Zero-Energy Homes with Revit and Insight 360: Make It, Market It, and Sell It

Jon A. Gardzelewski, AIA, LEED AP

Associate Lecturer, University of Wyoming, UW-BERG

twitter: uw_berg

Class summary

Everything this guys knows about Zero-Energy houses crammed into a Revit-based lecture

Key learning objectives

At the end of this class, you will be able to:

- Learn research-proven methods to integrate solar panels into residential design as architecturally expressive elements
- Understand energy-analysis and solar-analysis capabilities in Revit and Insight 360
- Learn Interoperability tricks for working with other simulation programs
- Learn how to market net-zero and positive energy homes to builders, realtors, architects, and prospective buyers

Who is Jon Allen Gardzelewski?

If someone steals your right ski…

UNIVERSITY OF WYOMING

ARCHITECTURAL ENGINEERING INSTITUTE

2016 US election results

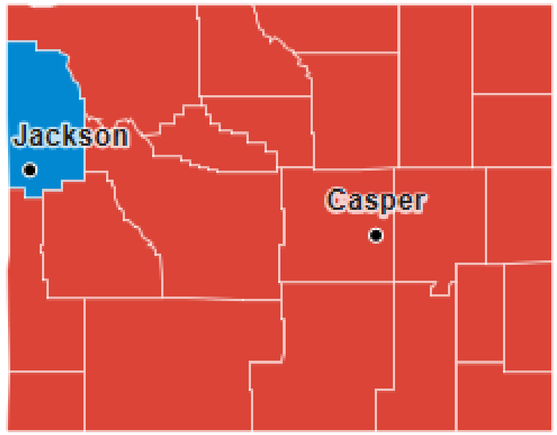
Updated Nov 13, 2016 7:22 PM MST

OVERVIEW | PRESIDENT | SENATE | HOUSE | GOVERNOR | REFERENDA

Results for
Wyoming

ALL STATES

3 electoral votes



Won

100% reporting

Votes

Donald Trump
Republican Party

70%
174,248

6. Wyoming

>2015 GDP growth: 0.4%

> 2015 GDP: $35.3 billion (2nd smallest)

> 1-yr. population change: 0.3% (19th largest increase)

> 2015 unemployment: 4.2% (13th lowest)

ARCHITECTURAL
ENGINEERING
INSTITUTE

AEI Vision

To be the worldwide resource for the advancement of the design and construction of integrated buildings.

1. Oregon

>2015 GDP growth: 4.1%

> 2015 GDP: $199.4 billion (25th largest)

> 1-yr. population change: 1.5% (9th largest increase)

> 2015 unemployment: 5.7% (17th highest)

Arch

IArch

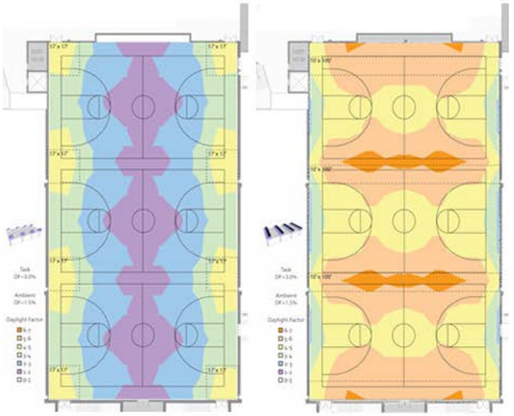
UO architecture ranked first in the nation for sustainable design education

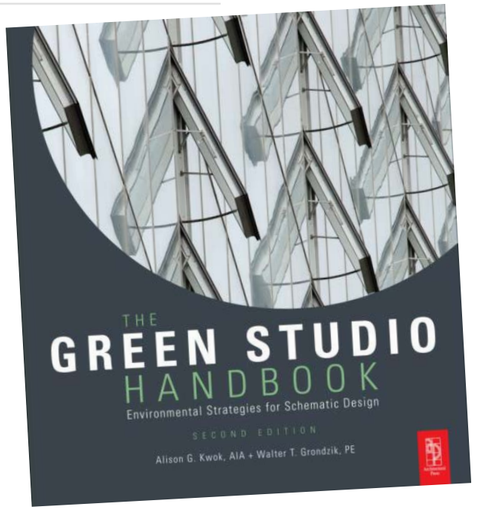
ESBL ENERGY STUDIES IN BUILDINGS LABORATORY

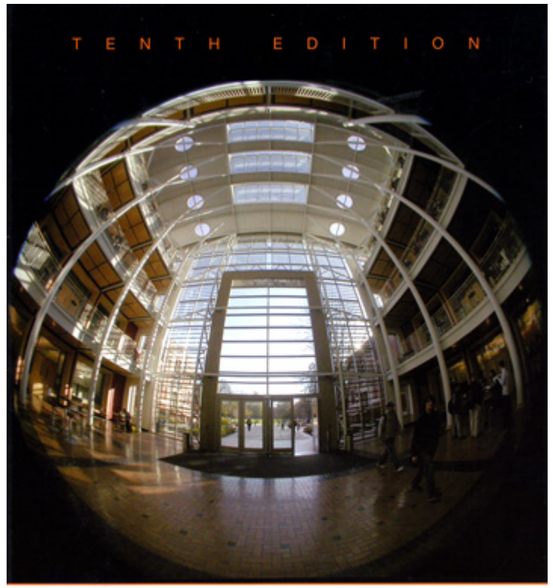
UNIVERSITY OF OREGON

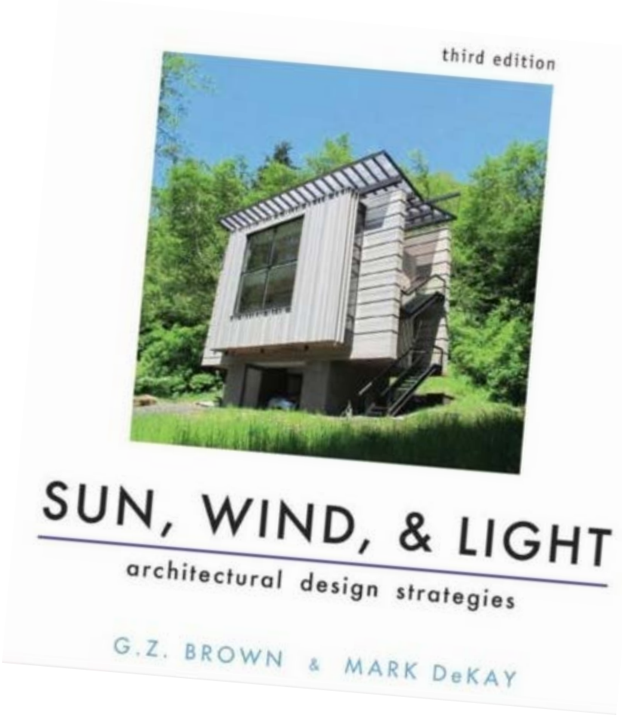
Sign in?

WHAT WE DO WHO WE ARE ALUMNI SITEMAP





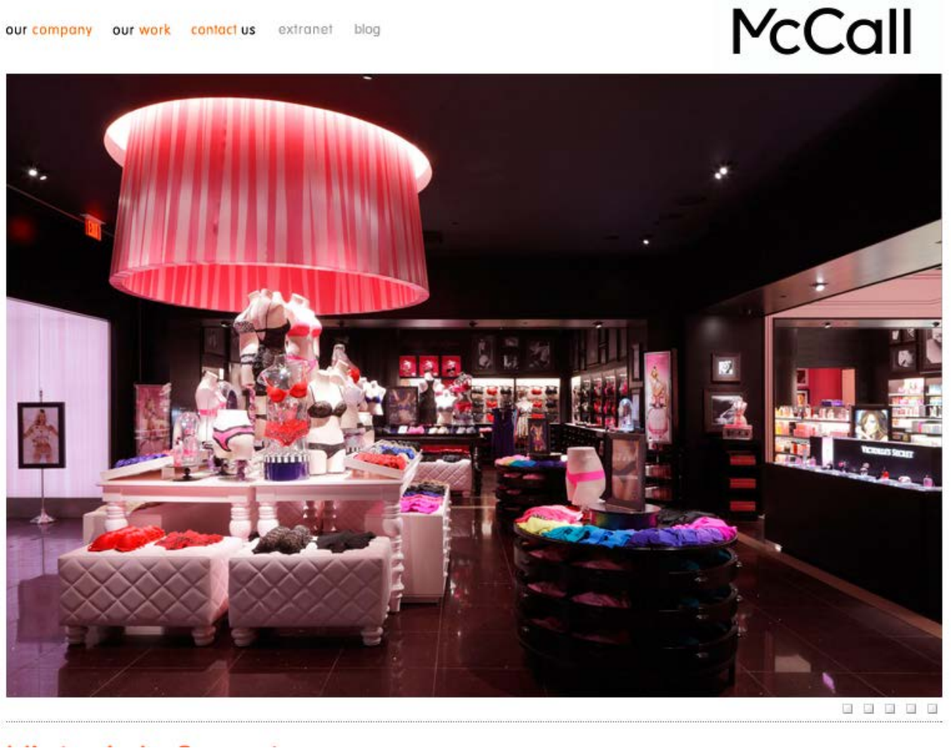




2004

M


design
collaboration
community
environment


our company
our work
contact us
extranet
blog
McCall

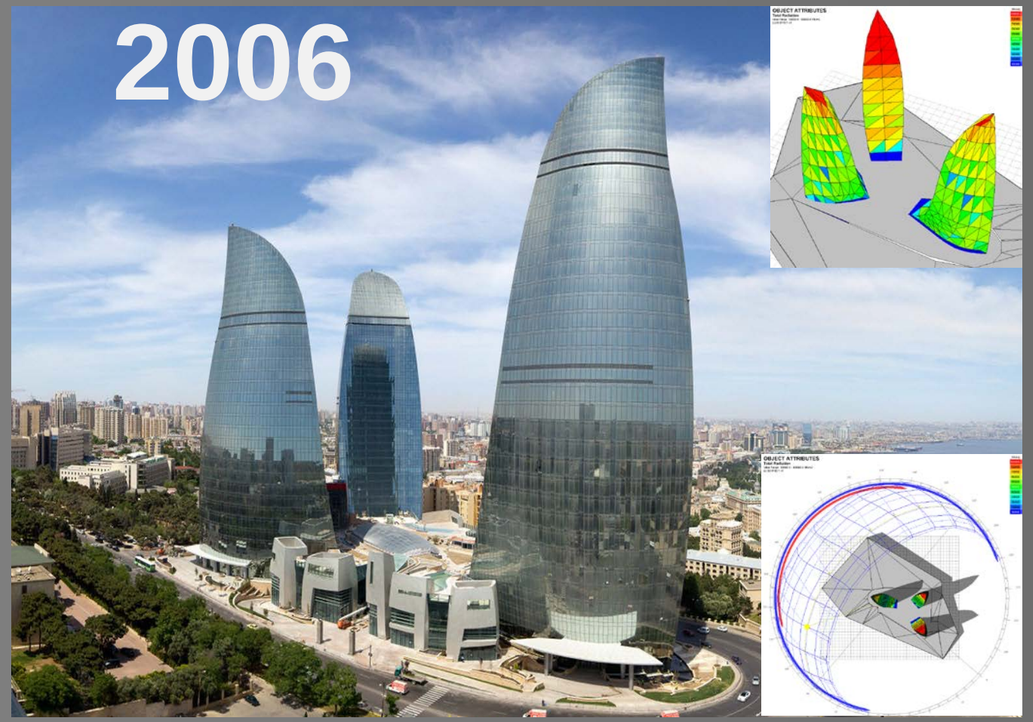
2005

SERA

2005

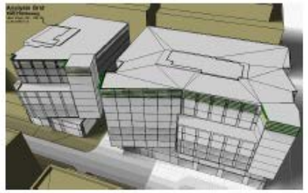
Guillotarchitectes
Paris

2006



hok

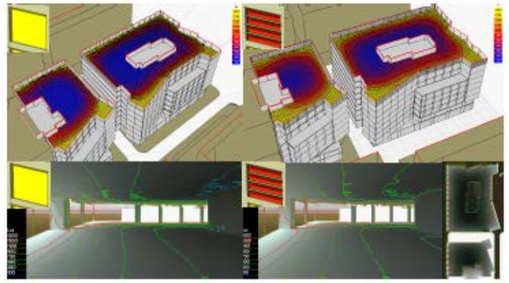
2007



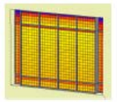
HORIZONTAL SHADING WITH PRECEDENT

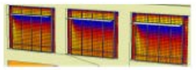
Radiation Gains During Cooling Season

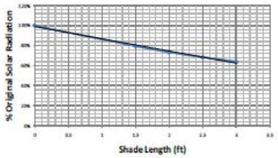
	Total Direct Radiation Wh/m2	% Improved
Base	688116	0%
Verticals	427045	38%
Horizontals	383080	44%

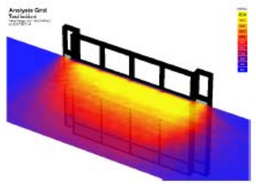


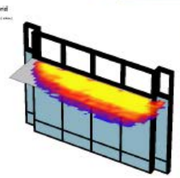
SOLAR & DAYLIGHTING



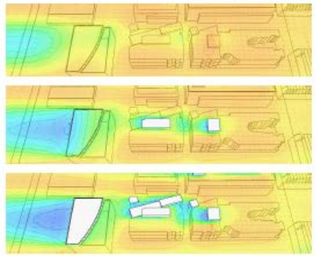


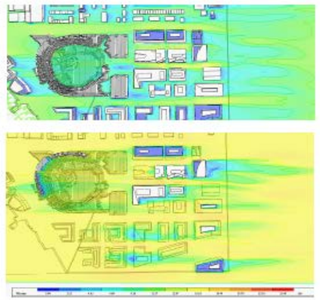






SHADING DEVICE OPTIMIZATION



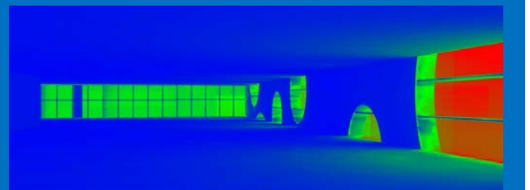


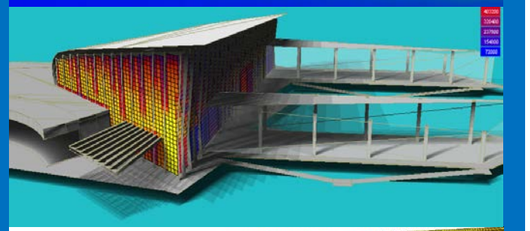
WIND FROM THE SOUTH

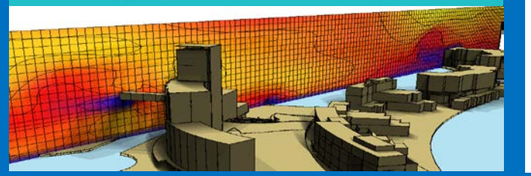
WIND POWER GENERATION

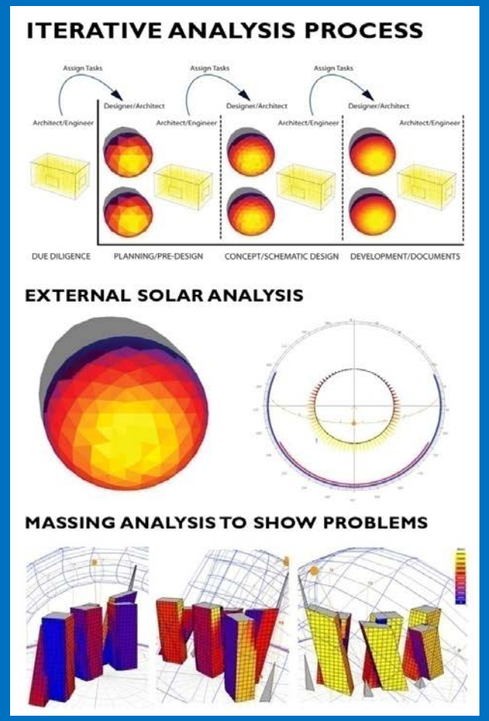
h+k

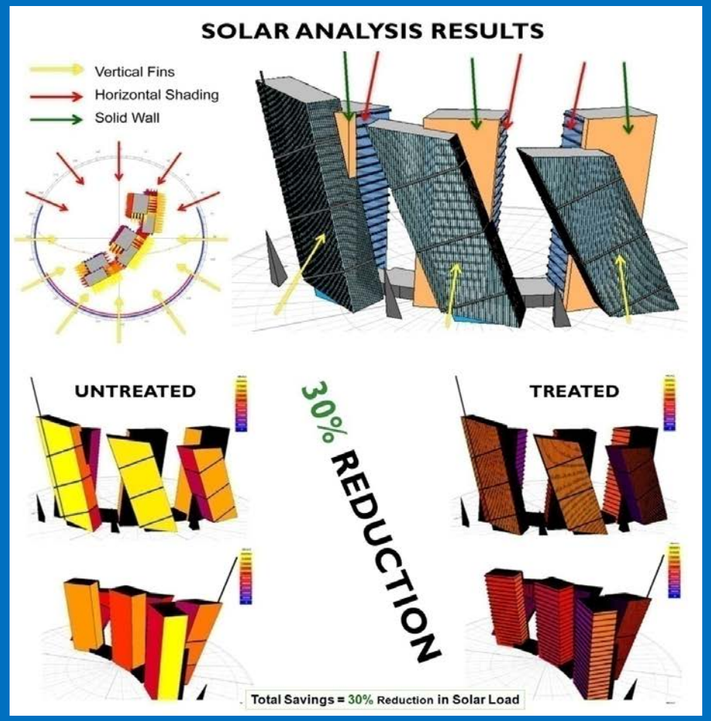
2008-9

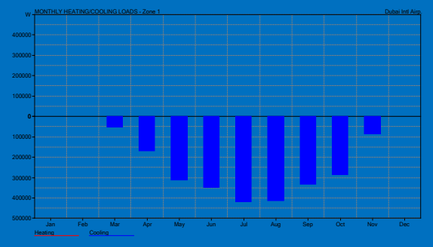




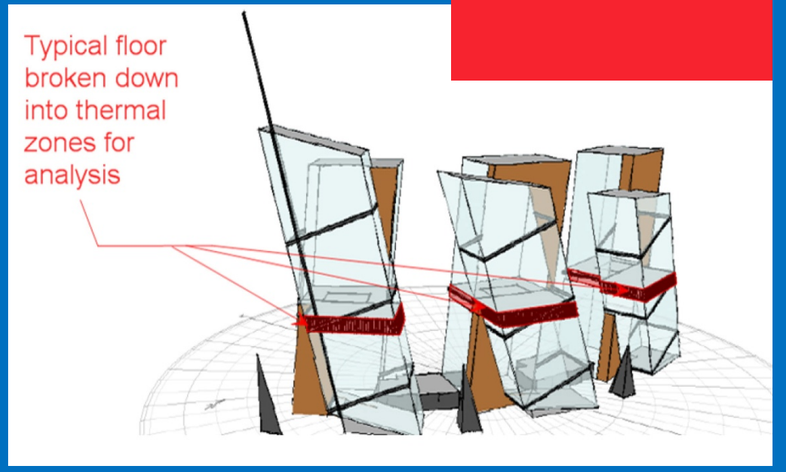



ITERATIVE ANALYSIS PROCESS
Assign Tasks
Designer/Architect
Architect/Engineer
DUE DILIGENCE
PLANNING/PRE-DESIGN
CONCEPT/SCHEMATIC DESIGN
DEVELOPMENT/DOCUMENTS
EXTERNAL SOLAR ANALYSIS
MASSING ANALYSIS TO SHOW PROBLEMS

