative features from GFA and/or SC (site coverage) calculations.	2-star green building has a bonus of RMB 45 per sqm.; 3-star green building has a bonus of RMB 80 per sqm.	

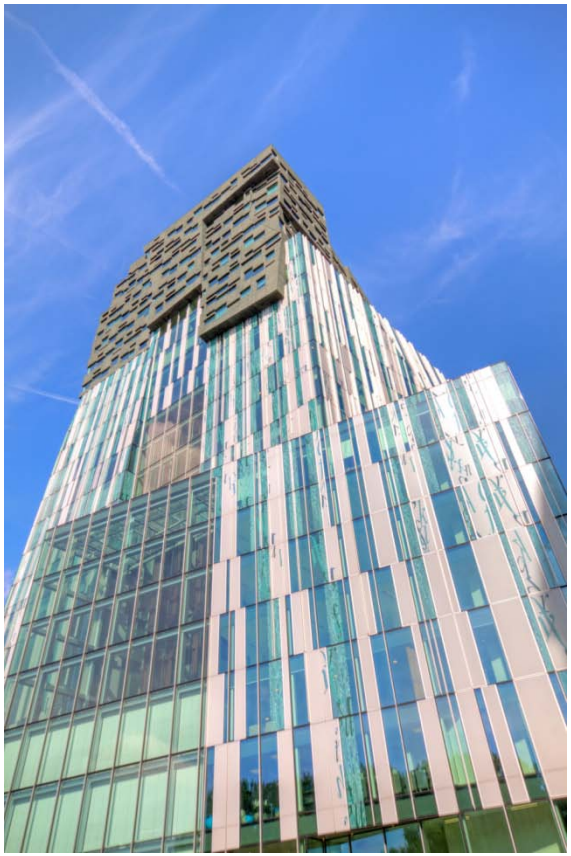
Curtain Wall Thermal Performance



AV19785



AV19787



AV19786

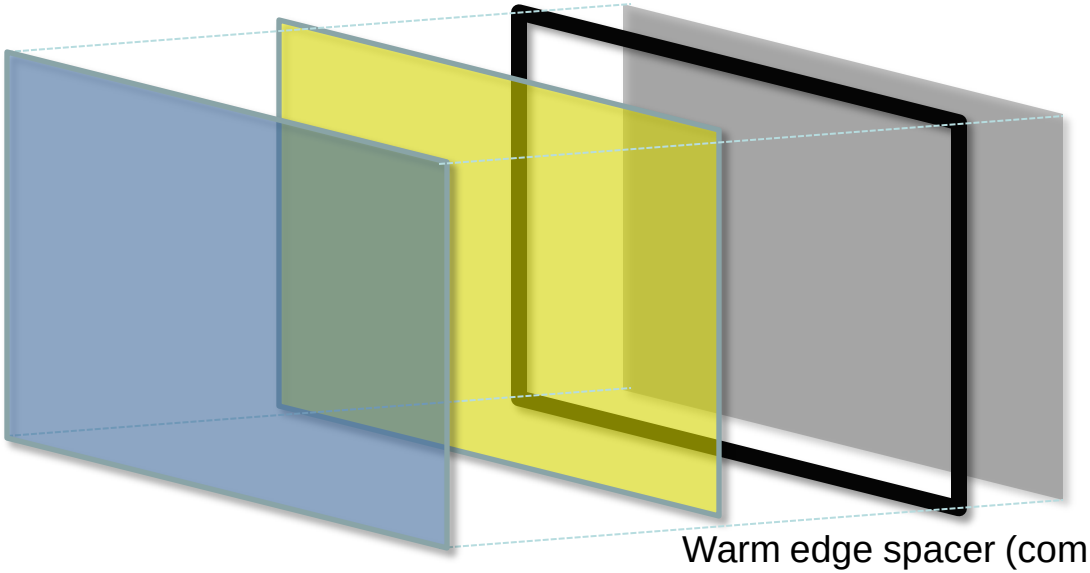
Product Concept: Architectural Insulation Module

