

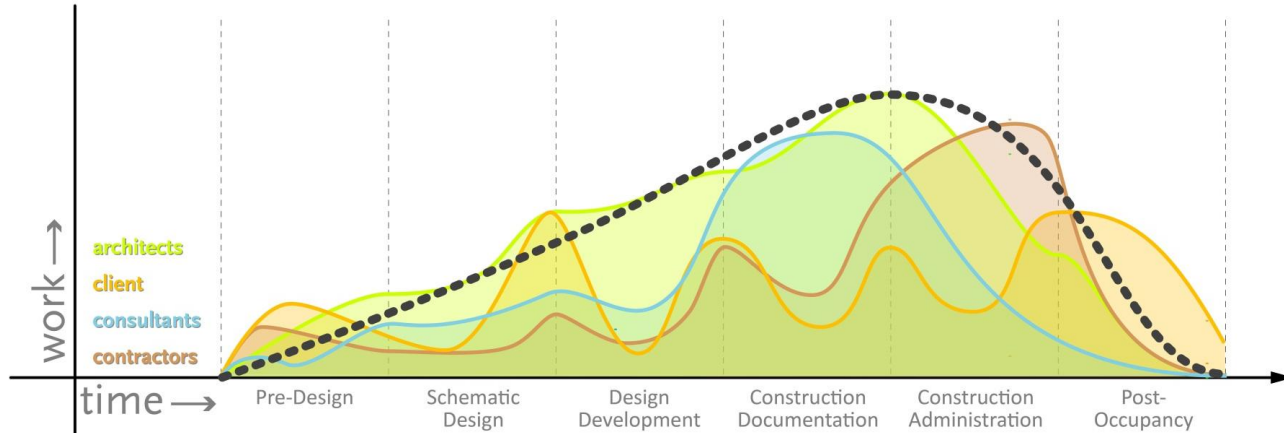
**eeB
HUB** Energy
Efficient
Buildings
Hub

**Integrated Solutions Showcase
Building 669 Testbed**

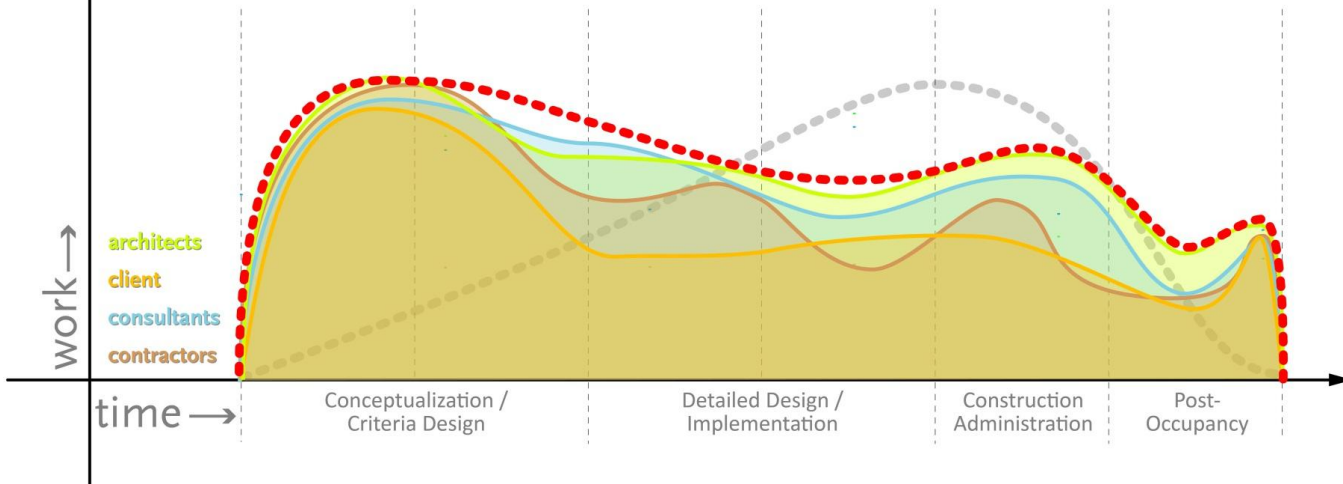
Richard Sweetser
EEB Hub
November 27, 2012

