THE EFFECT OF SHADING DESIGN AND MATERIALS ON BUILDING ENERGY DEMAND

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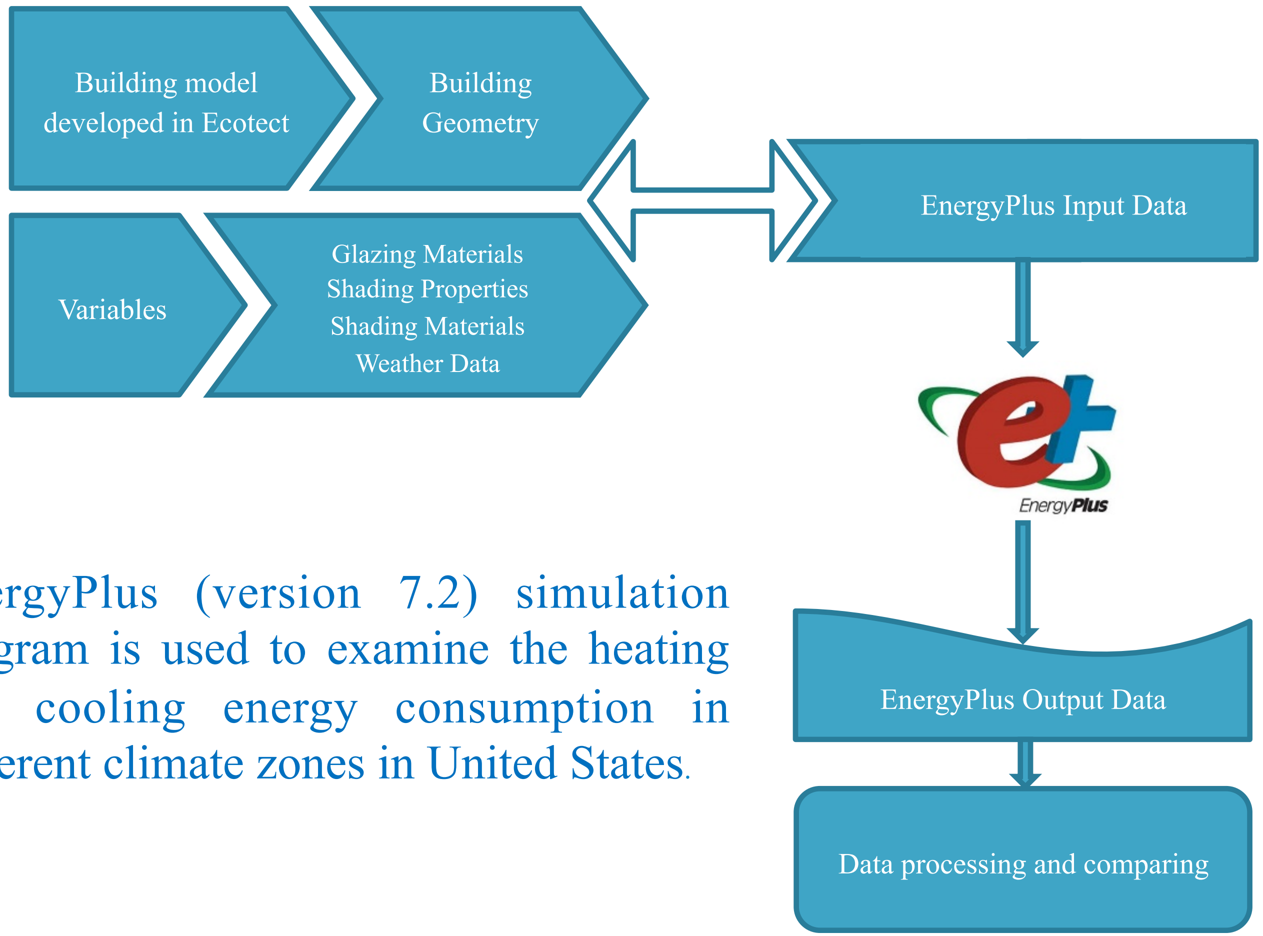
Problem statement

- The combined effect of external shading device configuration, shading material and glazing material are not well understood.
- Comparative study considering shading device materials, shapes of the shading devices, glazing materials and climate characteristics for identification of the efficient devices has not been performed.

Objectives

- To investigate the effect of
  - Shading types
  - Shading materials
  - glazing materials
- To obtain the specific shading guideline based on energy consumption which designers can select energy efficient shading devices with consideration of climate characteristics.

