



# *Multifunctional switchable window*



*Aritra Ghosh*

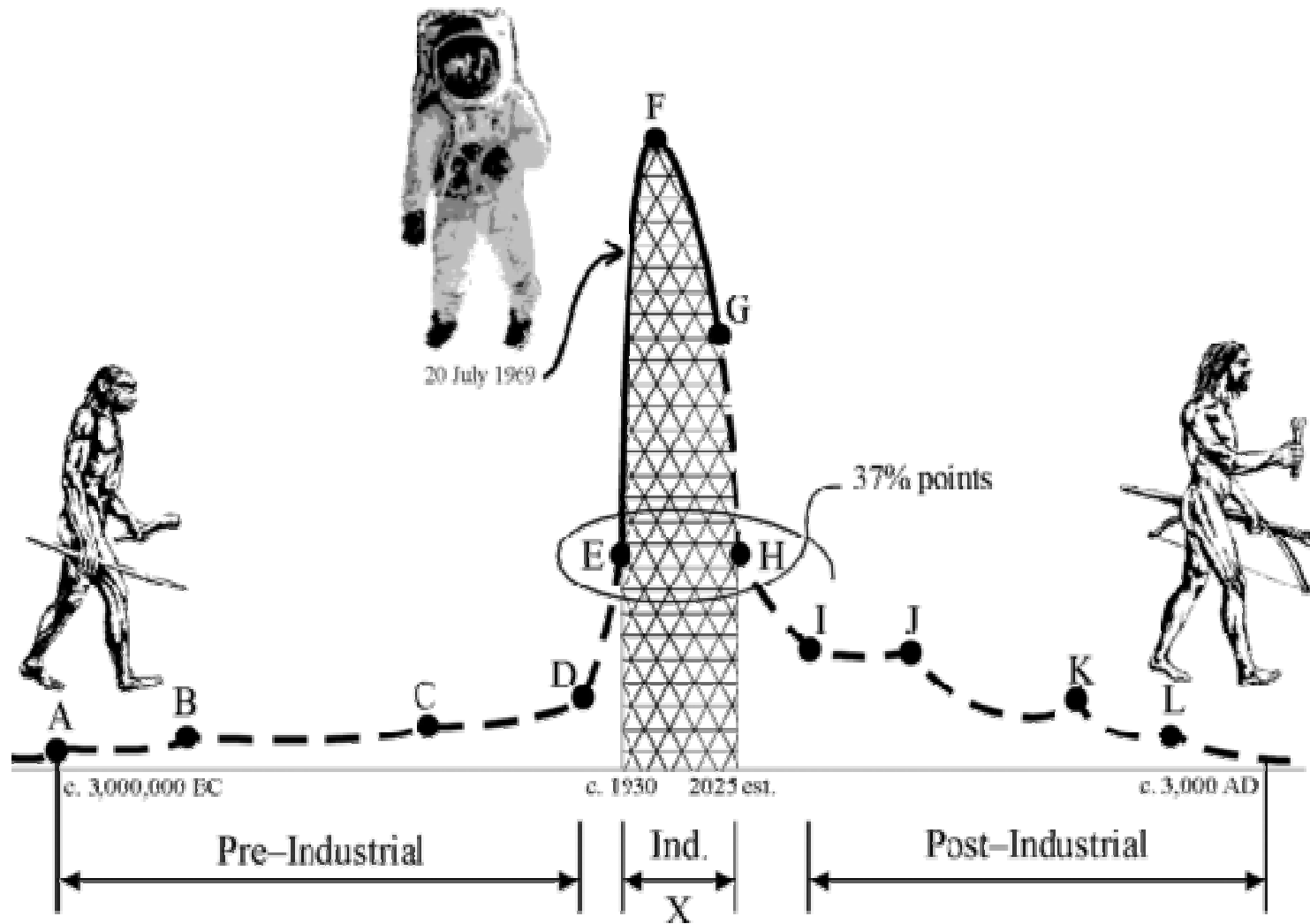
Civil & Building Services Engineering

Supervisors:

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Prof. Aidan Duffy

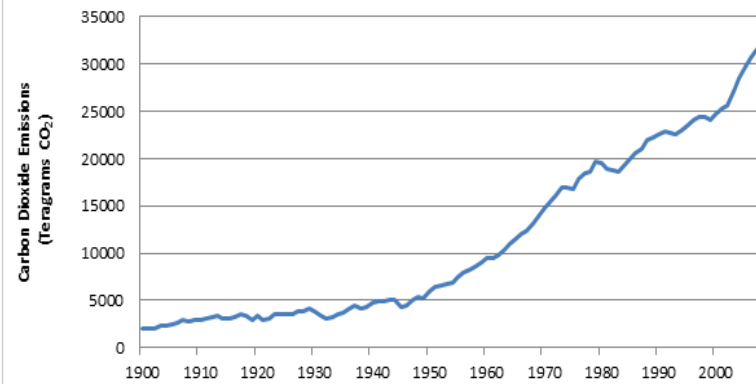
# *Fossil fuel depletion*



# Effect of green house gasses emission

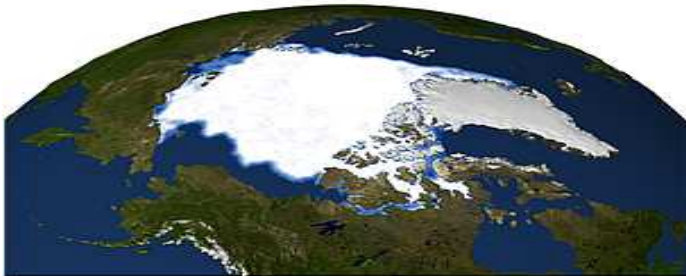


Global Carbon Dioxide (CO<sub>2</sub>) emissions from fossil-fuels 1900–2008

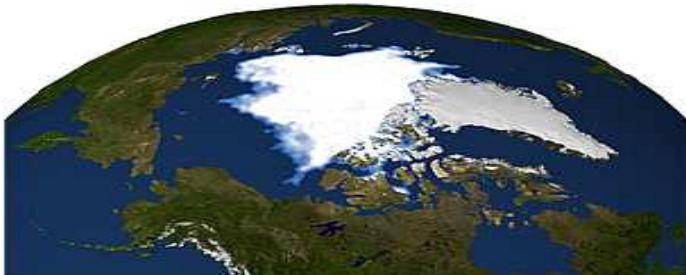


Source of data: Boden, T.A., G. Marland, and R.J. Andres (2010). Global, Regional, and National Fossil-Fuel CO<sub>2</sub> Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi 10.3334/CDIAC/00001\_V2010.

Sea ice minimum, September 1979



Sea ice minimum, September 2008



# *Motivation*

*Reduce greenhouse gas  
emission 30% (EU)*

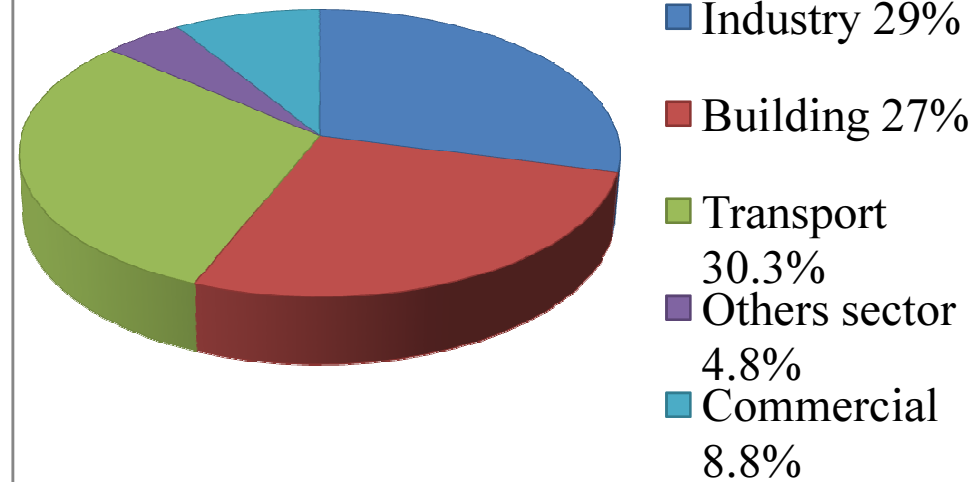
*20% energy generation  
from Renewable sources  
(EU)*



