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Improving the Integration of Sustainable Strategies in Schematic Design: Developing a multi-faceted tool to improve thermal resistance in architectural enclosure systems

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Improving the integration of sustainable strategies in schematic design.

Developing a multi-faceted tool to improve thermal resistance in architectural enclosure systems

This study seeks to develop a tool that can be quickly and easily used by schematic designers to set a thermal resistance target for the complete enclosure system and receive options in a variety of variables to achieve that goal.

1. Please ENTER Pricing for insulation Material			
Type	Cost / SF / IN	R-Value	
Vacuum Insulated Panel	\$5.00	30	
Expanded Poly (EPS)	\$0.35	7	
Extruded Poly (XPS)	\$0.70	4	
Spray Foam	\$1.05	7	
Mineral Wool	\$0.45	4	

*The figures given are exclusive of installation and support structure costs

2. Please ENTER WWR for Opaque Wall			
Window to Wall Ratio	Opaque Wall	Window	
	60.00%	40.00%	

3. Please ENTER Target Wall Enclosure R-Value	
Target R-Value for Enclosure System	
20	

4. Your Thermal Bridge Adjusted R-Value is:	
Adjusted R-Value	
20.83	

5. Least expensive insulation by R-Value of window selection.			
	Cost / SF (\$)	Type	Thickness Required (IN)
R-1 Window	\$ 0.00	n/a	n/a
R-2 Window	\$ 0.00	n/a	n/a
R-3 Window	\$ 0.00	n/a	n/a
R-4 Window	\$ 0.00	n/a	n/a
R-5 Window	\$ 2.86	EPS	8.17
R-6 Window	\$ 1.66	EPS	4.73
R-7 Window	\$ 1.27	EPS	3.64
R-8 Window	\$ 1.09	EPS	3.10

- Use standard formula to find adjusted R-value of the WWR. The U-Value is the reciprocal of the R-Value of a material or building assembly. As the R-Value describes the thermal resistance of a material or assembly, the U-Value describes the thermal conductivities of a material or assembly.
- Modify formula: find the adjusted R-Value for a wall assembly using one of the three CSS (Cascadia Clip).
- Modify formula: convert all U-values to R-values and rearrange the formula to solve for the adjusted R-Value of the comprehensive wall assembly after thermal bridging.
- Modify formula: find the $R_{ADJUSTED}$ for each WWR, and R_{WINDOW} values R-1—R-8.

$$\begin{aligned}
 ① \quad U_{TOTAL\ WALL} &= (\% \text{ OPAQUE AREA} \cdot U_{OPAQUE\ WALL}) + (\% \text{ GLAZE AREA} \cdot U_{GLAZE}) \\
 ② \quad U_{TOTAL\ WALL} &= (\% \text{ OPAQUE AREA} \cdot U_{OPAQUE\ WALL}) + (\% \text{ FIBERGLASS AREA} \cdot U_{FIBERGLASS}) + (\% \text{ STEEL BOLT} \cdot U_{STEEL}) \\
 ③ \quad R_{ADJUSTED} &= \% \text{ OPAQUE AREA} / ((1 / R_{TARGET}) - ((\% \text{ FIBERGLASS} / R_{FIBERGLASS}) + (\% \text{ STEEL} / R_{STEEL}))) \\
 ④ \quad R_{ADJUSTED} &= \% \text{ OPAQUE AREA} / ((1 / R_{OPAQUE(ADJUSTED\ FOR\ TB)}) - ((\% \text{ WINDOW} / R_{WINDOW})))
 \end{aligned}$$

WINDOW-TO-WALL RATIO WWR
 R-VALUE OF THE WINDOW R_{WINDOW}
 R-VALUE OF THE ENCLOSURE R_{TARGET}
 CLADDING SUPPORT SYSTEM CSS
 COST \$
 INSULATION TYPE VIP, XPS, EPS, SF, MP

