Window Labelling Program for India

Stakeholder consultation meeting : October 13, 2012, New Delhi

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Background

- High growth in building construction sector across India
- **Energy Conservation Building Code, India**
  - 50% new commercial buildings to be compliant by 2017
  - Process of Implementation and Enforcement in few states
  - Fenestration performance is key to achieve energy efficiency
- Success of Standards and labelling program in India
- Progressive industry representation – conducive environment

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Development of Roadmap

- Identify Window performance parameters based on ECBC
- Overview of International Practices
- Identification of codes, testing protocols - facilities, software
- Administration of Labelling program
- Scientific study to establish relevance of Window Label

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Window Labeling Program

International Practices

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UNITED STATES OF AMERICA: National Fenestration Rating Council. (NFRC)

Image Source - http://www.efficientwindows.org/nfrc.php

Parameters	Standards
U – Factor	ASTM C1199-00
Solar Heat Gain Coefficient (SHGC)	ISO 15099 in NFRC 200, NFRC 201
Visible Transmittance	ISO – 15099
Air Leakage	ASTM E 283 [1]
Condensation Resistance	ASTM C1199 ASTM E1423

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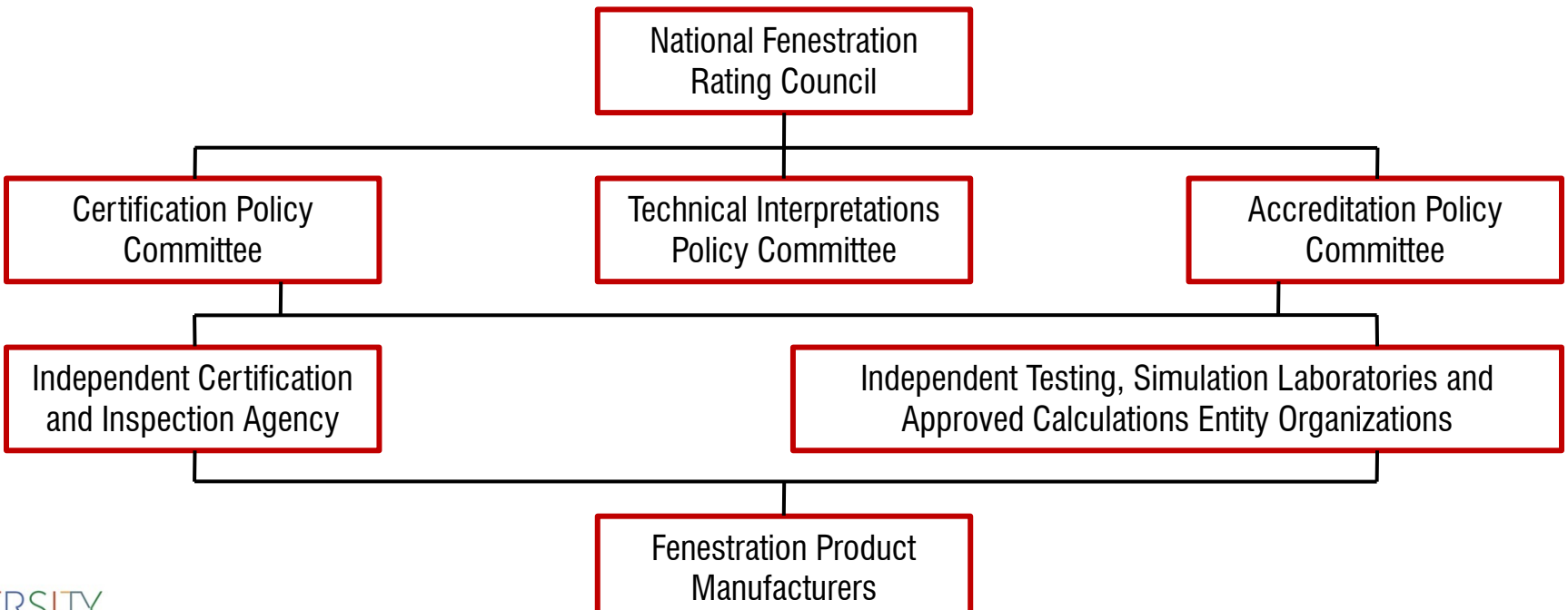
UNITED STATES OF AMERICA: National Fenestration Rating Council. (NFRC)



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International Practices

Image Source -
http://homeenergy.org/show/article/magazine/111/id/1422

AUSTRALIA: Australian Fenestration Rating Council. (AFRC)

Parameters	Standards
U – Value for the Window	ASTM C1199-00
Solar Heat Gain Coefficient (SHGC)	ISO 15099 in NFRC 200, NFRC 201
Visible Transmittance	ISO – 15099
Air Infiltration	AS 2047
Fabric Fading Transmittance	AS 2047 – 1999 & AS 1288 – 1994

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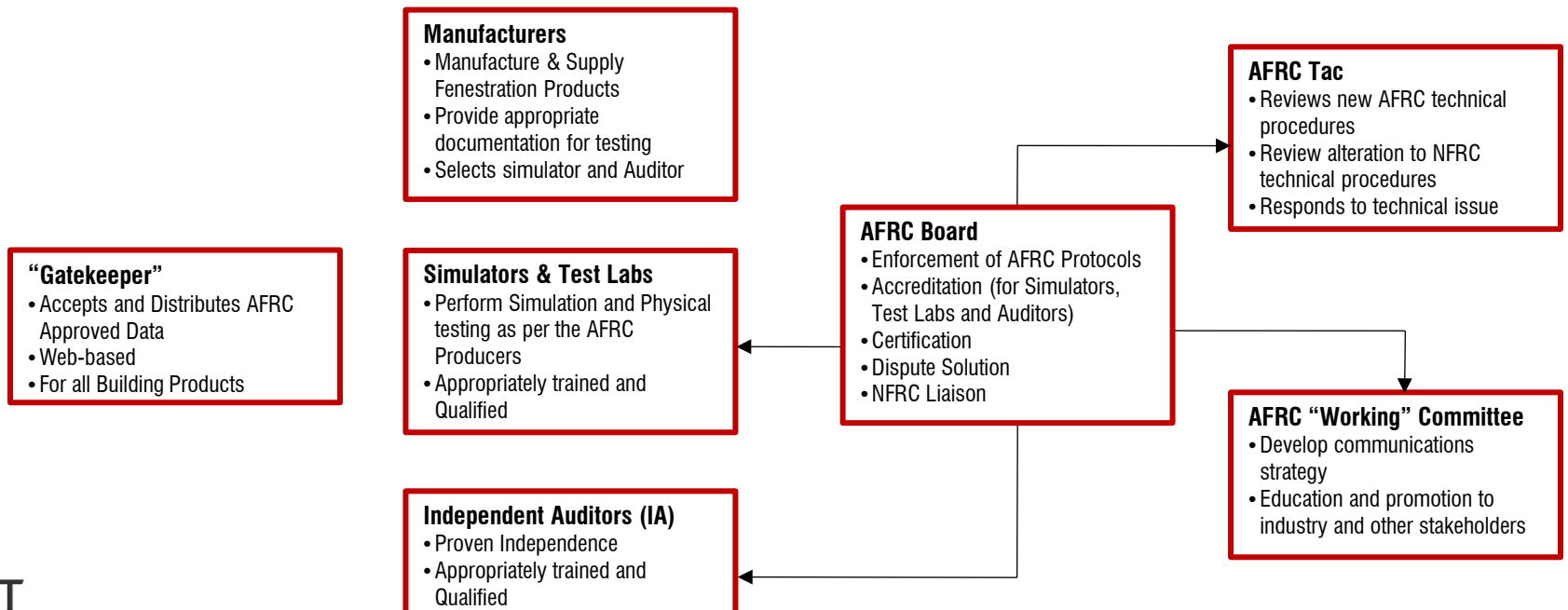
International Practices

AUSTRALIA : Australian Fenestration Rating Council. (AFRC)



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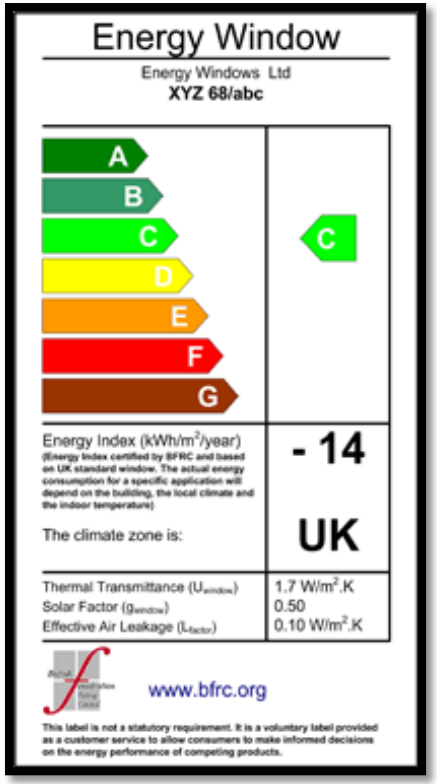
International Practices

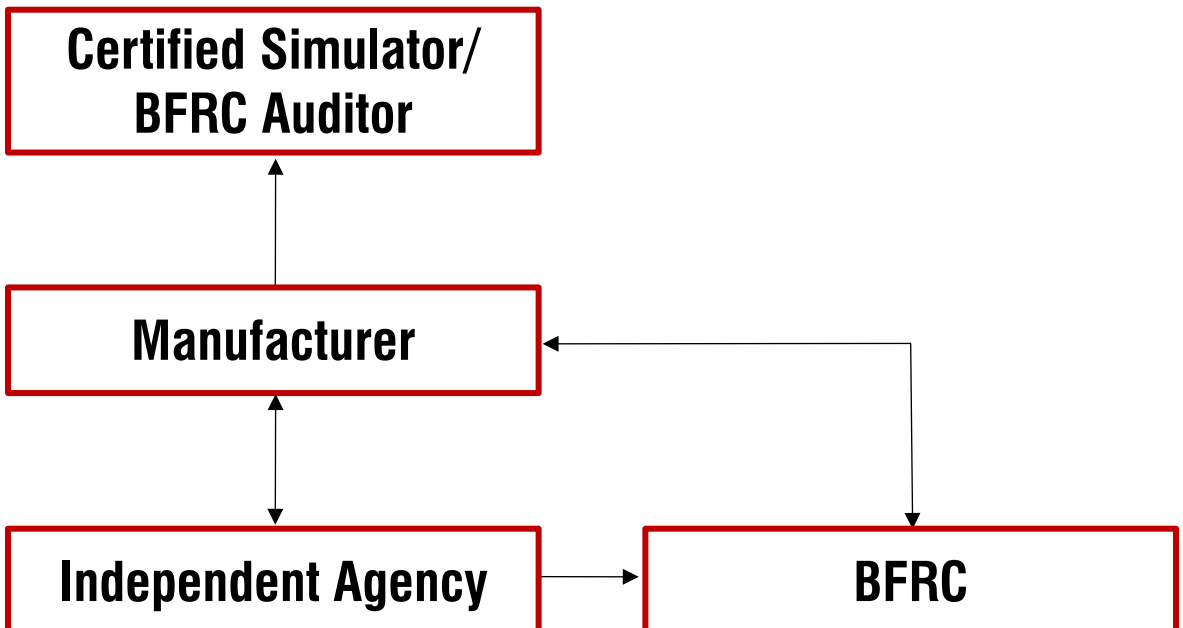
UNITED KINGDOM : British Fenestration Rating Council. (BFRC)