Integrated Design Process

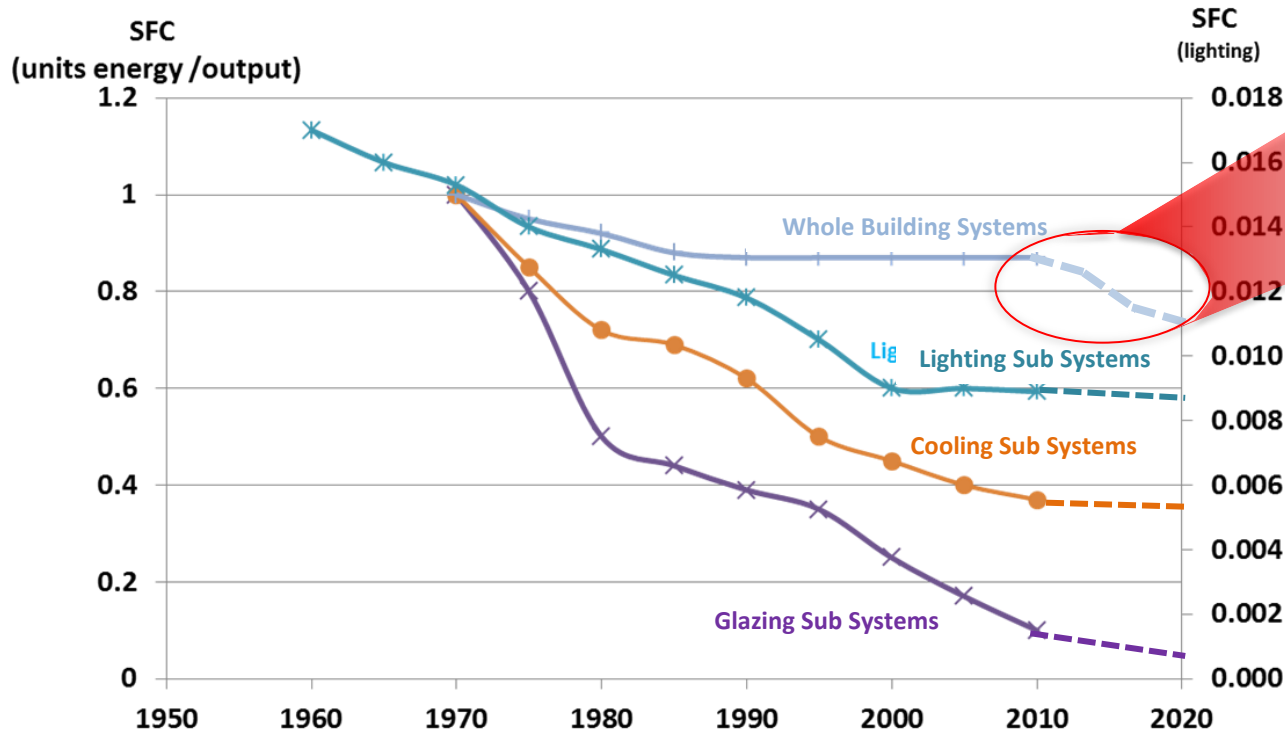
TYPICAL WORKPLAN



EEB HUB COLLABORATIVE WORKPLAN



Integrated Technologies Approach



Integrated Technology Approach Impact

Building Sector Accounts for :

40% of Total U.S. Prime Energy Expended
70% of all U.S. Electric Energy Use



Building 669



Building 669



Building 669 Testbed

- **Owner:** Philadelphia Industrial Development Corporation
- **Tenant:** Rhoades Industries (10 year lease with 10 year option)
- **Use:** New Maritime Operations HQ
- **Needs:** New roof, upgrade second floor to reflect new use
- **Occupancy:** Projected increase from 15 to 100 people