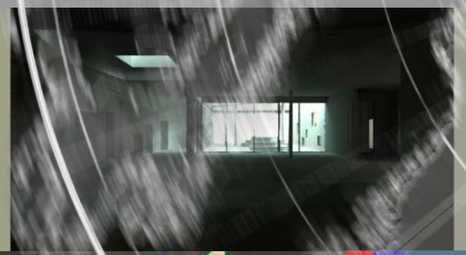

SOLAR ANALYSIS RESULTS
Vertical Fins
Horizontal Shading
Solid Wall
UNTREATED
30% REDUCTION
TREATED
Total Savings = 30% Reduction in Solar Load

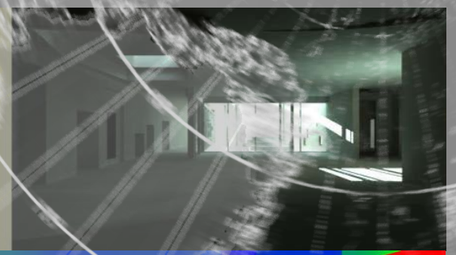

MONTHLY HEATING/COOLING LOADS - Zone 1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Heating
Cooling

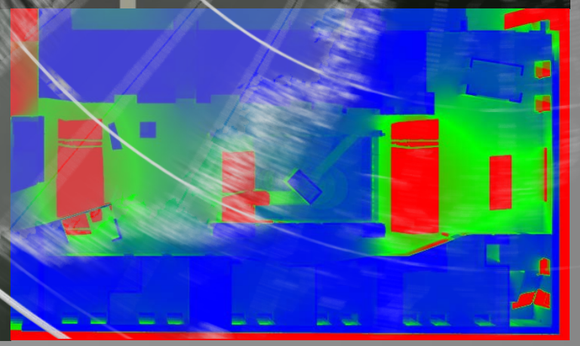
h+k

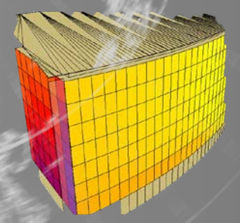

Typical floor broken down into thermal zones for analysis

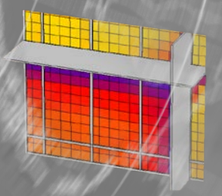
2009 - FREEFORM ENERGY

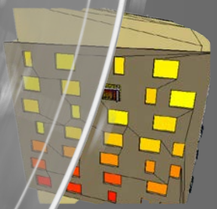


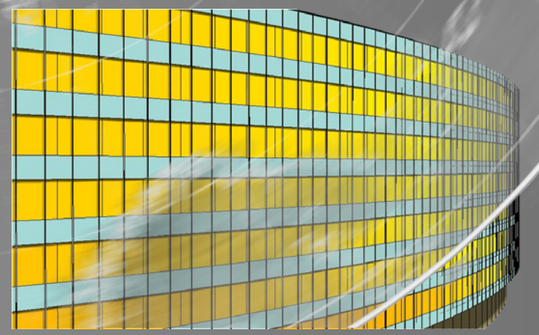


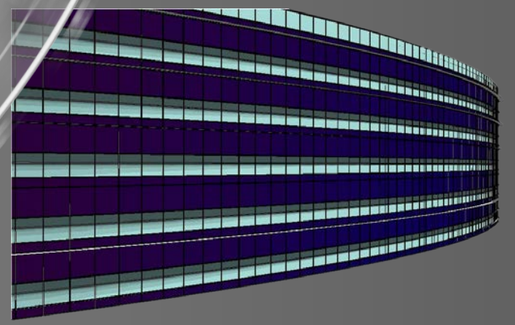












UNIVERSITY OF WYOMING

ARCHITECTURAL ENGINEERING INSTITUTE

Integrated Design Lab: Using BIM for Sustainable Design

Jon Gardzelewski
AIA LEED AP

Dear Mr. Gardzelewski:

Congratulations on receiving an Honorable Mention from the 2011 AIA TAP Building Information Model Awards Jury for the Next Level BIM: Integrated Design with BIM for Architectural Engineering Students. This is an honor certainly worth commendation, and I would like to offer you my greatest accolades.

Your willingness to document and describe your work on the Next Level BIM: Integrated Design with BIM for Architectural Engineering Students for a jury of your peers is an important aspect in advancing the relevancy of architects and architecture both here and abroad.

For further information about the official press announcement or other award recognition events, please contact the KnowledgeCommunities@aia.org.

Thank you for your participation in, and contribution to the 2011 National AIA Technology in Architectural Practice program —Again Congratulations!

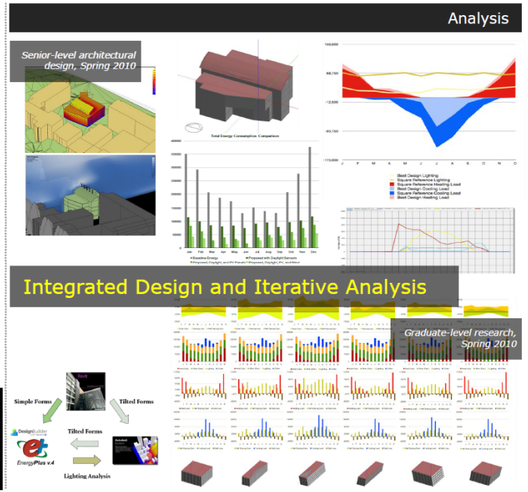
Sincerely,

Clark D. Manus, FAIA
President

It is imperative for Architecture and Engineering programs to explore methods of teaching Integrated Design due to the rapidity of change in professional practice. Clients today are demanding a level of energy efficient design that most practicing architects are incapable of fully delivering, which has prompted the need for design teams to restructure responsibilities.

In the age of BIM and sustainability, preparing students for the profession also means preparing them to upwards mentor in the areas of green building and applied software skills. But to excel as leaders in the profession, they should be able to successfully integrate iterative analysis into the design process.

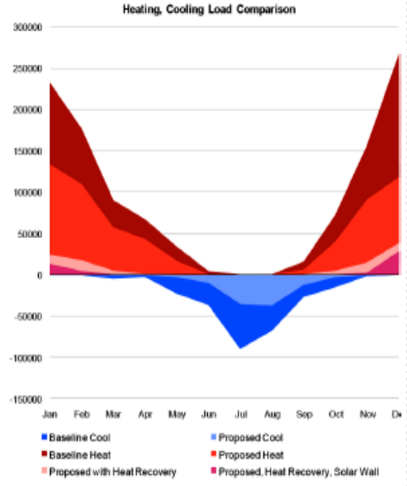
Text above excerpted from "Integrated Design Studio Utilizing a Multi-disciplinary Design Team," 2010 AECOO EcoBuild Conference.



Next Level BIM

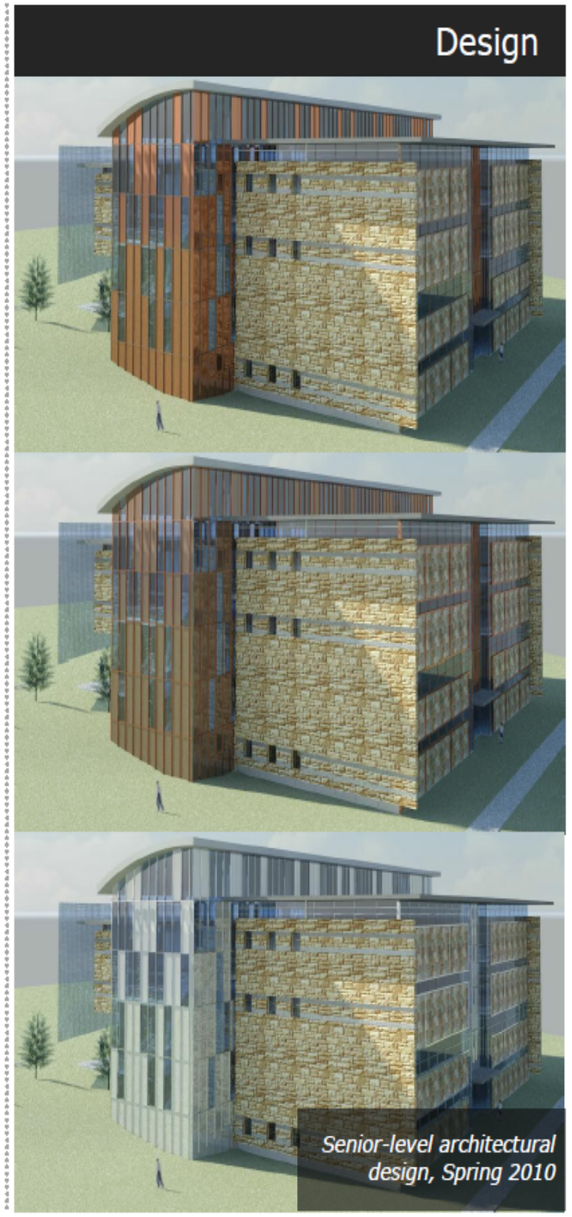
Integrated Design with BIM for Architectural Engineering Students

Several years ago when our University first experimented with Building Information Modeling we immediately saw educational advantages for architecture, engineering, and construction management. In just a few years we've become fully immersed in a BIM based curriculum, and are witnessing tremendous accomplishments: our students not only enter the workforce with a skillset advantage, but seem to have a better overall understanding of building construction, building performance, energy use, graphics, and multidisciplinary teamwork, just to name a few.



As a teaching tool, BIM is incomparable, particularly in the areas of building performance and collaborative team working. With an increasing global emphasis on Sustainability and Integrated Design, BIM has enabled us to jump out in front of other schools by linking our BIM design models to energy modeling and analysis programs. By developing iterative design-analysis requirements for our design studios, (including multi-disciplinary studios) our students gain invaluable insight into building performance fundamentals and the impacts of early design decisions on energy use and comfort.

The attached pages show a snapshot of where we are in 2011, and hopefully reveals a thorough commitment to BIM and the intention to continually push the envelope.



AEI ACADEMIC COUNCIL

SHARE

Purpose: The AEI Academic Council represents the ABET-accredited Architectural Engineering (AE) programs. The council develops, modifies, and oversees ABET program criteria and assists, consults and informs member programs. The council also informs, advises and engages outside groups on issues of collective interest to AE programs and provides guidance and support to AEI student chapters. The council works closely with the AEI Board of Governors to foster collaboration between academics and industry and to advance the AE discipline.

COMMITTEE MEMBERS

Jon Allen Gardzelewski, A.M.ASCE
Chair

Christopher J Ahern, P.E.
Member

Stuart Werner Baur, Ph.D., A.M.ASCE
Member

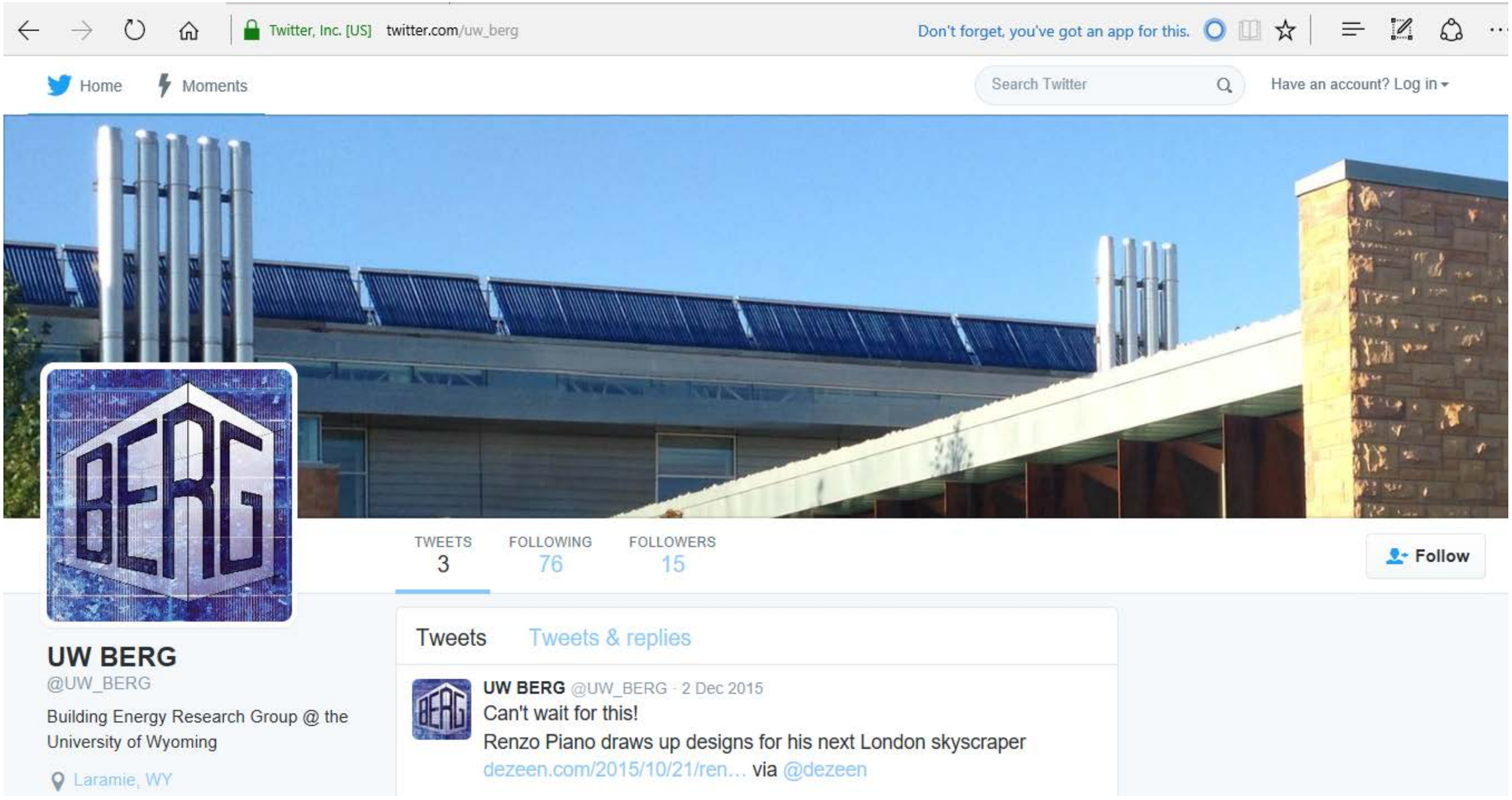
Ece Erdogmus, P.E., M.ASCE
Member

Allen C. Estes, Ph.D., P.E., F.ASCE
Member

AEI
ARCHITECTURAL
ENGINEERING
INSTITUTE

AEI Vision

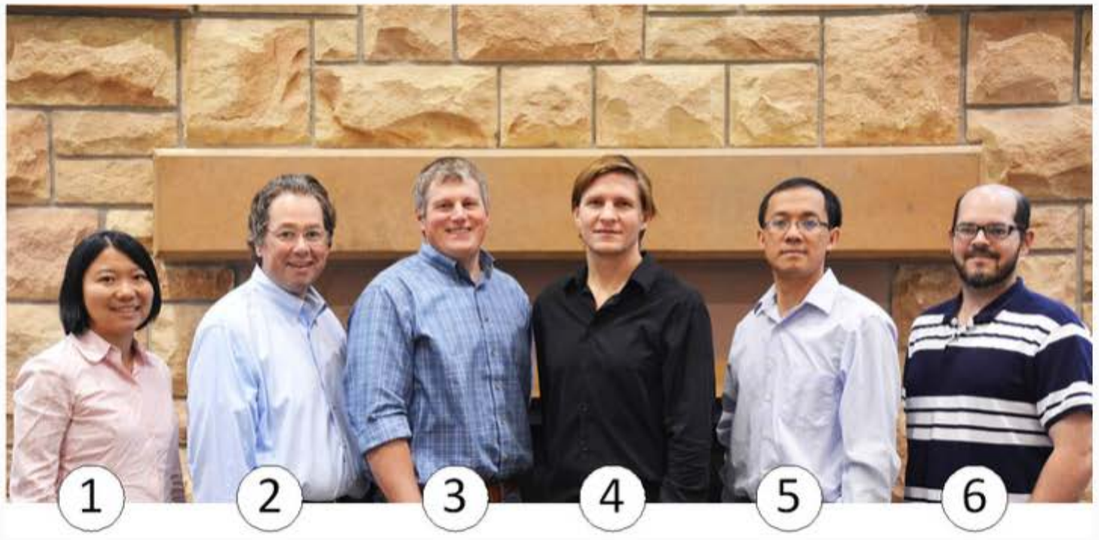
To be the worldwide resource for the advancement of the design and construction of integrated buildings.


Twitter, Inc. [US] twitter.com/uw_berg
Don't forget, you've got an app for this.
Home
Moments
Search Twitter
Have an account? Log in
BERG
TWEETS
3
FOLLOWING
76
FOLLOWERS
15
Follow
UW BERG
@UW_BERG
Building Energy Research Group @ the University of Wyoming
Laramie, WY
Tweets
Tweets & replies
UW BERG @UW_BERG · 2 Dec 2015
Can't wait for this!
Renzo Piano draws up designs for his next London skyscraper
dezeen.com/2015/10/21/ren… via @dezeen

UW BERG (@UW_BERG) | Tv | About Us — Building Er | uwberg.org/about

ABOUT

BERG, the UW Building Energy Research Group, uses faculty expertise and advanced students to improve Wyoming buildings in terms of design and energy performance. This service is aligned with UW's mission as a land-grant institution, emphasizing research, public service, and practical education.



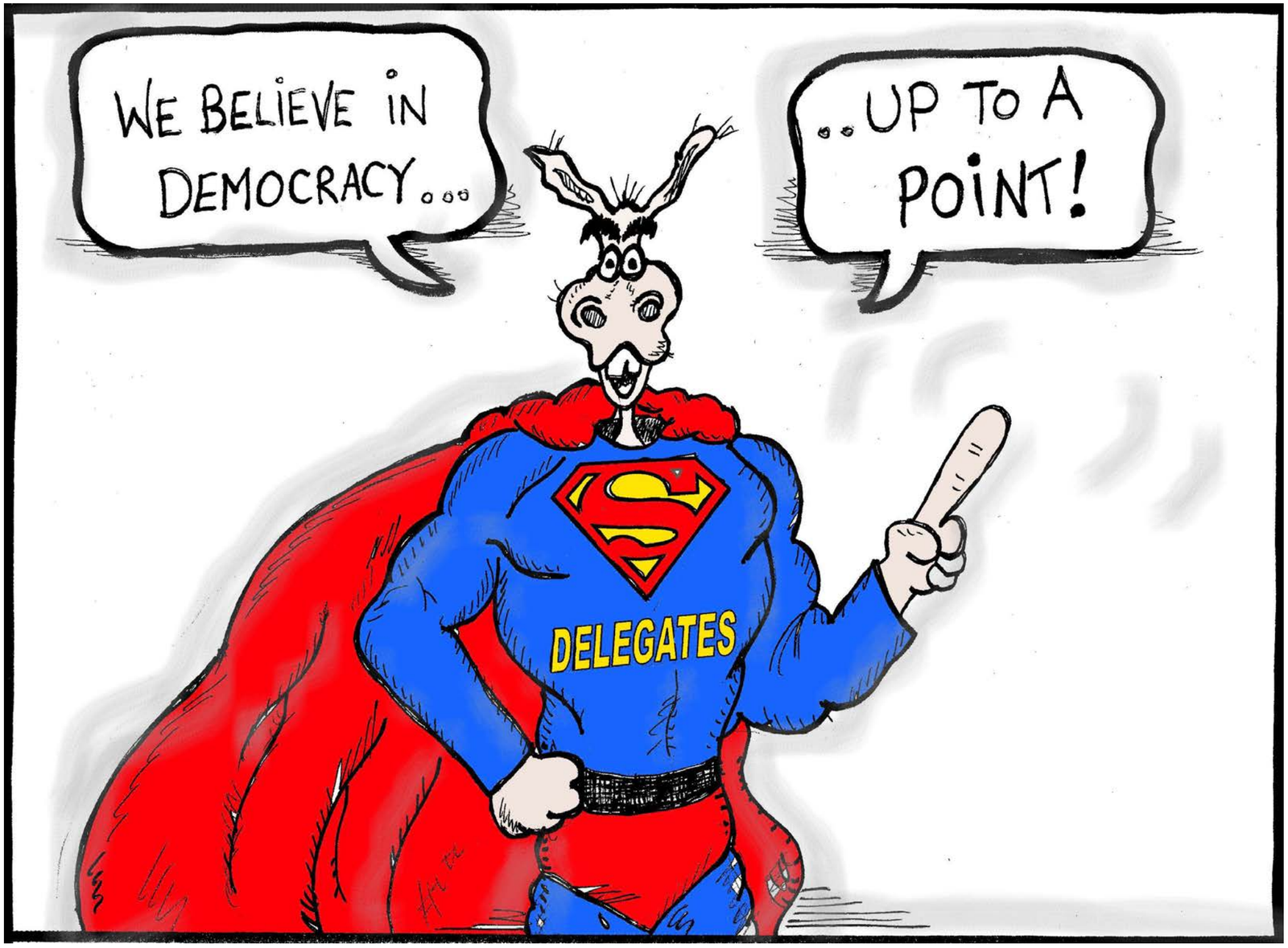
1. Liping Wang Ph.D., P.E.