Parameters	Standards
U – Value for the Window	BS EN ISO 10077-2
Solar Heat Gain 'G'	EN - 832
Air Leakage 'I'	BS 6375, Part 1 (EN 42)

Image Source - http://www.cwct.co.uk/thermal/schemes/bfrc.htm

UNITED KINGDOM : British Fenestration Rating Council. (BFRC)



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International Practices

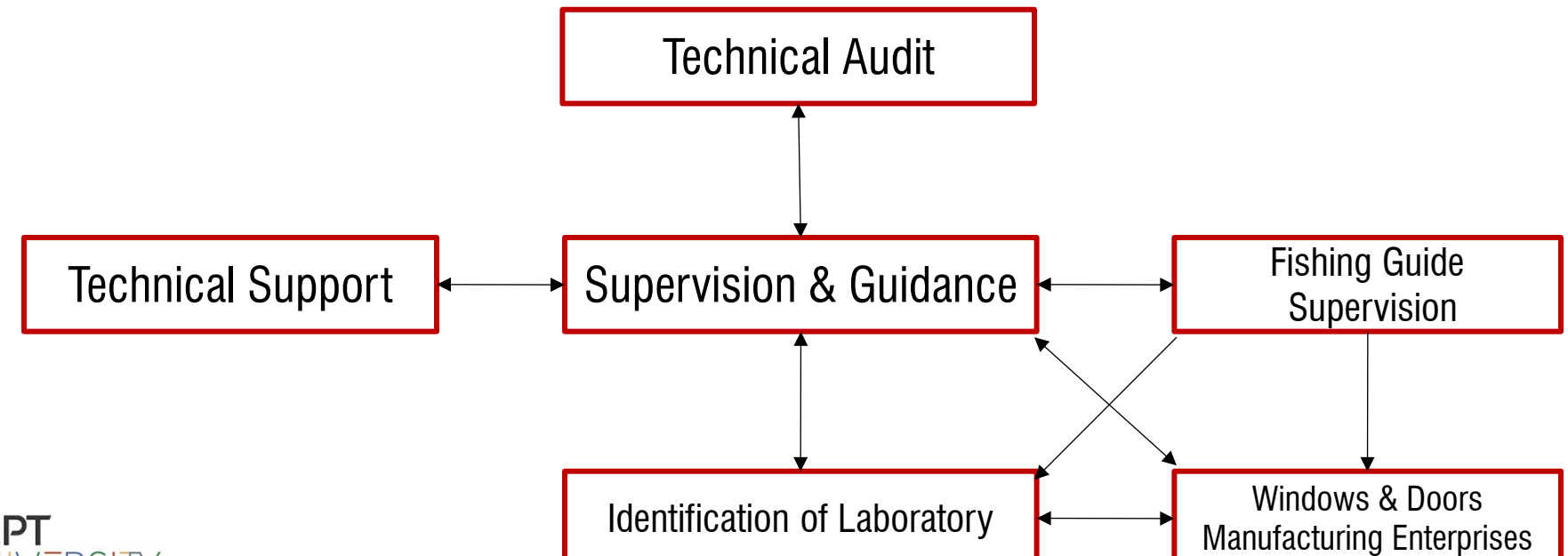
CHINA : China Fenestration Energy Efficiency Performance Labelling

Parameters	Standards
Heat Transfer Coefficient	
Shading Coefficient	
Air Permeability	JG/T 192 – 2006
Visible Transmittance	
Energy Saving Performance Objection Description	

Image Source (secondary) - http://www.globalchange.umd.edu/data/seminars/2014-10-29-China_Bldg_EE_Opportunities.pdf

International Practices

CHINA : China Fenestration Energy Efficiency Performance Labelling



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SOUTH AFRICA : South African Fenestration Insulation Energy Rating Association

Image Source - http://www.safiera.co.za/energyrating.html

Parameters	Standards
U – Value	NFRC 100
Solar Heat Gain Coefficient	NFRC 200
Air Leakage	NFRC 400
Visible Transmittance	NFRC 200
Condensation Resistance	NFRC 500

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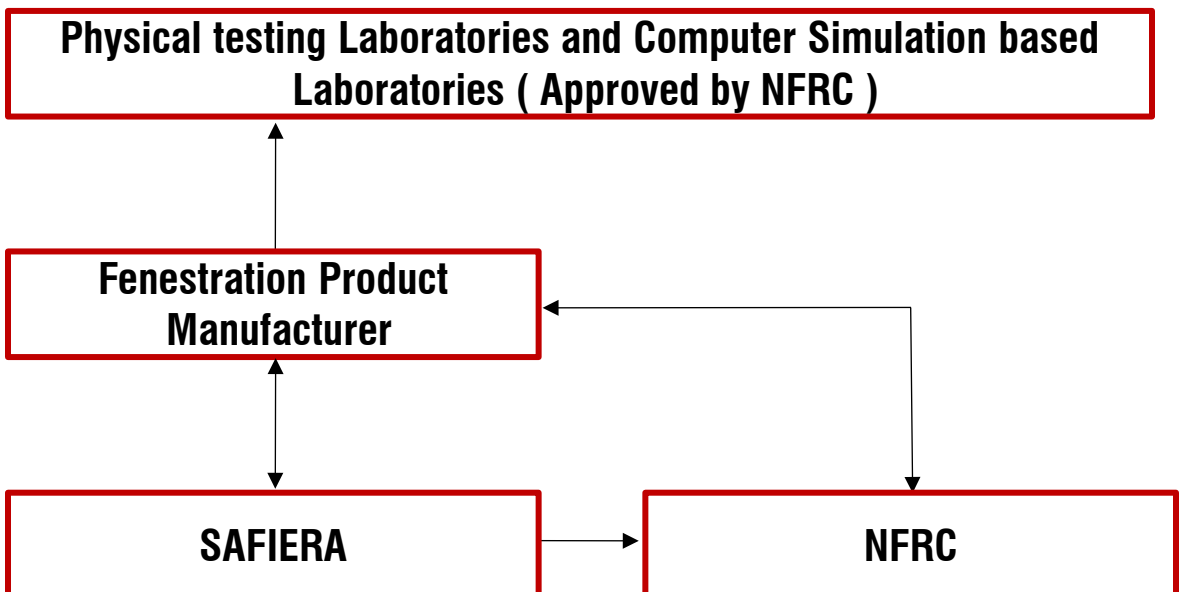
SOUTH AFRICA : South African Fenestration Insulation Energy Rating Association



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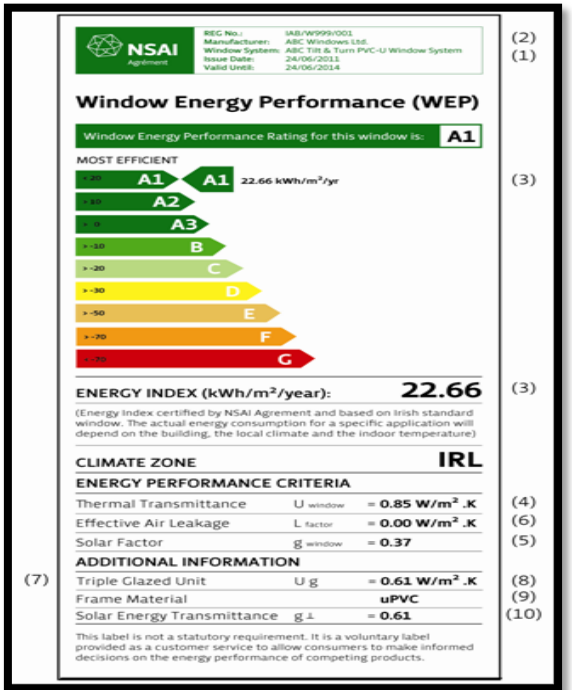
International Practices

IRELAND : National Standards Authority of Ireland (NSAI)



Parameters	Standards
U – Window or Thermal Resistance	I.S. EN ISO 12567 – 1: 2001
The Solar Factor	I.S. EN 410
Air Leakage	I.S. EN 12207: 1999
Condensation Resistance	

Image Source - https://www.nsai.ie/Our-Services/Certification/Agrement-Certification/WEP-(Wind-Energy-Performance)-Scheme.aspx