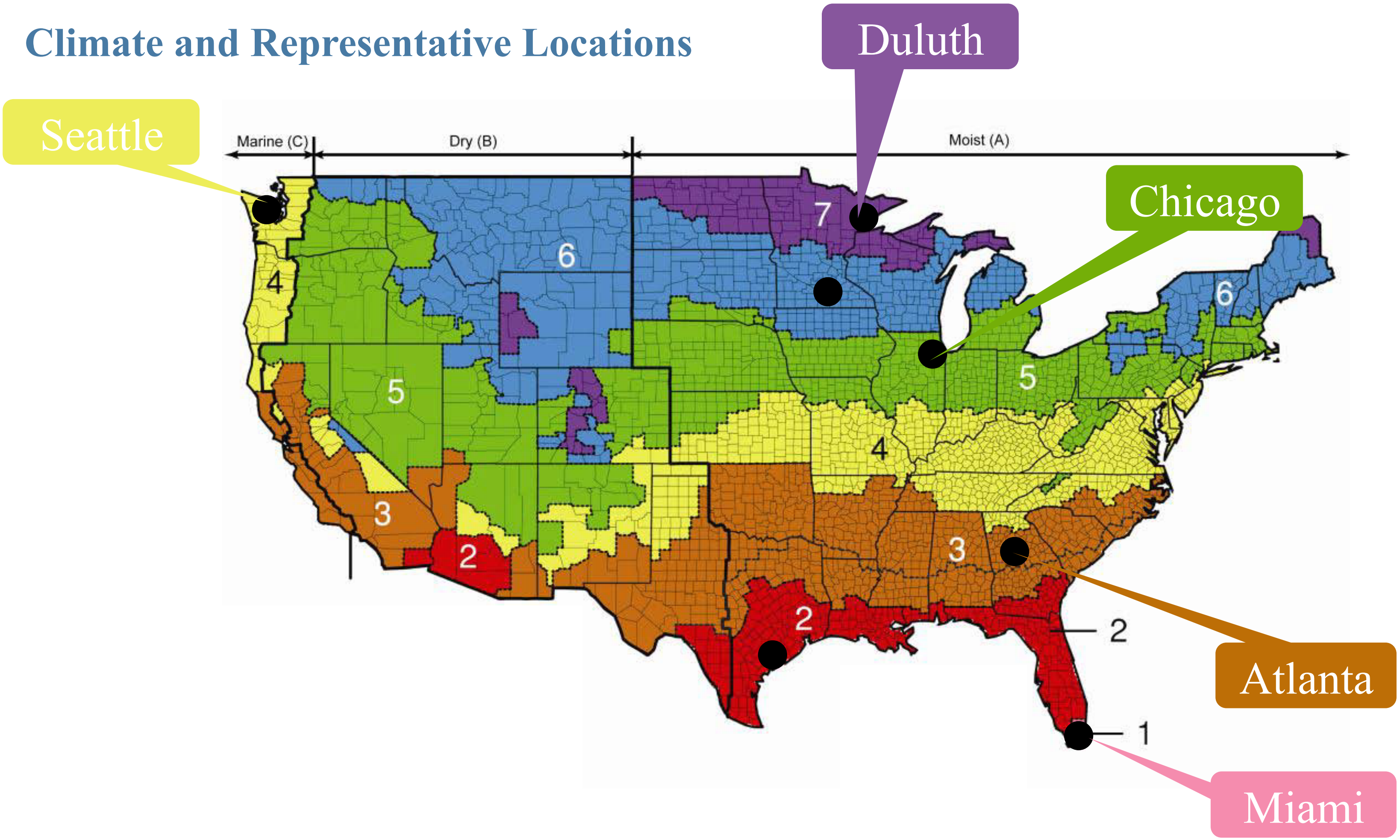
Methodology



EnergyPlus (version 7.2) simulation program is used to examine the heating and cooling energy consumption in different climate zones in United States.