Liping is Assistant Professor of Architectural Engineering, with expertise in: Energy systems design; Building energy simulation and model calibration; Commissioning; Fault detection, Control sequence modeling, and

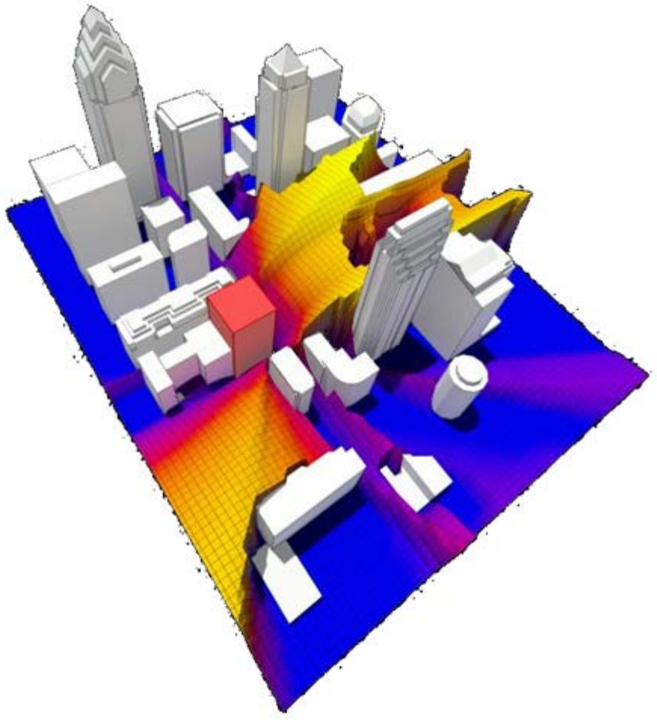
Ask me anything

4:55 AM
11/13/2016


VISIT CHEYENNE
Bernie


WE BELIEVE IN DEMOCRACY...
..UP TO A POINT!
DELEGATES

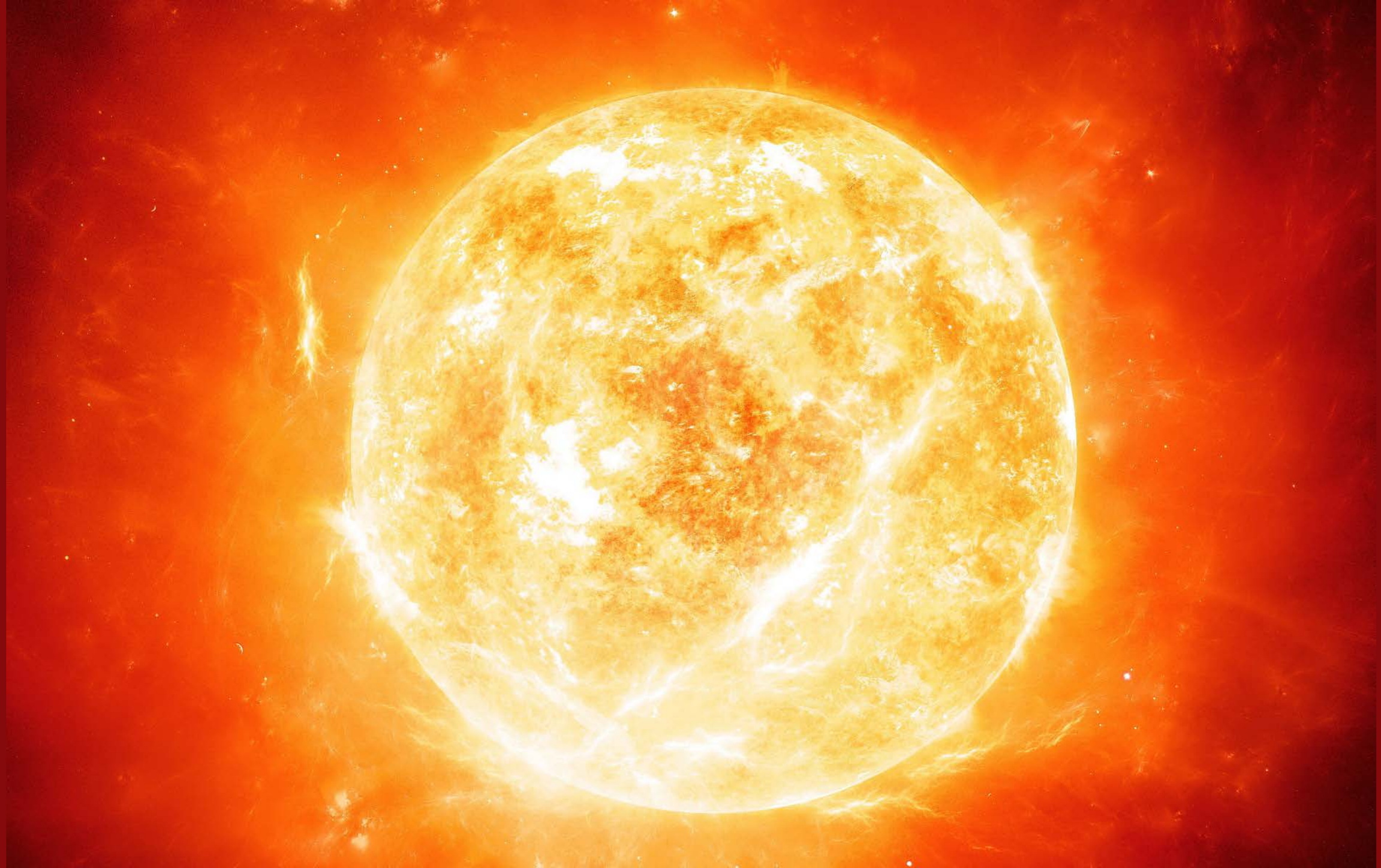
Curious **Solve Problems** **Create** **Teach**

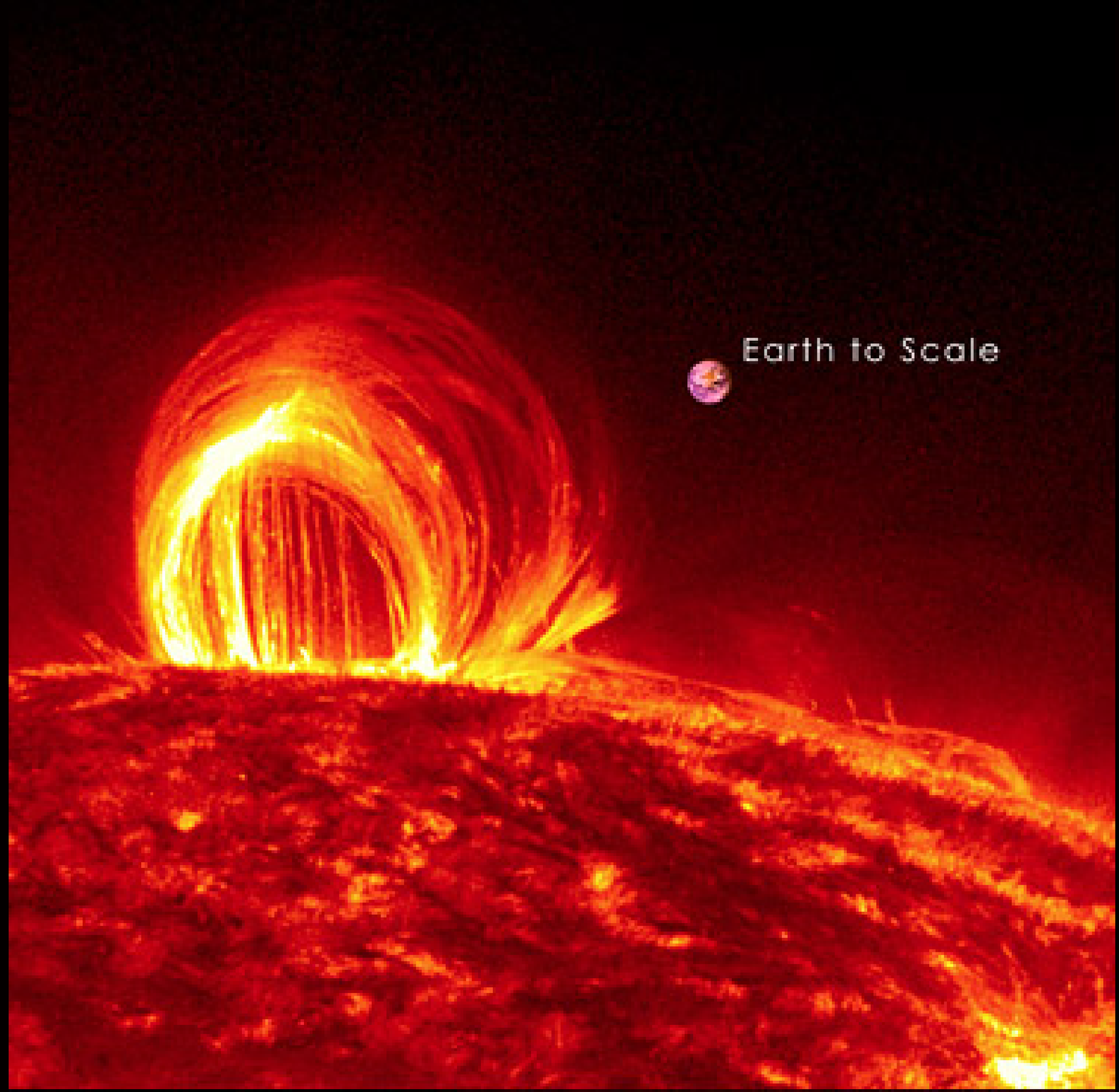


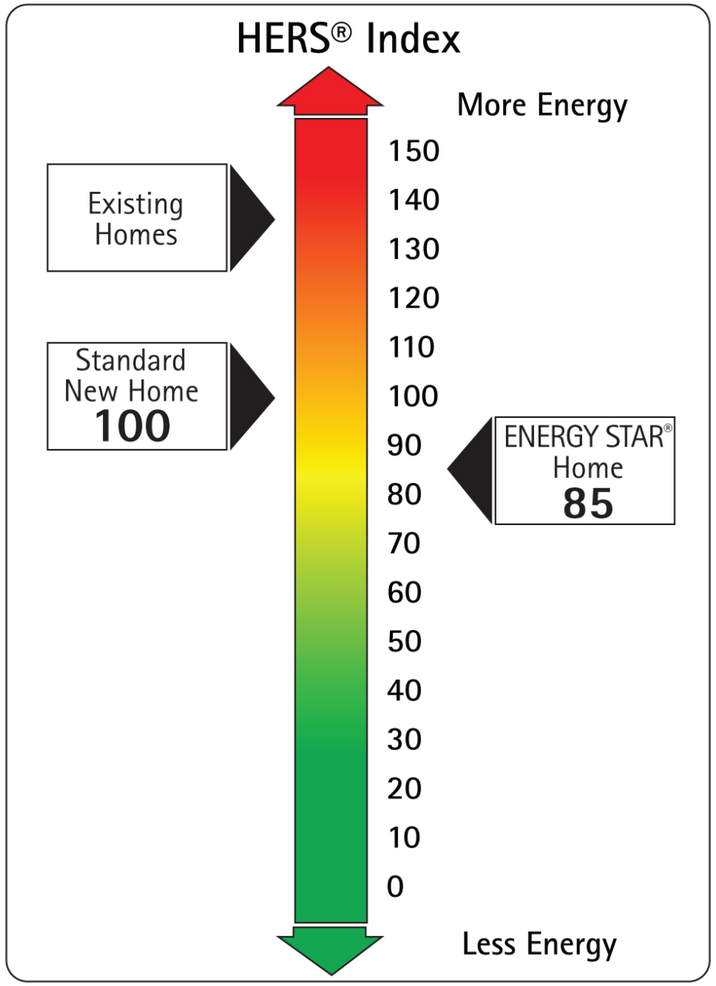
NETZERO
ENERGY BUILDING
CERTIFICATION℠

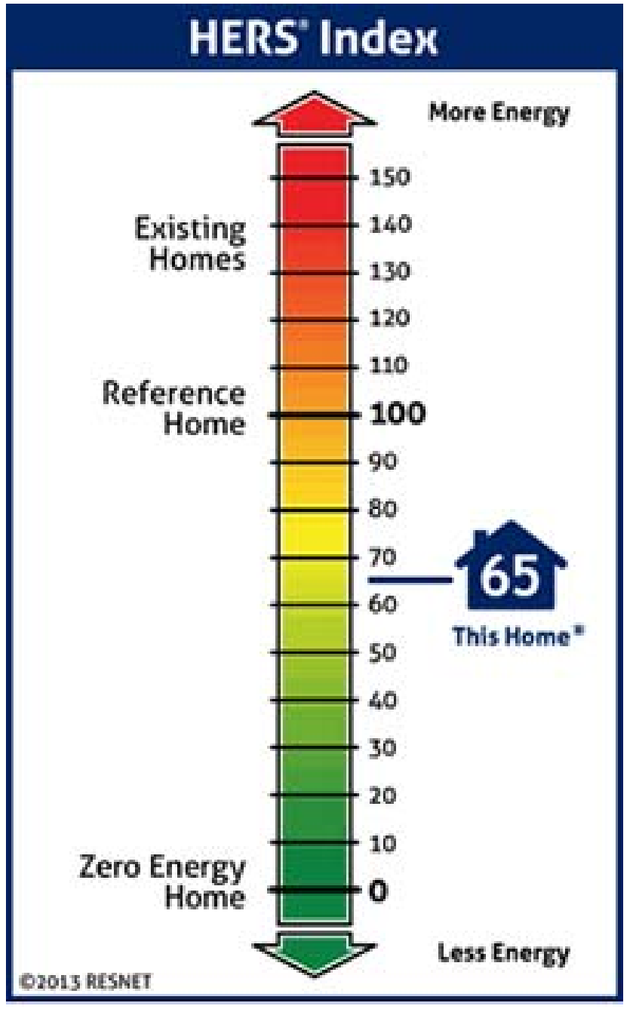
Zero Energy

Zero Energy or Net Zero or Net Positive




Earth to Scale


HERS® Index
More Energy
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Less Energy
Existing Homes
Standard New Home 100
ENERGY STAR® Home 85


HERS® Index
More Energy
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Less Energy
Existing Homes
Reference Home
Zero Energy Home
65
This Home*
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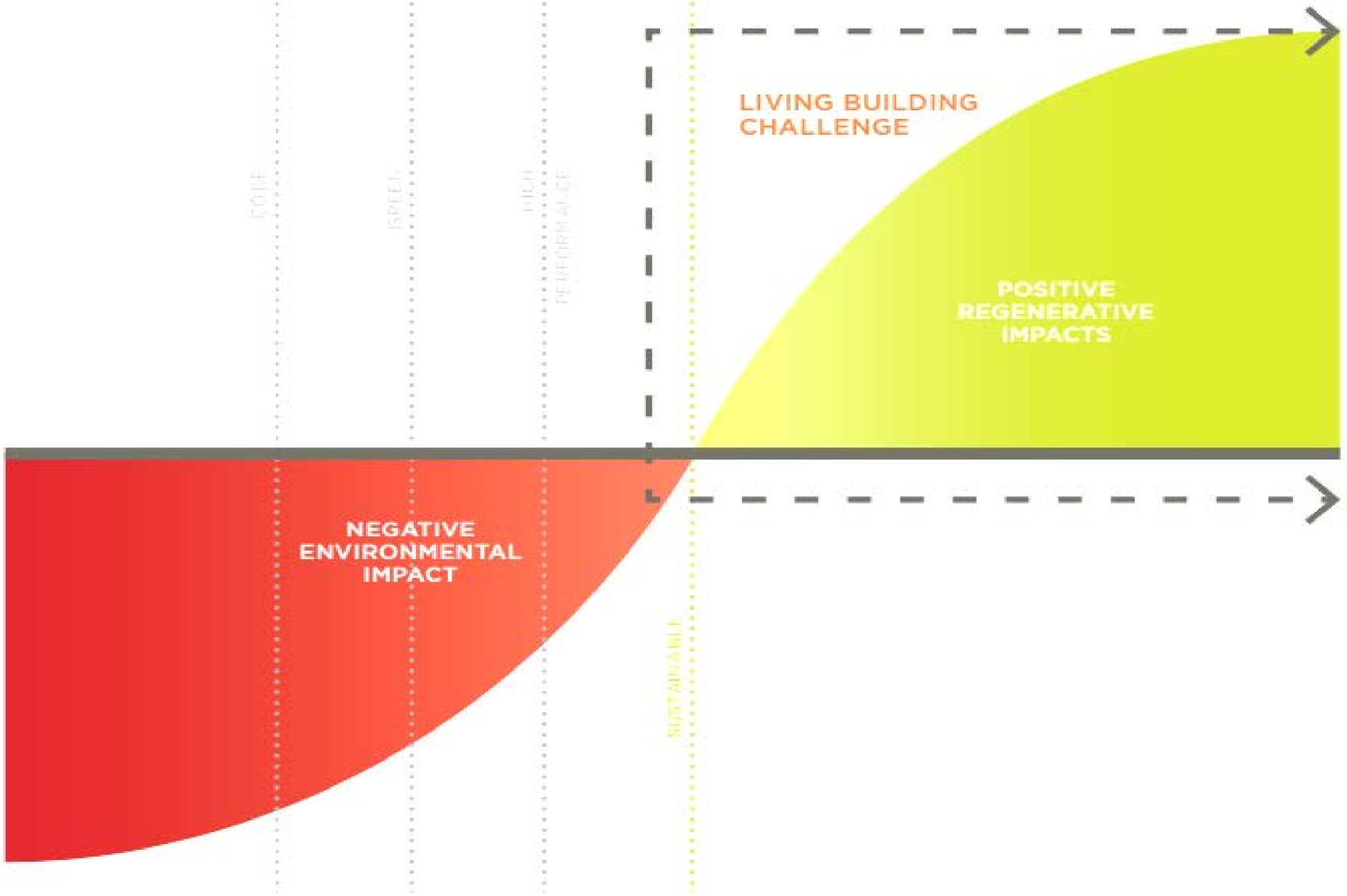
INTERNATIONAL LIVING FUTURE INSTITUTE

ABOUT PROGRAMS GET INVOLVED TRIM TAB EDUCATION EVENTS BOOKSTORE

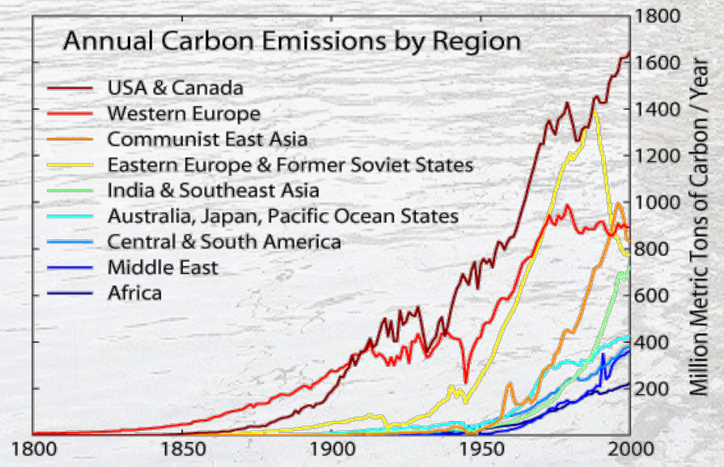
Net Zero Energy Building Certification

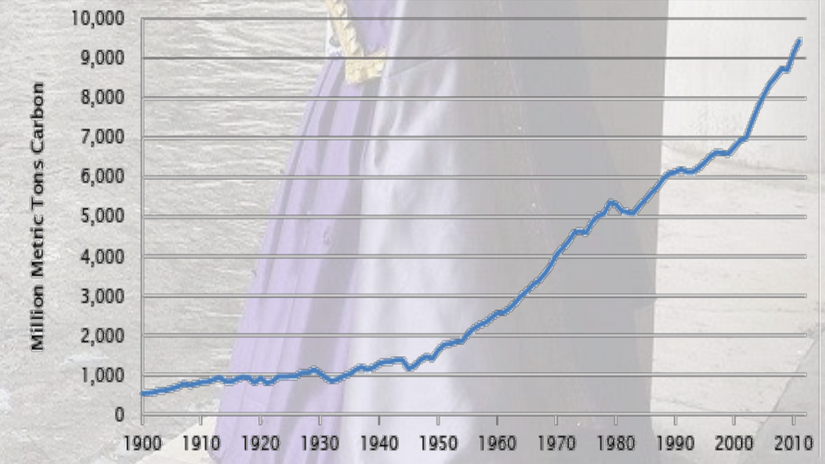
Whether on the boards, under construction or already in use, Living Building Challenge can put a spotlight on your Net Zero Energy Building.