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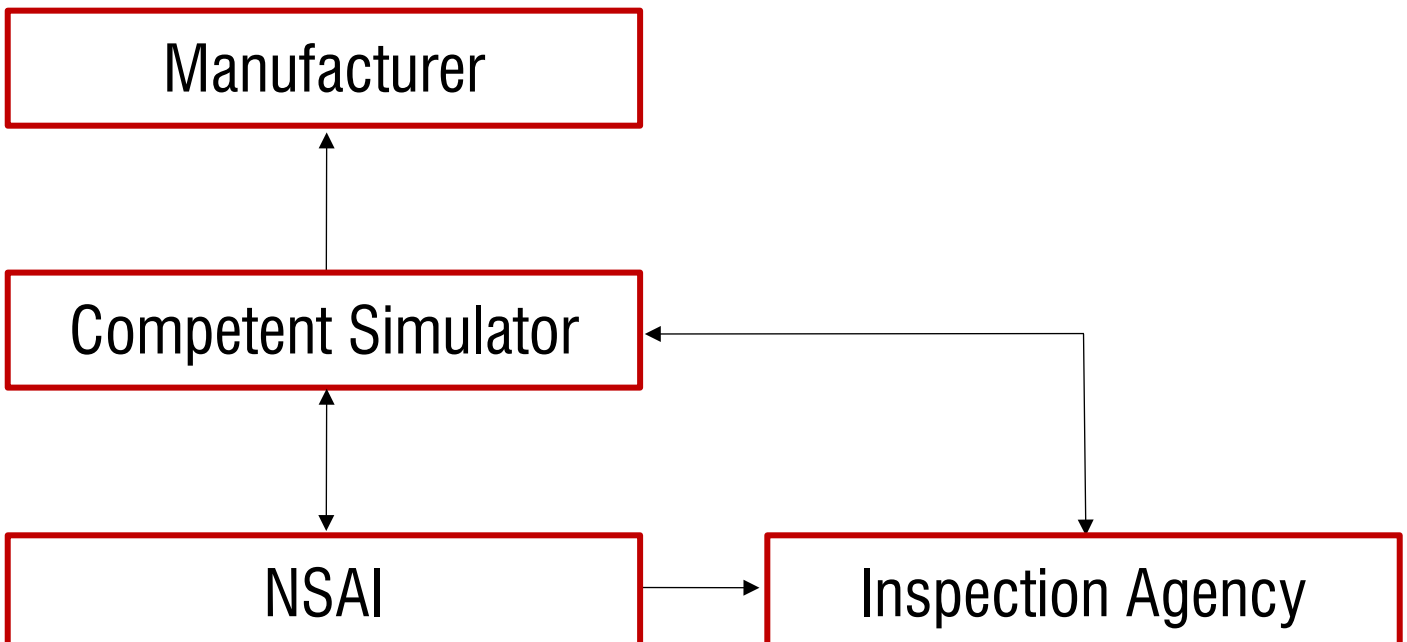
International Practices

IRELAND : National Standards Authority of Ireland (NSAI)



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INDIA : Energy Conservation Building Code (ECBC)

Parameters	Standards	Content
U – Window or Thermal Resistance	ISO 15099	Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence
Solar Heat Gain Coefficient	ISO 15099	
Visible Transmittance	ISO 15099	
Air Leakage	ISO 15099	

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Window Performance Parameters in ECBC

- **U- Factor:** U-factors shall be determined for the overall fenestration product (including the sash and frame) in accordance with ISO-15099, by an accredited independent laboratory, and labeled and certified by the manufacturer or other responsible party.
- **ISO 15099:** ISO 15099:2003 specifies detailed calculation procedures for determining the thermal and optical transmission properties (e.g., thermal transmittance, total solar energy transmittance) of window and door systems based on the most up-to-date algorithms and methods, and the relevant solar and thermal properties of all components
- **ASTM C1199-00**

  Standard Test Method for Measuring the Steady-State Thermal Transmittance of Fenestration Systems Using Hot Box Methods
- **BS EN ISO 10077-2**

  It explains procedures for Thermal performance of windows, doors and shutters, calculation of thermal transmittance and numerical method for frames.
- **NFRC 100** Procedure for Determining Fenestration Product U-factors

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Window Performance Parameters in ECBC

- **Solar Heat Gain Coefficient (SHGC) :** SHGC shall be determined for the overall fenestration product (including the sash and frame)
  - in accordance with ISO-15099,…by an accredited independent laboratory, and labeled and certified by the manufacturer or other responsible party……

- **ISO 15099**
  Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence (NFRC 200)

- **NFRC 201**
  Interim Standard Test Method for Measuring the Solar Heat Gain Coefficient of Fenestration Systems Using Calorimeter Hot Box Methods (NFRC 201)

- ***"G' value - EN – 832 :*** *European EN 832 standard was primarily designed for use in judging compliance with regulations expressed in terms of energy targets; it was also intended for use in comparing the energy performance of various design alternatives for a planned building, or for assessing the effect of possible energy conservation measures on an existing building.*

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Window Performance Parameters in ECBC

- **Visible Light Transmittance (VLT) :** The visible transmittance (VT) is an optical property that indicates the amount of visible light transmitted. The NFRC's VT is a whole window rating and includes the impact of the frame which does not transmit any visible light.

- **ISO – 15099**

  ISO 15099:2003 specifies detailed calculation procedures for determining the thermal and optical transmission properties (e.g., thermal transmittance, total solar energy transmittance) of window and door systems based on the most up-to-date algorithms and methods, and the relevant solar and thermal properties of all components.

- **NFRC 200**

  Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

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Window Performance Parameters in ECBC

- **Air Leakage (AL) :** Heat loss and gain occur by infiltration through cracks in the window assembly

- **ASTM E 283 [1]**
  This test method is a standard procedure for determining the air leakage characteristics under specified air pressure differences at ambient conditions.
- **AS 2047**
  This Standard specifies requirements, materials, construction, installation and glazing for windows, sliding glazed doors, adjustable louvers, shop fronts and window walls with one-piece framing elements.
- **BS 6375, Part 1 (EN 42)**
  Performance of windows: Classification for weather tightness" is the basis for assessing the weather tightness of windows up to a maximum frame size of 3 meters and provides a means of selecting a performance level against which the window may be assessed. This standard also includes guidance on the selection and specification of windows. The test methods called up by BS 6375 to measure weather performance are the various parts of BS 5368. This standard can be applied to windows manufactured from any material.
- **JG/T 192-2006**
  Test method for repeated opening and closing performance of windows and doors.
- **NFRC 400**
  Procedure for Determining Fenestration Product Air Leakage

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Window Performance Parameters

Condensation Resistance (CR) : CR measures how well the window resists water build-up. Condensation Resistance is scored on a scale from 0 to 100. The higher the condensation resistance factor, the less build-up the window allows.

- **ASTM C1199**

  This test method covers requirements and guidelines and specifies calibration procedures required for the measurement of the steady-state thermal transmittance of fenestration systems installed vertically in the test chamber. This test method specifies the necessary measurements to be made using measurement systems conforming to Test Method C 1363 for determination of fenestration system thermal transmittance.

- **ASTM E1423**

  Standard Practice for Determining Steady State Thermal Transmittance of Fenestration Systems.

- **NFRC 500**

  Procedure for Determining Fenestration Product Condensation Index Values

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Window Performance Parameters

Fabric Fading Transmittance : Fabric Fading Transmittance is a measure of the extent to which a window transmits those wavelengths of light that cause fading.

- **AS 2047–1999**

  This Standard specifies requirements, materials, construction, installation and glazing for windows, sliding glazed doors, adjustable louvers, shop fronts and window walls with one-piece framing elements.

- **AS 1288–1994**

  This Standard sets out procedures for the selection and installation of glass in buildings, subject to wind loading, human impact, and special applications such as overhead glazing, balustrades and glass assemblies. (AS 1288-1994)

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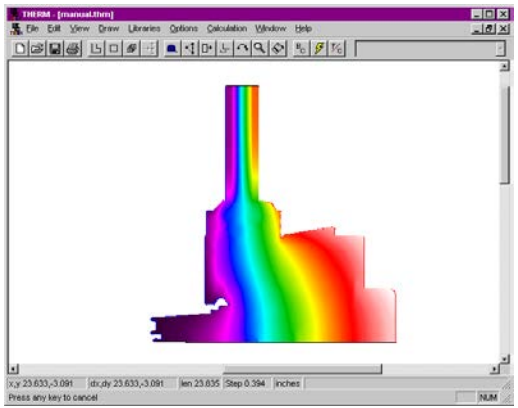
Window Simulation tools



WINDOW: WINDOW is a publicly available computer program for calculating total window thermal performance indices (i.e. U-values, solar heat gain coefficients, shading coefficients, and visible transmittances). WINDOW provides a versatile heat transfer analysis method consistent with the updated rating procedure and that is consistent with the ISO 15099 standard.

THERM: THERM is a state-of-the-art, Microsoft Windows™-based computer program for use by building component heat transfer. One can model two-dimensional heat-transfer effects in building components such as windows, walls, foundations, roofs, and doors; appliances; and other products where thermal bridges are of concern.

OPTICS: Optics allows the user to view and modify glazing data. Properties of a series of structures can be generated from those of a base structure.

Image Source - http://www.nfrc.org/industry/certification/product-certification-program/heat-transfer-modeling-software/

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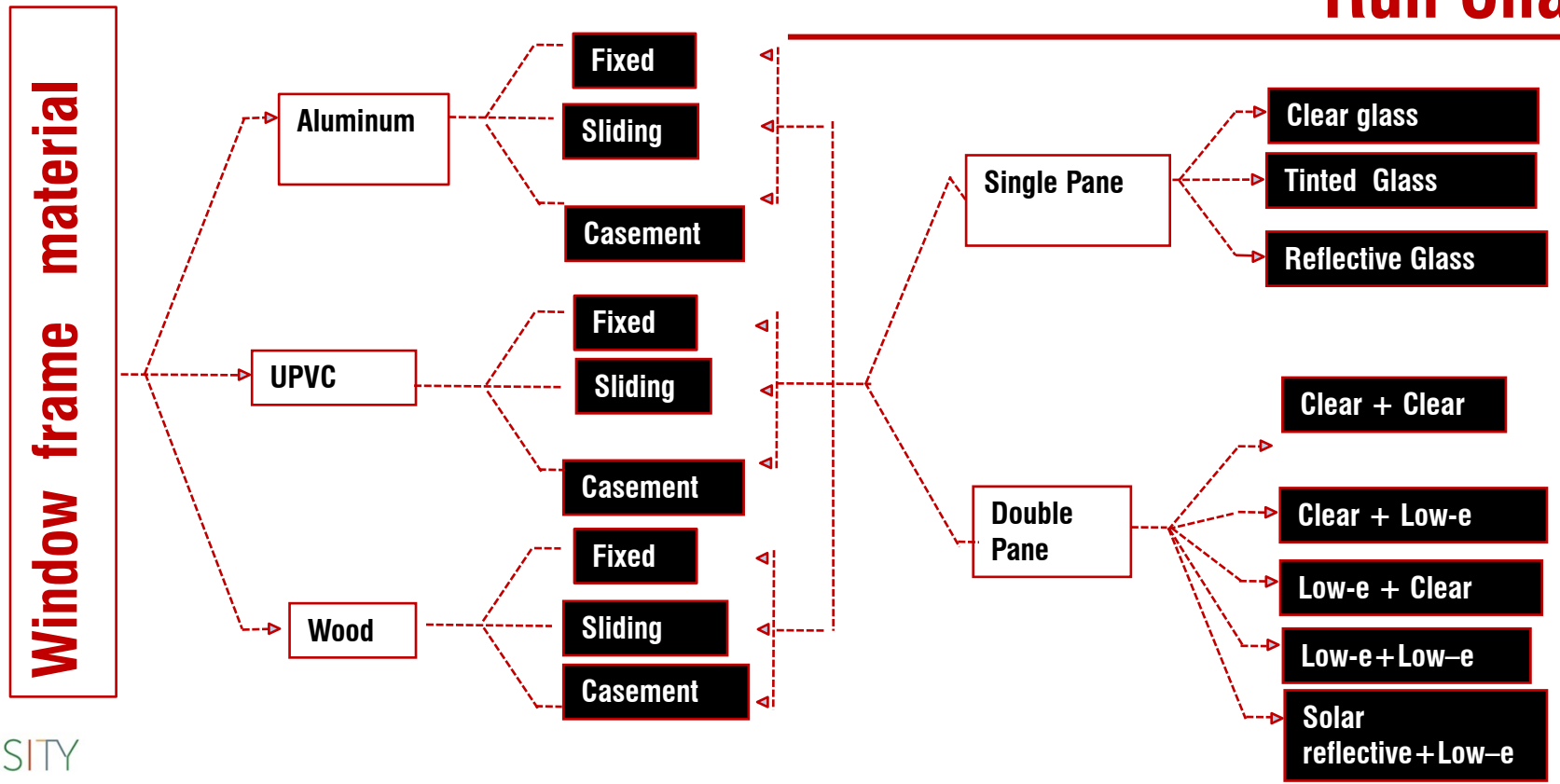
How Close or Far are we presently from ECBC Windows?

