Energy Efficiency in Buildings & Façade Design

Case Study: ITC Green Centre, Bangalore

Delhi | Feb 15 2016

ITC Green Center Team
&
Environmental Design Solutions

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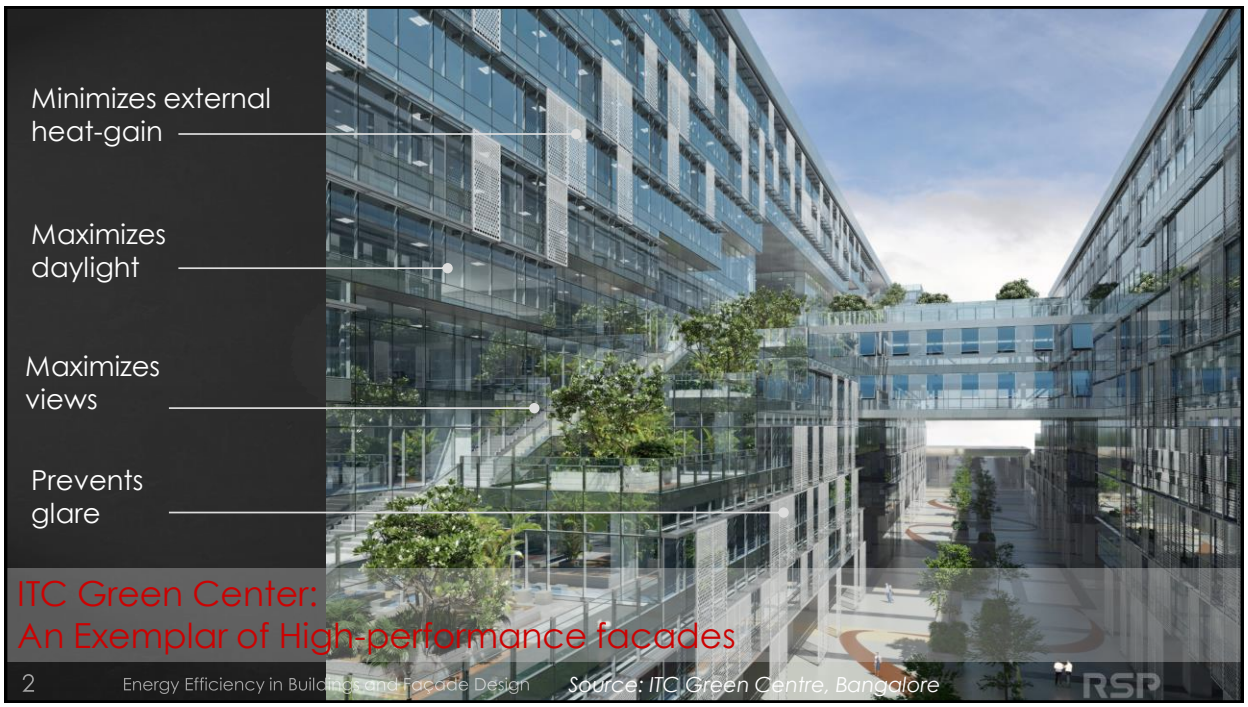


Source: ITC Green Centre, Bangalore

- Orientation
- Floor-plate depth
- Insolation and Shading of external facades
- High-performance fenestrations (parametric analysis)
  - Optimized Window Wall Ratio (WWR)
  - High-performance glazing
  - Optimized shading devices for fenestrations
- Daylight integration & controls
- Light-colored interiors

Major factors for façade optimization

- Project type: **Commercial**
- Functions and Use: **Commercial + Offic space**
- Project location: **Bangalore**
- Site area: **49, 252 sq.m**