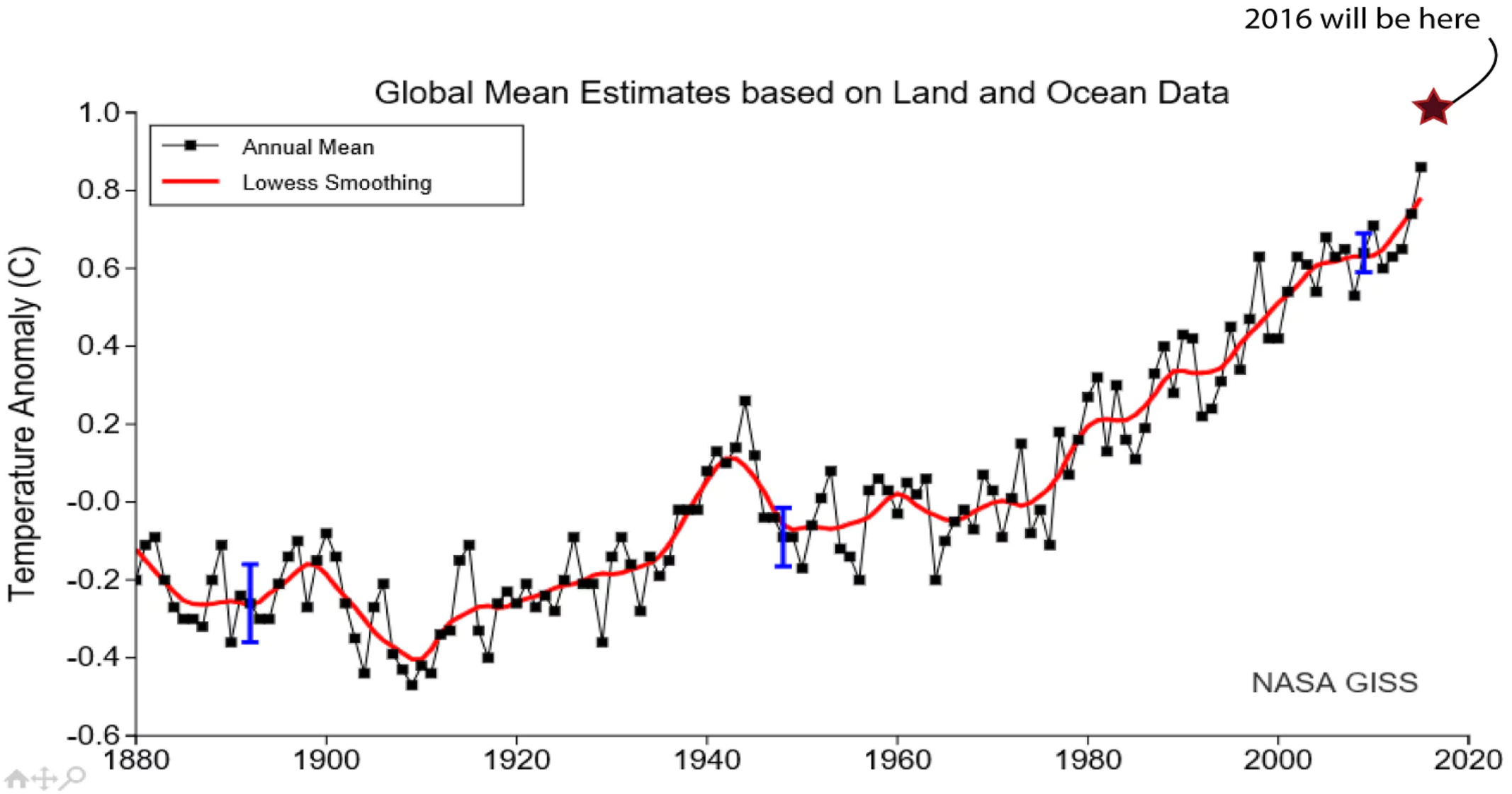
Net Zero Energy Building Certification


LIVING BUILDING
CHALLENGE
POSITIVE
REGENERATIVE
IMPACTS
NEGATIVE
ENVIRONMENTAL
IMPACT

Science: Everything is Rising!



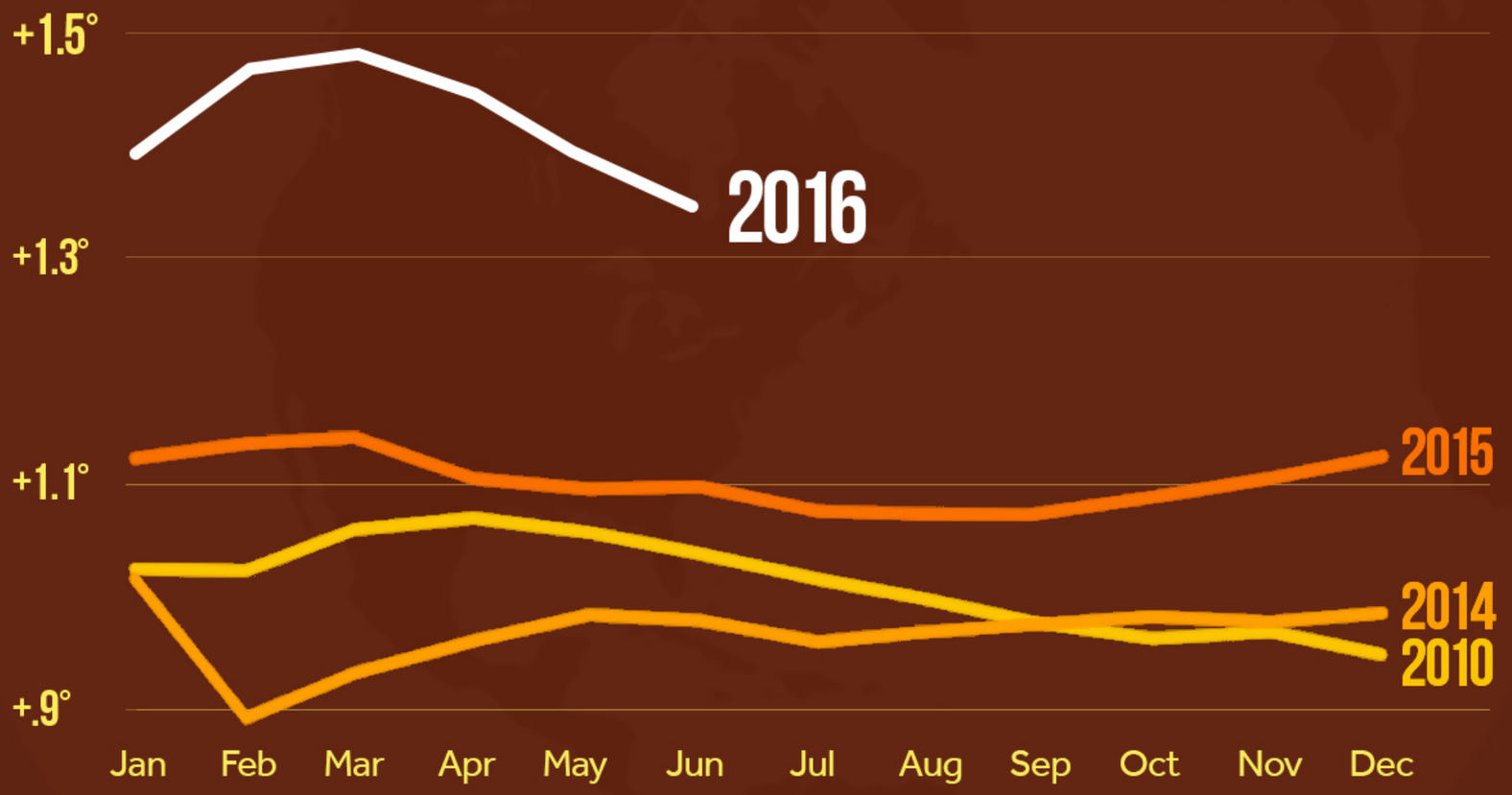




Estimate made on October 6, 2016 (J.P. Abraham)

Blowing Away Heat Records

Global Year-to-Date Anomalies From 1881-1910



Source: NASA GISS and NOAA NCEI global temperature data averaged and adjusted to early industrial baseline (1881-1910). Data as of July 2016.

CLIMATE CENTRAL

We have to talk about Trump

UW BERG (@UW_BERG) | Tv | 'Complete insanity' to p

cbc.ca/news/politics/trump-environment-energy-ambrose-1.3845889

CBC news | Politics

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'Complete insanity' to pursue carbon tax now that Trump will be president, says Ambrose

Trudeau says 'you cannot separate a strong economy from a sustainable environment'

By Peter Zimonjic, CBC News Posted: Nov 10, 2016 3:56 PM ET | Last Updated: Nov 12, 2016 3:51 PM ET

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Ask me anything

2:55 AM 11/13/2016

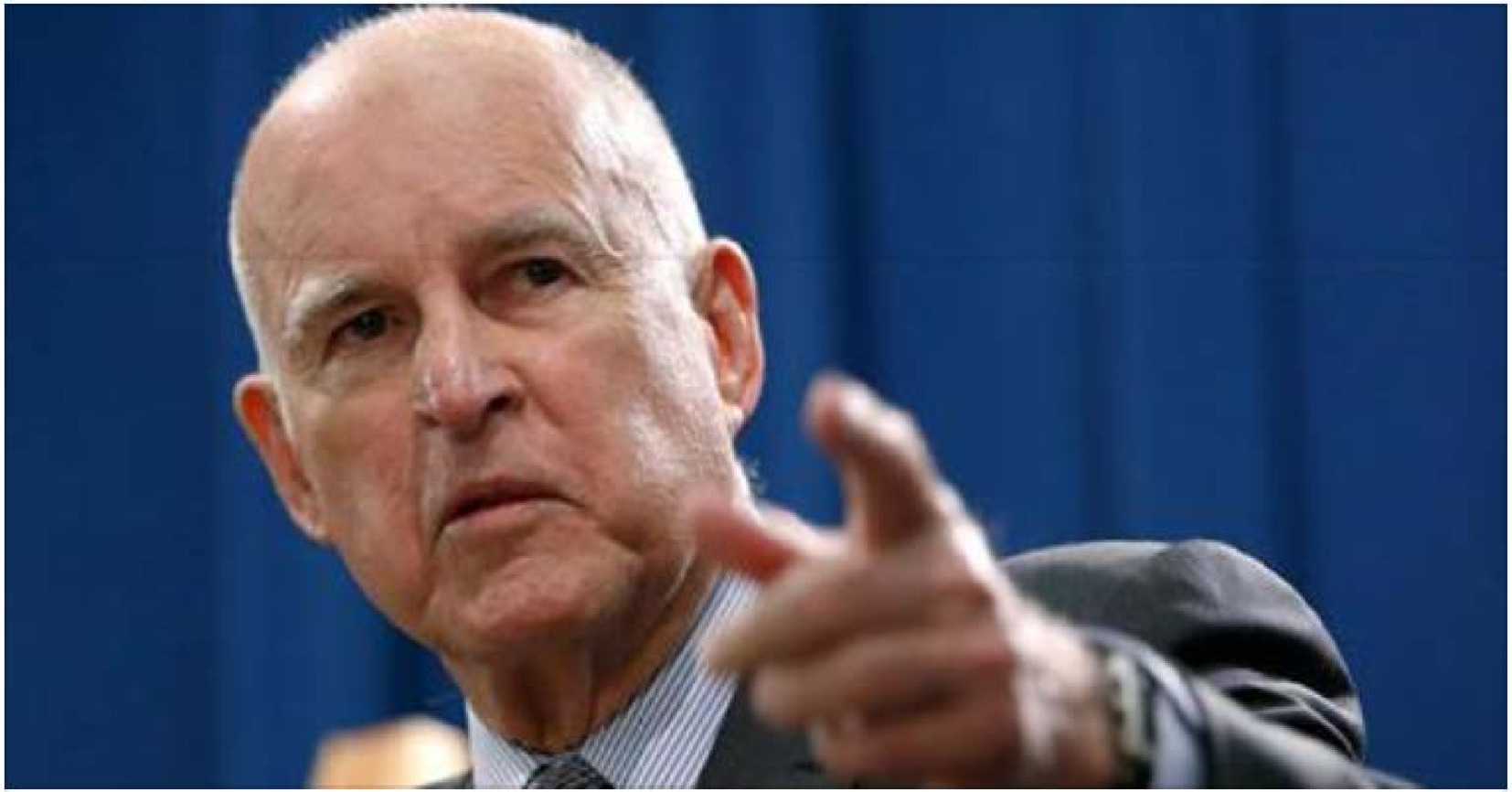
Prime Minister Justin Trudeau appeared unwilling to budge from his plan to put a price on carbon Thursday, saying

"you cannot separate a strong economy from a sustainable environment."

Canada not ready for catastrophic effects of climate change, report warns

Are Canadian provinces prepared for the next major flood or wildfire? A new report suggests provinces are ill-prepared to handle the devastating effects of extreme weather.

GLOBALNEWS.CA | BY ANDREW RUSSELL



Gov. Jerry Brown warns Trump that California won't back down on climate change


NOT REPEALING OBAMACARE, SUPPORT FOR LGBT RIGHTS,
NOT JAILING HILLARY, PROGRESSIVE STUDENT LOAN DEBT POLICY,
NOT BANNING MUSLIM IMMIGRANTS....
Gotcha Suckers

How do we move forward?!?!

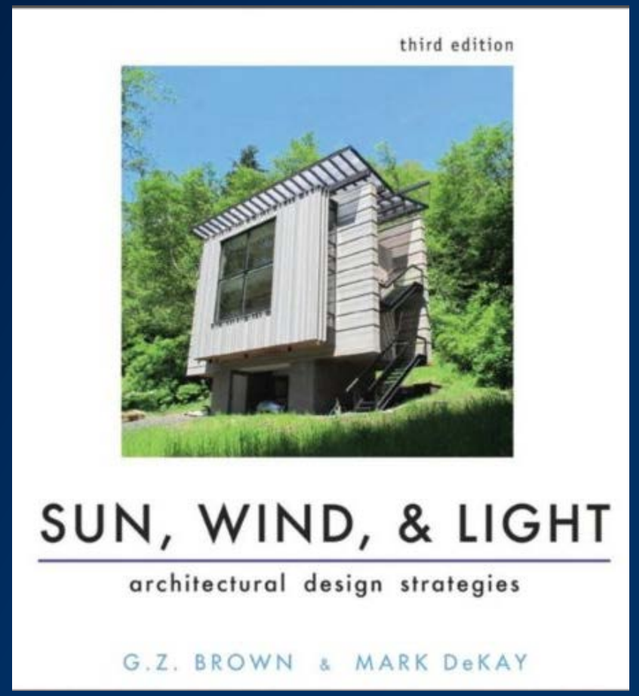
It’s the economy, stupid

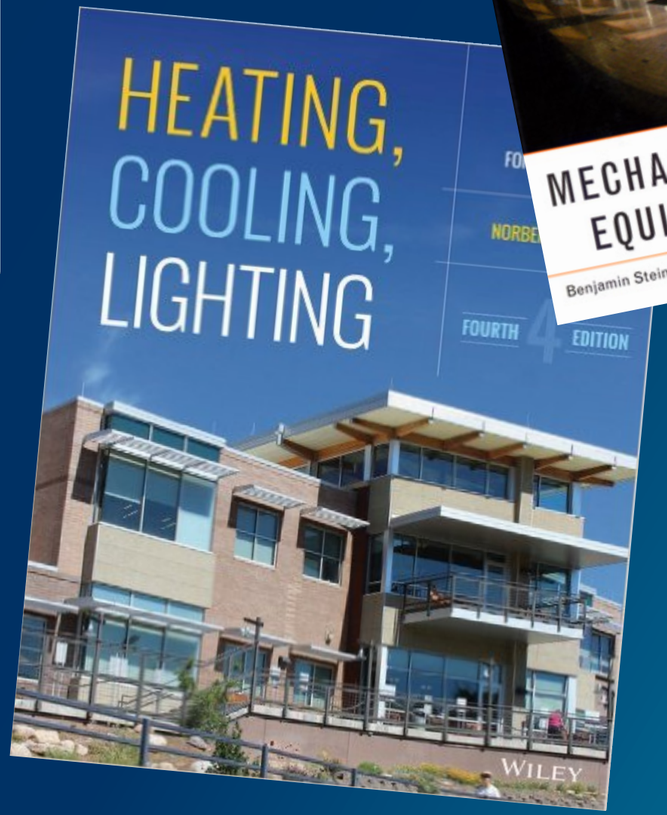
Must Convince

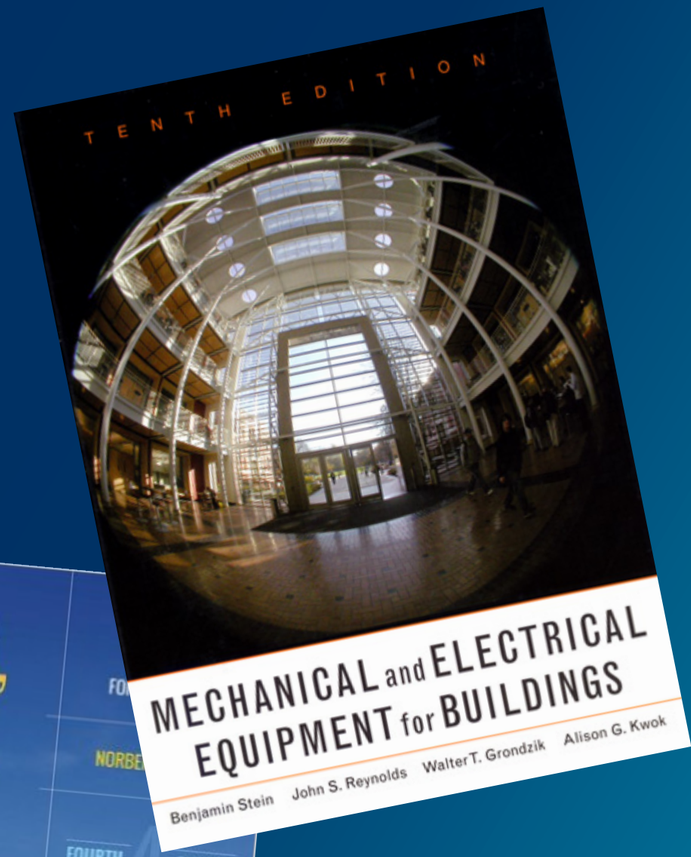

7BILLION
ON 31 OCTO 2011, WORLD POPULATION WILL REACH 7 BILLION. JOIN A GLOBA T FOR ALL HUMANITY.
7 BILLION ACTIO
www.7BillionActions.org
UNFPA United Nations Population Fund