City Code - ASHRAE 90.1-2007

Nonresidential

| Opaque Elements | Assembly Maximum | Insulation Min. R-Value |
|--------------------------------|------------------|-------------------------|
| <i>Roofs</i> | | |
| Insulation Entirely above Deck | U-0.048 | R-20.0 c.i. |
| Metal Building | U-0.065 | R-19.0 |
| Attic and Other | U-0.027 | R-38.0 |
| <i>Walls, Above-Grade</i> | | |
| Mass | U-0.104 | R-9.5 c.i. |
| Metal Building | U-0.113 | R-13.0 |
| Steel-Framed | U-0.064 | R-13.0 + R-7.5 c.i. |
| Wood-Framed and Other | U-0.089 | R-13.0 |
| <i>Walls, Below-Grade</i> | | |
| Below-Grade Wall | C-1.140 | NR |
| <i>Floors</i> | | |
| Mass | U-0.087 | R-8.3 c.i. |
| Steel-Joist | U-0.038 | R-30.0 |
| Wood-Framed and Other | U-0.033 | R-30.0 |
| <i>Slab-On-Grade Floors</i> | | |
| Unheated | F-0.730 | NR |
| Heated | F-0.860 | R-15 for 24 in. |
| <i>Opaque Doors</i> | | |
| Swinging | U-0.700 | |
| Nonswinging | U-1.500 | |

| Fenestration | Assembly Max. U | Assembly Max. SHGC |
|---|------------------------|---------------------------|
| <i>Vertical Glazing, 0%–40% of Wall</i> | | |
| Nonmetal framing (all) ^b | U-0.40 | |
| Metal framing (curtainwall/storefront) ^c | U-0.50 | SHGC-0.40 all |
| Metal framing (entrance door) ^c | U-0.85 | |
| Metal framing (all other) ^c | U-0.55 | |
| <i>Skylight with Curb, Glass, % of Roof</i> | | |
| 0%–2.0% | U _{all} -1.17 | SHGC _{all} -0.49 |
| 2.1%–5.0% | U _{all} -1.17 | SHGC _{all} -0.39 |
| <i>Skylight with Curb, Plastic, % of Roof</i> | | |
| 0%–2.0% | U _{all} -1.30 | SHGC _{all} -0.65 |
| 2.1%–5.0% | U _{all} -1.30 | SHGC _{all} -0.34 |
| <i>Skylight without Curb, All, % of Roof</i> | | |
| 0%–2.0% | U _{all} -0.69 | SHGC _{all} -0.49 |
| 2.1%–5.0% | U _{all} -0.69 | SHGC _{all} -0.39 |