Flexible Design to fit Building Uniqueness

Customized architectural unit: *performance*, *dimensions* and *finish*

AV 17411

Non vision curtainwall element with VIP inside



Warm edge spacer (commercial)

Architectural Finish (options)
- Glass (opaque)
- Aluminum
- Steel
- Photovoltaics…

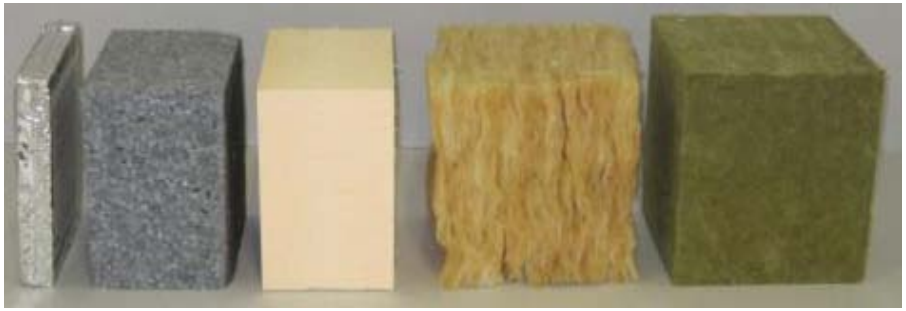
High Performance Insulation
- **VIP**

Back panel (options)
- Glass (opaque)
- Aluminum
- Steel

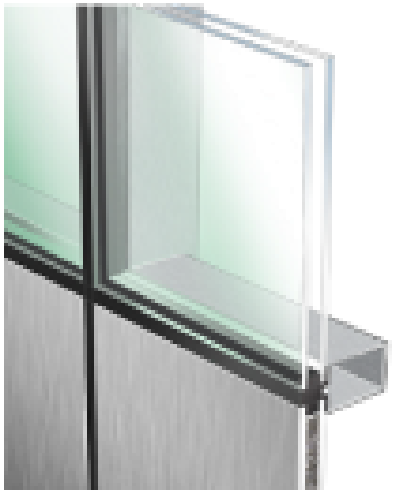
Product Concept: High Performance Insulation Through Vacuum Insulation Panel inserts

Thermal Conductivity λ (W/mK)			
VIP	EPS/ XPS	Glass Wool	Rock Wool
0.005	0.030	0.040	0.042