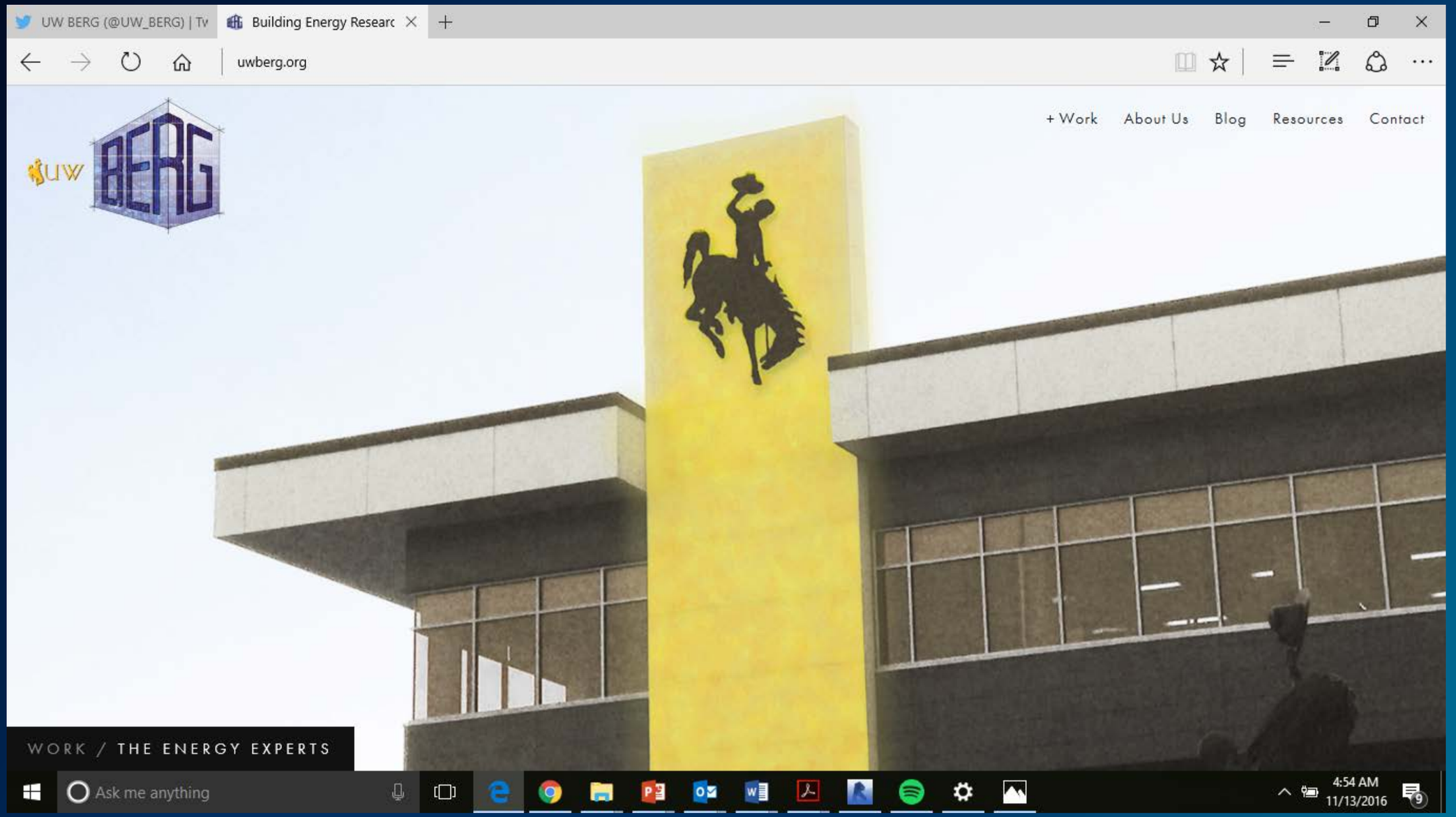

Just keep swimming.


THE
GREEN STUDIO
HANDBOOK
Environmental Strategies for Schematic Design
SECOND EDITION
Alison G. Kwok, AIA + Walter T. Grondzik, PE


third edition
SUN, WIND, & LIGHT
architectural design strategies
G.Z. BROWN & MARK DeKAY


HEATING,
COOLING,
LIGHTING
FOURTH 4 EDITION
WILEY


TENTH EDITION
MECHANICAL and ELECTRICAL
EQUIPMENT for BUILDINGS
Benjamin Stein John S. Reynolds Walter T. Grondzik Alison G. Kwok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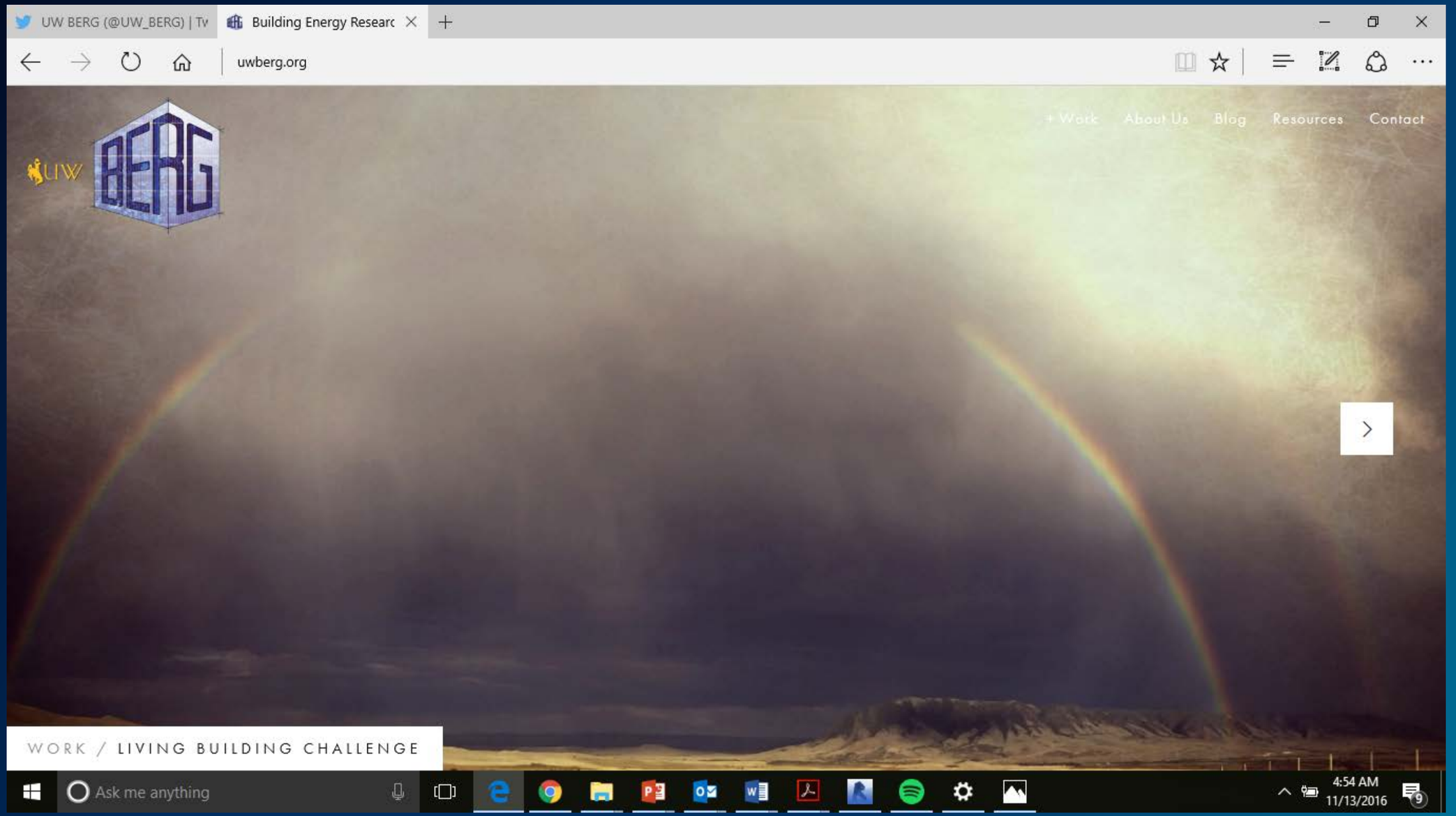
11/13/2016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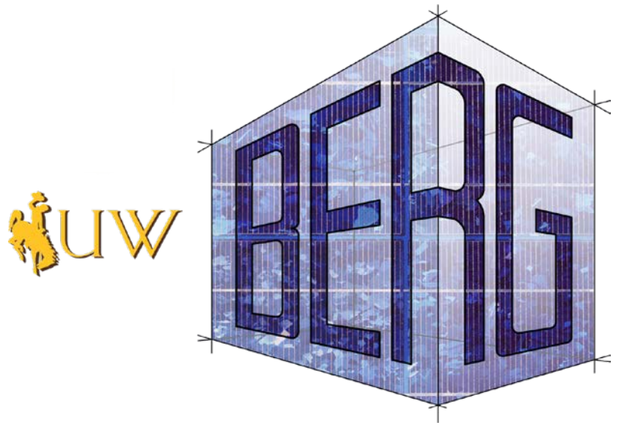
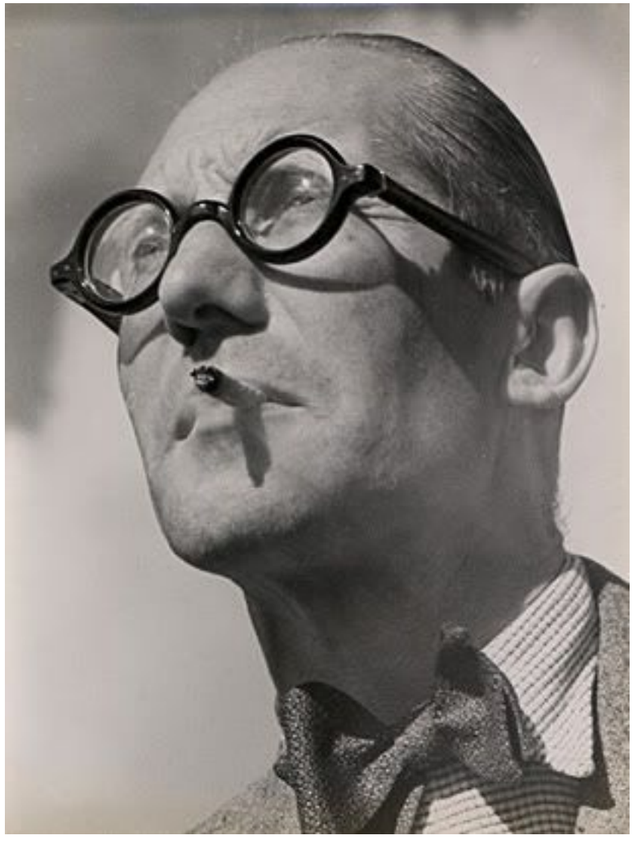
Just keep swimming.

UW

Solving the big problems



Architecture and Aesthetics



Instant Architect

Instruction:

1. Cut out pieces
2. Attach Tab A to B
3. Wa-Lah!

Entrepreneurs as Architects


REVENGE
OF THE
ELECTRIC CAR


Tuscan Glass Tile
Slate Glass Tile
Textured Glass Tile
Smooth Glass Tile

Bloomberg L.P. [US] bloomberg.com/news/articles/2016-10-31/no-one-saw-tesla-s-solar-roof-coming

BloombergTechnology | No One Saw Tesla's Solar Roof Coming

No One Saw Tesla's Solar Roof Coming

Elon Musk just showed us the grand unification of Tesla: Fast cars, big batteries, and a stunning solar rooftop.

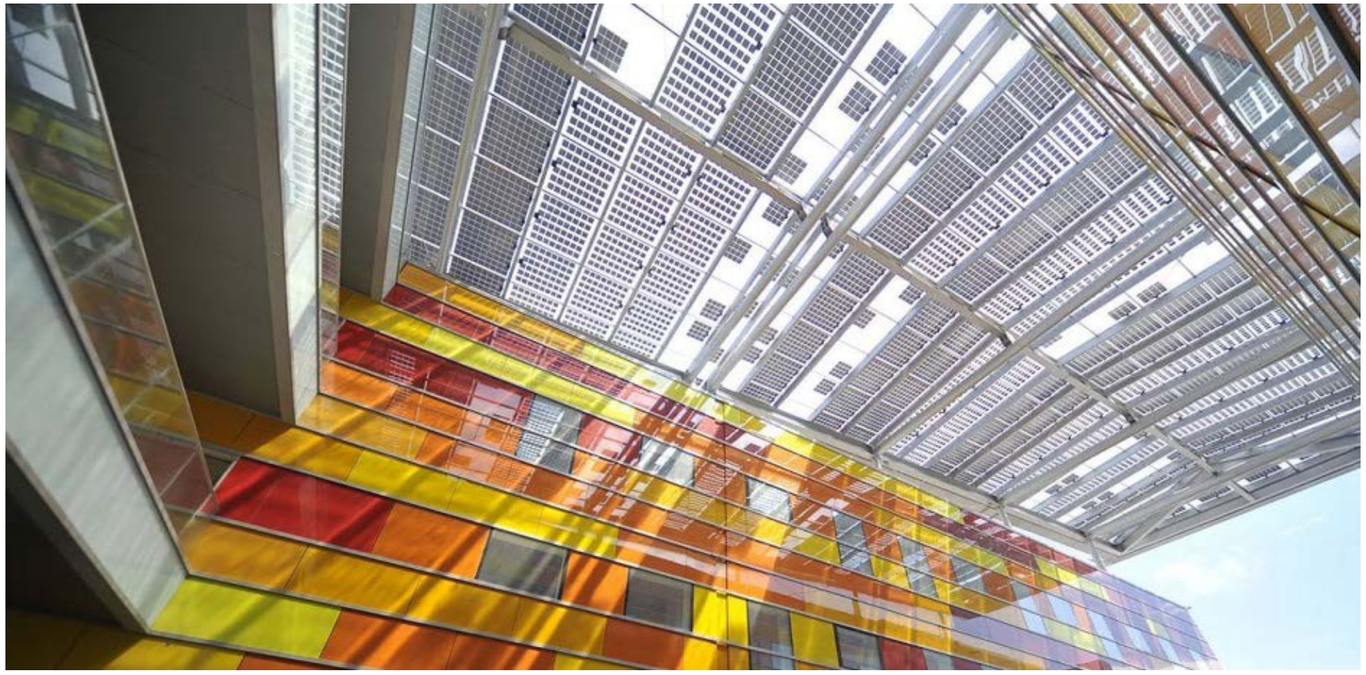
by **Tom Randall**
October 31, 2016 — 3:00 AM EDT *Updated on* October 31, 2016 — 3:15 AM EDT

Werner Sobek– Effizienzhaus Plus

Building-Integrated Photovoltaics (BIPV)