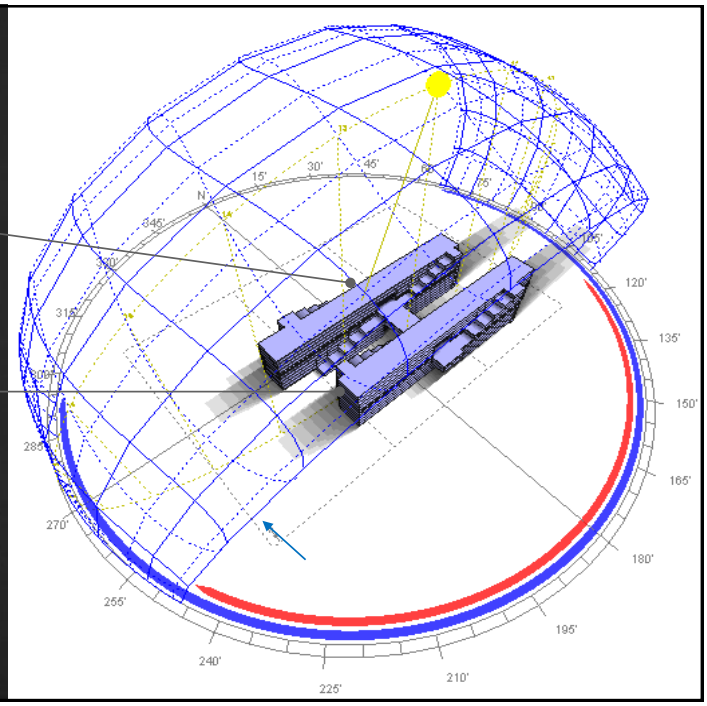
Project Details

Source: ITC Green Centre, Bangalore

The longer facades are oriented along the North-South direction

Maximizes daylight between 9:00 to 15:00

Minimized area of East and West facades reduces excessive heat gain



Orientation

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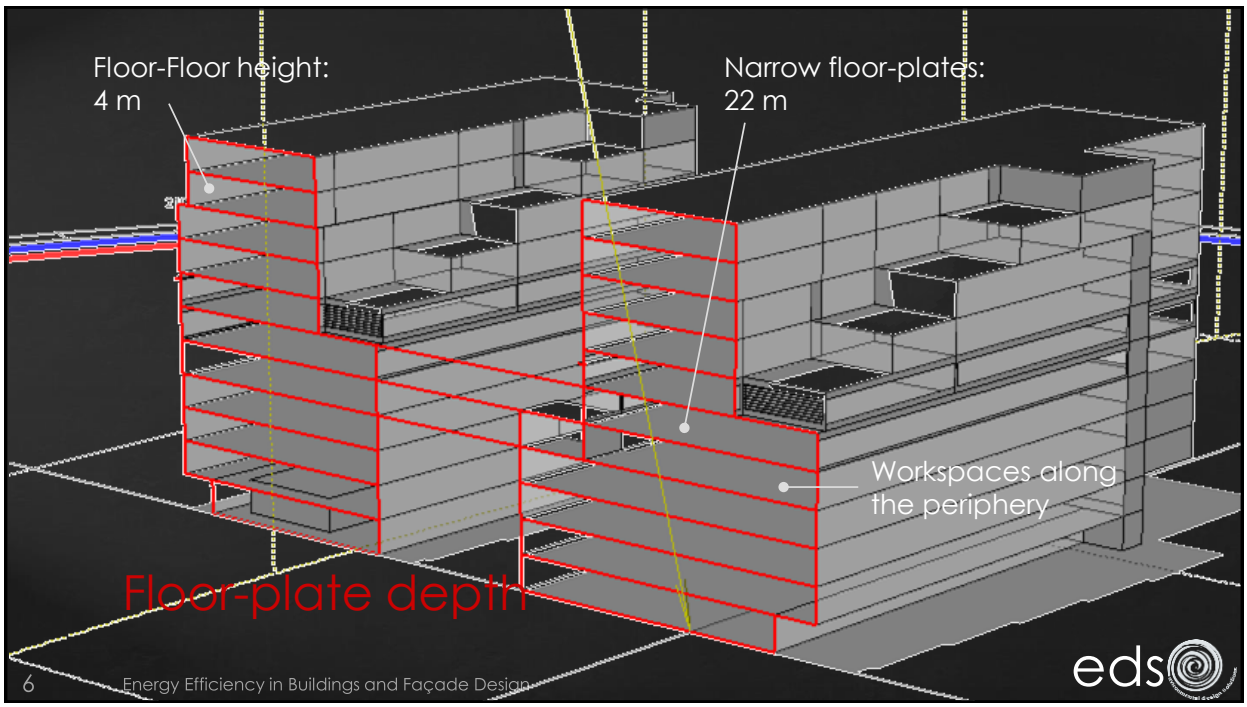