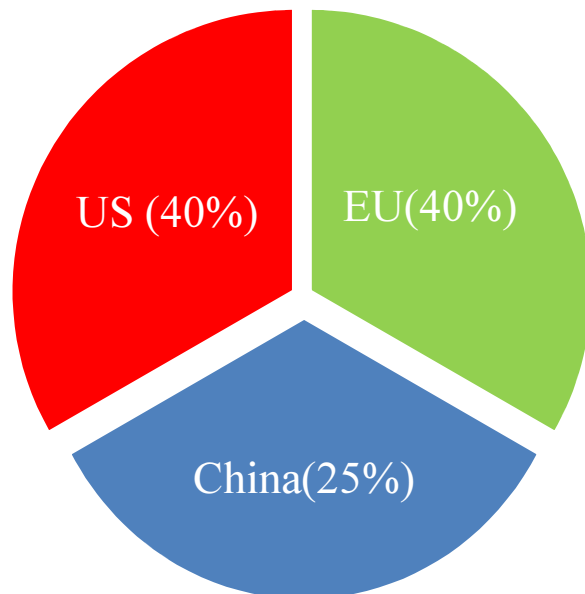
*16% Final energy  
consumption from  
renewable sources  
(Ireland)*

*40% Gross electricity  
consumption from renewable  
sources (Ireland)*

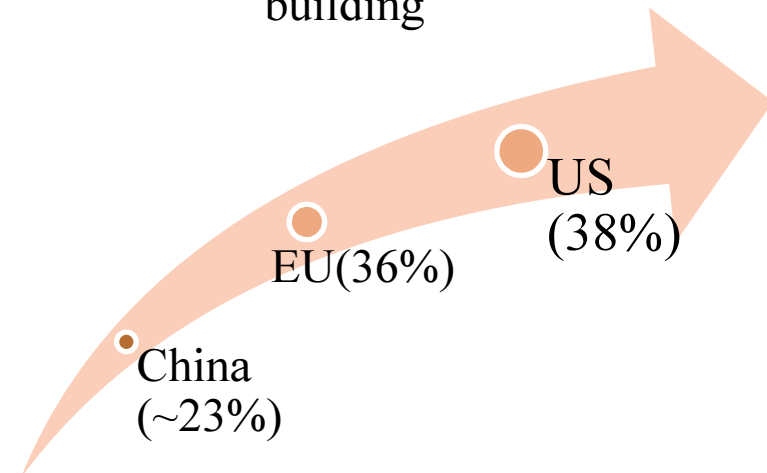
## Energy Consumption



## Building Energy consumption



## CO<sub>2</sub> emission from building



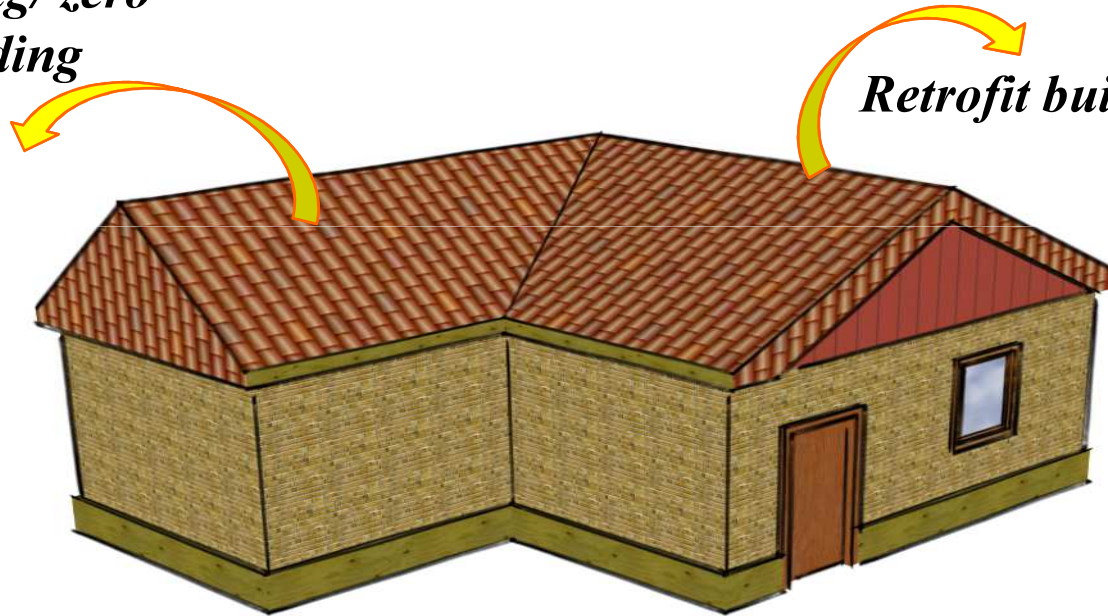
# Energy efficient building

All new buildings must be nearly zero energy buildings by 31 December 2020

35% of the EU's buildings are over 50 years old

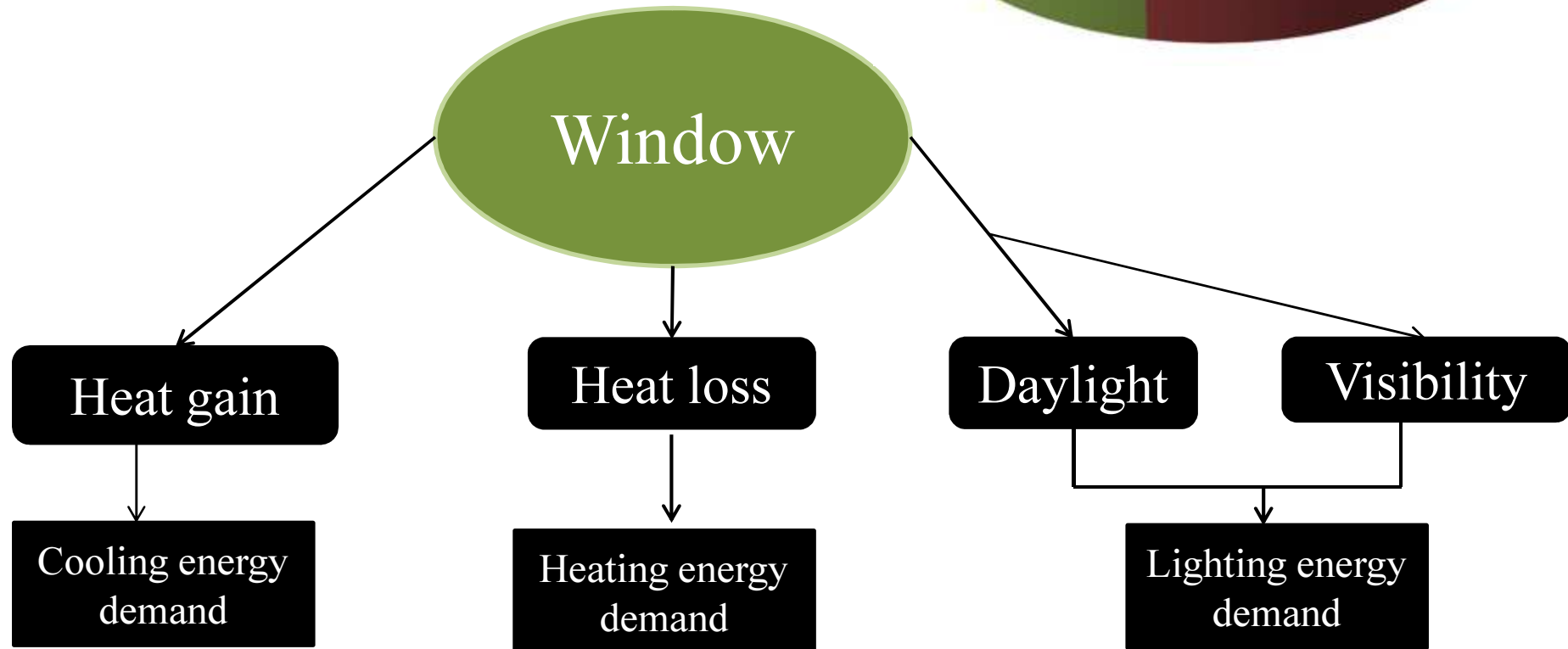
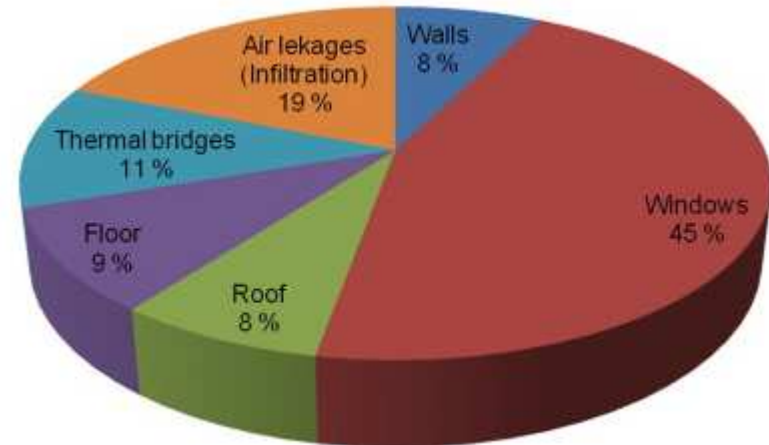
*New building/ zero energy building*