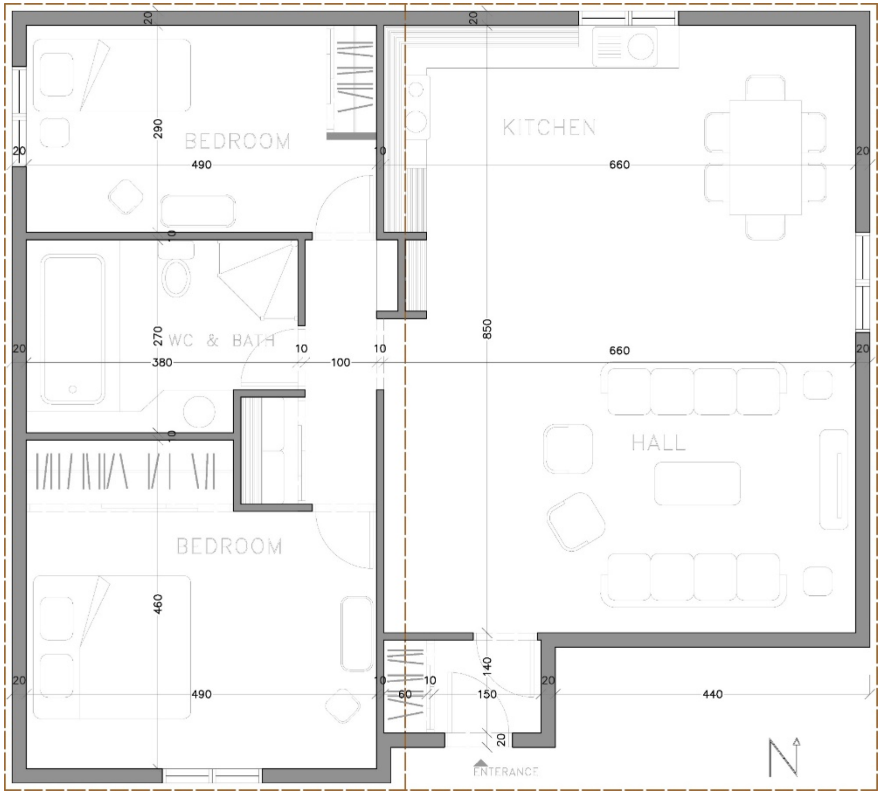
Methodology

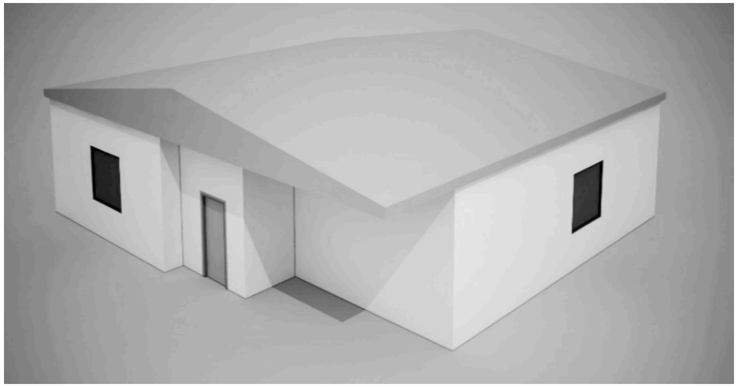
Climate and Representative Locations

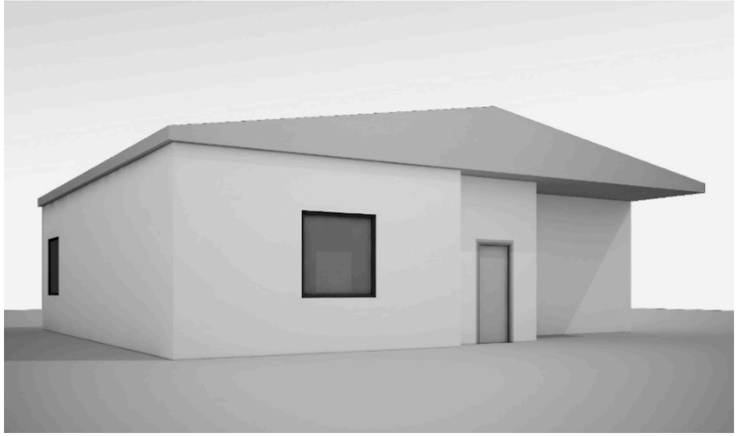


Methodology

❑ Building Model

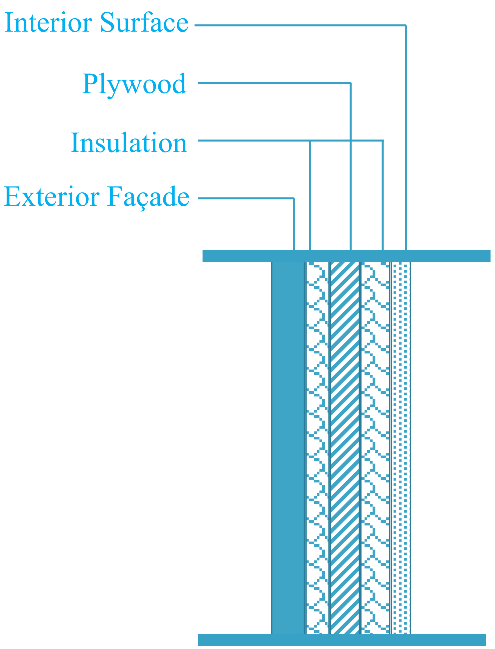






Methodology

❑ Building Model



Wall Section

Parameters	Value
Design Temperature	Cooling set point 24ºc Heating set point 20ºc
People	4 persons
Use schedule	All day used
Location and weather data	FL-Miami GA-Atlanta WA-Seattle IL-Chicago MN-Duluth
HVAC system	Ideal System
Building area	130 m^2
Window high	1.4 m
Window Area	6.72 m^2
Floor-to-ceiling	3.2 m
Building construction	Wood
Roof	Roofing wood shingles
Floor	Acoustic Tile

Methodology

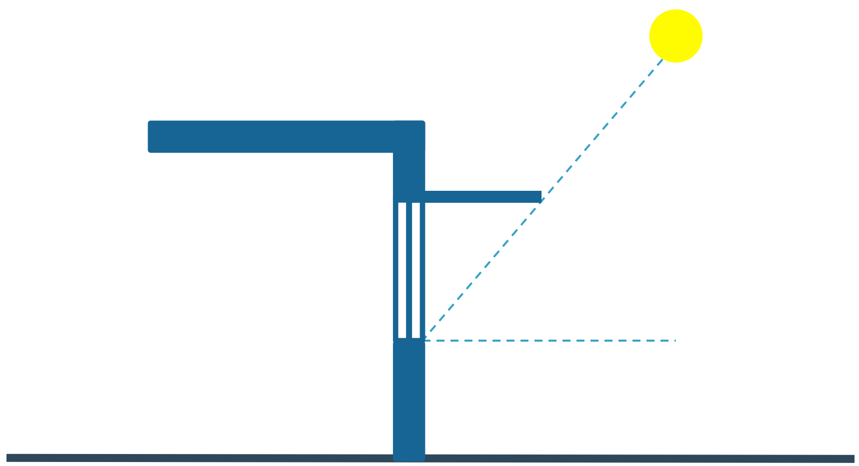
❑ Studied Glazing Materials

Glass Type	Thickness (mm)	Conductivity (W/m.k)	Solar Transmittance
Clear	6	0.9	0.775
Low-E Clear	6	0.9	0.6
Low-E Tint	6	0.9	0.36
Low-E Iron	6	0.9	0.889
Ref Tint	6	0.9	0.1

Methodology

❑ External Solar Shading Devices Depth

Shading depth= (window height × cos (solar azimuth-window azimuth)) / tan (solar altitude)