Floor-plate depth

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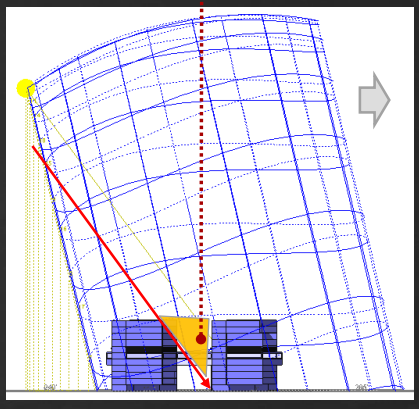
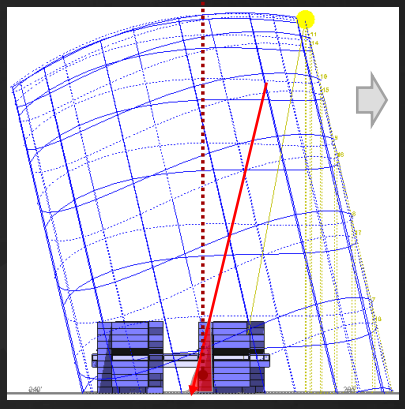
Winter sun on south facades



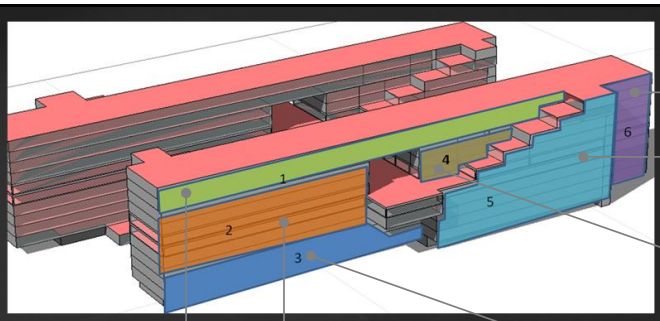
12:00, December, 55 degree

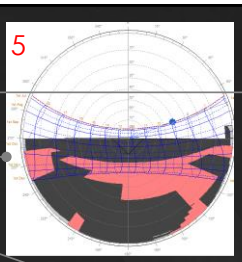
Summer shadows on south facades

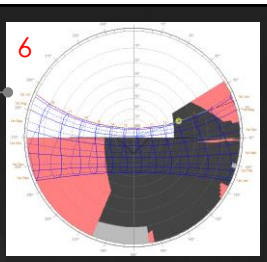


12:00, July, 82 degree

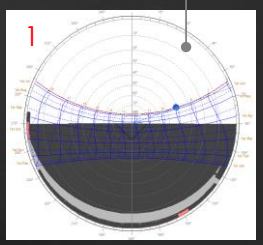
Insolation & Shading of external facades