*Retrofit building*



## *Why window?*

20-40% total energy wasted through the window

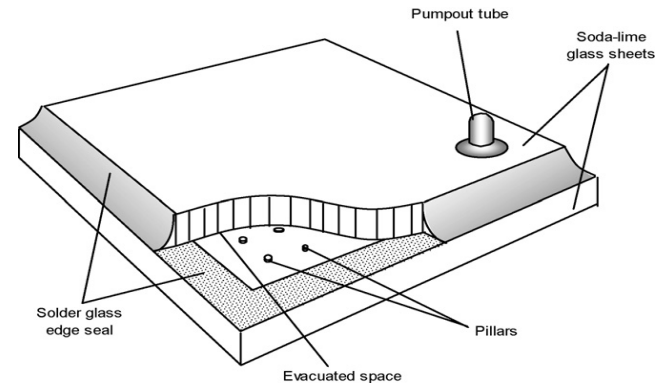




# Review of window



Aerogel window



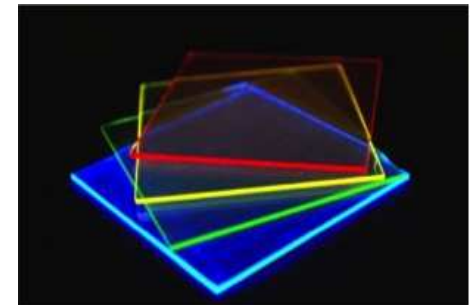
Vacuum window



Smart window



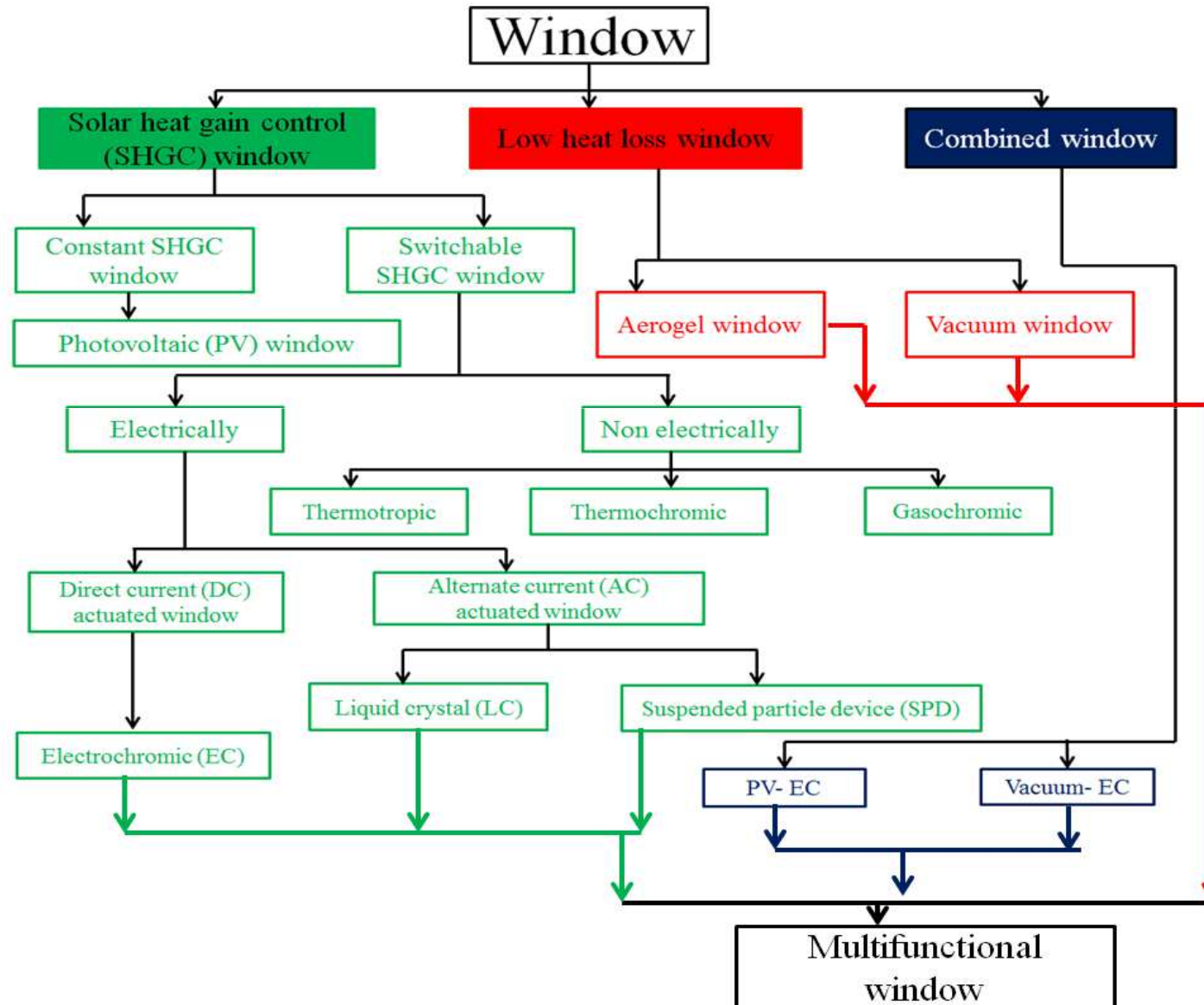