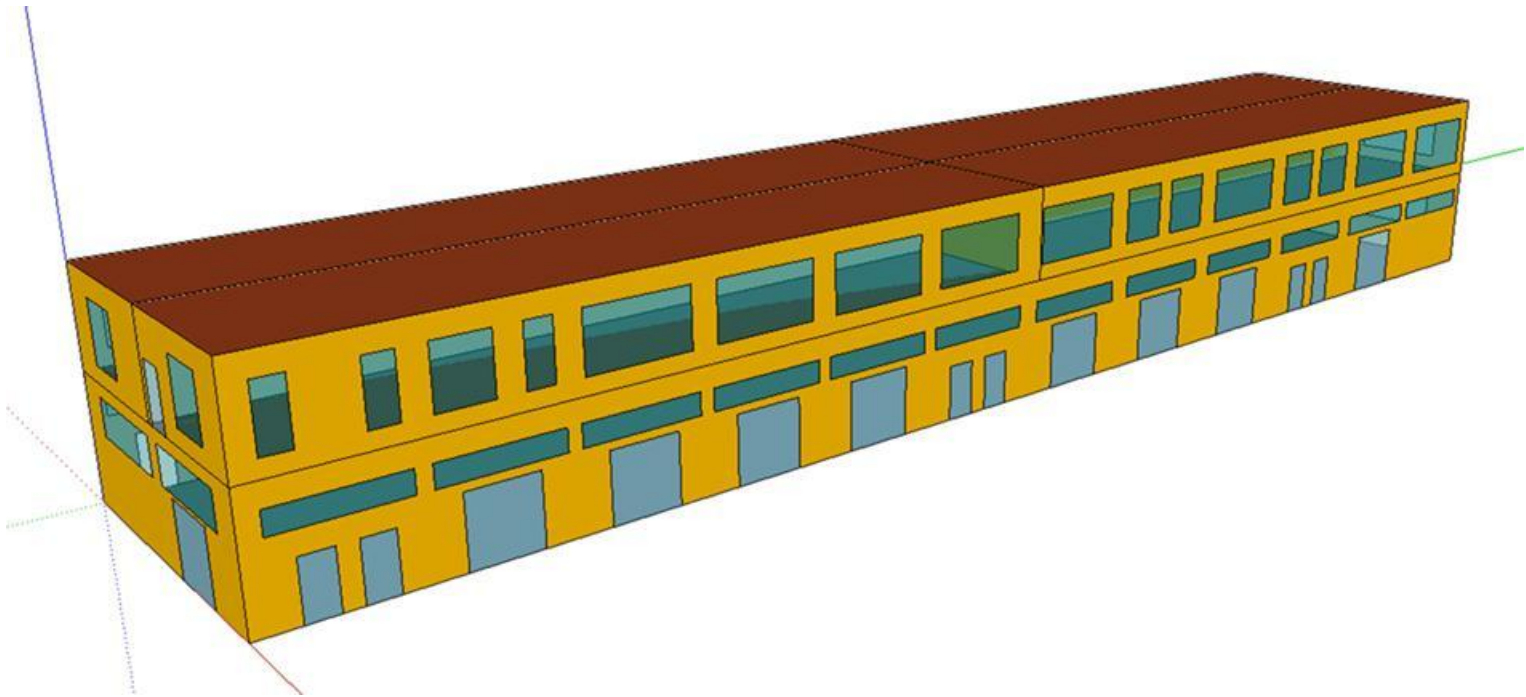
Building 669 Integrated System Project Design

- **Integrated Technology Optimization**
 - **Envelope**
 - **Roof Scenarios**
 - **Black EPDM membrane as roof surface finish with R-24**
 - **PVC membrane (reflective roof) with R-24**
 - **Walls**
 - **Polyurethane rigid foam board application on the interior (R-24)**
 - **Hybrid Insulation application- 2” SPF + 3” Blown-in Cellulose fill (~R-25)**
 - **Glazing Scenarios**
 - **Existing single pane clear glazing**
 - **Double glazed solarban 60 + etch glass combination window for better thermal performance and high Tvis**