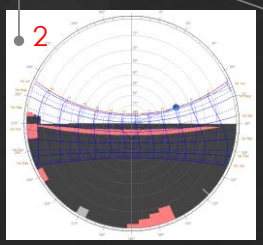


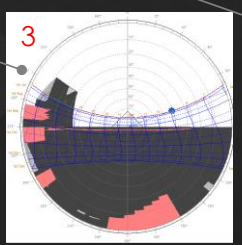


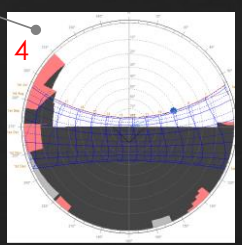


North façade of North block

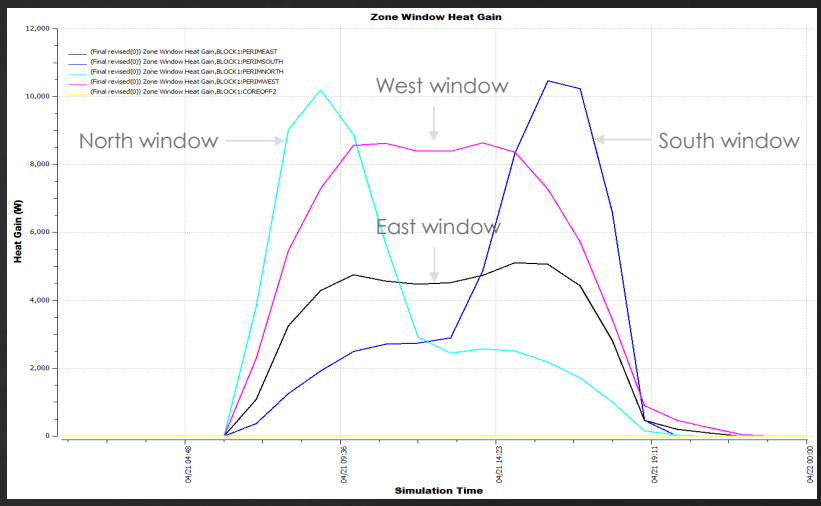




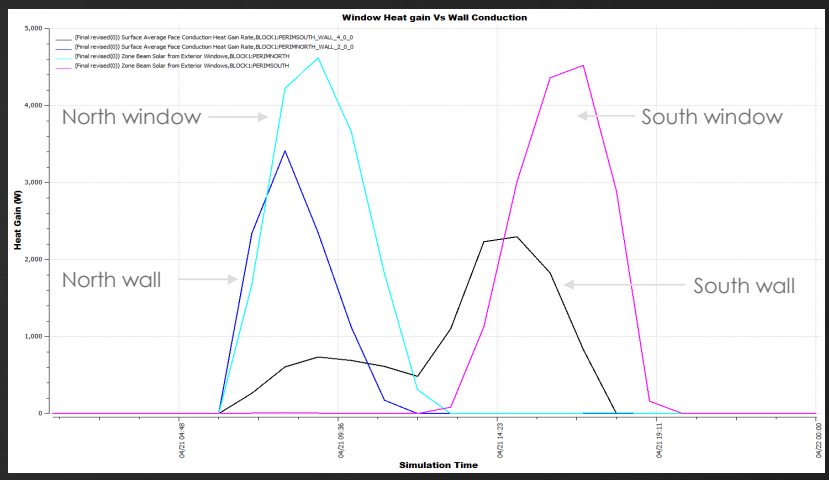




Insolation & Shading of external facades

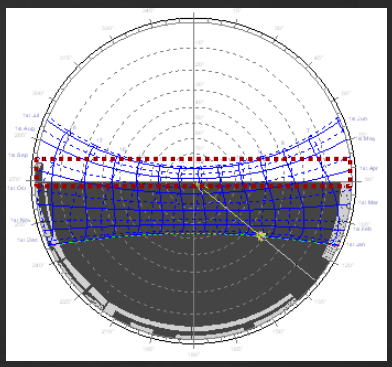


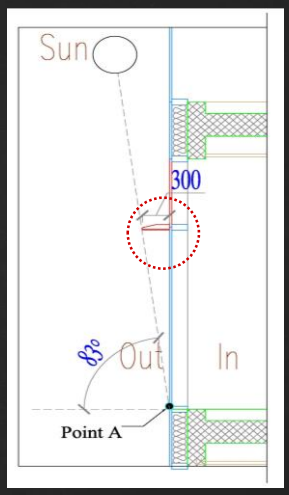
Heat gain from different windows

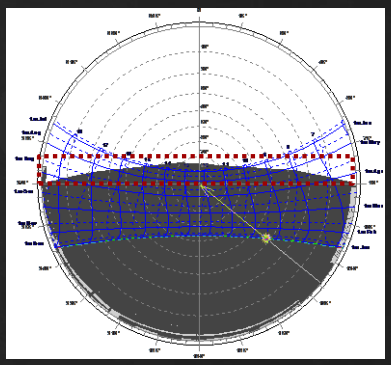


Heat gain : Windows vs Walls

Conceptual shading strategy



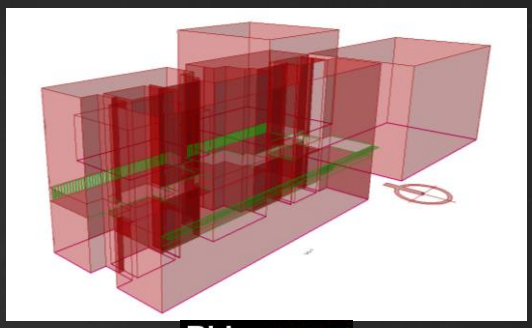


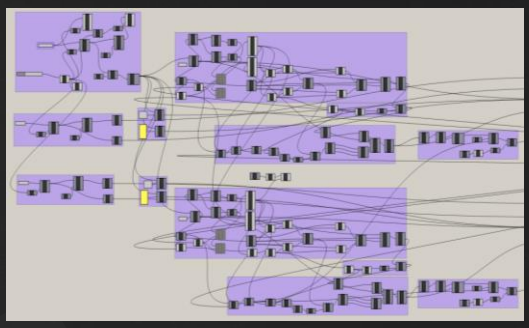


Insolation & Shading of external facades

- Energy efficient fenestration design through parametric analysis
  - Optimizing Window Wall Ratio (WWR)
  - Positioning of glazing
  - Optimized shading devices for fenestrations