PV window



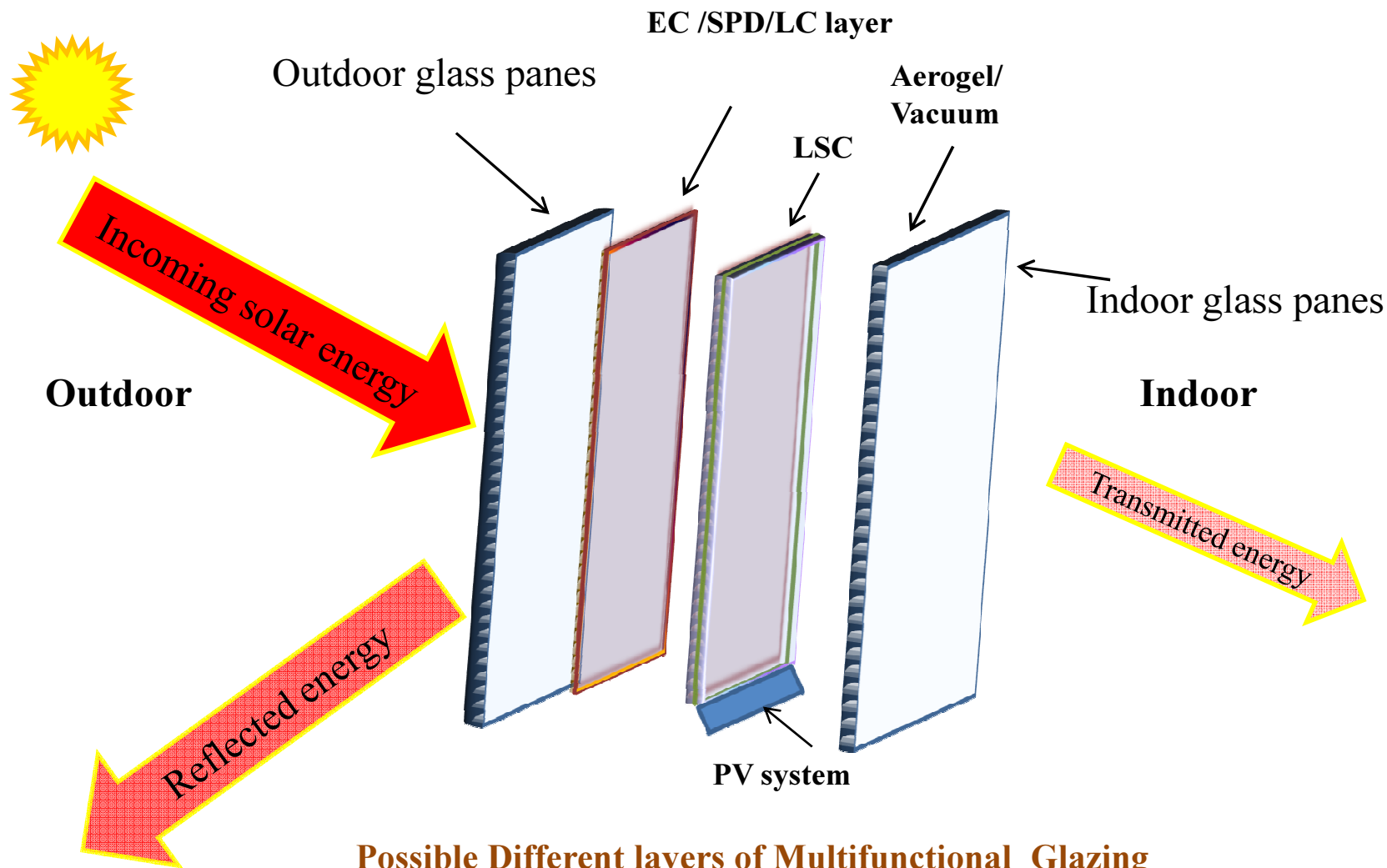
LSC



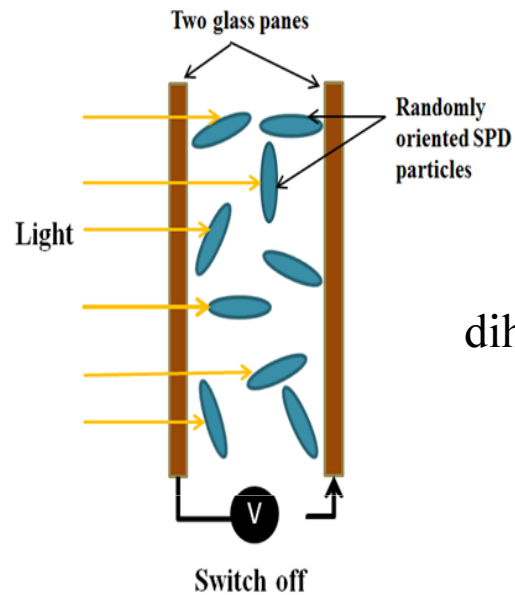
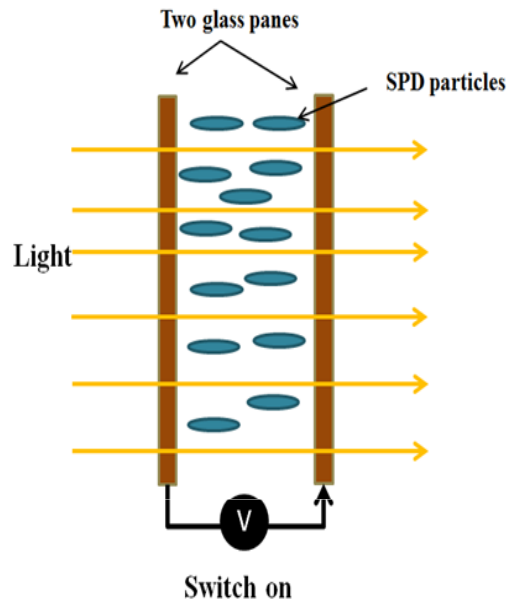
# Multifunctional window



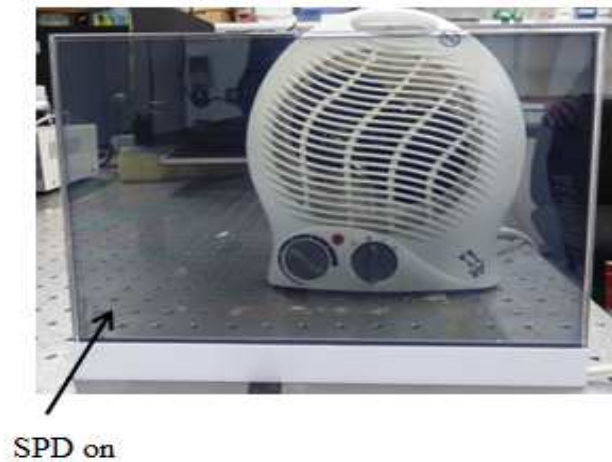
# *Design of Multifunctional switchable window*