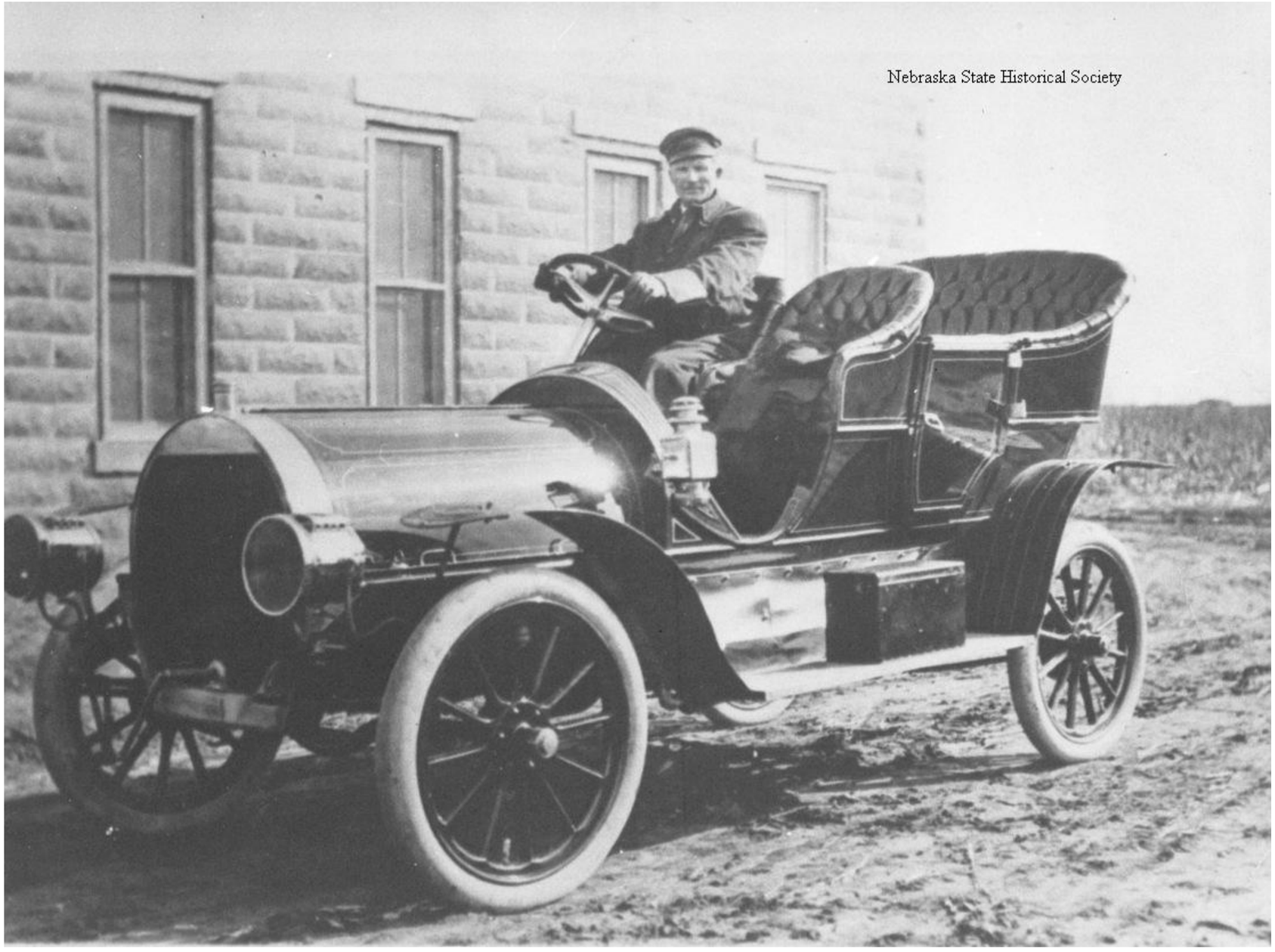

onyx


Genyo
Pfizer




Google earth


ZEN


Nebraska State Historical Society

Someone must step forward and solve this

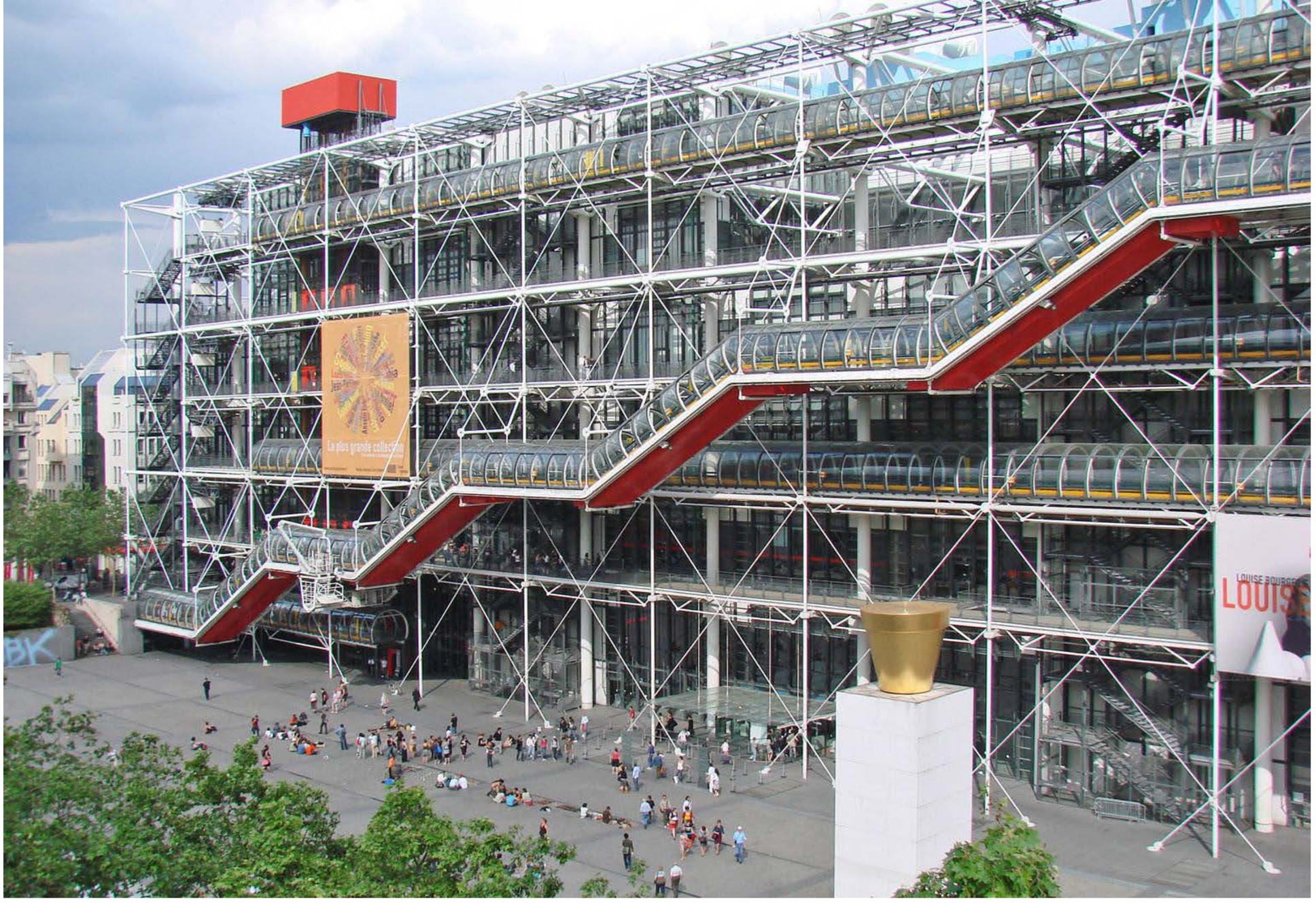
Students…. Solar Decathlon

Architecturally Integrated Taxonomy

- **Legibility**
- **Material Planes**
- **Form Follows**
- **Shading**
- **Disguise**
- **Undesigned**

Architecturally Integrated Taxonomy

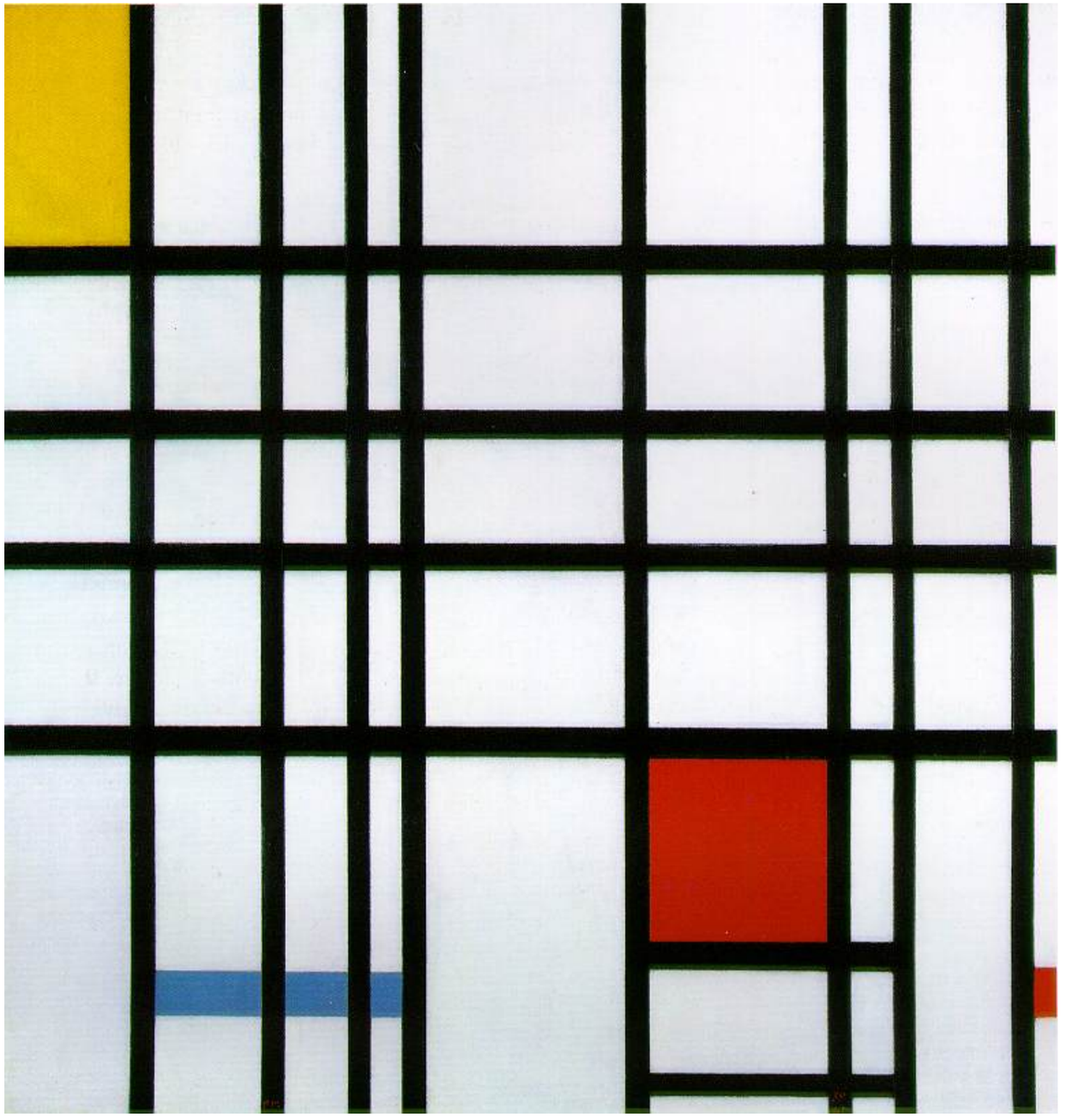
Legibility—From High-tech Modernism, revealing and celebrating building systems. The downside of this strategy is that the house may look industrial rather than residential in terms of popular tastes and the norms of the real estate industry.


La plus grande collection
LOUISE BOURGEOIS

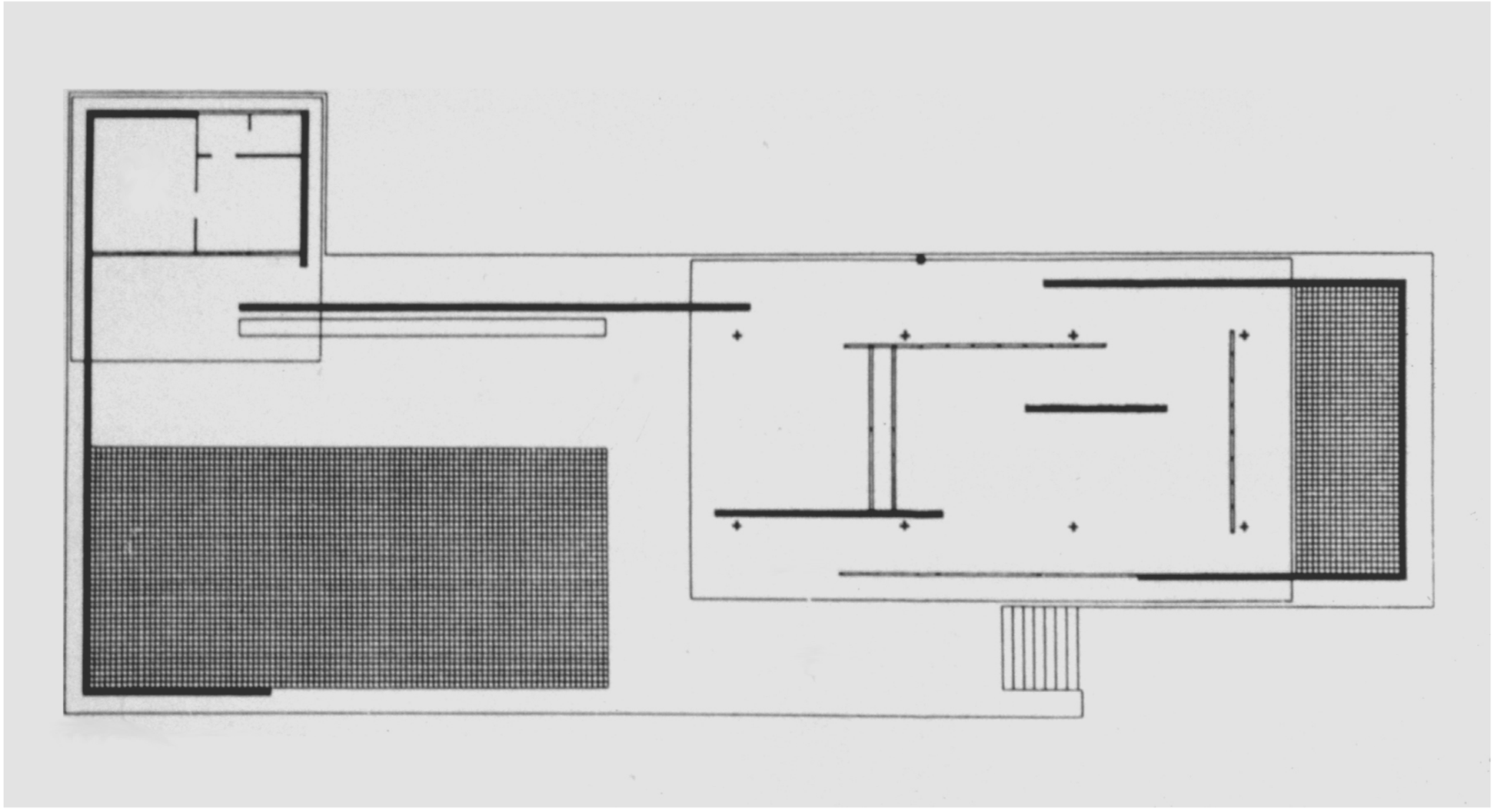
Architecturally Integrated Taxonomy

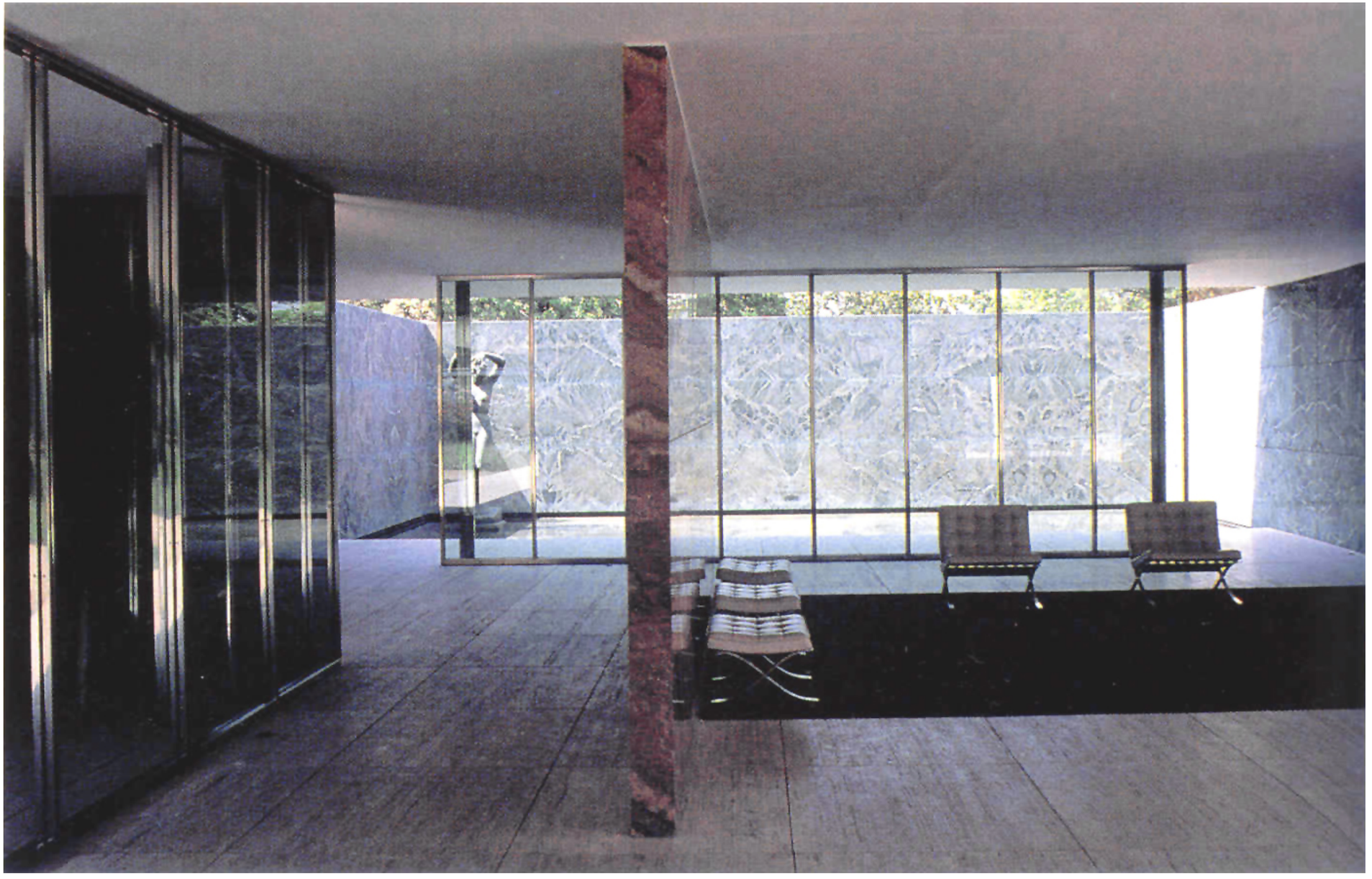
Material Planes—From early Modernism, composing in planes, often to emphasize or celebrate the “richness” of a material, and often achieving a lightweight or floating visual effect.

Gerritt Rietveld, Schroeder House (1924-25)



Mies van der Rohe, Barcelona Pavilion (1929)





Architecturally Integrated Taxonomy

Form Follows—From the Modernist phrase “form follows function,” the building form adapts to the need for a large area of PV panels facing south.

Architecturally Integrated Taxonomy

Shading—The PV panels also provide shading for the building or an outdoor space.

Disguise—The PV panels are hidden through either a compositional strategy or a technological innovation (PV embedded glass, etc). This includes a flat roof with a parapet to hide the panels.

Undesigned—The PV is applied after-the-fact to a predetermined form

Name the Approach

Legibility—From High-tech Modernism, revealing and celebrating building systems. The downside of this strategy is that the house may look industrial rather than residential in terms of popular tastes and the norms of the real estate industry.

Material Planes—From early Modernism, composing in planes, often to emphasize or celebrate the "richness" of a material, and often achieving a lightweight or floating visual effect.

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Shading—The PV panels also provide shading for the building or an outdoor space.

Disguise—The PV panels are hidden through either a compositional strategy or a technological innovation (PV embedded glass, etc). This includes a flat roof with a parapet to hide the panels.

Undesigned—The PV is applied after-the-fact to a predetermined form


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Opportunities?

Nope

Nope

Yep

See it?


OLD CORRAL
HOTEL&RESTAURANT


STEAKS & OTHER GRUB
OLD CORRAL
HOTEL&RESTAURANT
GIFTS & ANTIQUES
THANK YOU!


OLD CORRAL
HOTEL&RESTAURANT

See it?

Almost

Who else will solve this?

FRONTIER ZERO


Lower Falls
Lower Falls model details
Narrow lot : East- or West-facing
900 sq. ft.: One level. Optional basement.
2 bedrooms: 1 bath
Estimated construction cost: $154,000-176,000
Solar View
First Floor 900 sq. ft.
Br 1
Br 2
Great Rm
Kitchen
Garage
*See Appendix A.
Note: This is not a guarantee.
Building Energy Research Group
Frontier Zero Home Catalogue / frontierzero@uwyo.edu


FRONTIER ZERO
Building Energy Research Group
Frontier Zero Home Catalogue / frontierzero@uwyo.edu


Gooseberry Creek
Gooseberry Creek model details
Narrow lot
800 sq. ft.: Two levels. Optional basement.
2 bedrooms: 1-1/2 baths
Estimated construction cost*: $128,000-162,000
Solar View
First Floor 420 sq. ft.
Second Floor 380 sq. ft.
Kit
Great Rm
Br 2
Br 1
*See Appendix A.
Note: This is not a guarantee.
Building Energy Research Group
Frontier Zero Home Catalogue / frontierzero@uwyo.edu

Refinement Options

Preferencing Survey

I would choose the standard version of this home:

I would choose the version below:
HERS 70
Design-integrated Solar

Avoids Pollution Equivalent to:
80 tons of coal
17,000 gallons of gasoline

$1,600 Annual Energy Cost Savings

Price: $25,000 above standard

15% of the other homes nearby are solar homes

I would choose the version below:
HERS 70
Traditional Rooftop Solar

Avoids Pollution Equivalent to:
80 tons of coal
17,000 gallons of gasoline

$1,600 Annual Energy Cost Savings

Price: $40,000 above standard

75% of the other homes nearby are solar homes

I would choose the version below:
HERS 70
High Efficiency Walls & Windows

Avoids Pollution Equivalent to:
80 tons of coal
17,000 gallons of gasoline

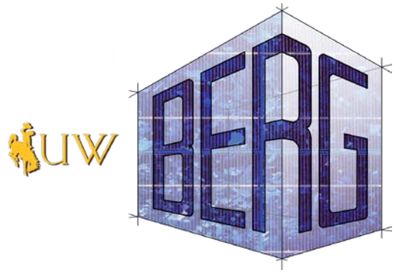
$1,600 Annual Energy Cost Savings

Price: $10,000 above standard

75% of the other homes nearby are solar homes

Results show…

$10K added value for visual integration



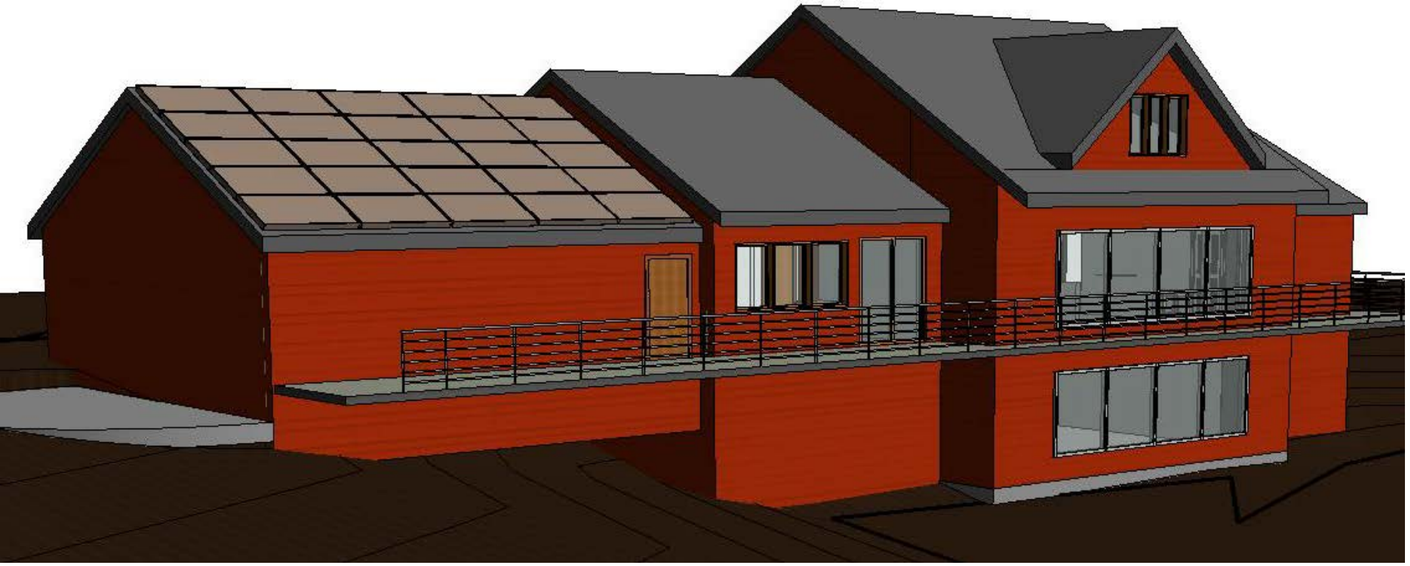
Common Formula in Wyoming: 3 Gable Ranch