High performance fenestration





Rhinoceros

NURBS modeling for Windows

grasshopper

GENERATIVE MODELING FOR RHINO

Parametric model

Parameter	Value
Occupant density	10.0 m^2/person
Light Power Density [LPD]	8.0 W/m^2
Equipment Power Density [EPD]	4.0 W/m^2
Cooling set point	24.0 deg C
Heating set point	21.0 deg C
Threshold illuminance	200.0 lux

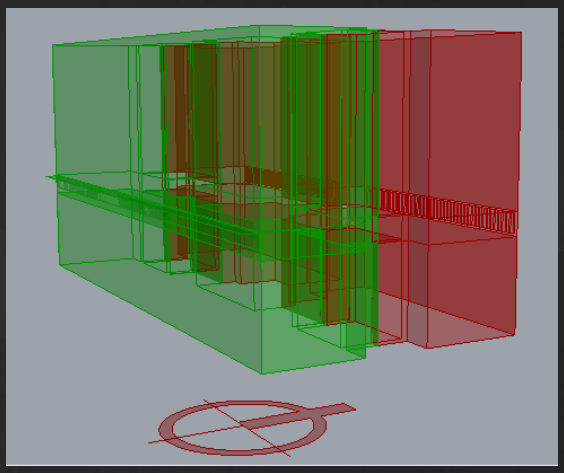
Inputs for Thermal and Daylight Analysis

Building component	Reflectance (%)	U-value (KWh/m2/y)	SHGC	VLT (%)
Walls	50		-	-
Ceiling	70		-	-
Floor	20		-	-
Window	80	3.3	0.25	40

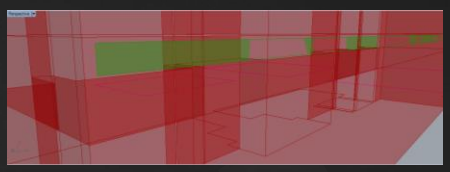
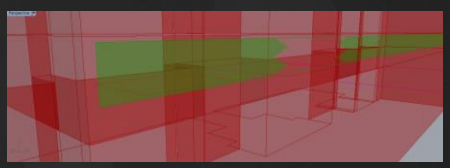
Material Properties

1. Total energy use (Cooling and Lighting) analysis for varying WWR 10-90% at an increment of 10%
2. Combined UDI and energy analysis for change in window position
3. Analyzing impact of shading on total energy use
4. Combined UDI and energy analysis for selected WWR range with shading