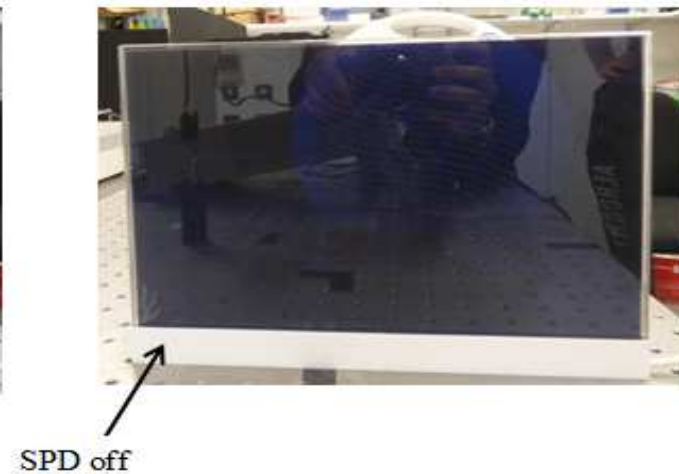
# Suspended particle window



dihydrocinchonidine bisulfite polyiodide

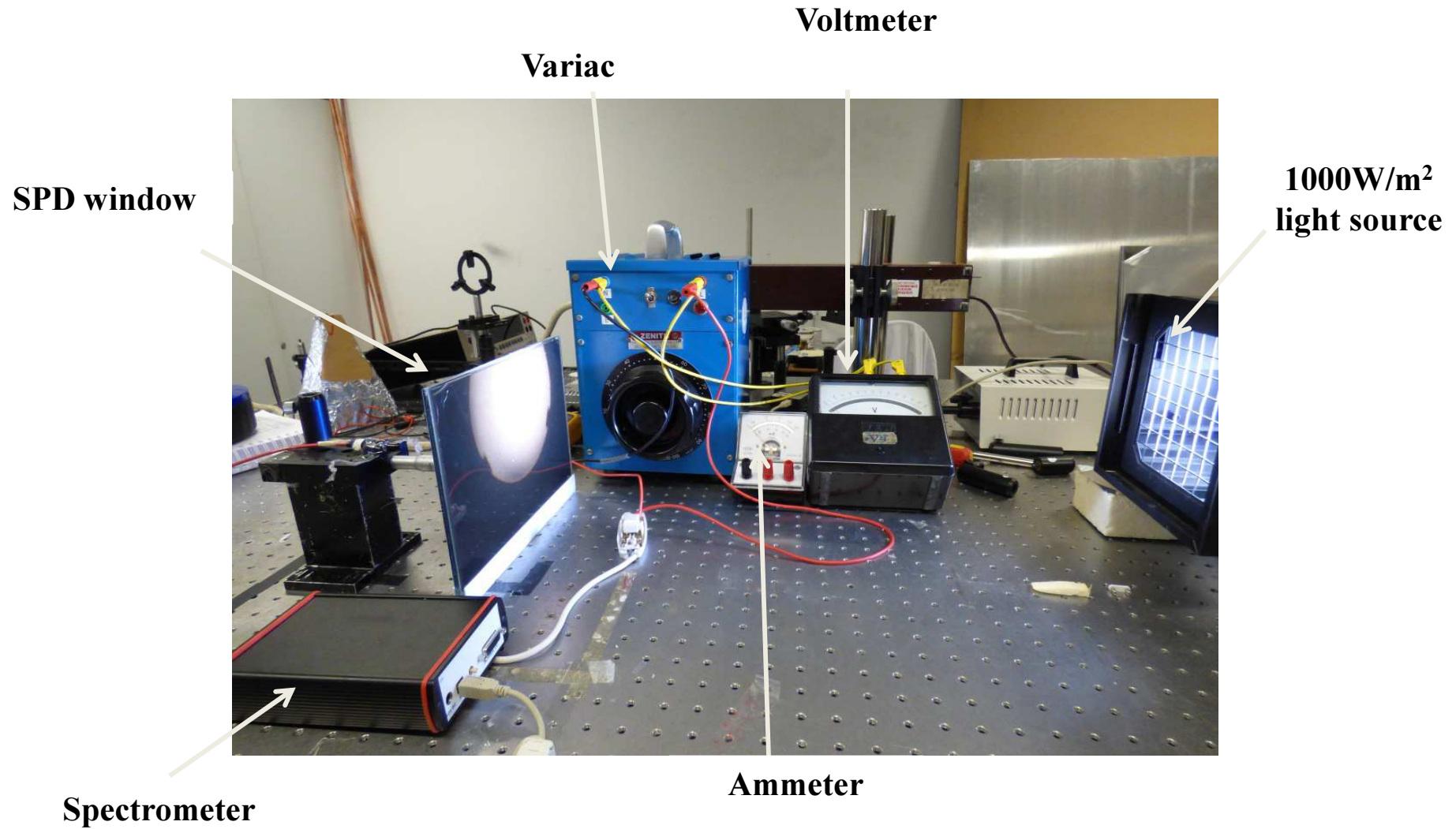


110V, 60% transparent

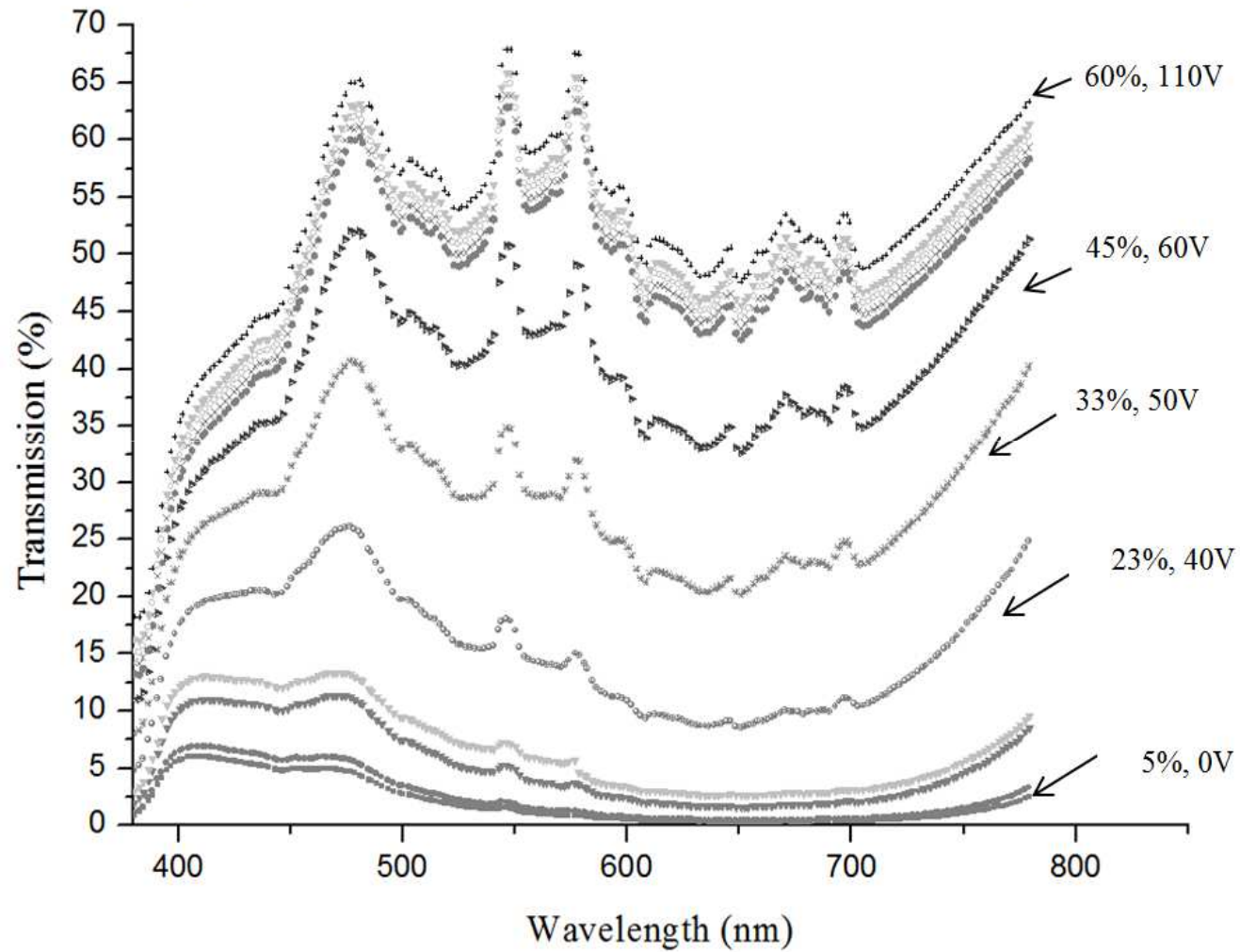


0V, 5% transparent

# Electro-optical test



# Luminous transmittance