Run Chart



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Environmental Conditions

Standard used	ISO 15099

U- Factor Calculation

▪Interior Temperature	24 ^{o}C (75.2 ^{o}F)
▪Exterior Temperature	32 ^{o}C (89.6 ^{o}F)
▪Exterior Wind Velocity	3.3 m/s (7.5 mph)
▪Radiant mean temperature exterior	$T_{r,m} = T_{exterior}$
▪Radiant mean temperature interior	$T_{r,m} = T_{interior}$

Solar heat gain Calculation

▪Interior Temperature	24 ^{o}C (75.2 ^{o}F)
▪Exterior Temperature	32 ^{o}C (89.6 ^{o}F)
▪Exterior Wind Velocity	2.8 m/s (6.3 mph)
▪Radiant mean temperature exterior	$T_{r,m} = T_{exterior}$
▪Radiant mean temperature interior	$T_{r,m} = T_{interior}$
▪Incident solar flux	783 W/m^2 (248 btu/hr-ft^2)
▪Solar Spectrum	ISO 9050/ 9845

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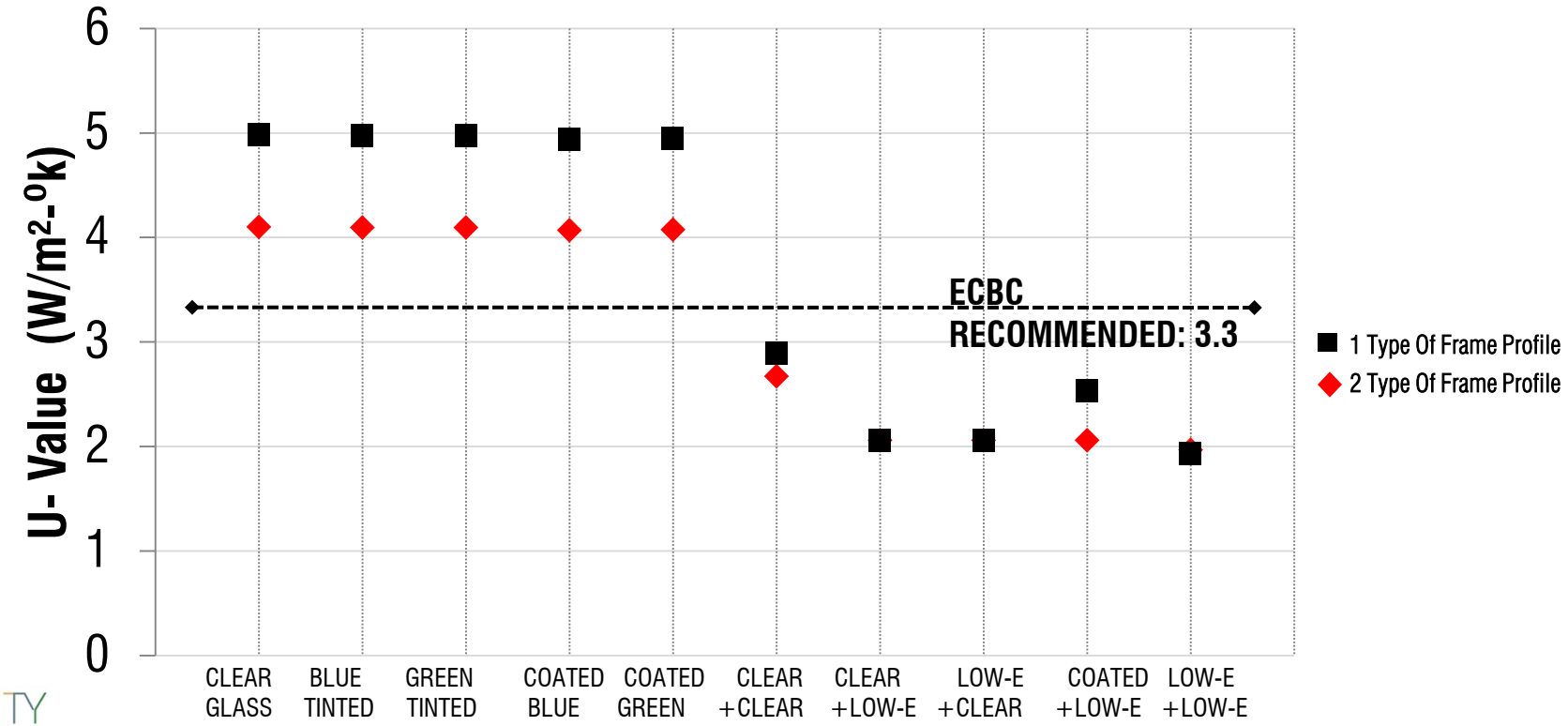
Two Types of Wooden Fixed Frame Profile -Plotted for Different Glass Types

Observations



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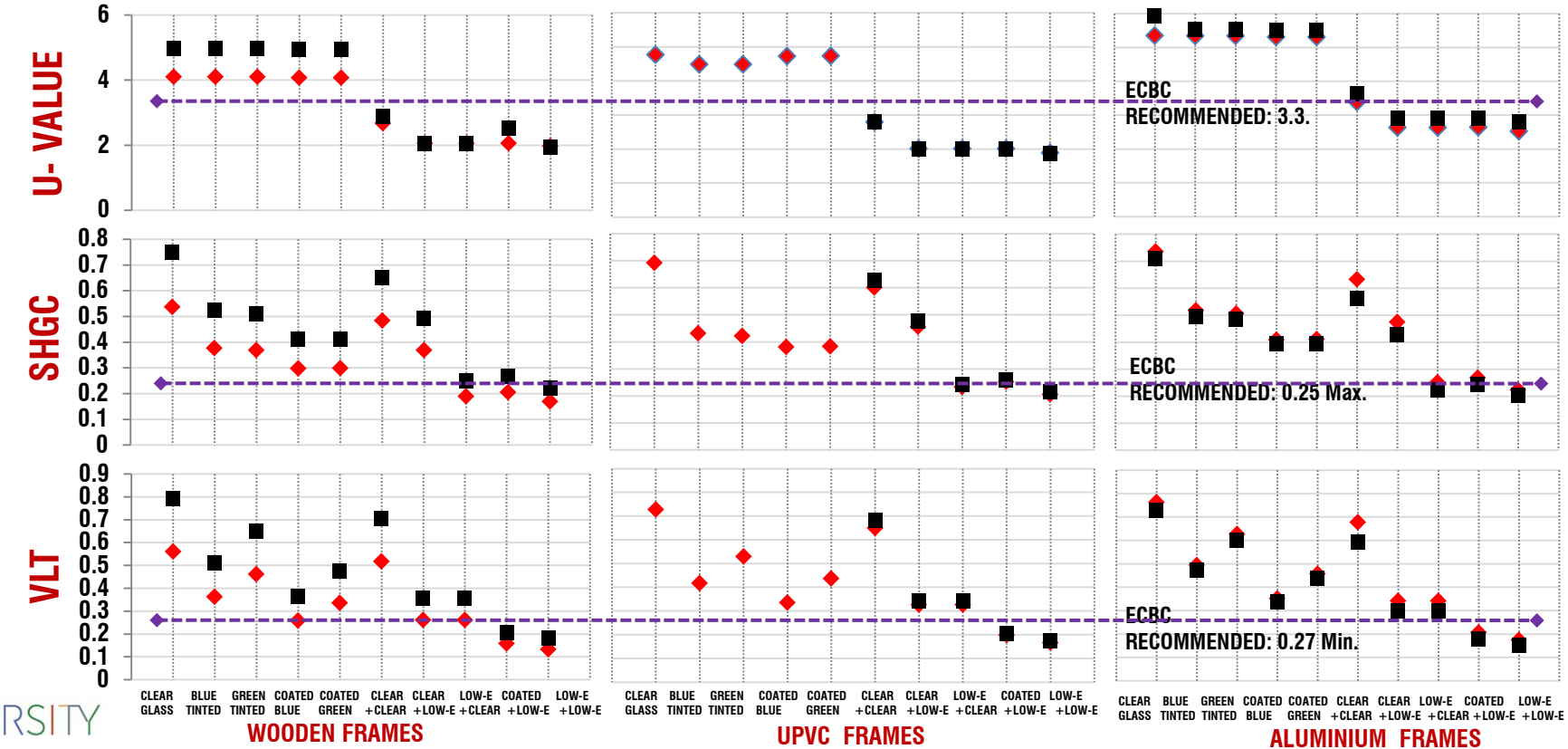
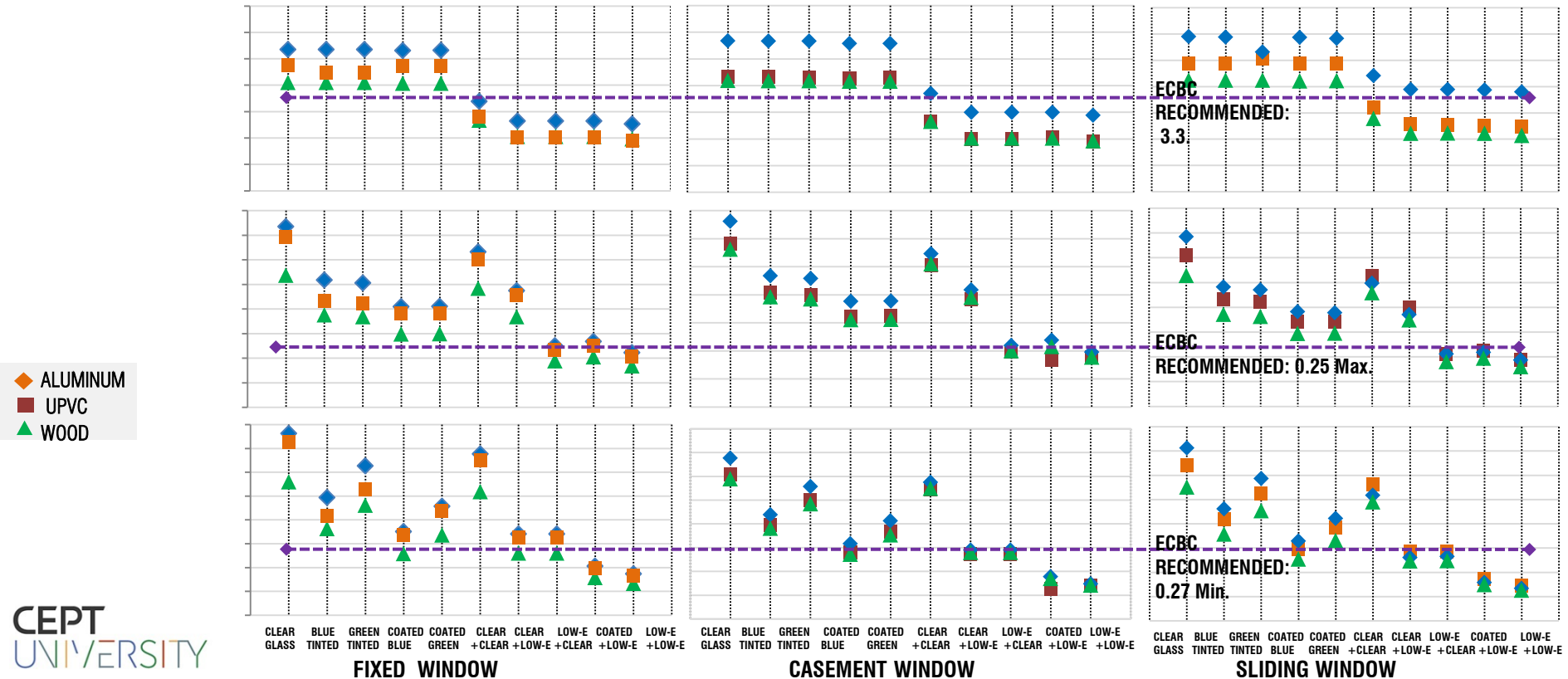
Material of Window Frame – Fixed Windows