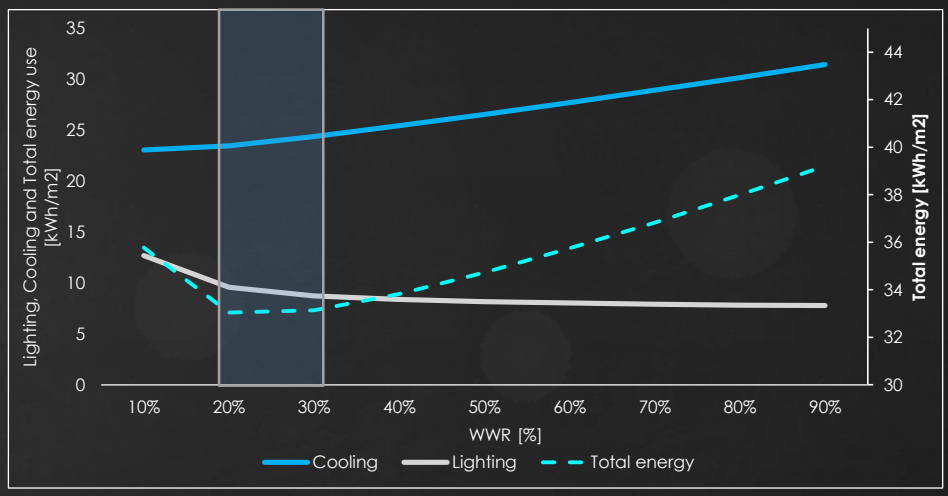
Methodology



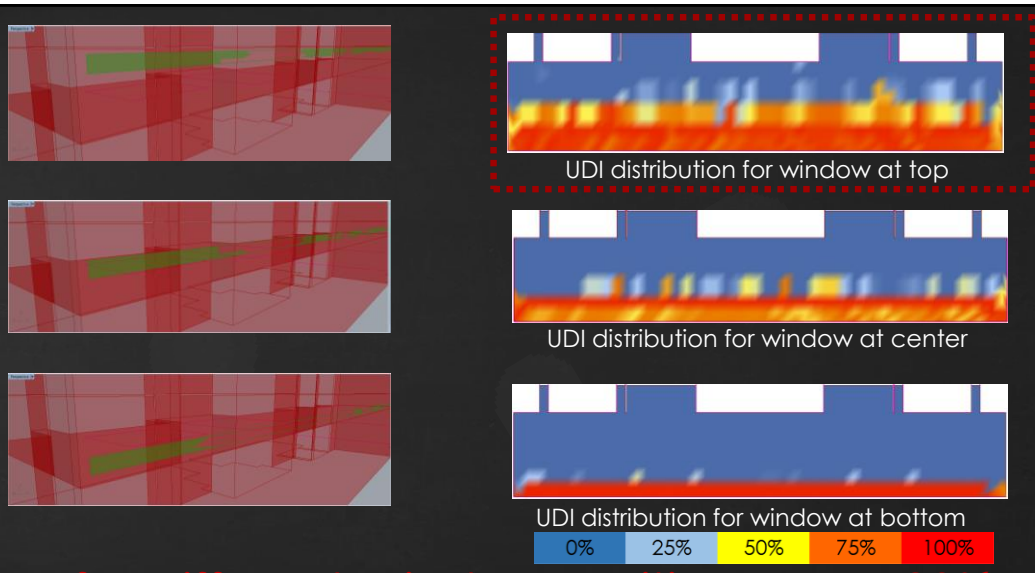
Results and Analysis – South Facade

WWR	
30%	
60%	
90%	

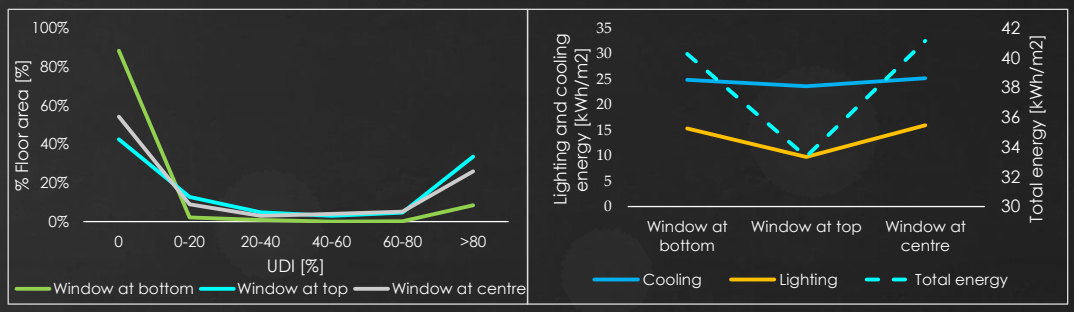
Modelled Glazing for Varying WWR



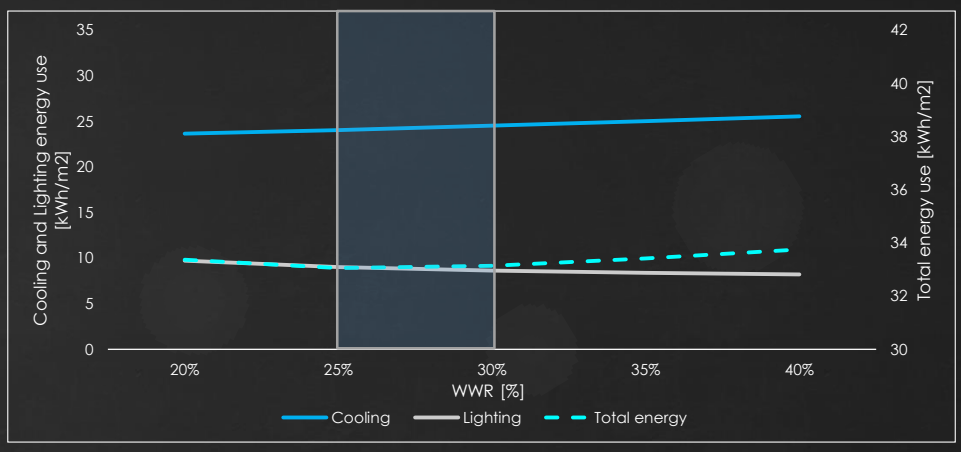
Varying WWR and its Impact on Energy Use