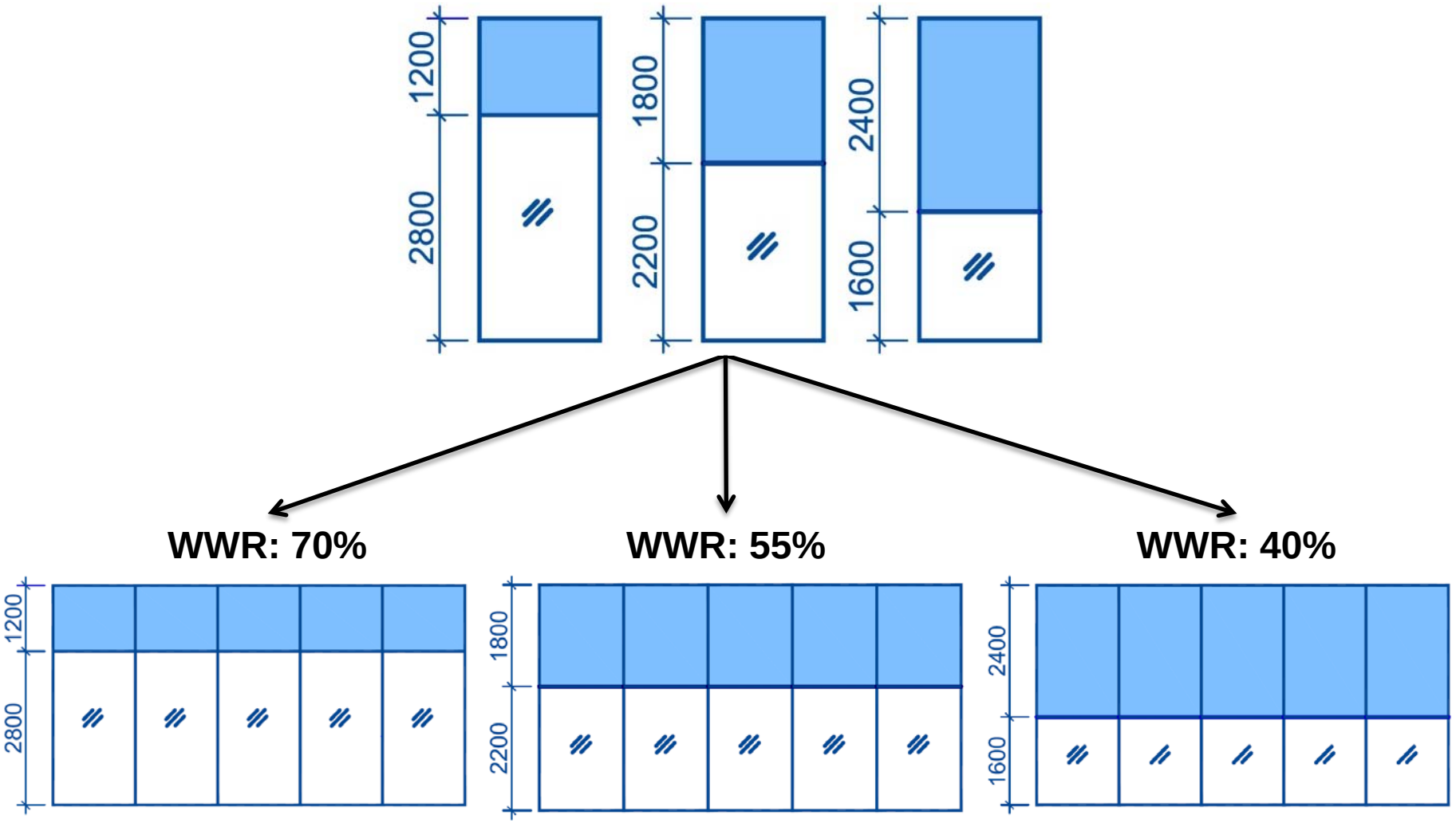
Comparative Thickness For U-value of 0.3 W/m²K



Product Concept: Customized Finishes



Façade Designs



Thermal Performance Study

- **Framing**
  - Typical Unitized Curtain Wall
    Four-side structurally glazed system with no exterior vertical or horizontal capping

- **Vision Area Glazing**
  - Vision: Double Pane IGU
    6Double Silver Low-E/12Ar(90% Argon-air mix) /6mm, U_g=1.4 W/(m²K), SC=0.39

- **Spandrel**
  - S1: 6 Reflective Coating + 2mm Aluminum Backpan + 50mm Rock Wool (RW)
  - S2: 6 Reflective Coating + 2mm Aluminum Backpan + 150mm RW
  - S3: 6 Double Low-E + 12A + 6 + 2mm Aluminum Backpan + 130mm RW
  - S4: 6 Double Low-E + 16A + 6 Ceramic Paint + 16A (w/ **15mm VIP**) + 6 + 2mm Aluminum Backpan + 100mm RW
  - S5: 6 Ceramic Paint + 2mm Aluminum Backpan + 150mm RW
  - S6: 6 Ceramic Paint + 16A (w/ **15mm VIP**) + 6 + 2mm Aluminum Backpan +100mm RW