Observations



Type of Window Frame – For Varying Materials – Frame Profile 1

Observations



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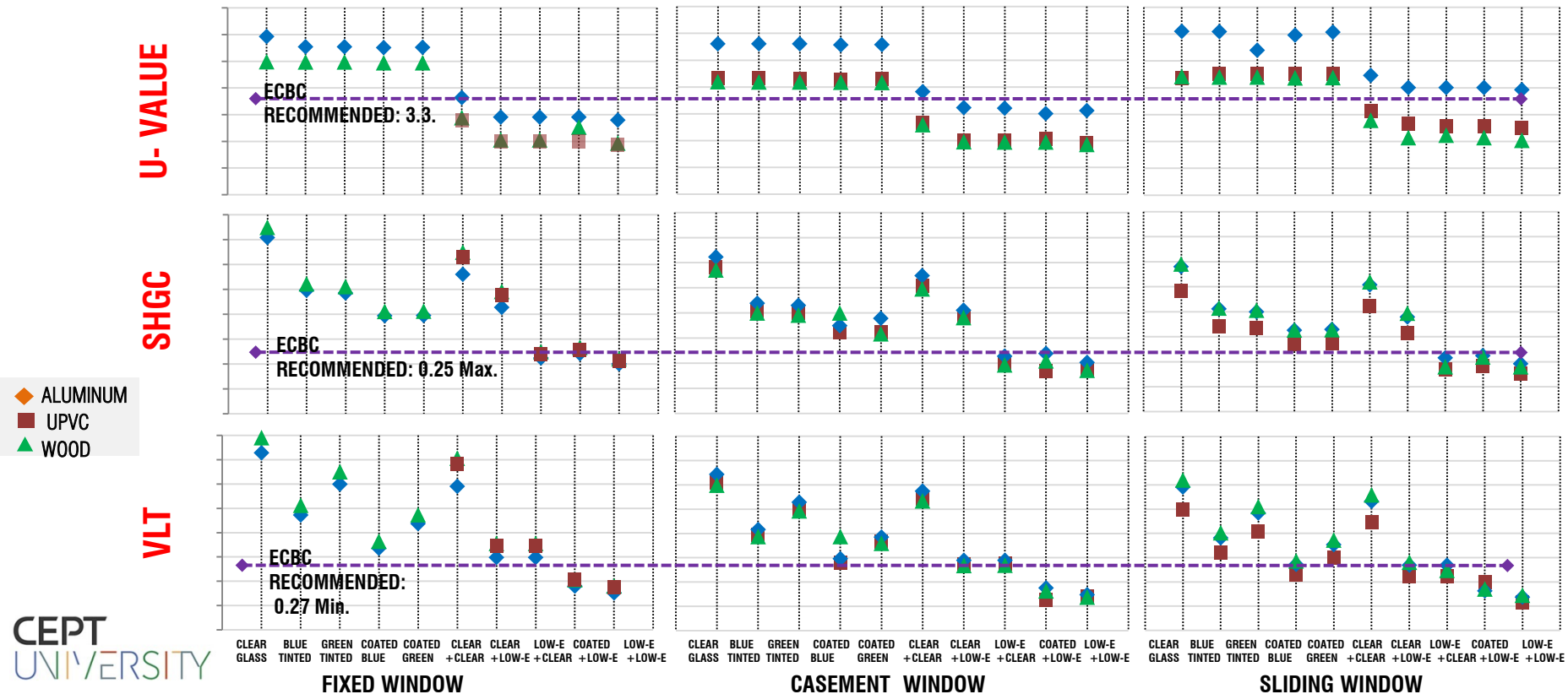
Type of Window Frame – For Varying Materials- Frame Profile 2

Observations



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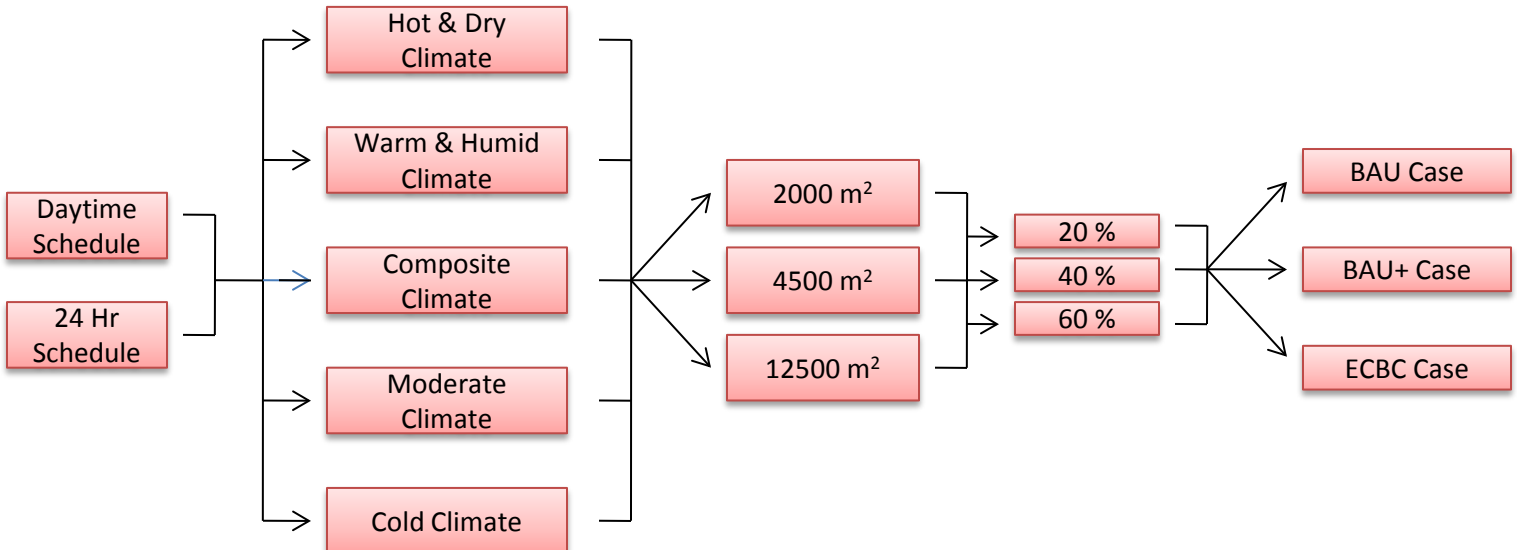
Run-chart



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Model Data for Simulation

Geometry type – Five Zone Square Building
No. of Floors – 5
Floor Height – 3m

Input Parameters	ECBC	BAU
LPD	10.8	13.99
EPD	12.9	12.9
OD	9.3 sqm/person	9.3 sqm/person
Cooling COP	2.6	2.05
Infiltration	0.1 ach	0.25 ach
Cooling Setpoint	24 C	24 C
Heating Setpoint	18 C	18 C
Daylight Control	Yes	No