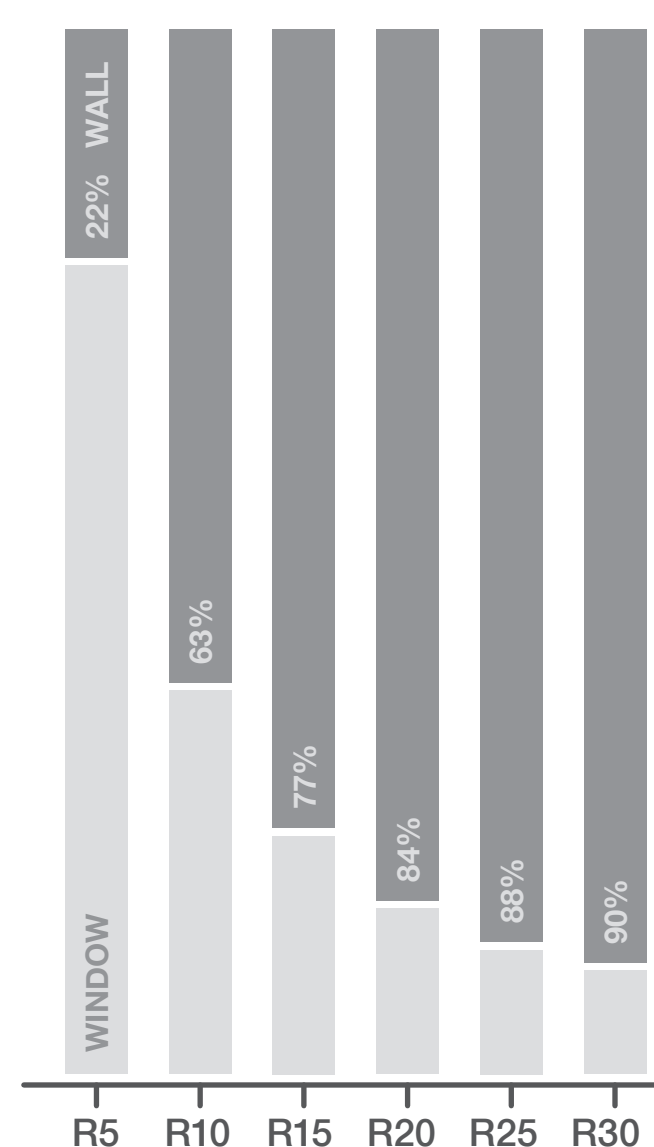


Chart 1 — Maximum window-to-wall ratios per target R-value.
 Assumed parameters:
 Window R-value of 4
 Cascadia Clip Cladding Support System