# Test cell fabrication





# Thermal performance of SPD using heat exchanger



## Side view of test cell set up

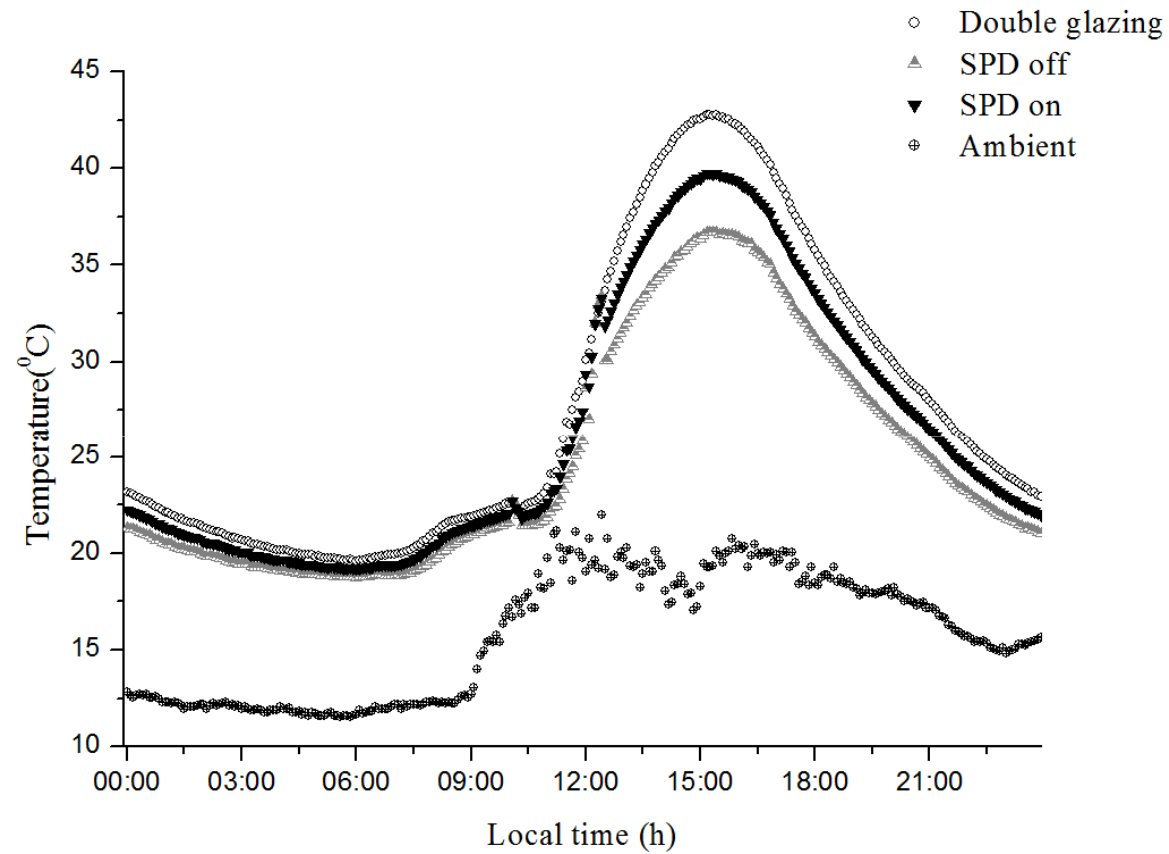




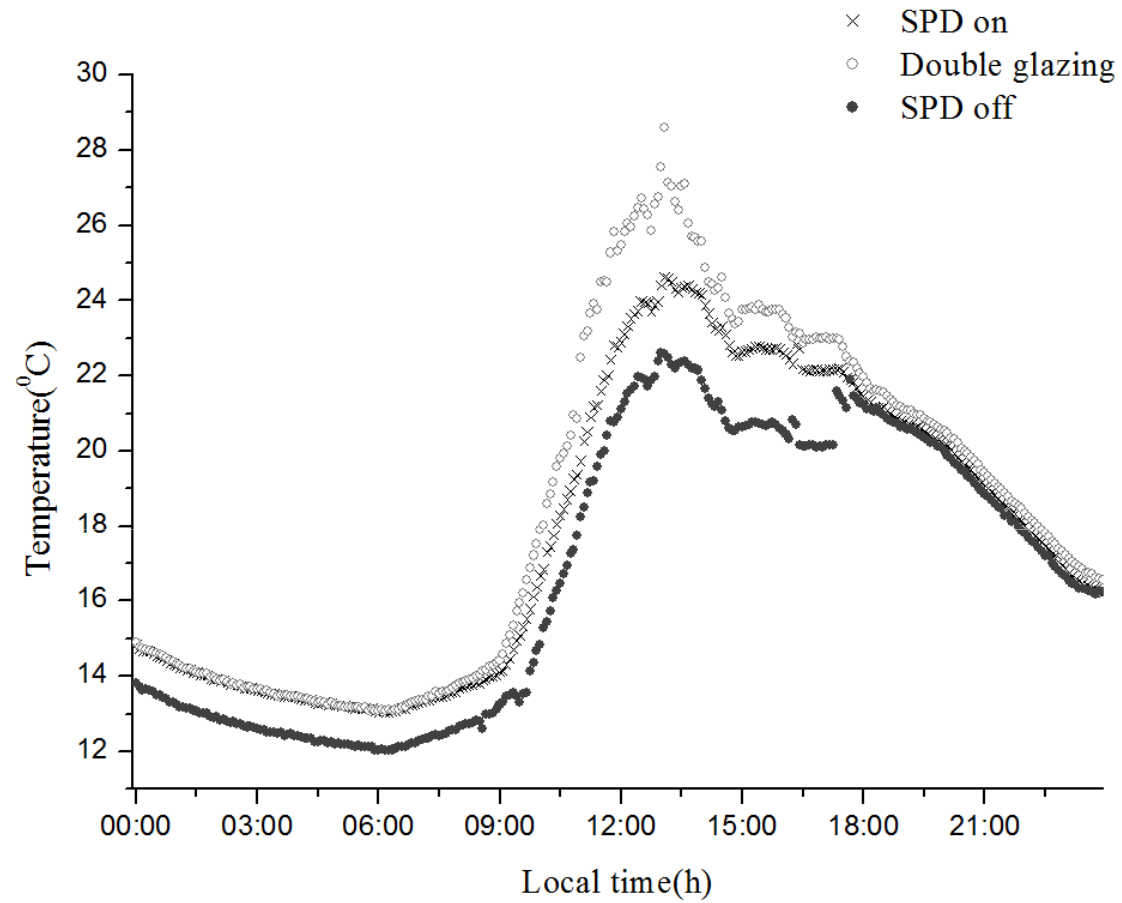
## Rear view of test cell set up



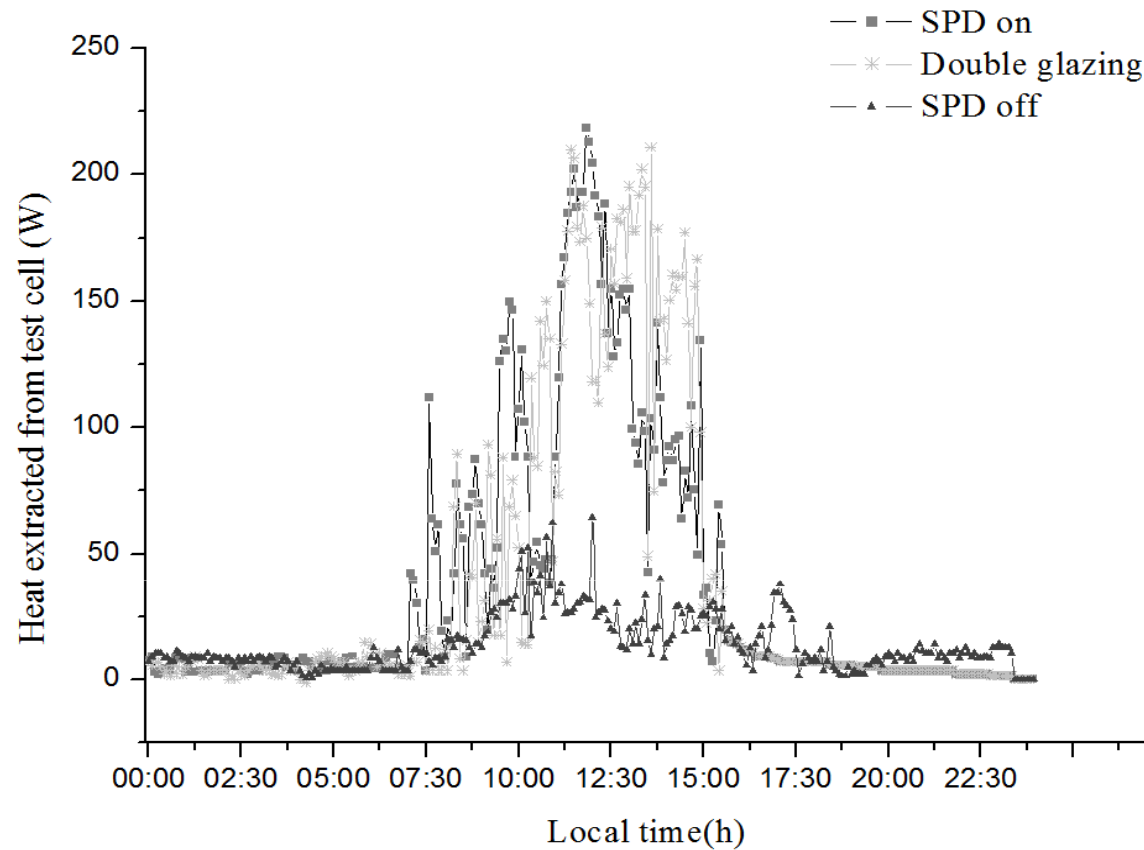