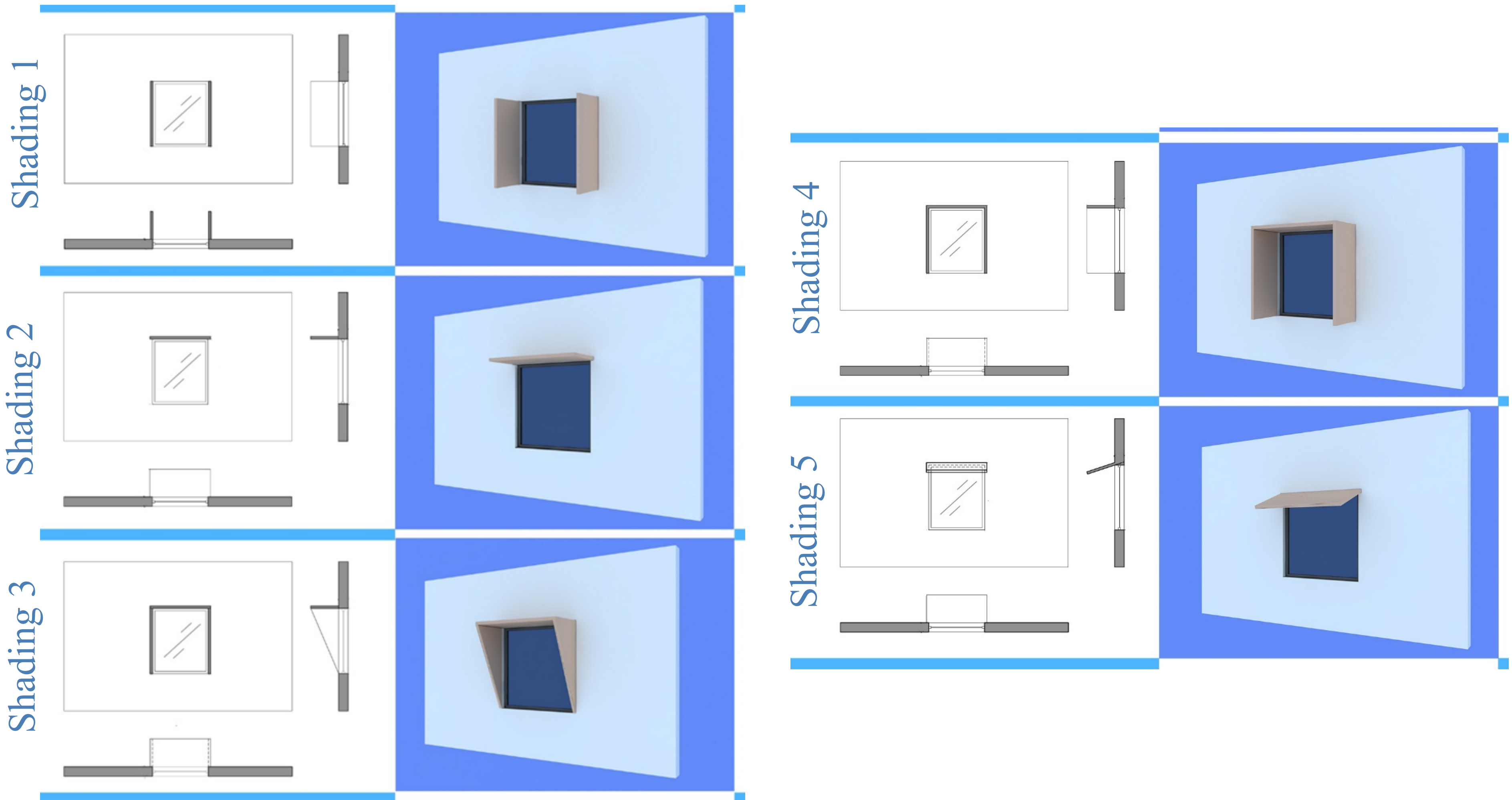


Cities	Miami	Atlanta	Seattle	Chicago	Duluth
Shading Depth (m)	0.5	0.7	1.1	0.9	1.1

(Rungta and Singh, 2011)

Methodology

❑ External Solar Shading Devices Type



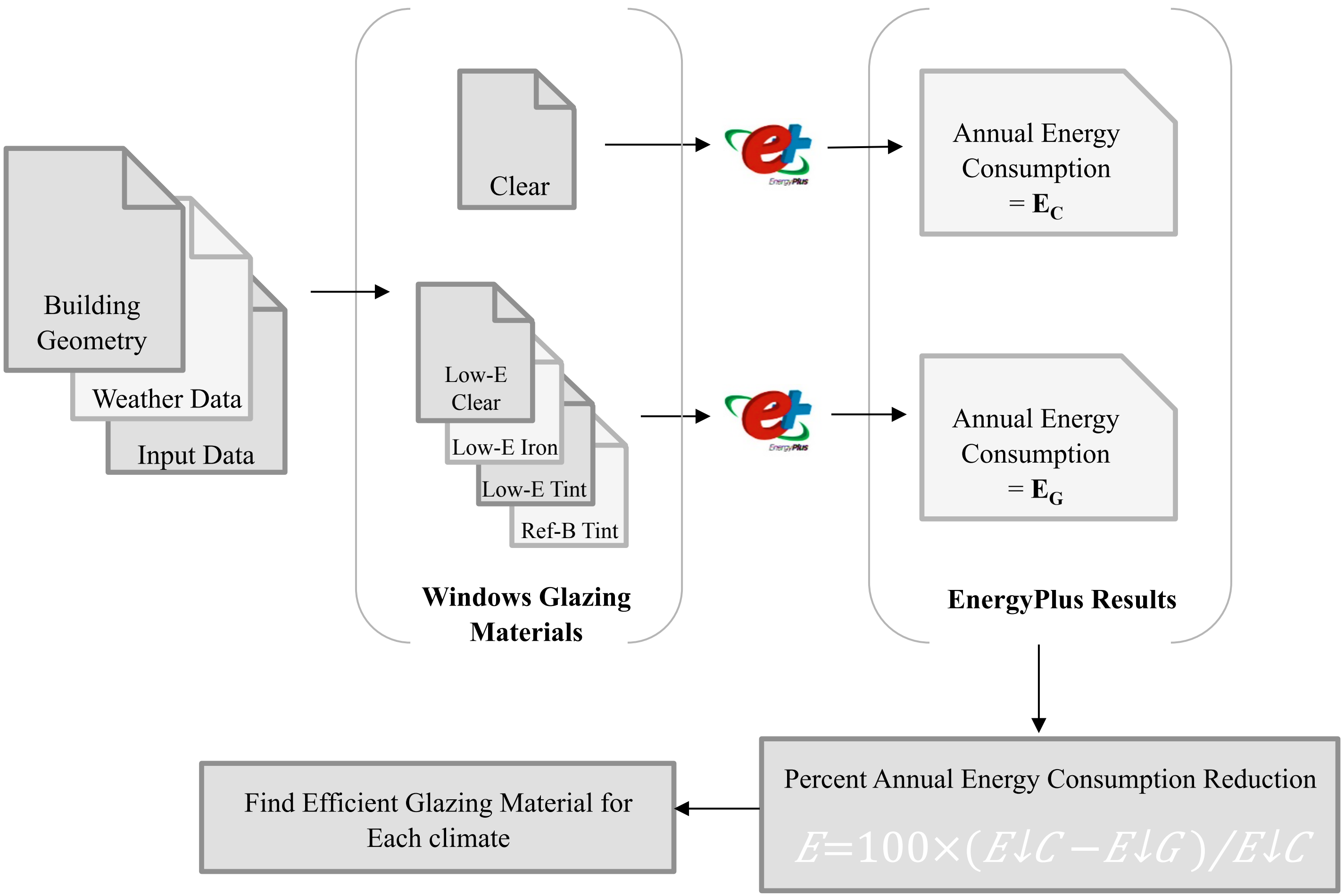
Methodology

❑ External Solar Shading Devices Material

Type	Roughness	Thickness (m)	Conductivity (W/m.K)
Wood	Medium Smooth	0.1016	0.15
PVC	Medium Smooth	0.1	0.2
Aluminum	Rough	0.01	230