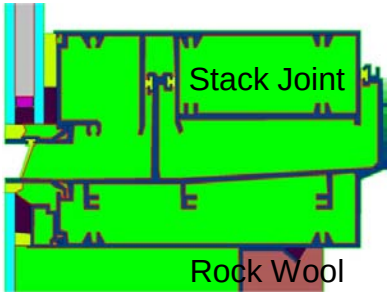
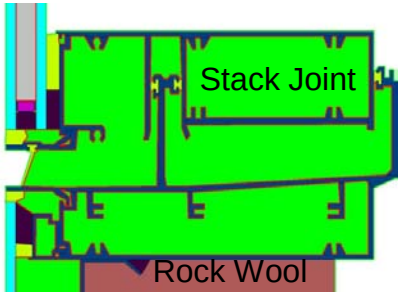
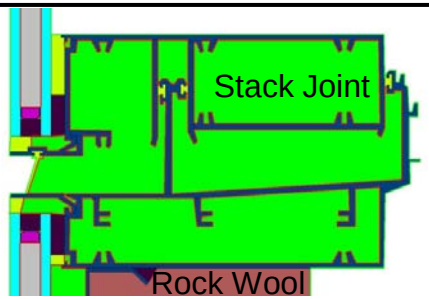
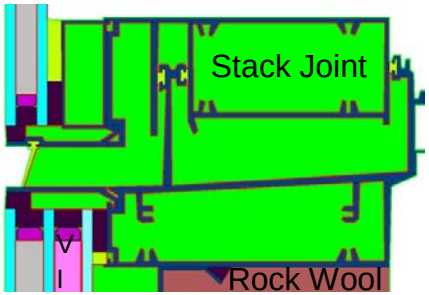
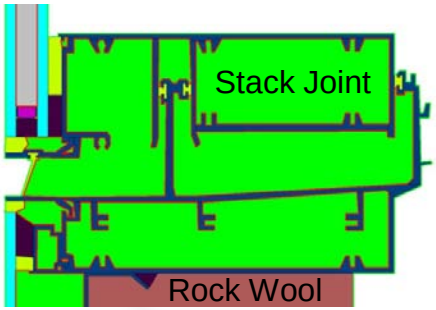
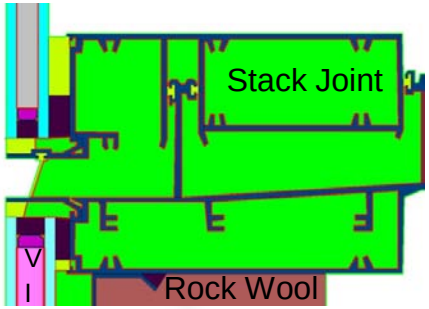
Thermal Performance Study: Modeling

Compare conventional insulation with high performance insulation (AIM) installed in *Shadow Box* and *Opaque Spandrel*

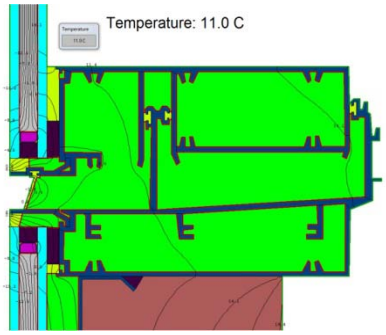
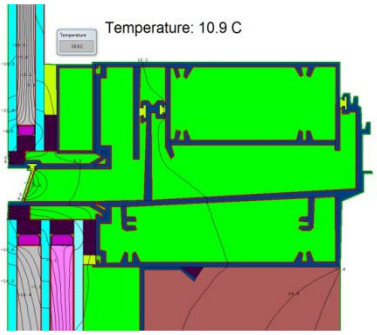
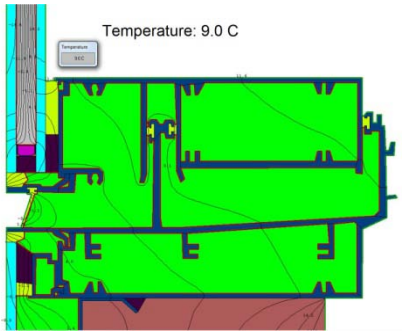
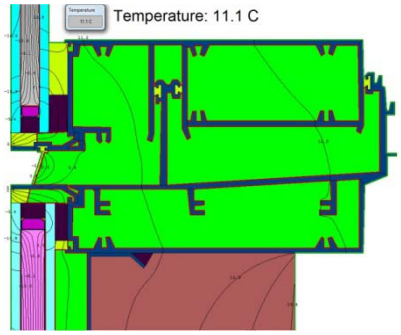
- Software
  - WINDOW 5.2 & THERM 6.3 (by LBNL, certified by National Fenestration Rating Council, NFRC).