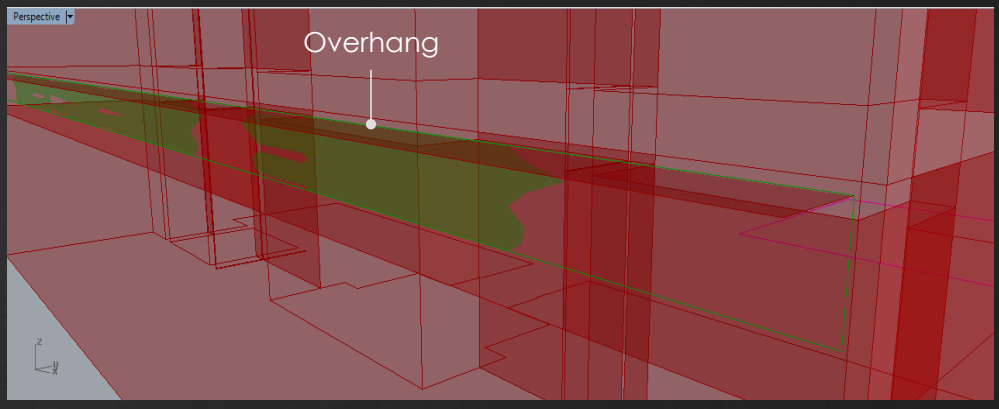
UDI for Different Window Position WWR- 20%



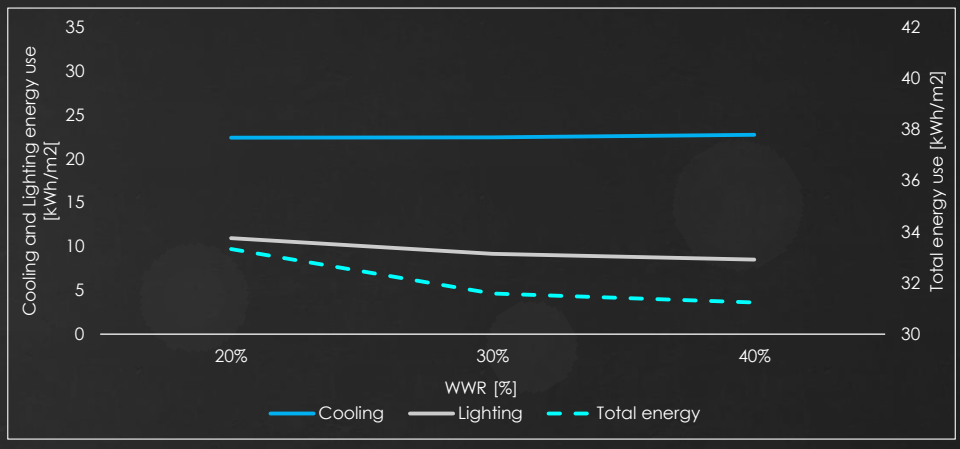
UDI Distribution and Variation in Energy Use for Different Window Positions



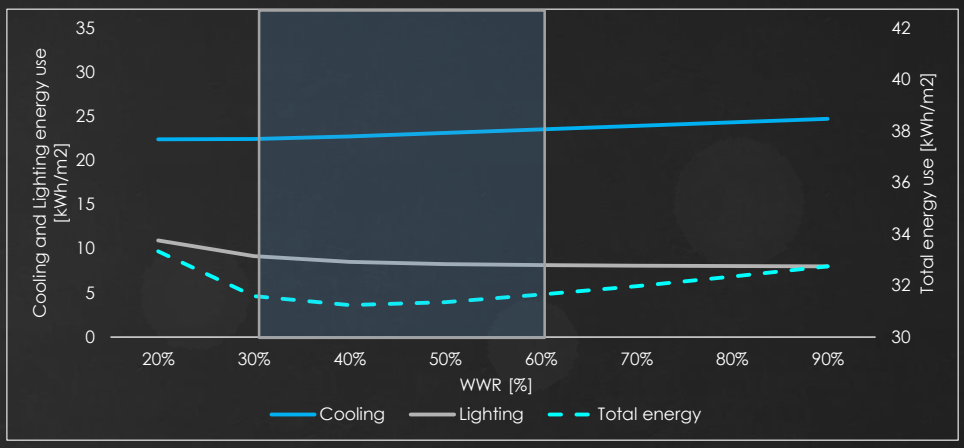
Energy Use for 20-40% WWR and Window Located at Top, in steps of 5% increment