3 Gable Ranch

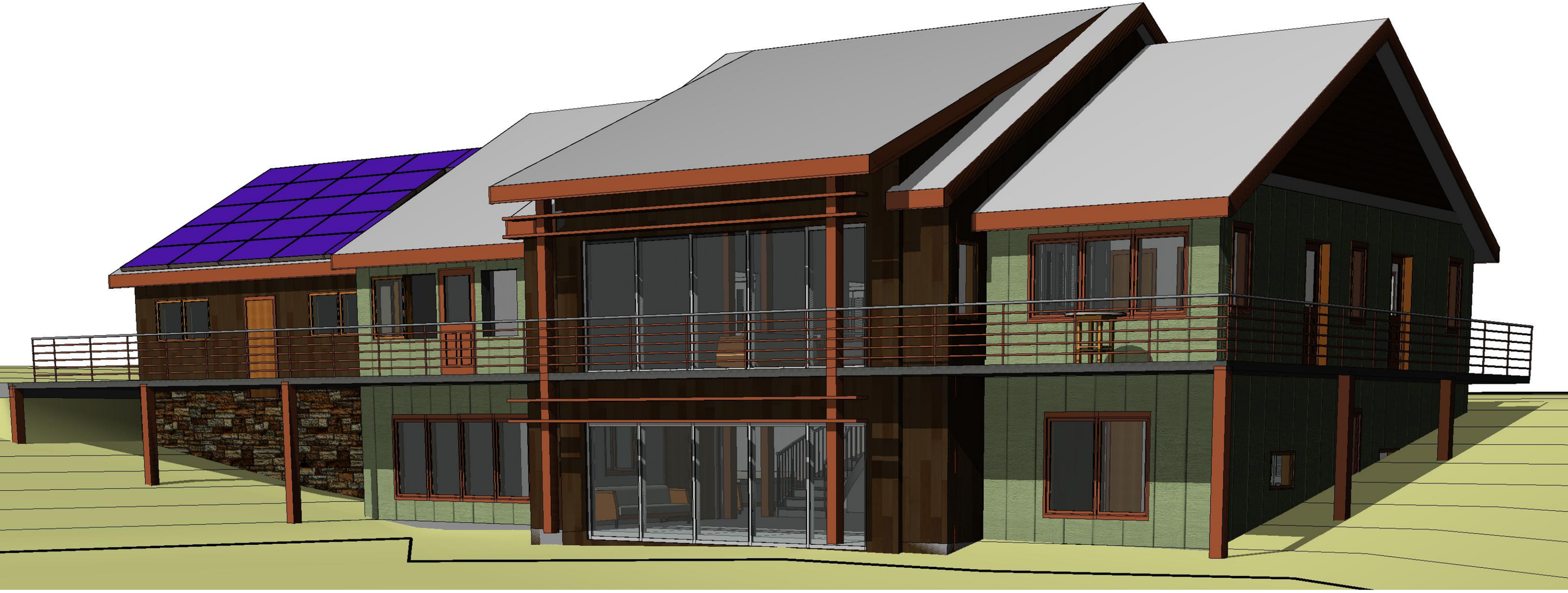
Case Study

3 Gable Ranch

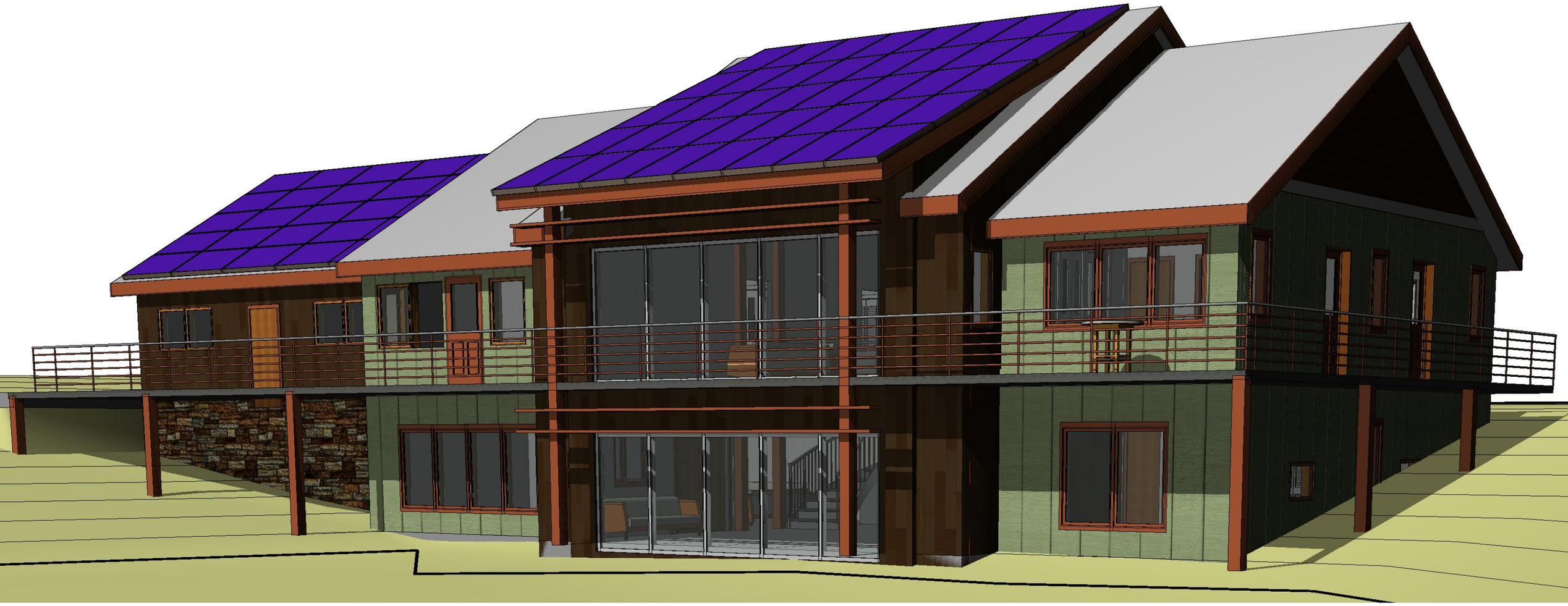
Sheds over gables for South facade



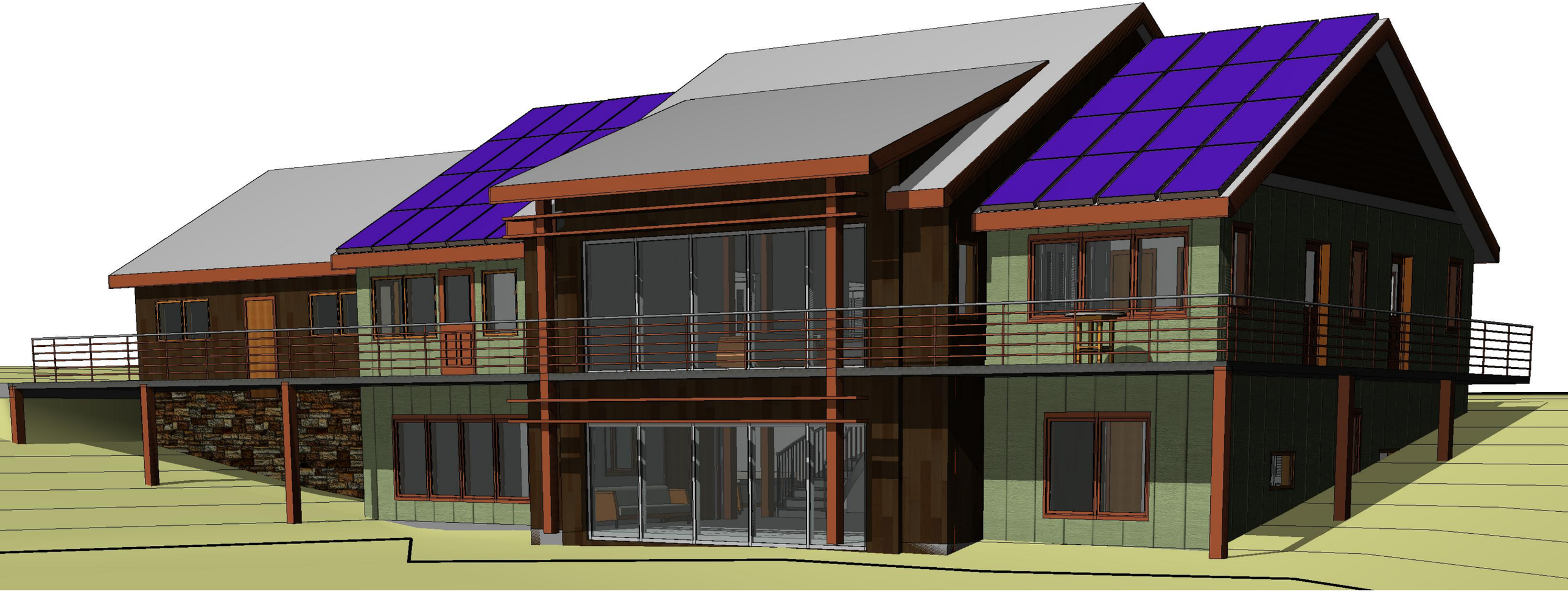
More PV

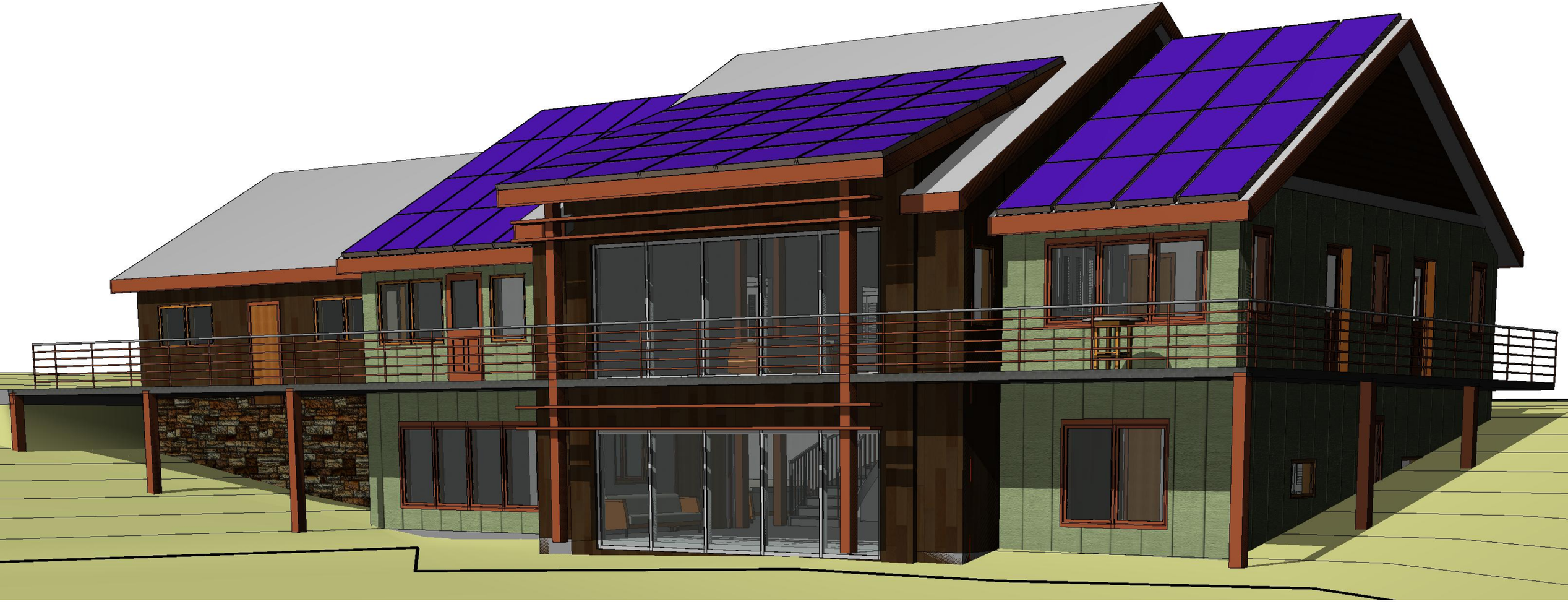


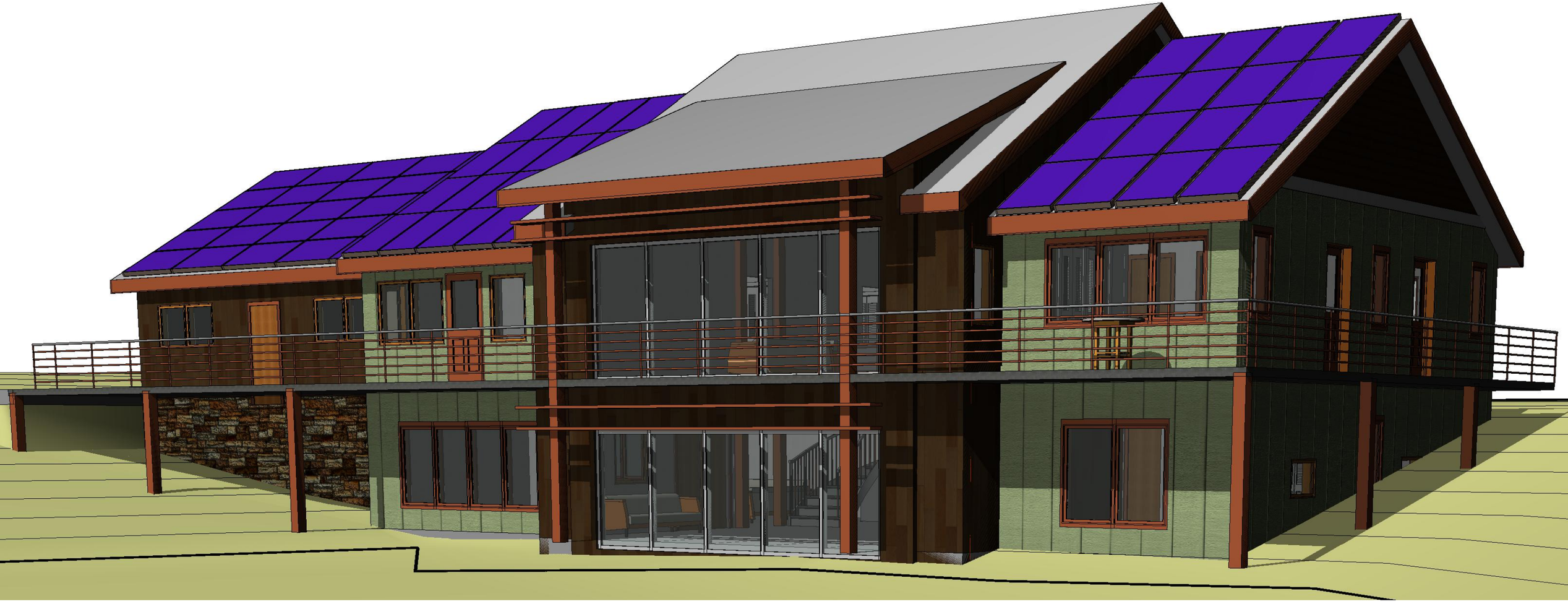
More PV



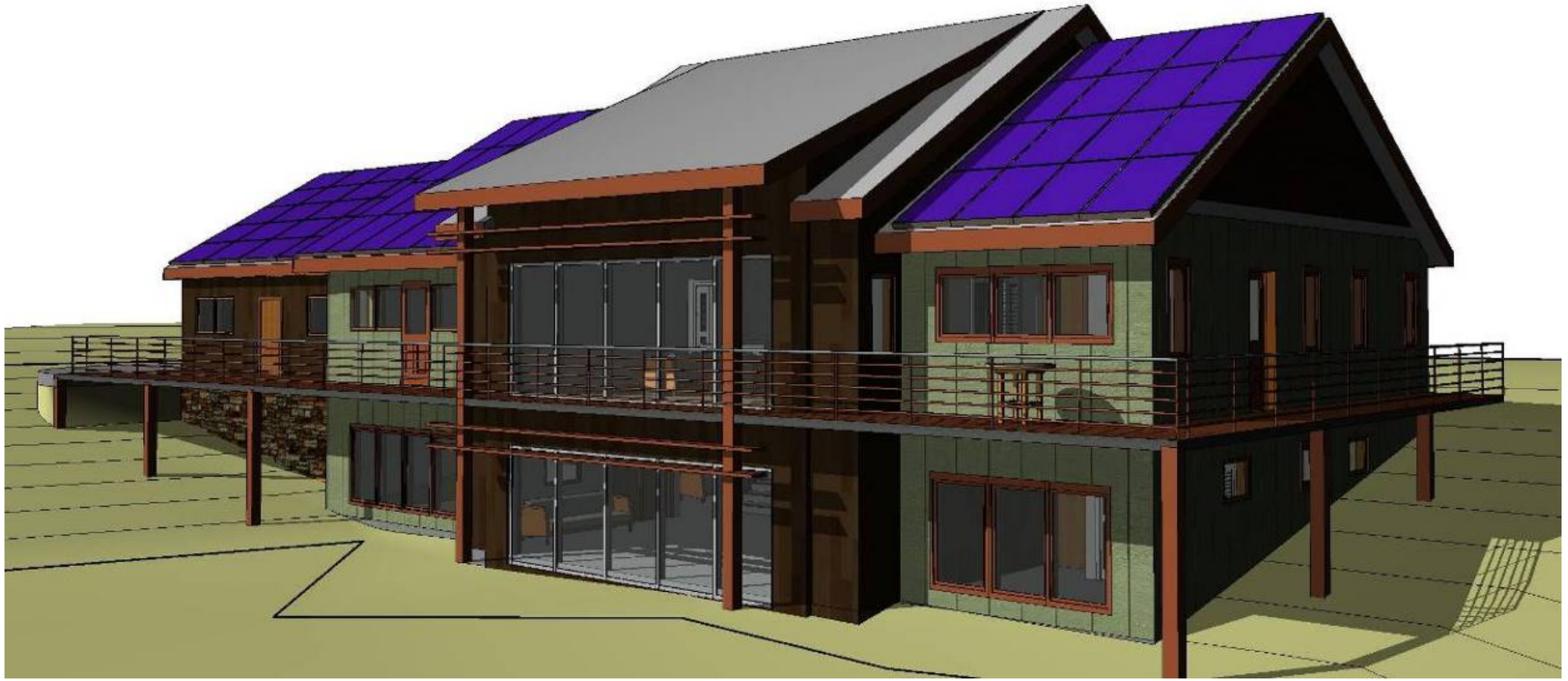
More PV







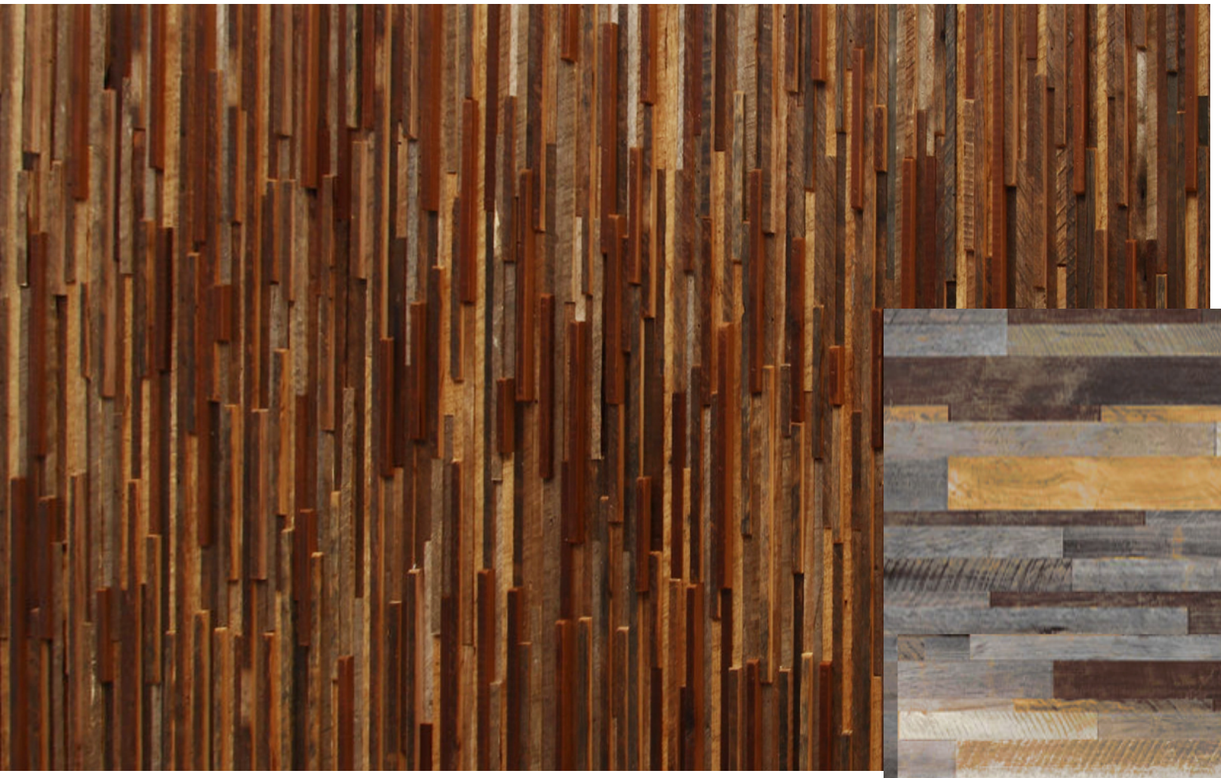
More PV…final solution

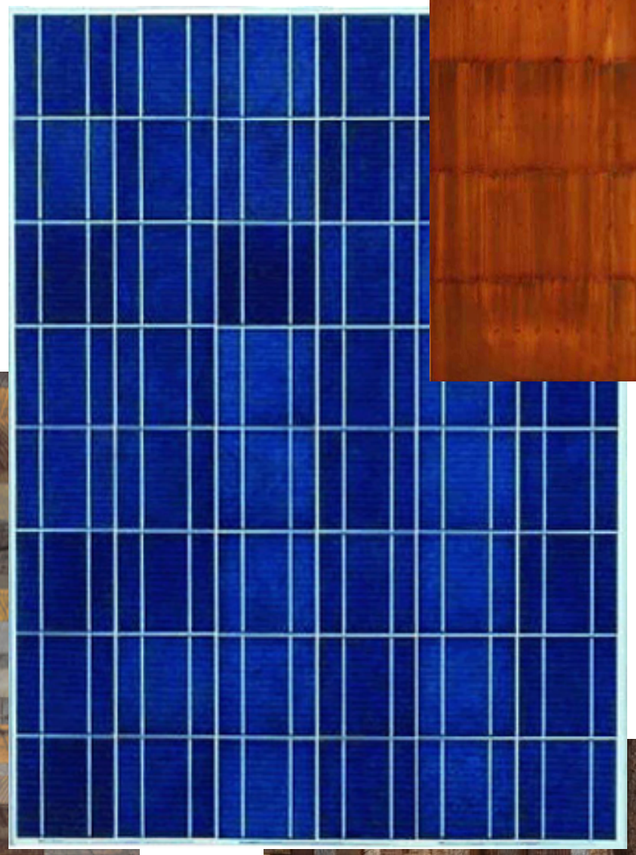


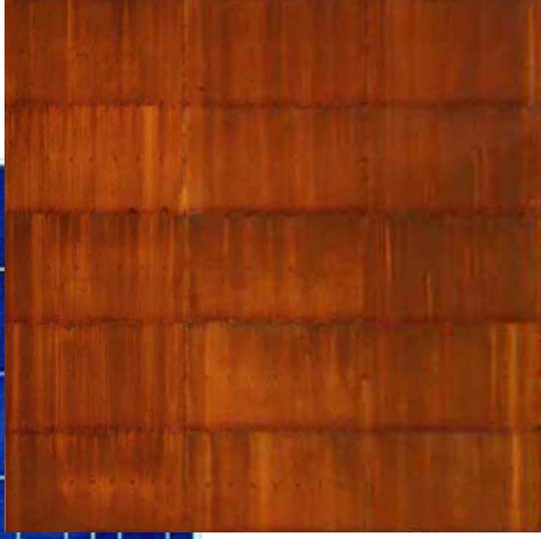
Aesthetics, Ethics, & Economics