- Standards and Norms
  - ISO 10077-1: Thermal Performance Of Windows, Doors And Shutters-Calculation Of Thermal Transmittance-Part 1: Simplified Method.
  - JGJ/T151-2008: Calculation Specification For Thermal Performance Of Window, Doors And Glass Curtain-Walls. China.
  - CWCT: Standard For Systemized Building Envelopes, Part 5. Centre For Window And Cladding Technology. United Kingdom.

Thermal Performance Study: Modeling

	Conventional Insulation			High Performance Insulation
Shadow Box	 S1: Monolithic glass with 50mm RW U_{cop} =0.67 W/(m^{2}K)	 S2: Monolithic glass with 150mm RW U_{cop} =0.24 W/(m^{2}K)	 S3: IGU with 130mm RW U_{cop} =0.28 W/(m^{2}K)	 S4: AIM (15mm VIP) with 100mm RW U_{cop} =0.18 W/(m^{2}K)
Opaque		 S5: Monolithic glass with 150mm RW U_{cop}=0.24 W/(m^{2}K)		 S6: AIM (15mm VIP) with 100mm RW U_{cop} =0.20 W/(m^{2}K)

Results: Condensation Risk

			
Vision+Shadow Box (IGU)	Vision+Shadow Box (AIM)	Vision+Opaque (Monolithic)	Vision+Opaque (AIM)

Combinations of Vision And Spandrel	Minimum Internal Surface Temperature (°C)		Dew Point
	Stack Joint	Intermediate Transom	
Vision+Shadow Box (IGU) (Conventional)	11.0	9.9	> 6°C (40%RH, 20°C)
Vision+Shadow Box (AIM)	10.9	10.5	
Vision+Opaque (Conventional)	9.0	6.9	
Vision+Opaque (AIM)	11.1	8.1	

Results: Overall Façade U-value

Combinations of Vision And Spandrel		Overall Facade U-Value (W/m^2K)		
		WWR 70%	WWR 55%	WWR 40%
Vision+ Shadow Box (Conventional)	Vision + S1 Monolithic Glass, 50mm RW 	2.5	2.3	2.2
	Vision + S2 (Monolithic Glass, 150mm RW) 	2.4	2.3	2.1
	Vision + S3 (IGU, 130mm RW) 	2.2	2.1	1.9
Vision+ Shadow Box (AIM)	Vision + S4 Shadow Box AIM, 15mm VIP,100mm RW 	2.2	2.0	1.8
Vision+Opaque (Conventional)	Vision + S5 Monolithic Glass, 150mm MW 	2.4	2.3	2.1
Vision+Opaque (AIM)	Vision + S6 AIM, 15mm VIP, 100mm RW 	2.2	2.0	1.8

Conclusion

- Novel High Performance Insulation (AIM) can enhance the thermal performance of typical curtain wall systems, compared with conventional insulation solutions.
- Increasing the thickness of conventional insulation will not be efficient enough to meet the overall U value for the near-future buildings, however, improving the thermal break level of frame, reducing the WWR, and using High Performance Insulation could be considered as the solutions for China.
- The study shows that the novel designs reduce the condensation risk compared with the conventional solutions.
- Given the same overall facade U-value requirement, the AIM solution offers building designer with freedom to design higher WWR for curtain walls compared with conventional solutions.
- Rock wool insulation is always modeled as filling the spandrel with no gap, which is not the truth in the real life. It should be worth notice from the professionals, and further work is required to establish ‘as built’ performance of common spandrel details.

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