UDI & Energy Use for varying WWR and Window located at Top with Overhang

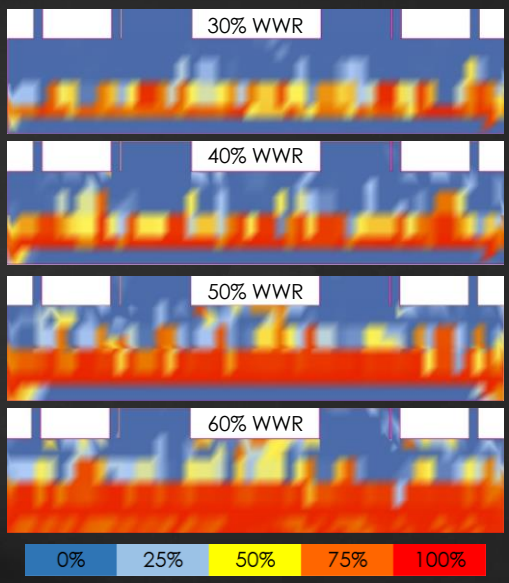


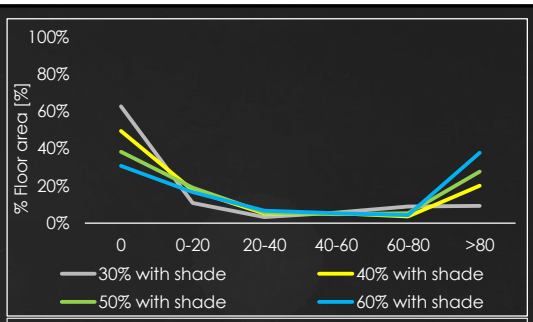
Energy Use for 20-40% WWR and Window Located at Top With Overhang

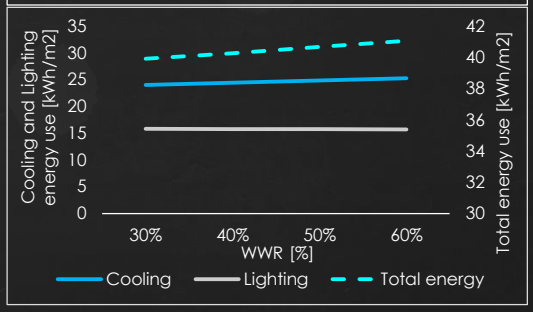


Energy Use for 20-90% WWR and Window Located at Top with Overhang

Combined UDI and Energy Use Analysis for 30-60% WWR and Window Located at Top With Overhang







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Impact of WWR on Energy

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Conditioned Area						
WWR	WWR Visible Area	Cooling KWh/sqft	Lighting KWh/sqft	Total KWh/sqft	Peak Sqft/Tr	% Savings
29%	34%	3.366	1.247	4.613	439.43	18%
37%	43%	3.459	1.227	4.686	428.44	16%
44%	52%	3.567	1.216	4.784	417.13	13%
52%	61%	3.681	1.213	4.894	406.40	11%
60%	70%	3.797	1.210	5.008	395.83	9%
67%	80%	3.916	1.209	5.125	385.43	6%
75%	89%	4.041	1.208	5.249	374.20	3%
83%	98%	4.169	1.207	5.376	361.68	0%

Impact of WWR on Energy

East and West Facade

Internal courts

Optimized shading devices

External (North & South) Facade

Optimized shading devices

Electricity rate (Rs/kWh)		9	
Cases	**Annual Energy Use (kWhr/Yr)**	**Percentage savings**	**Annual Cost Savings**
Basecase with no shading	***10,649,820***		
Basecase + 15 %perforated aluminium panel	***6,922,383***	***35***	***33,546,933***
Basecase+ 20 %perforated aluminium panel	***6,283,394***	***41***	***39,297,836***
Basecase + 25%perforated aluminium panel	***5,857,401***	***45***	***43,131,771***
Basecase + 30 %perforated aluminium panel	***5,644,405***	***47***	***45,048,739***

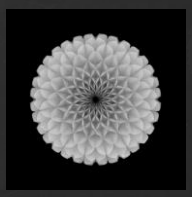
Energy impact for perforated facades

- Without shading devices, a WWR ratio of 20-30%, is optimum for maximum daylighting with minimum building energy performance.
- Having higher lintel levels provide better daylight penetration of daylight.
- With careful shading strategies, increasing the WWR from 20% to 60% increases the UDI by 4 times while increasing the energy consumption by only 1 KWh/m2/y (2.5%)

Key Takeaways

In ITC Green Center, Bangalore, an integrated design process combined with parametric daylight simulations, made it possible to achieve adequate daylight in 100% of the regularly occupied spaces, without compromising on energy performance.

Summary



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Thank You