# Results



Test cell temperature without heat exchanger



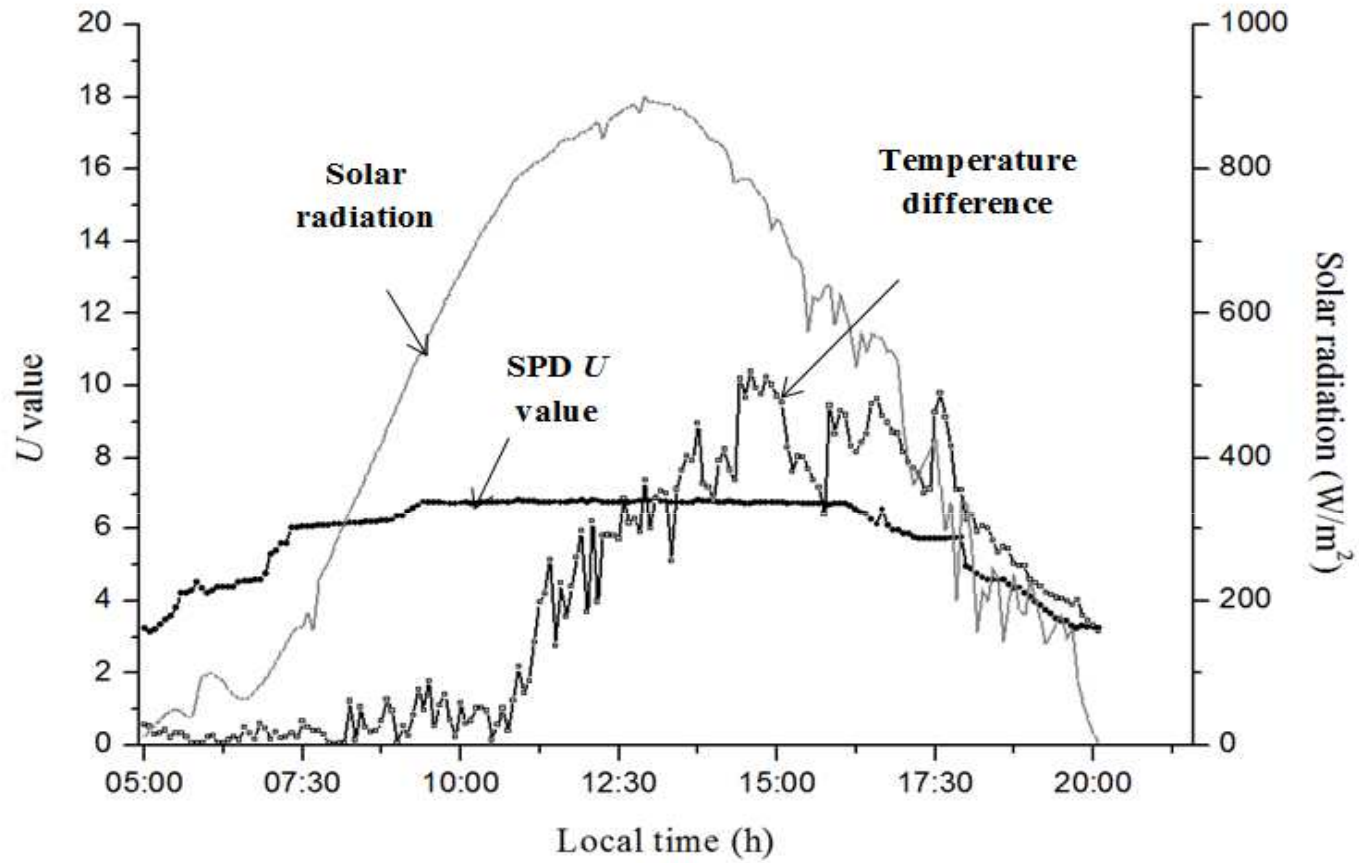
Test cell temperature after water flow (mass flow rate at 0.01kg/s)



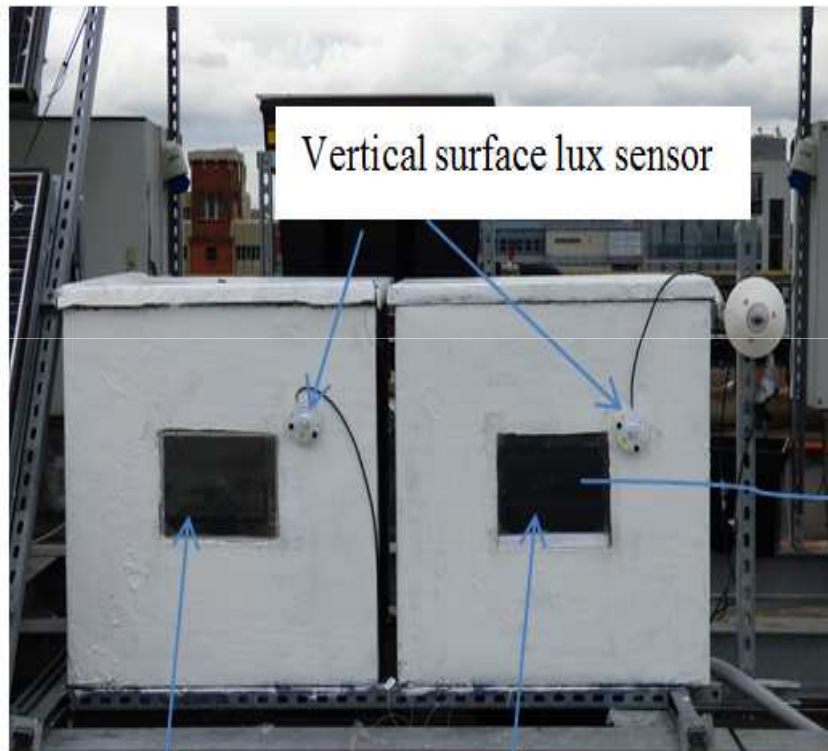
***Extracted heat double (10.64KWh) ,SPD on (10.38KWh), and SPD off (4.02KWh)***