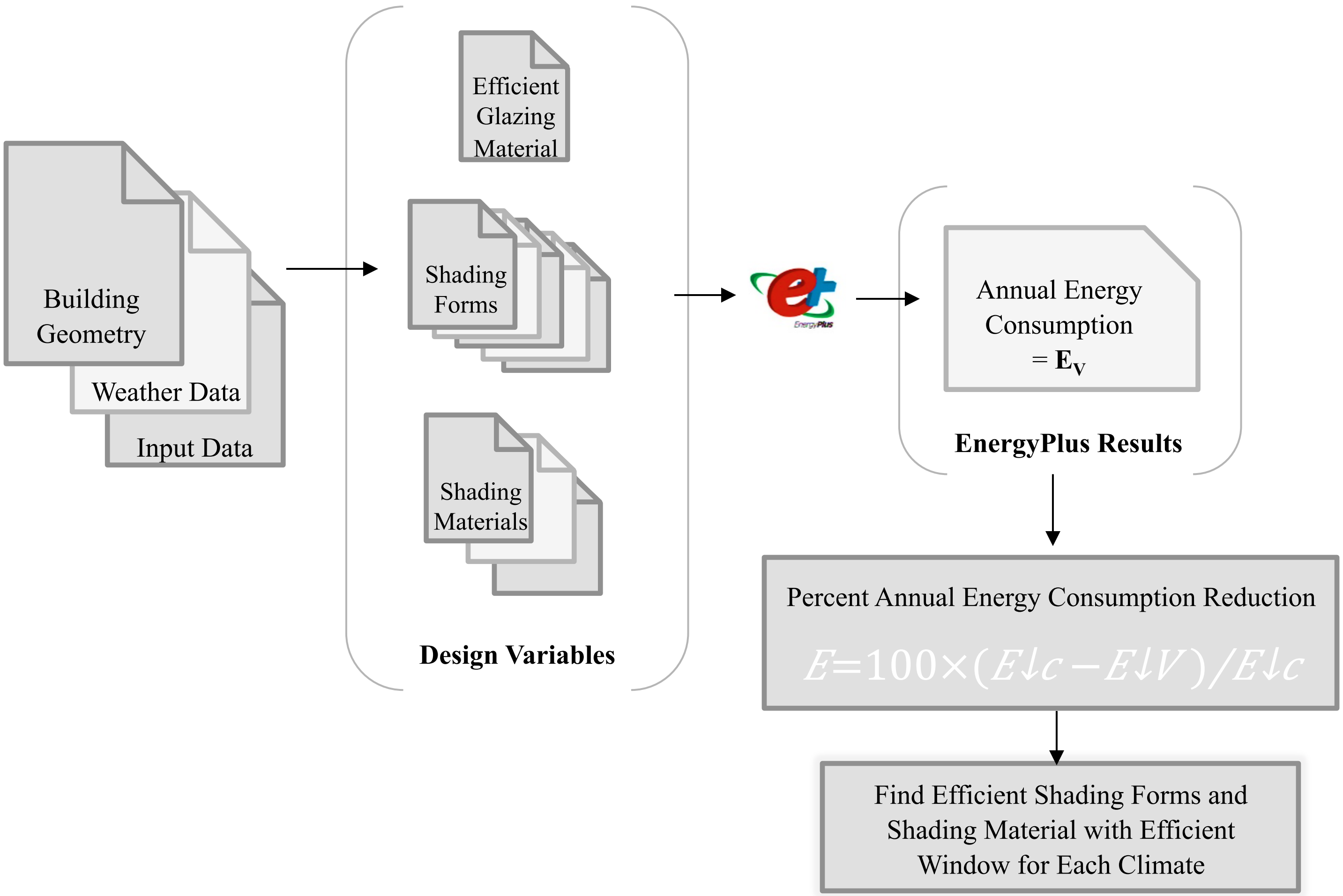
Methodology

❑ Parametric study



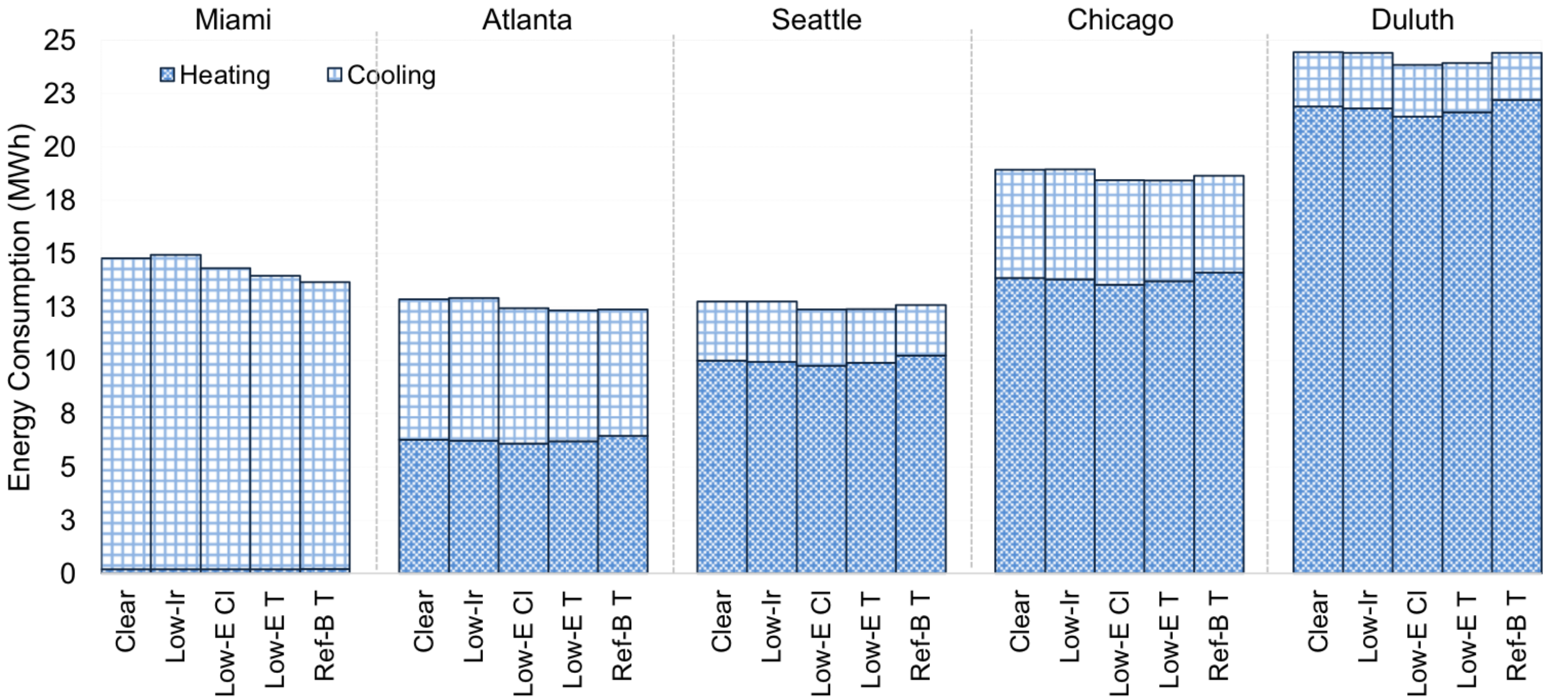
Methodology

❑ Parametric study



Results and discussion

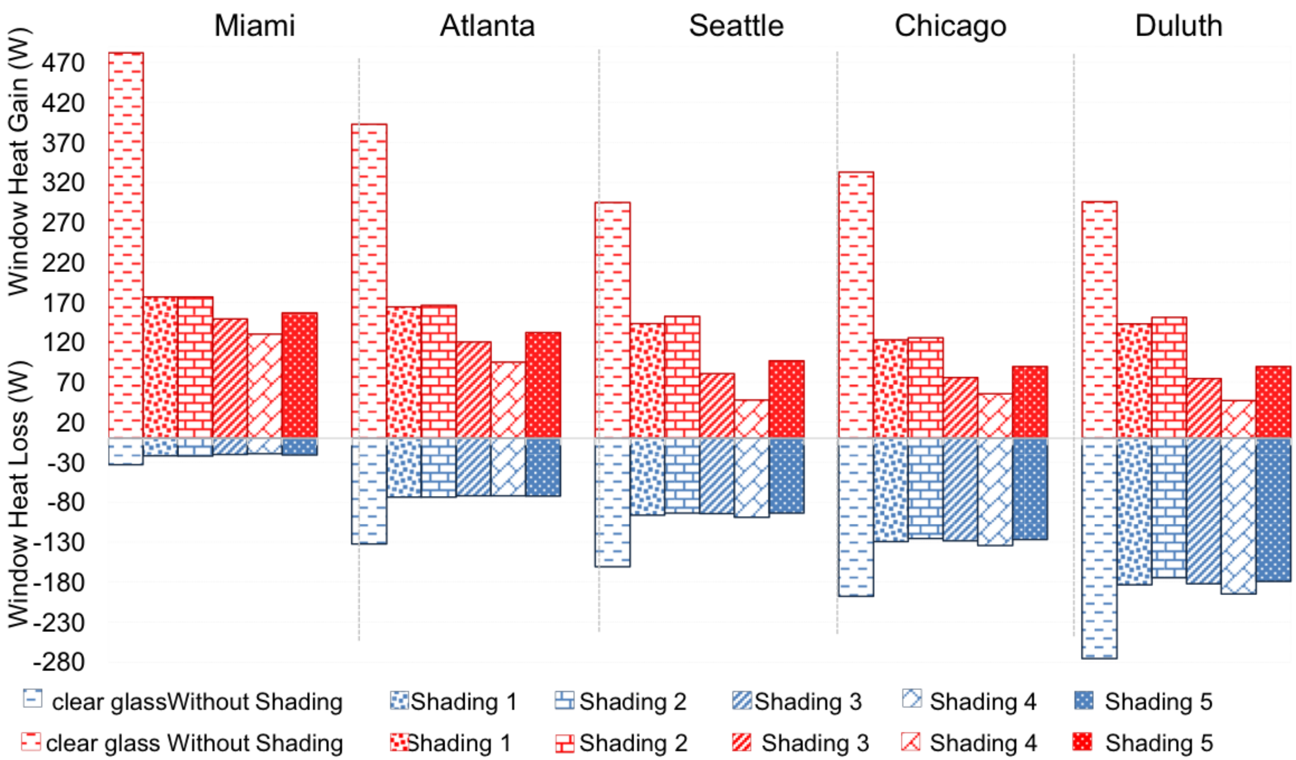
❑ Efficient glazing materials



Annual energy consumption of glazing materials

Results and discussion

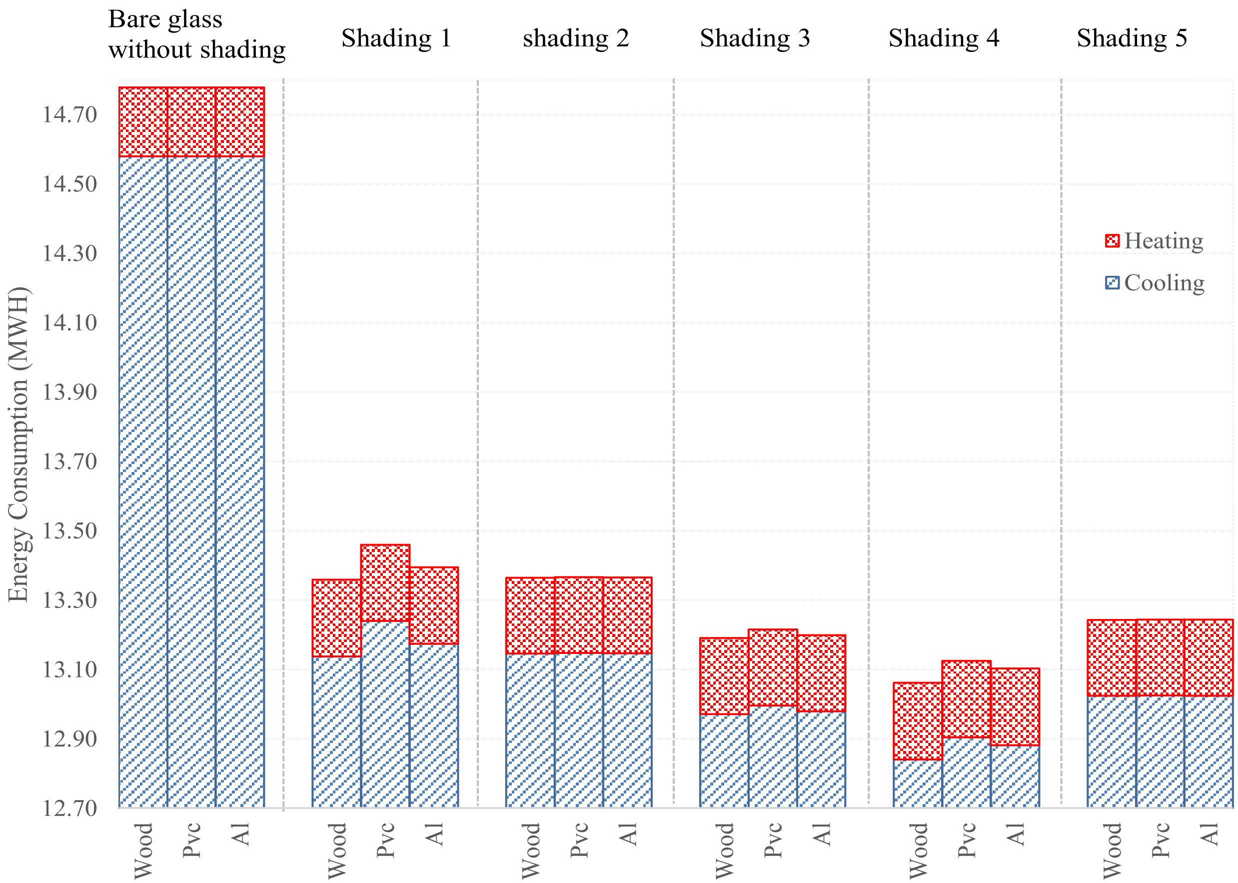
❑ Annual window heat gain and heat loss