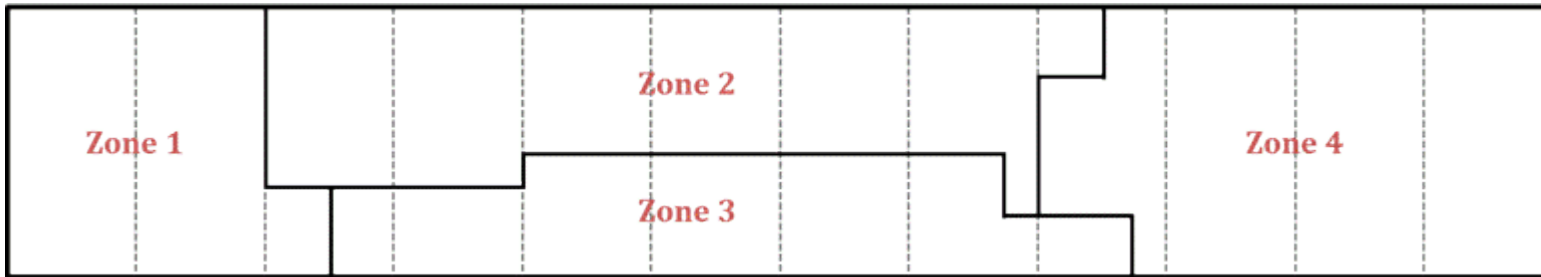
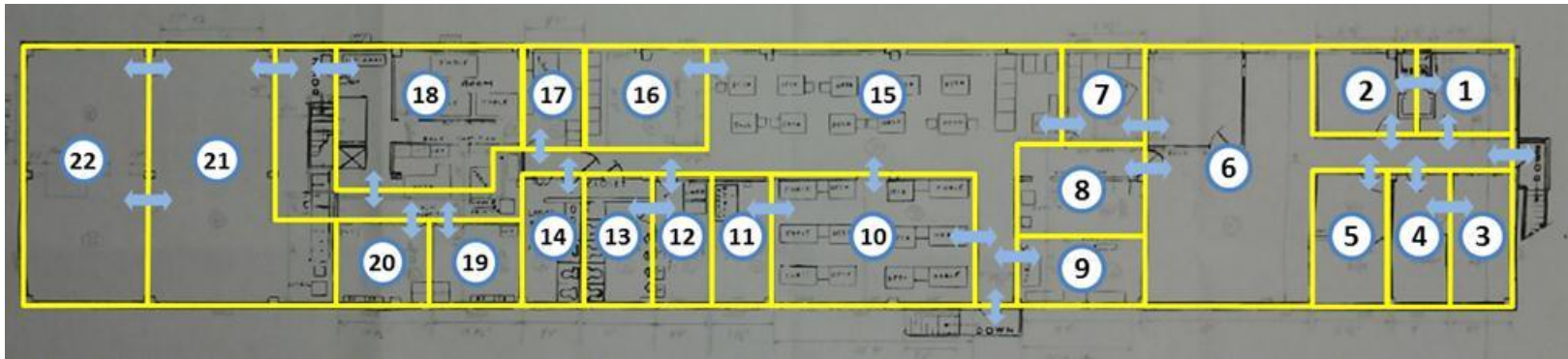
HVAC System Retrofit Options Assessed

- **Integrated Technology Optimization**
 - **Baseline (Window mount air conditioners/infiltration, boiler heat)**
 - **Rooftop A/C system (heat pump)**
 - **Dual compressor rooftop A/C (heat pump)**
 - **Variable speed rooftop A/C (heat pump)**
 - **Multi-split heat pump**
 - **Geothermal (or river source/sink) heat pump**
 - **VAV DX system through the whole building**
 - **DOAS system through the whole building**
 - **Radiant heating/chilled beam cooling**
 - **Energy recovery ventilator**
 - **Demand-controlled ventilation**