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*other than envelope properties

Envelope Properties

Window Glazing measures				
Type	WWR	U-Factor	SHGC	VLT
BAU	20%	5.8	0.82	0.8
BAU	40%	5.8	0.82	0.8
BAU	60%	5.8	0.82	0.8
ECBC (CP, HD, WH)	20%	3.3	0.25	0.27
ECBC (CP, HD, WH)	40%	3.3	0.25	0.2
ECBC (CP, HD, WH)	60%	3.3	0.2	0.13
ECBC (Moderate)	20%	6.9	0.4	0.27
ECBC (Moderate)	40%	6.9	0.4	0.2
ECBC (Moderate)	60%	6.9	0.3	0.13
ECBC (Cold)	20%	3.3	0.51	0.27
ECBC (Cold)	40%	3.3	0.51	0.2
ECBC (Cold)	60%	3.3	0.51	0.13

Opaque Construction Measures				
	Daytime Schedule		24 Hr Schedule	
Type	Maximum Wall U-Value	Maximum Roof U-Value	Maximum Wall U-Value	Maximum Roof U-Value
BAU	1.99	2.98	1.99	2.98
ECBC (HD,WH,CP)	0.44	0.409	0.44	0.261
ECBC (Moderate)	0.44	0.409	0.44	0.409
ECBC (Cold)	0.352	0.409	0.369	0.261

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Cases

Cases	BAU	BAU+	ECBC
Window Type	BAU	ECBC Compliant	ECBC Compliant
Other Envelope & System Type	BAU	BAU	ECBC Compliant

BAU – Business as usual, ECBC – Energy Conservation Building Code

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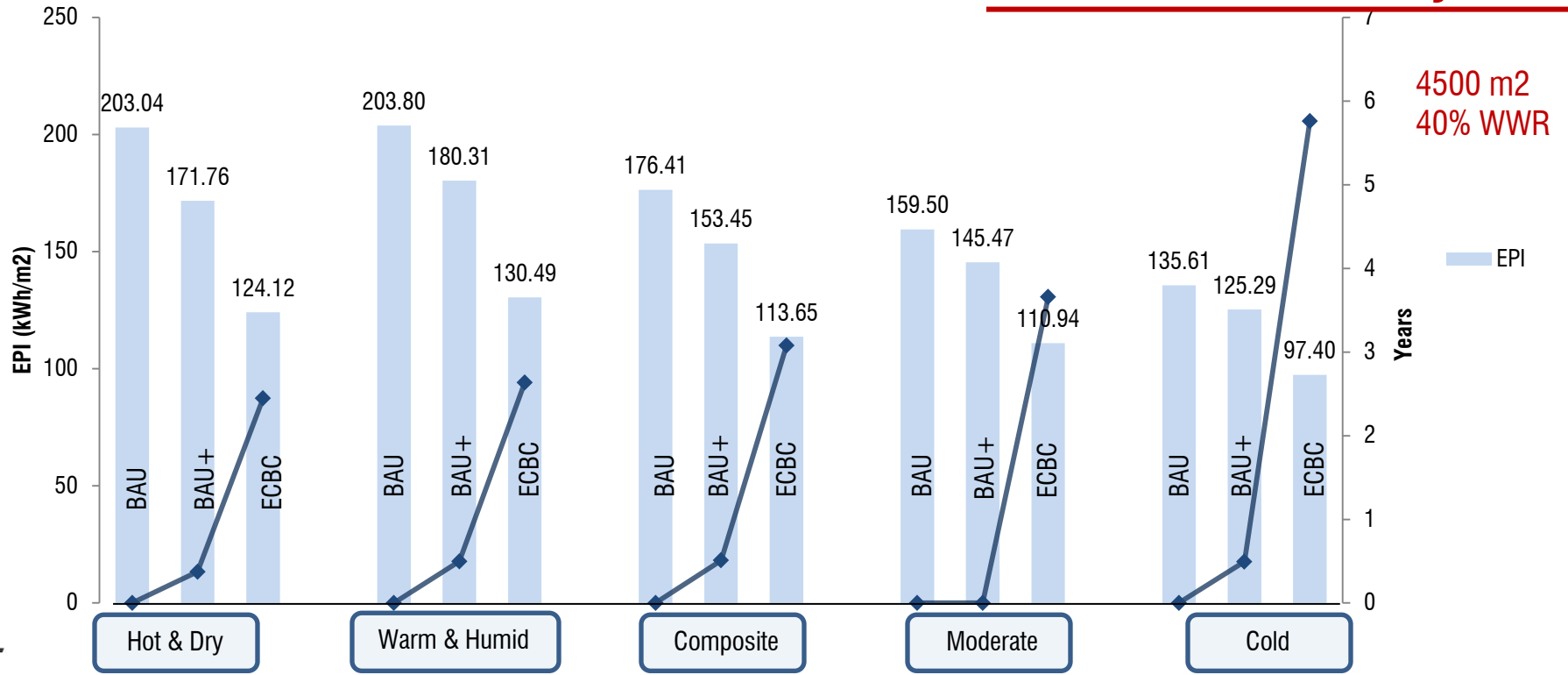
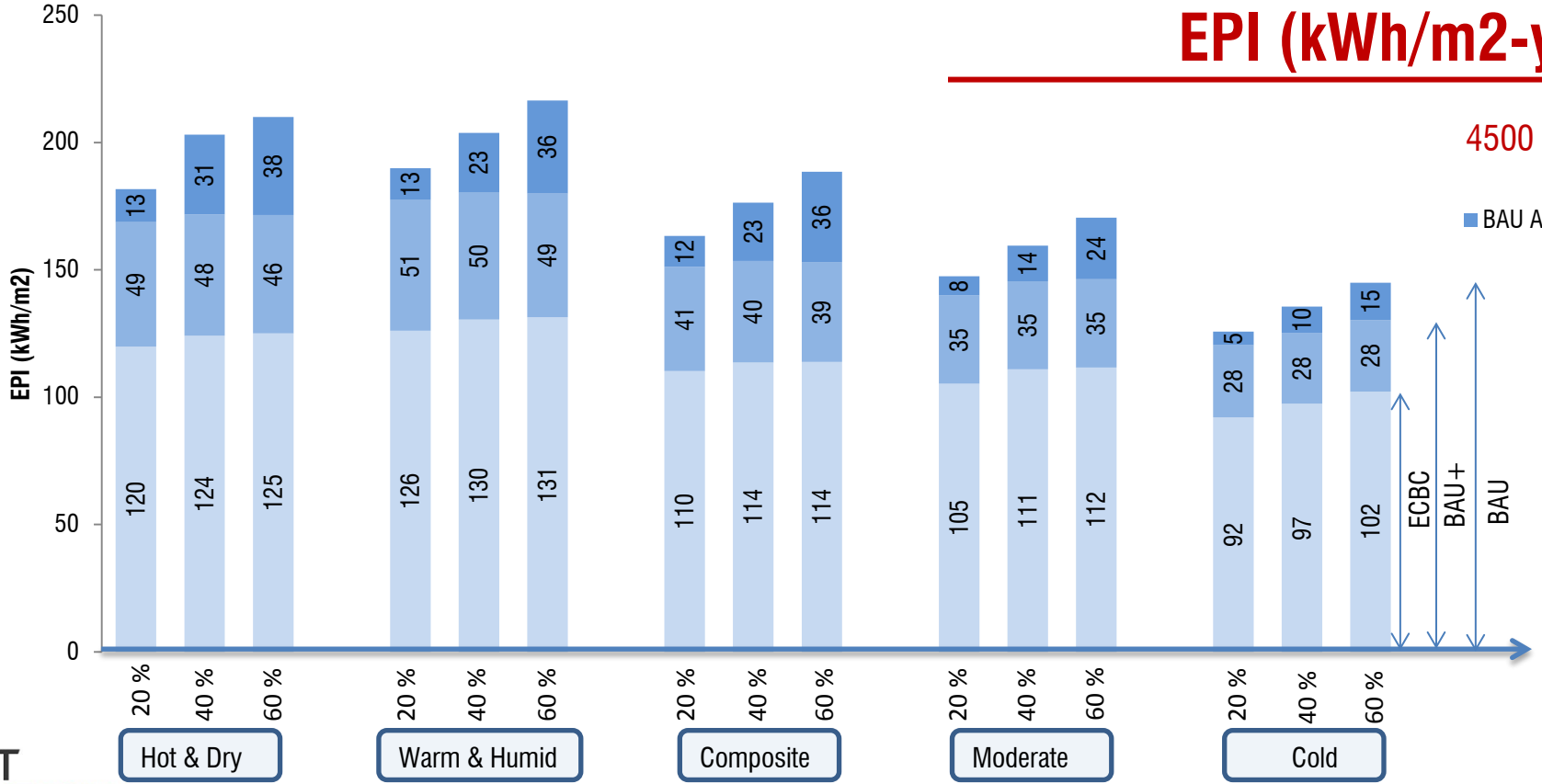
EPI & Payback


EPI (kWh/m2)
Years
4500 m2
40% WWR
EPI
203.04
171.76
124.12
203.80
180.31
130.49
176.41
153.45
113.65
159.50
145.47
110.94
135.61
125.29
97.40
BAU
BAU+
ECBC
Hot & Dry
Warm & Humid
Composite
Moderate
Cold

EPI (kWh/m2-year)