Annual window heat gain and heat loss

Results and discussion

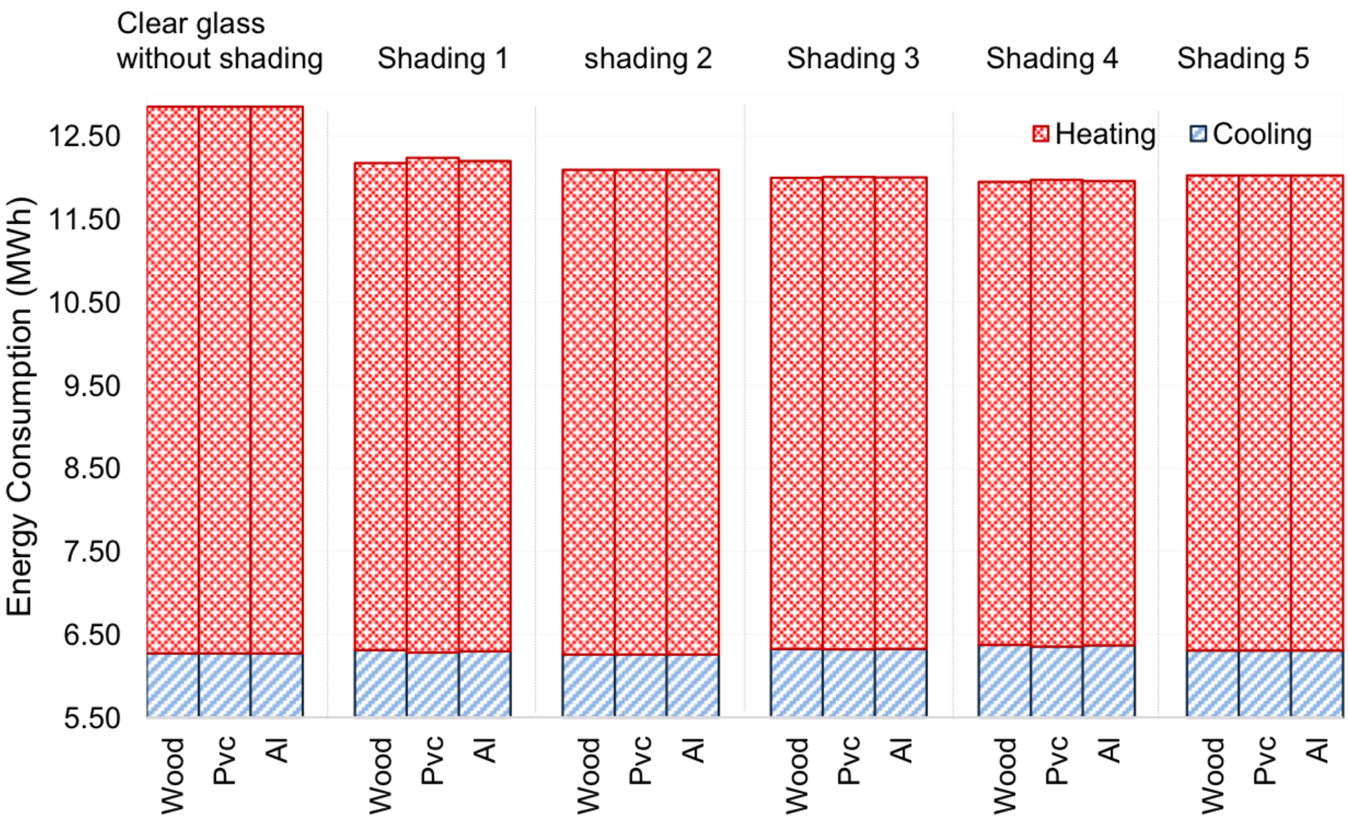
Hot-Humid climate zone



Annual energy consumption of various variables in Miami

Results and discussion

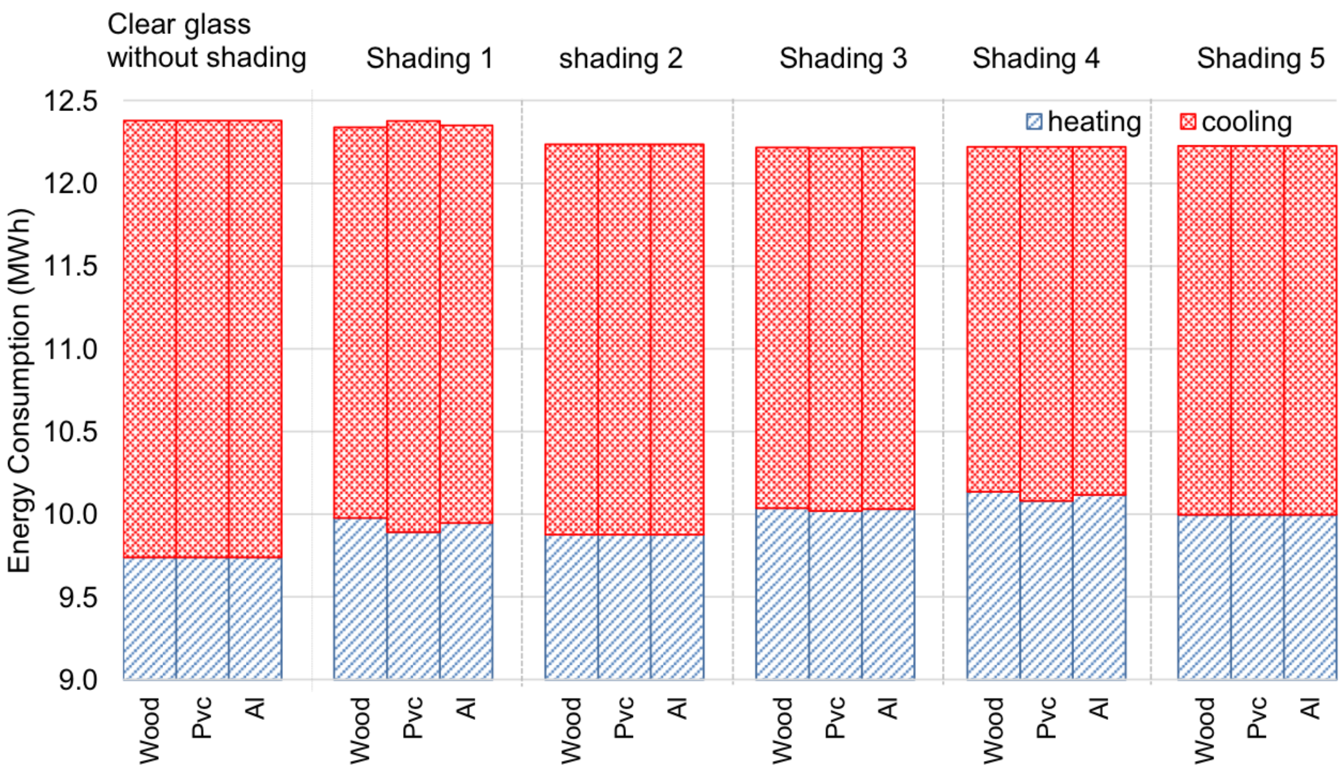
Mixed-humid climate zone



Annual energy consumption of various variables in Atlanta

Results and discussion

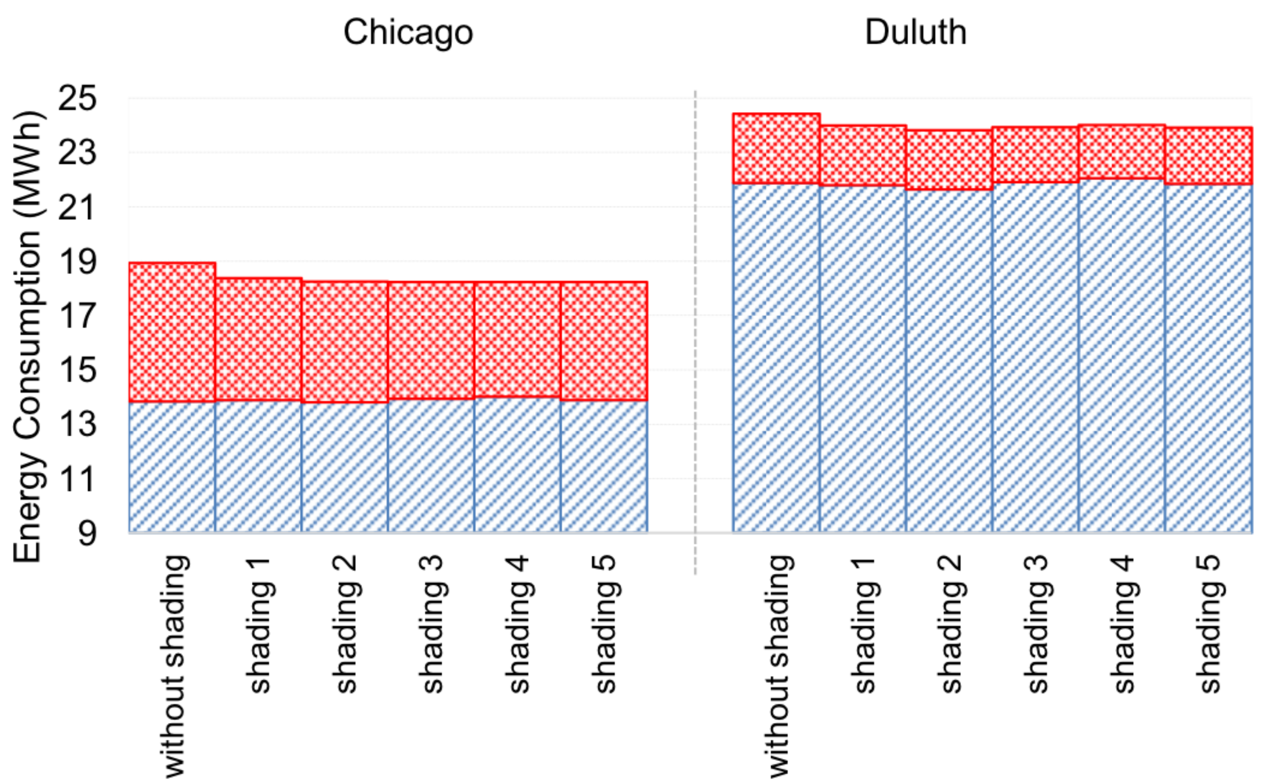
Marine climate zone



Annual energy consumption of various variables in Seattle

Results and discussion

Cold and very cold climate zone



Total energy consumption of cold and very cold climate zones

Conclusions

- **Shading devices' restriction on solar radiation and the resulting reduction of cooling demand of buildings both depend on the shading configuration.**

City	Energy consumption (MWH)	%Decrease in energy	Glazing Material	Shading Type	Shading Material	Orientation
Miami	13.06	11.6%	Ref B Tint	Shading 4	Wood	All Side
Atlanta	11.95	7.1%	Low E Tint	Shading 4	Wood	All Side
Seattle	12.21	4.2%	Low E Clear	Shading 3 and 4	-	All Side
Chicago	18.23	3.7%	Low E Tint	Shading 3 and 4	-	All Side
Duluth	23.82	2.5%	Low E Clear	Shading 2	-	All Side

THANK YOU!

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