TRNSYS Optimization Model



Building Zones



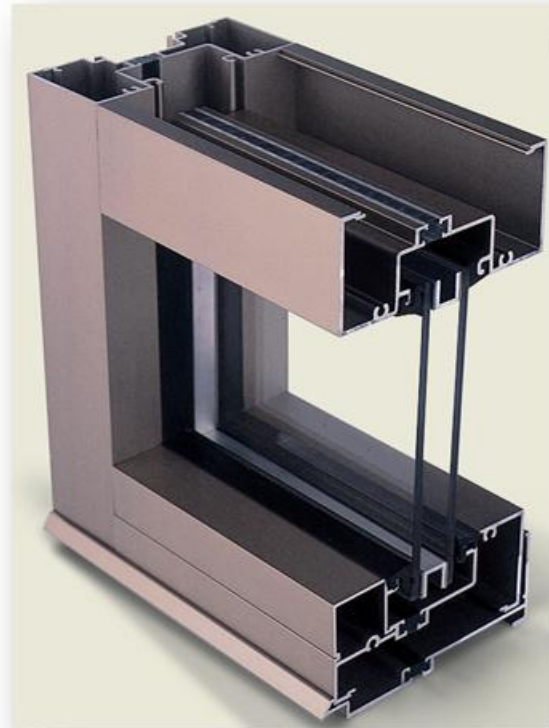
2nd Floor Glazing



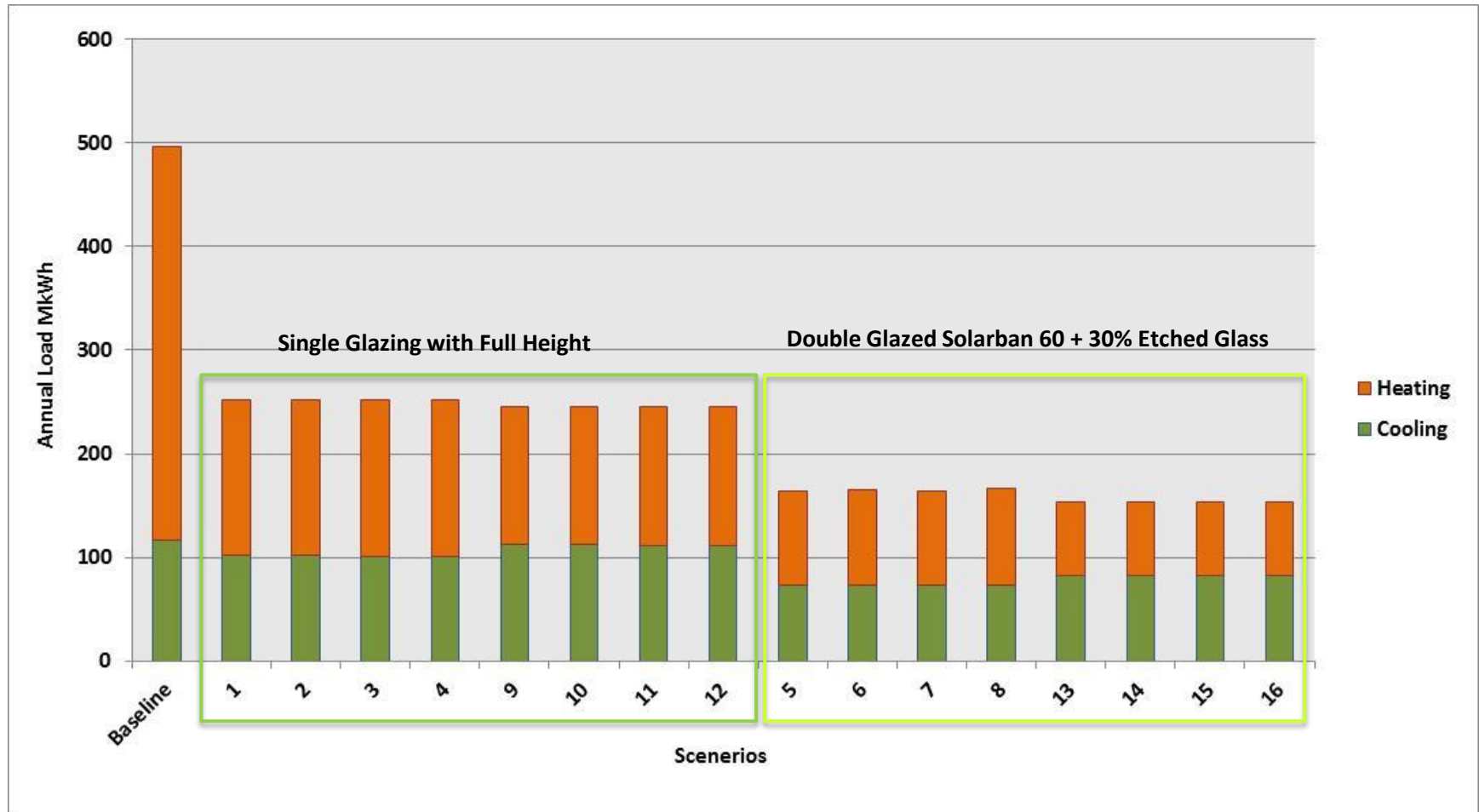
Glazing



Storefront Solution



Envelope Driven Energy Use