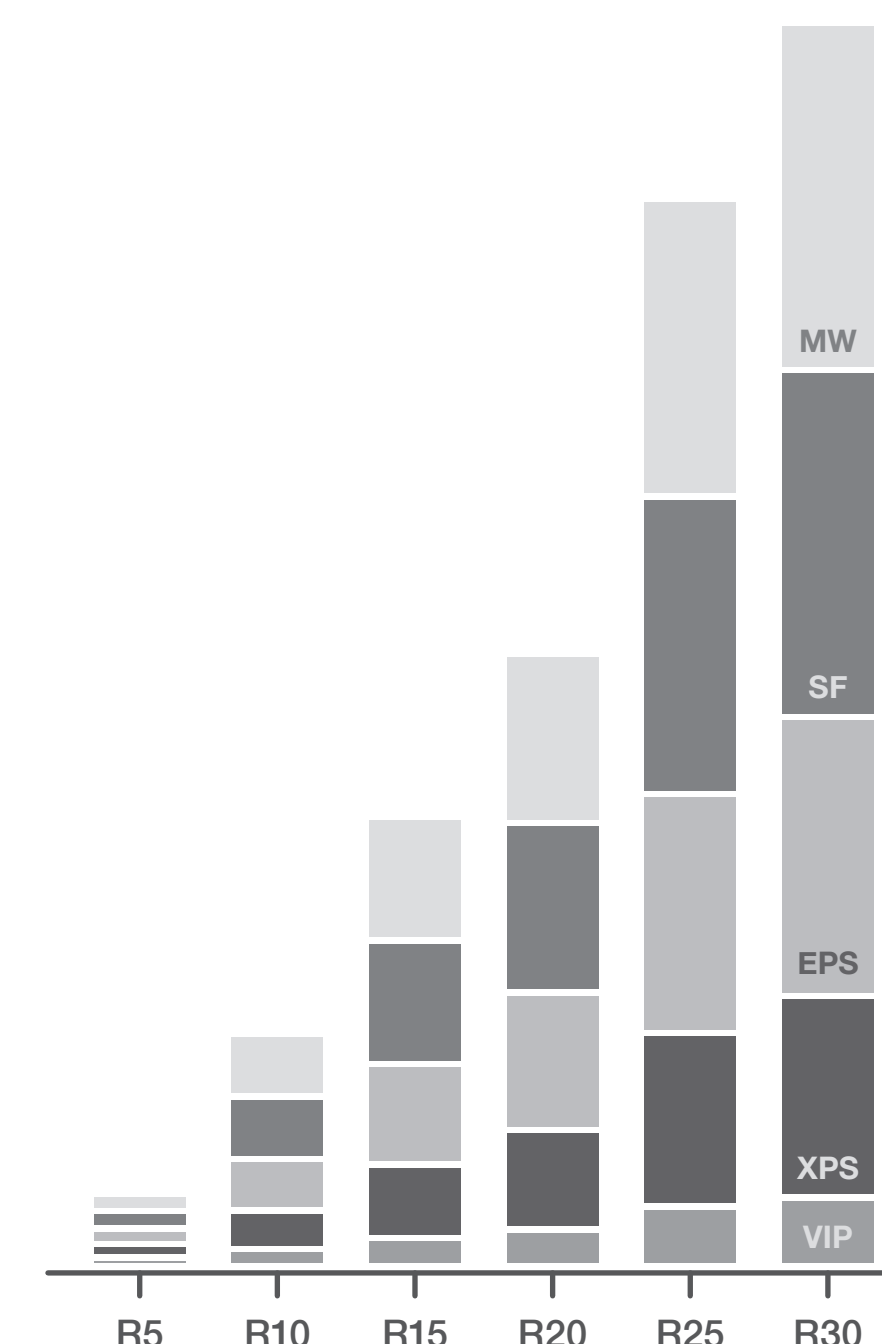


Chart 2 — Insulation type thickness per target R-value.
 Assumed parameters:
 60 wall ratio / 40% WWR
 Window R-value of 4
 Cascadia Clip Cladding Support System

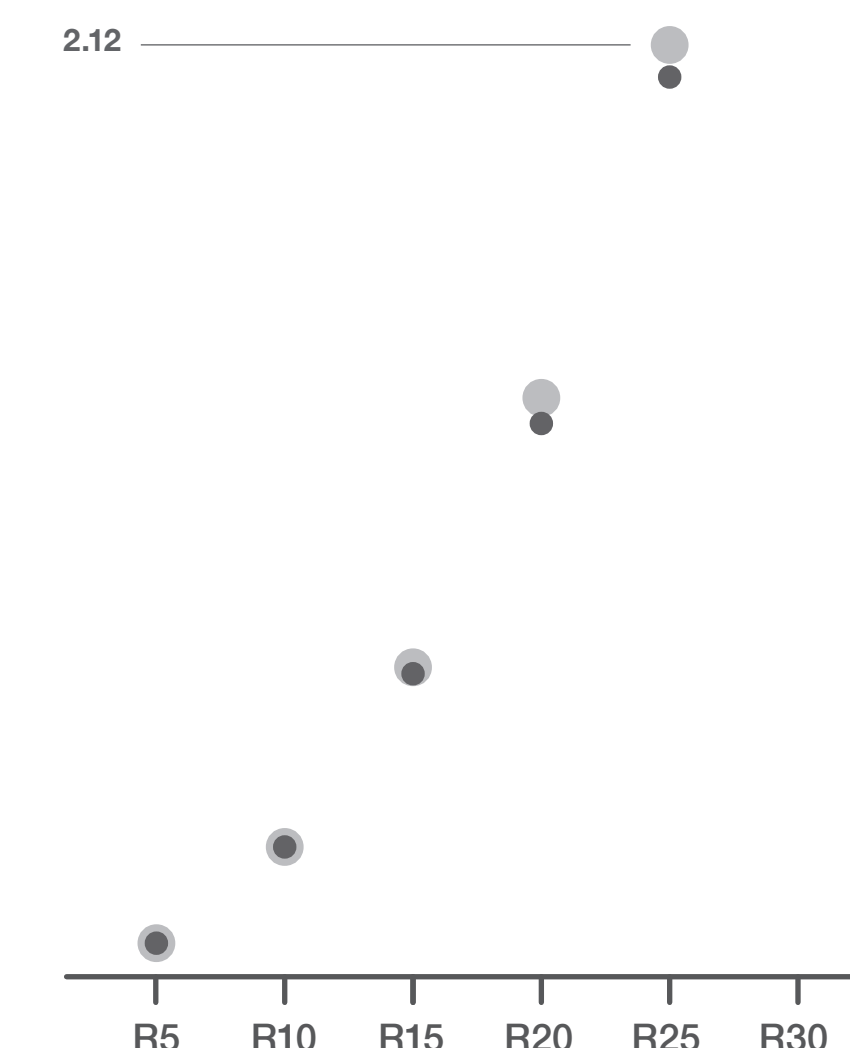


Chart 3 — Change in actual required R-value per cladding support clip type.
 Assumed parameters:
 60 wall ratio / 40% WWR