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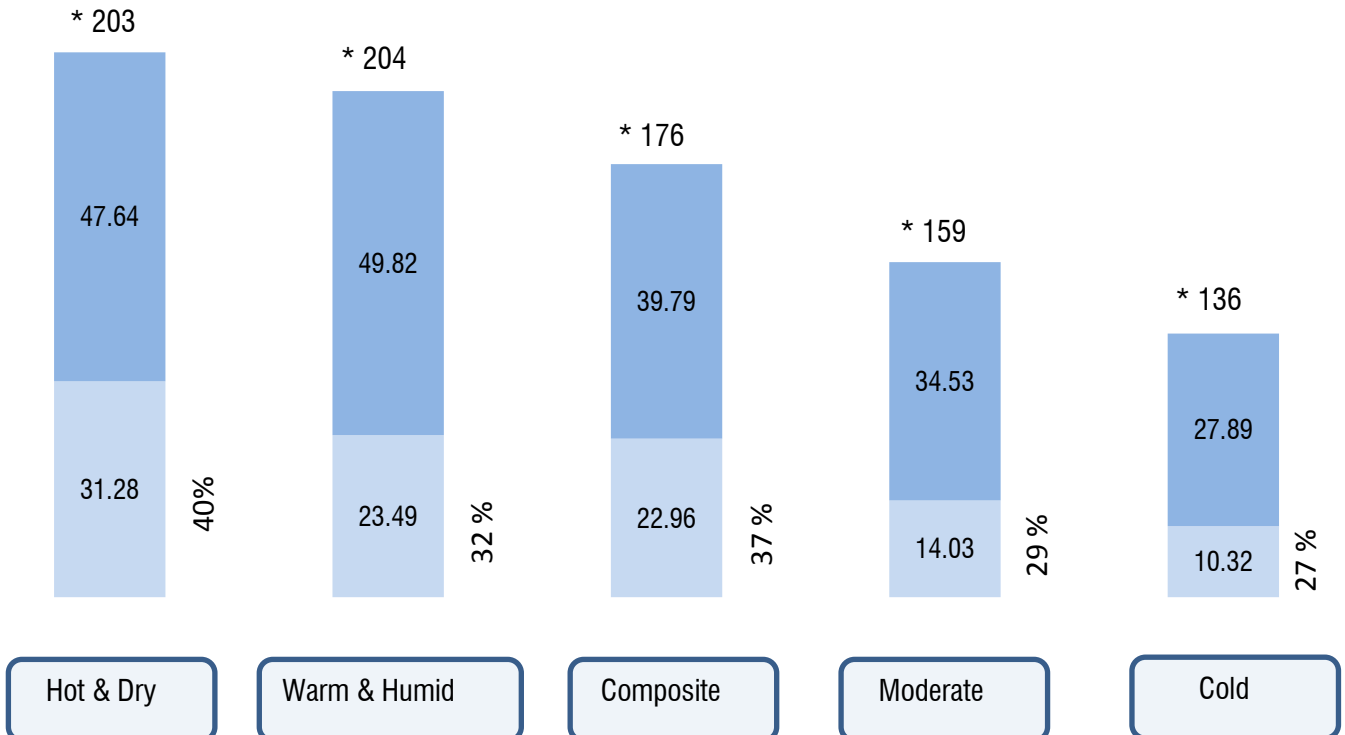
EPI Savings (kWh/m2-year)



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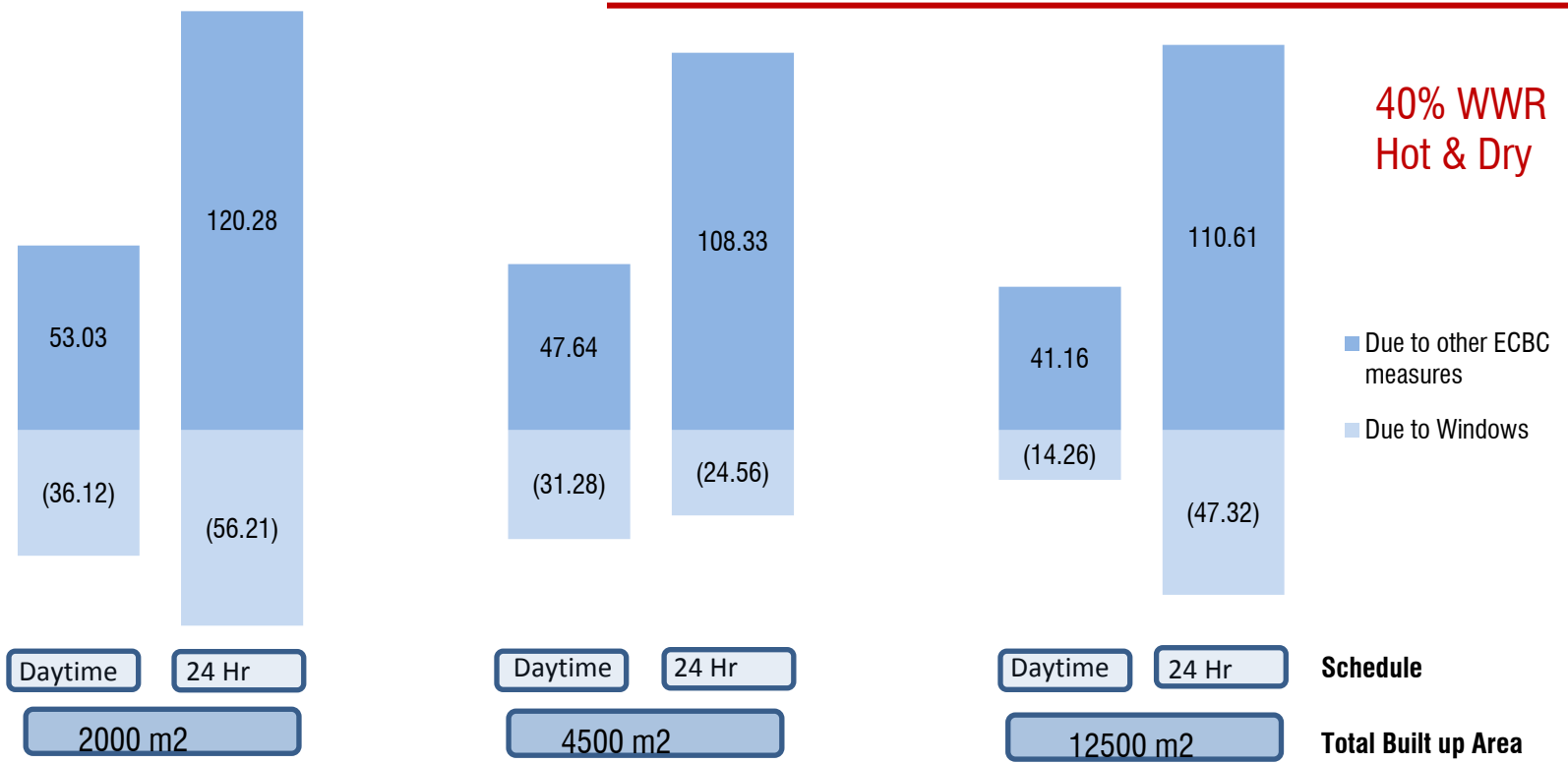
EPI Savings (kWh/m2-year)



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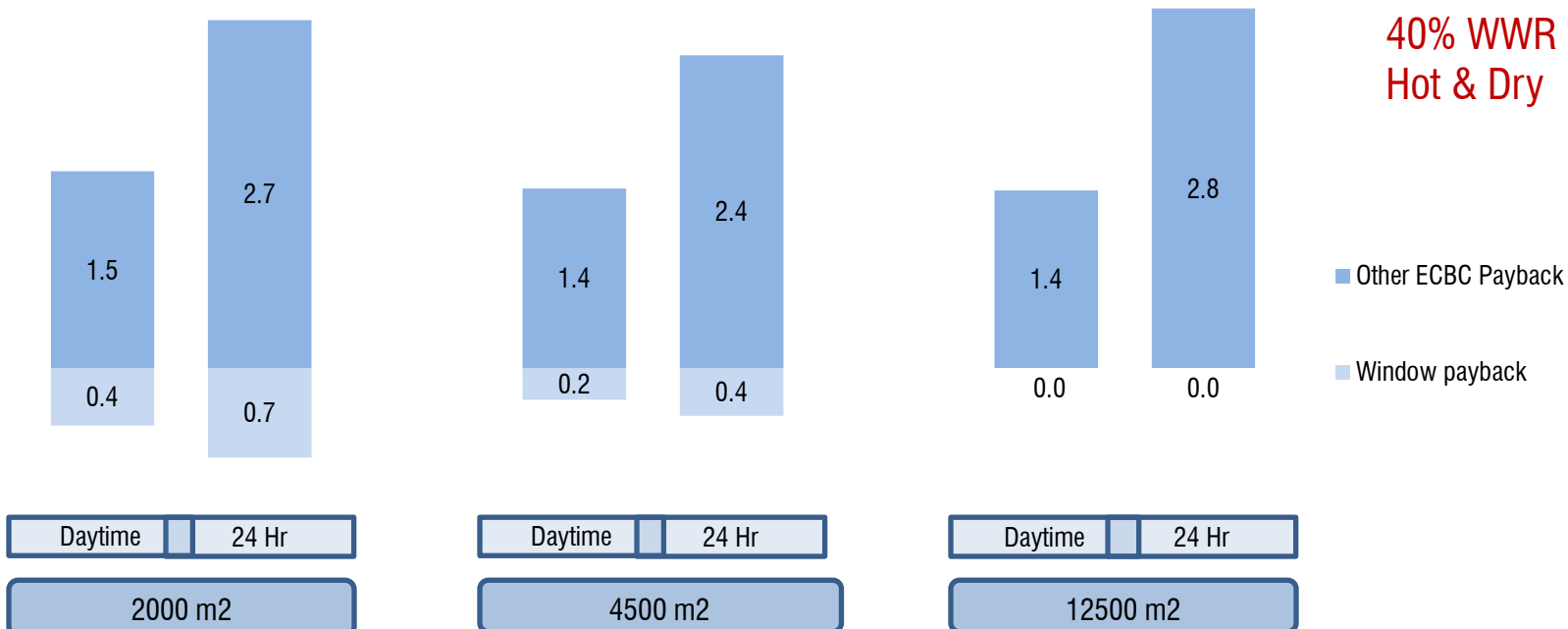
Payback (Years)