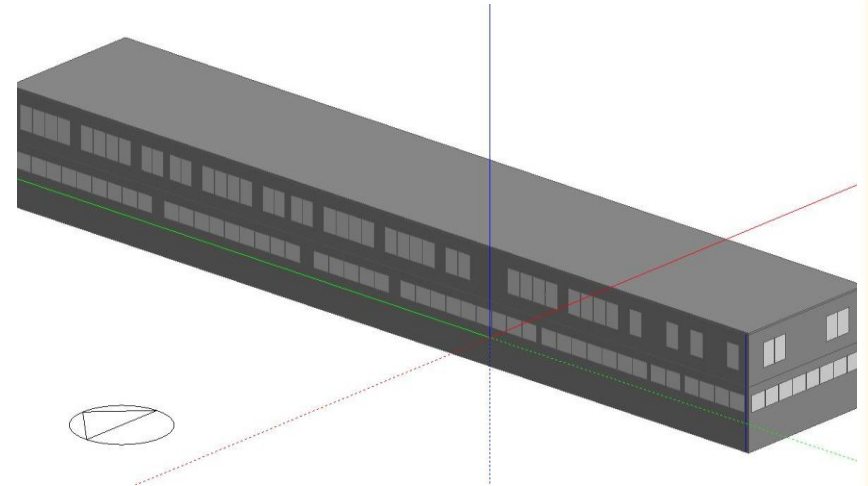
Conclusions

- In this case, glazing has a high energy impact on the building load

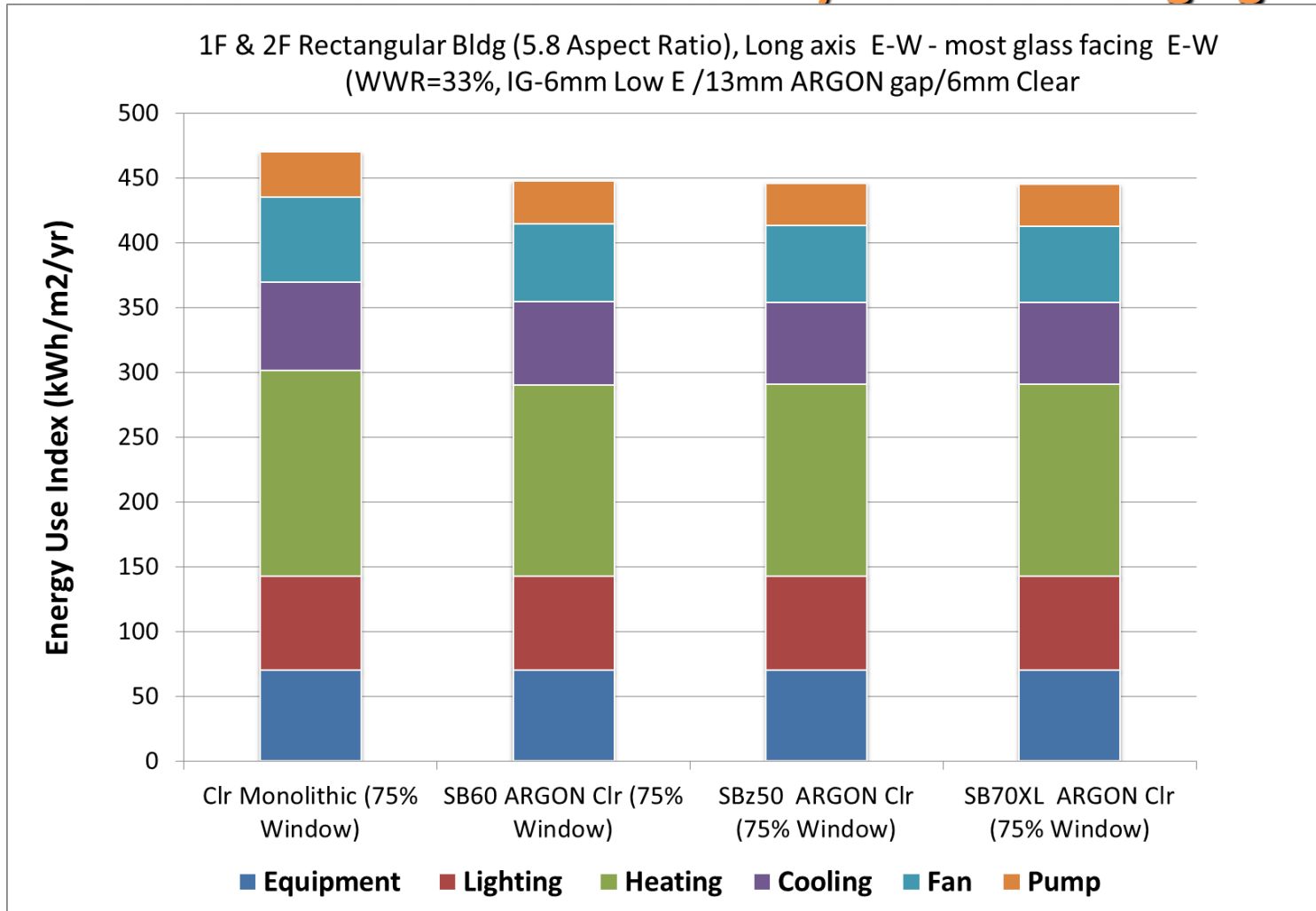
Preliminary Energy+ Simulation with DesignBuilder