***62% less heat had to be extracted from SPD off condition compare to Double glazing  
2% while SPD on***

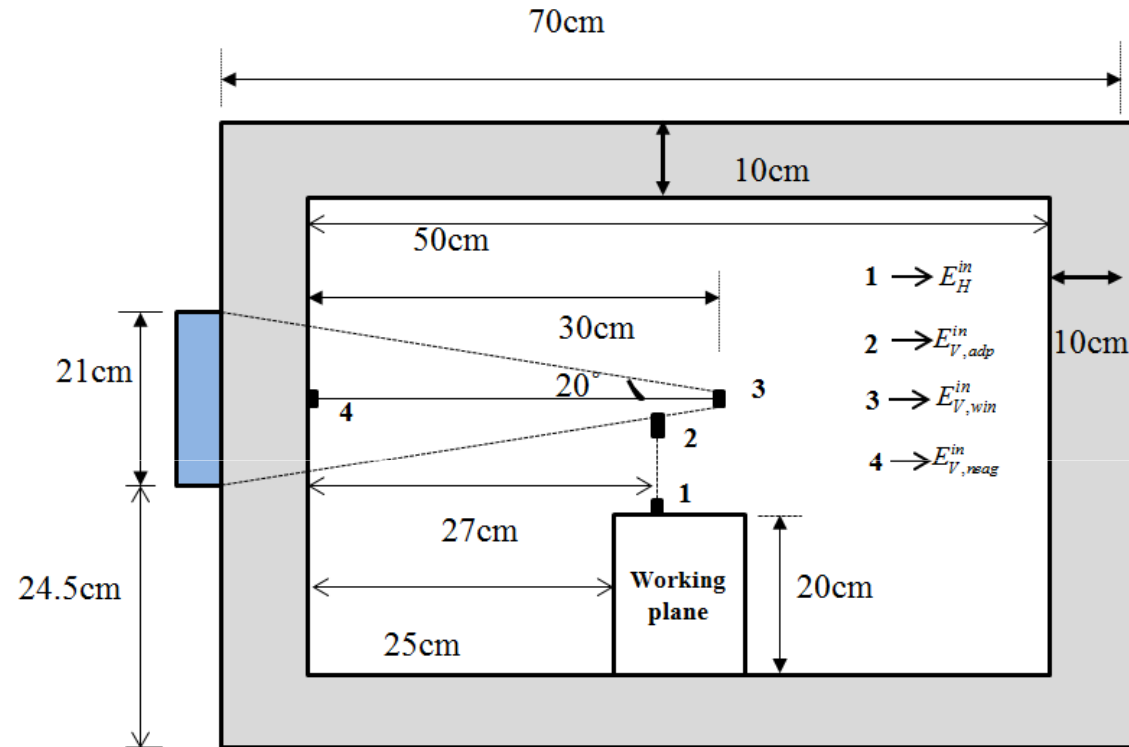




# Daylight performance of SPD

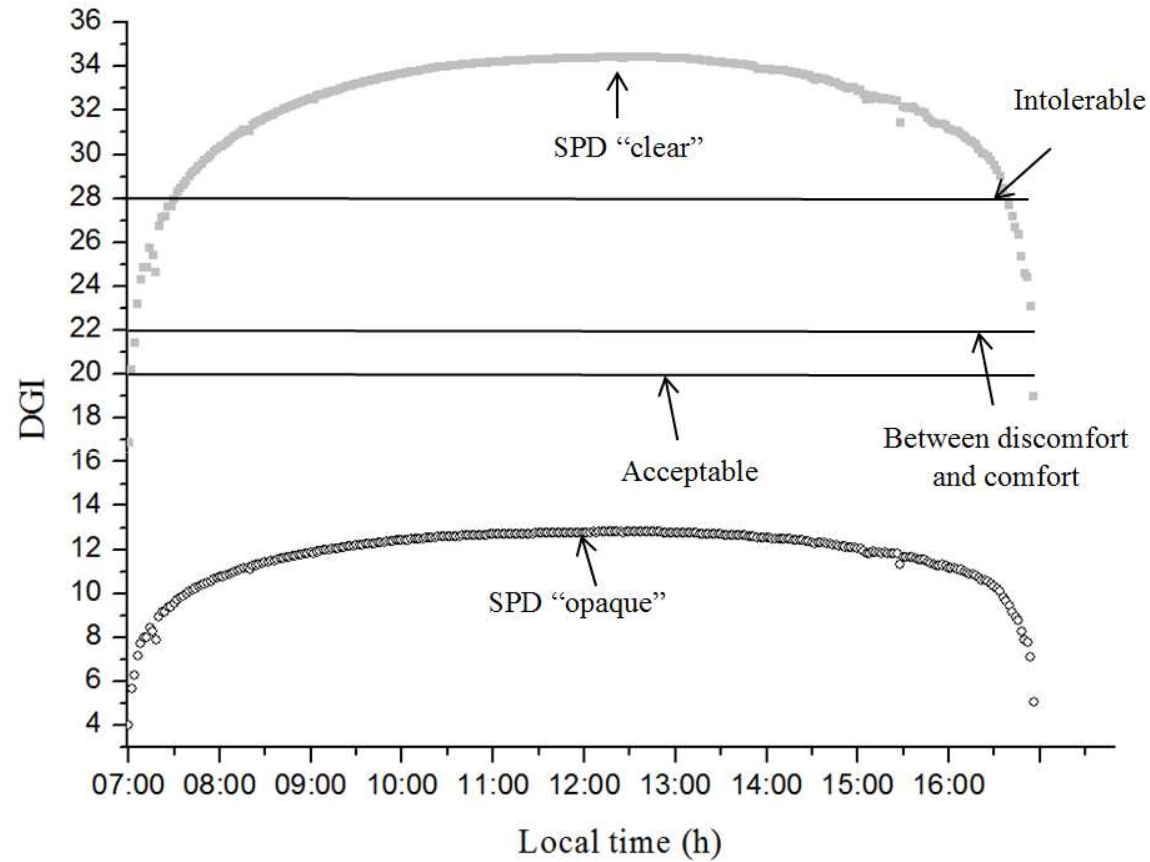


# Methodology of glare calculation

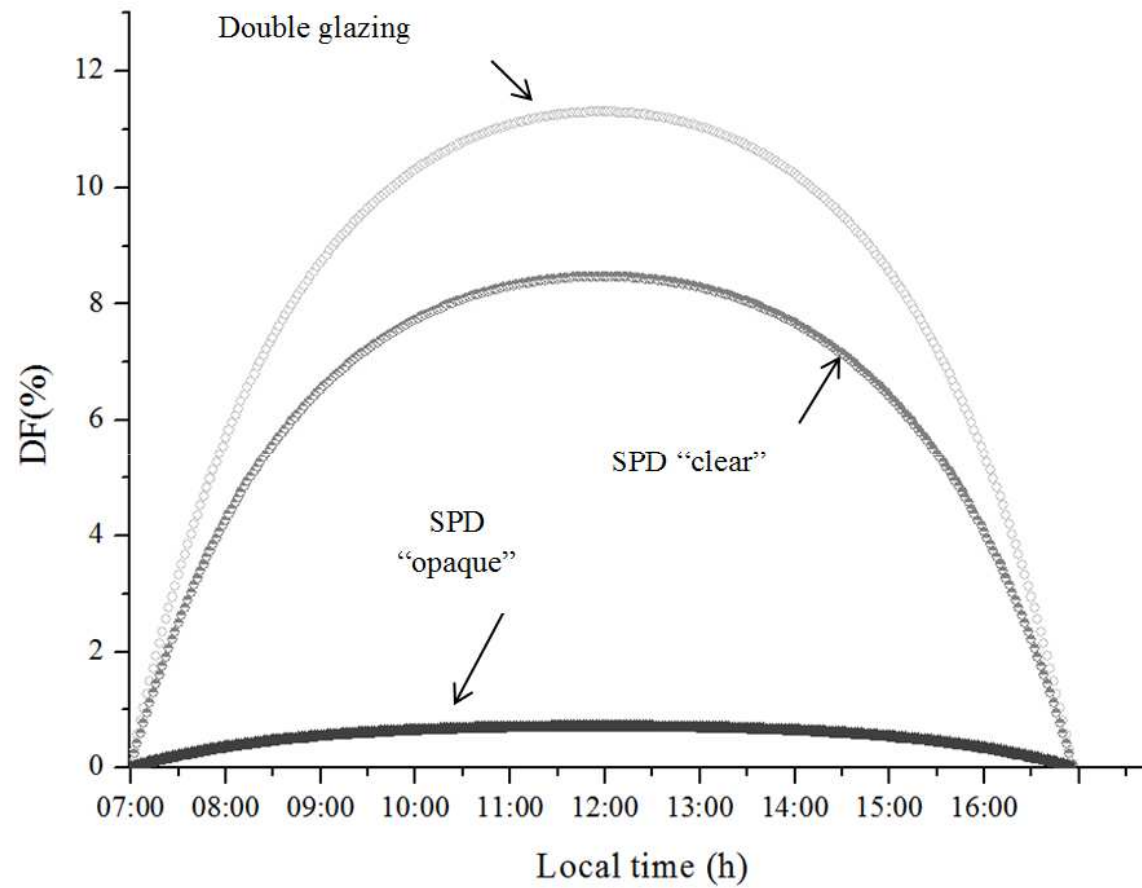


$$DGI_N = 10 \log_{10} 0.478 \sum_{i=1}^n \frac{L_{ext}^{1.6} \Omega_{pN}^{0.8}}{L_{adp} + 0.07 \omega_N^{0.5} L_{win}}$$

# Daylight glare index



# Daylight factor

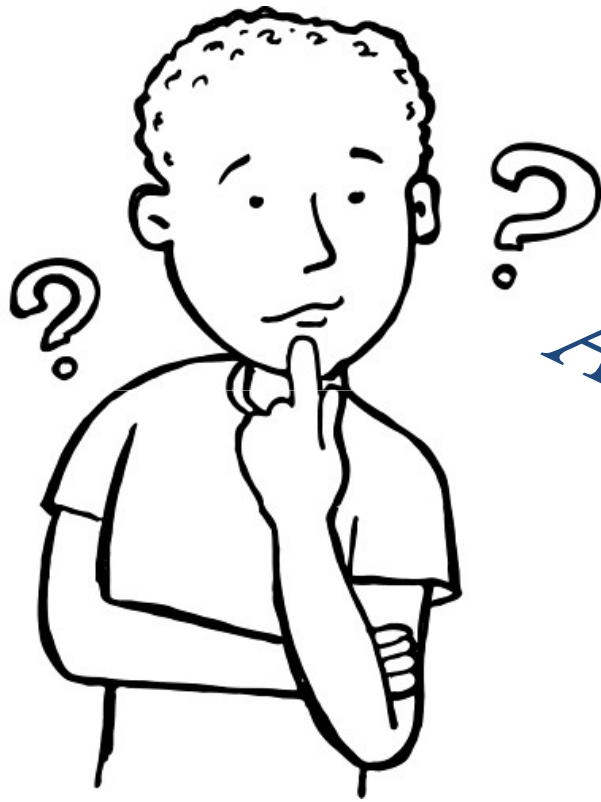


# Conclusions

- SPD glazing behaves as a single glazing ( $5.6\text{W/m}^2\text{K}$ )
- It has potential to control the glare
- Using variable switch different modes of transparency can be used
- SPD glazing switchable property enhance its use in the field of multifunctional switchable glazing







*Any question*