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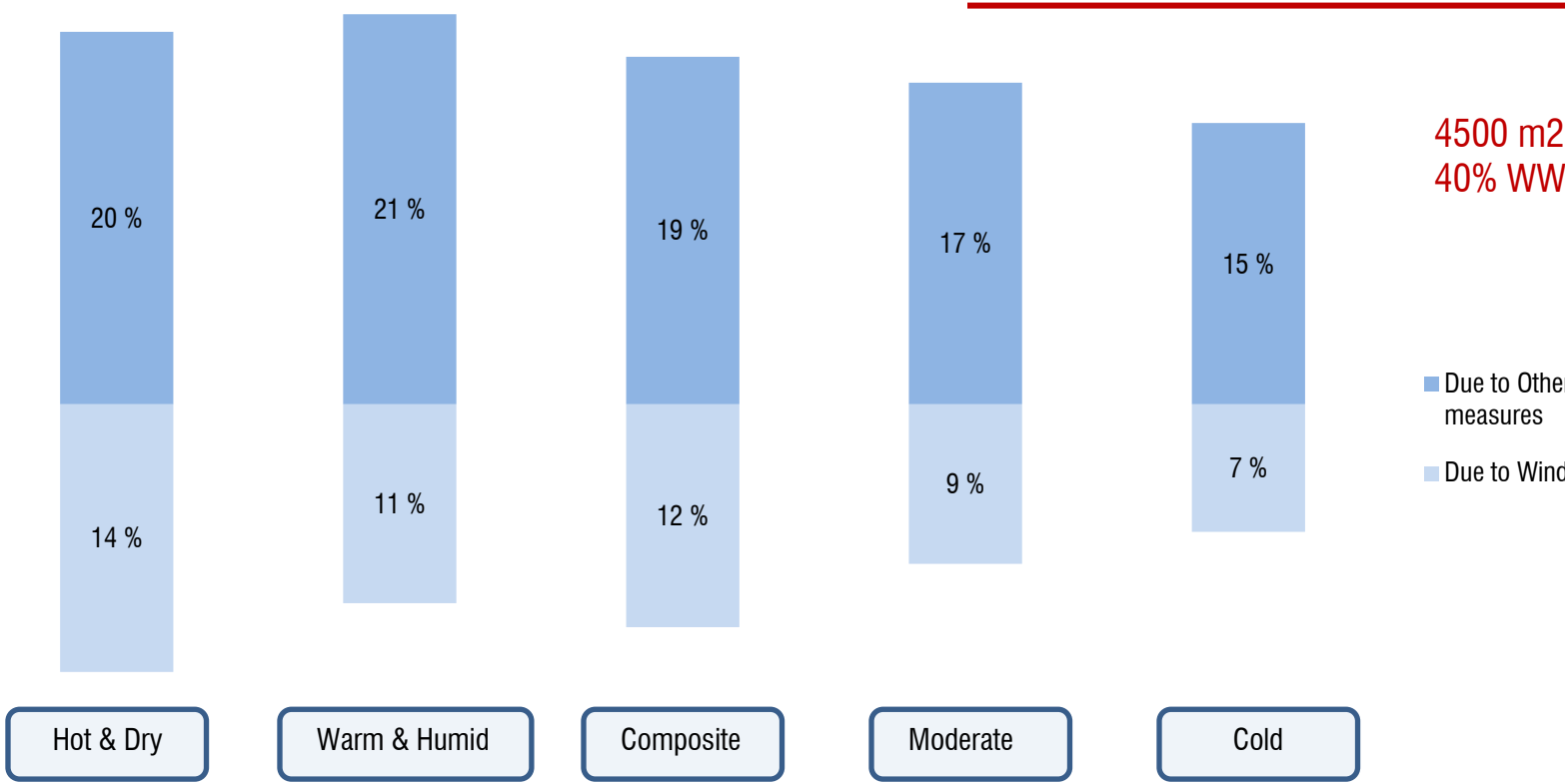
LCC Savings



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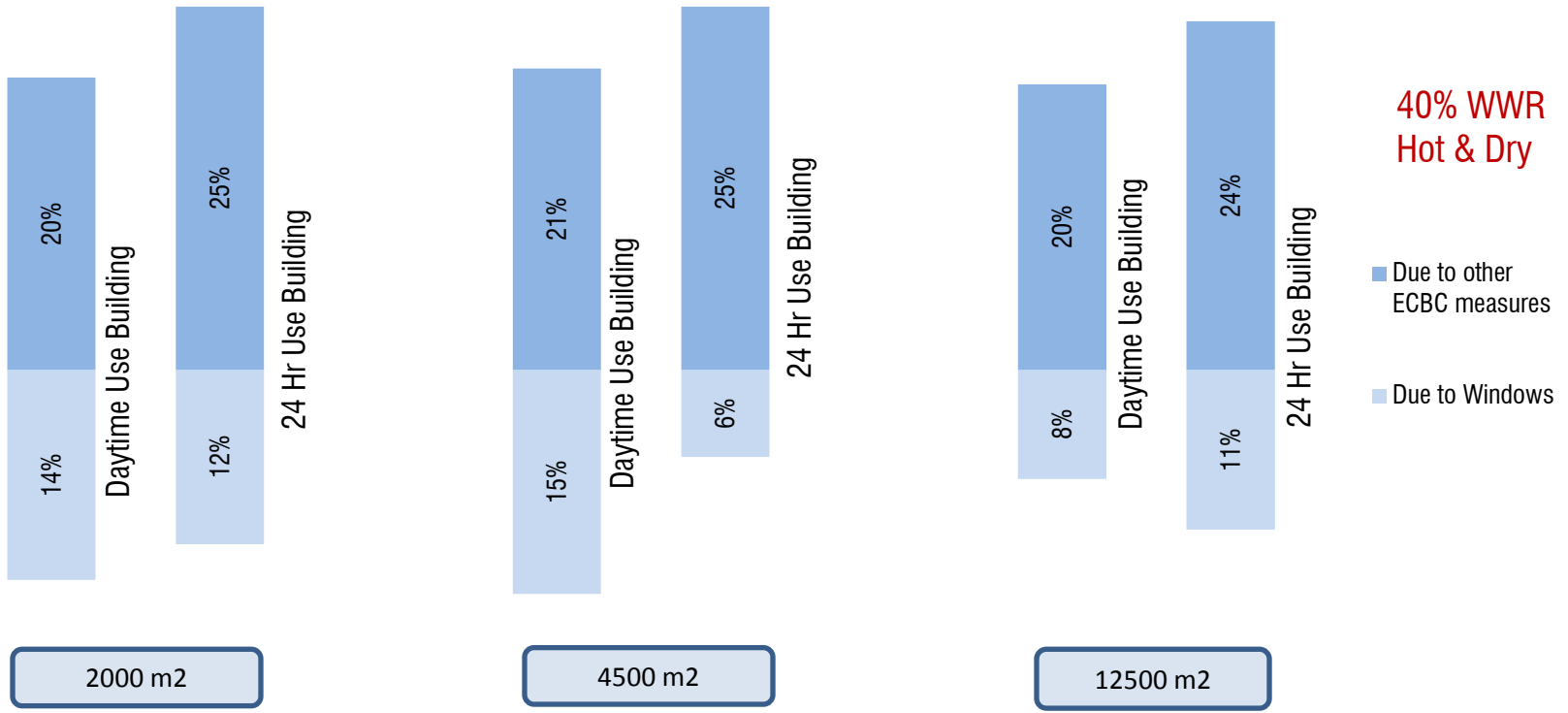
LCC Savings



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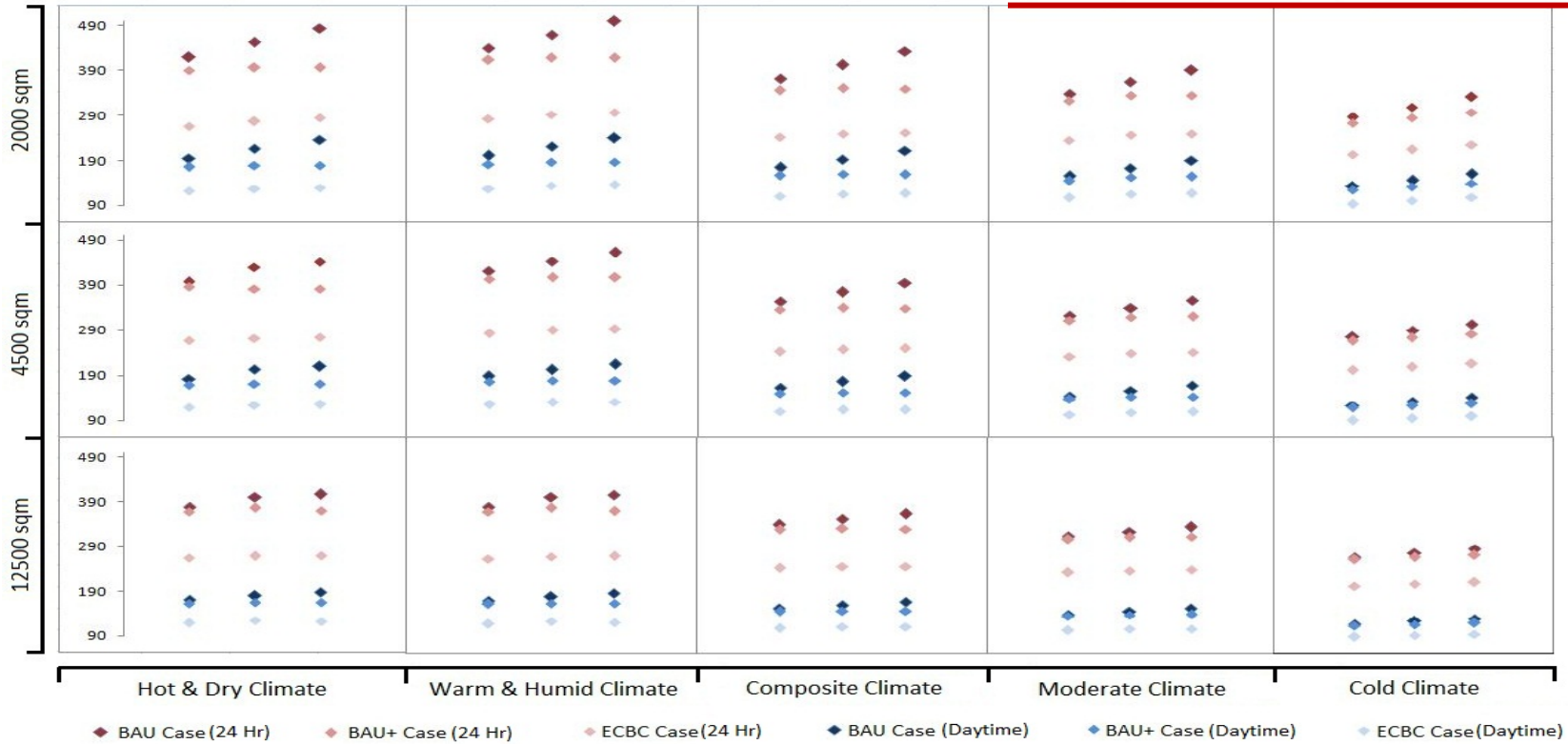
EPI (kWh/m2-year)



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