Zone 4 Code - Ashrae -90.1-2010

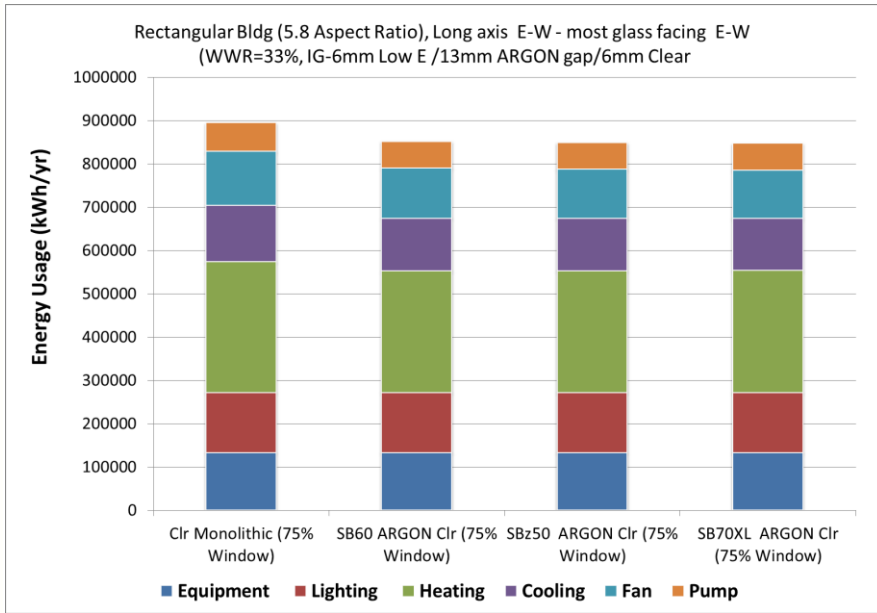
| Building 669 | | | | | | |
|-------------------|---------------------|-----------------------|-----|----------------------|-----------------|-----|
| From Drawings | | | | | | |
| From Drawings | 100% Window opening | Façade Area | WWR | 75% Window opening | Façade Area | WWR |
| 1F | ft ² | ft ² | | ft ² | ft ² | |
| East | 932 | 4268 | 22% | | | |
| West | 923 | 4268 | 22% | | | |
| South | 140 | 741 | 19% | | | |
| North | 295 | 741 | 40% | | | |
| | 2289 | 10016 | 23% | 1717 | 10016 | 17% |
| Building 669 | | | | | | |
| | 100% Window opening | Façade Area | WWR | 75% Window opening | Façade Area | WWR |
| 2F | ft ² | ft ² | | ft ² | ft ² | |
| East | 1515 | 3402 | 45% | | | |
| West | 1515 | 3402 | 45% | | | |
| South | 147 | 590 | 25% | | | |
| North | 261 | 590 | 44% | | | |
| | 3438 | 7985 | 43% | 2578.5 | 7985 | 32% |
| Total IG Glass (: | | 11454 ft ² | | 8591 ft ² | | |



Preliminary Building Energy Simulation – w/Thermally broken Al frame - 75% window size – Glass only variable changing



Total Energy Usage in kWh/yr For 1F & 2F



Heating & Cooling Usage in kWh/yr for 1F & 2F