Utilizing Revit& Insight 360

Utilizing Revit& Insight 360



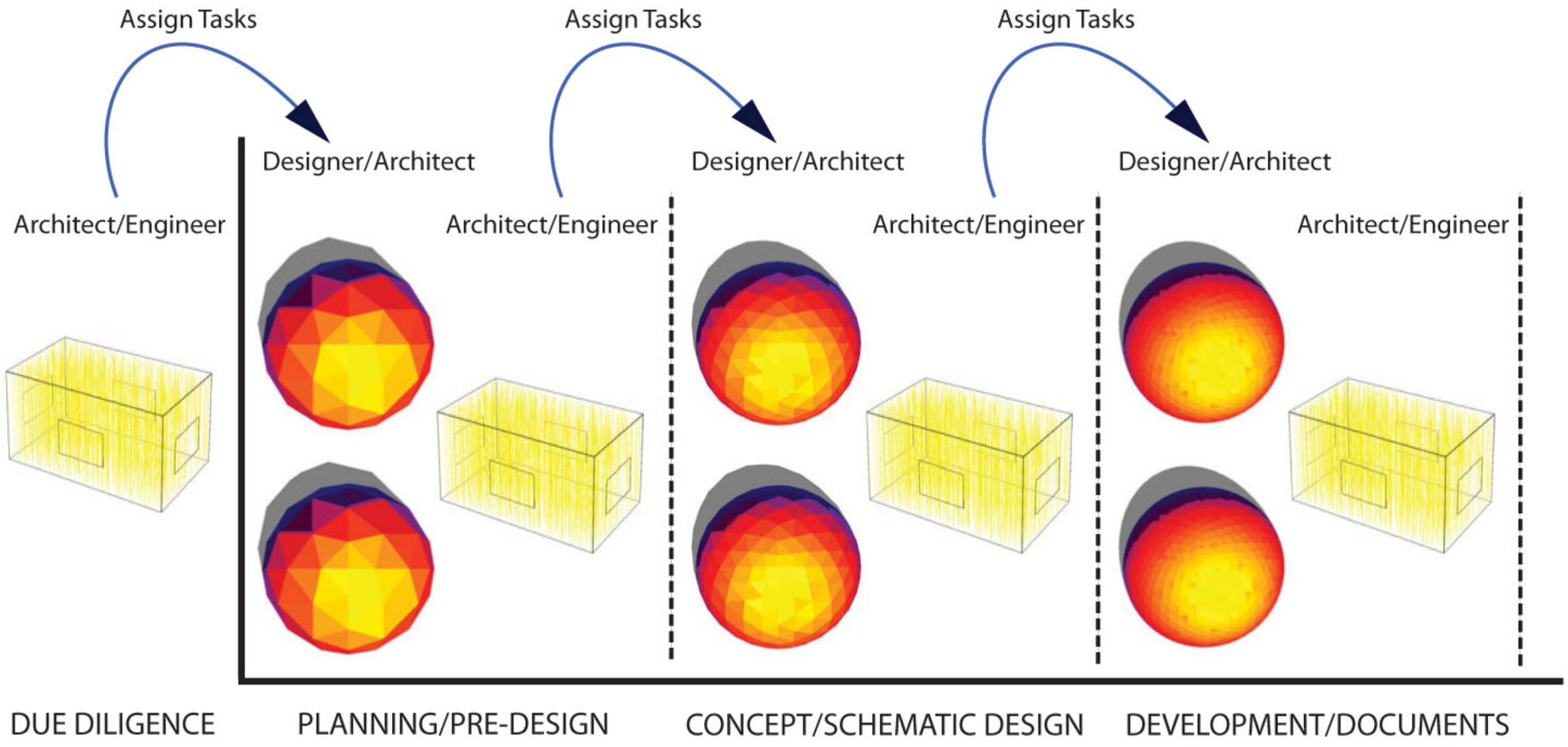




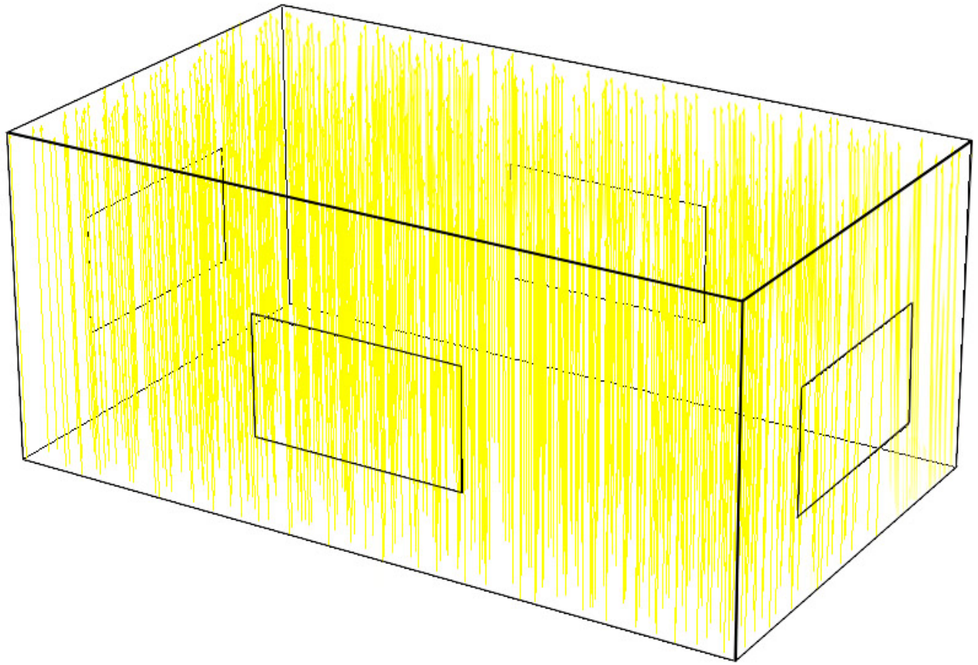
Utilizing Revit& Insight 360

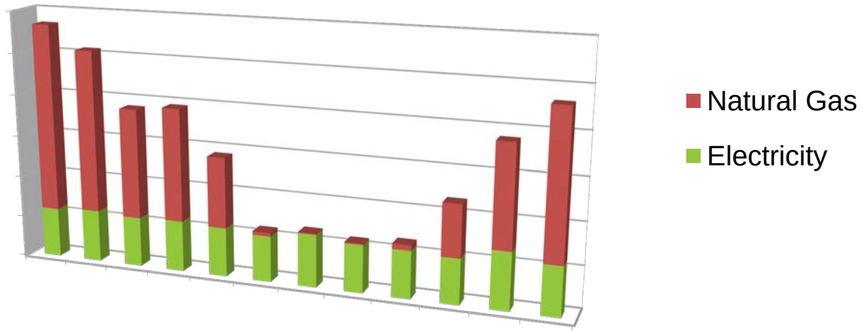
Analysis Process

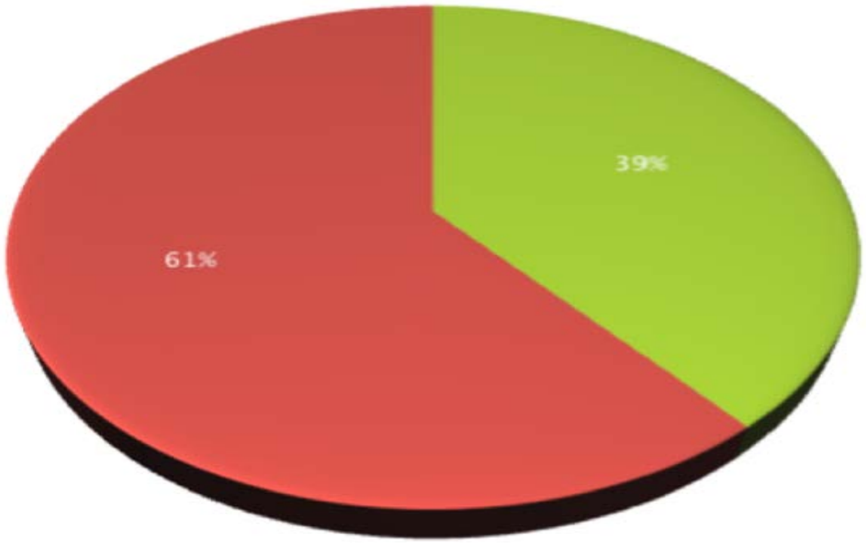
Analysis Process



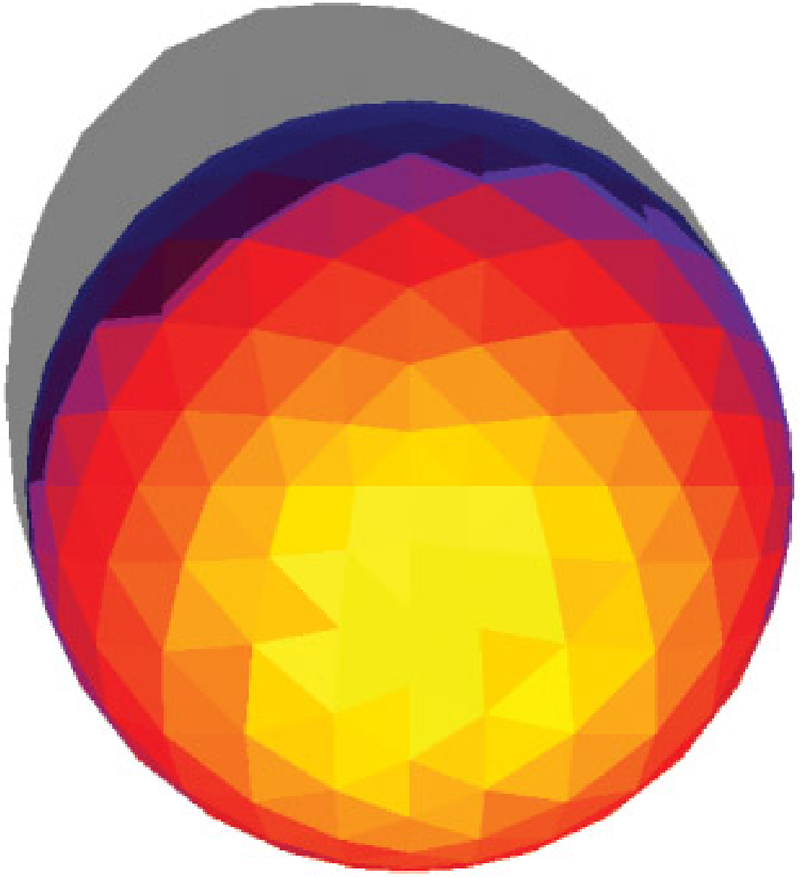
Energy Modeling

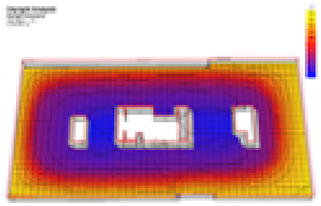


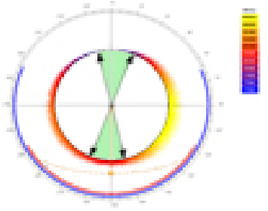


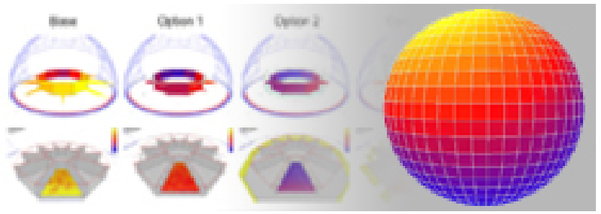


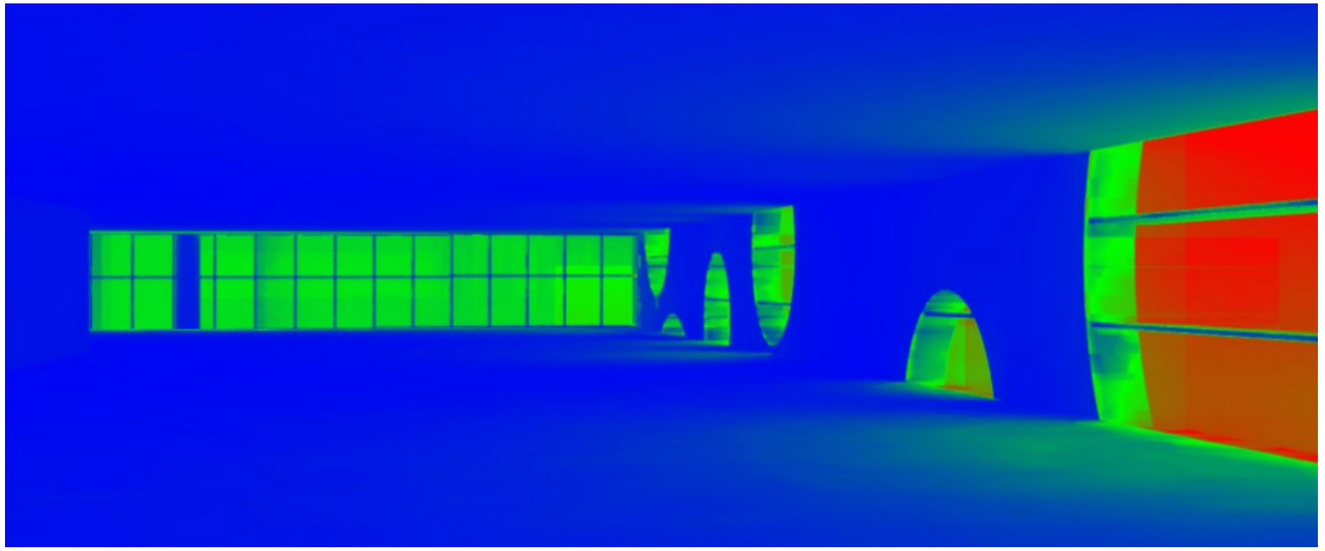
Environmental Analysis



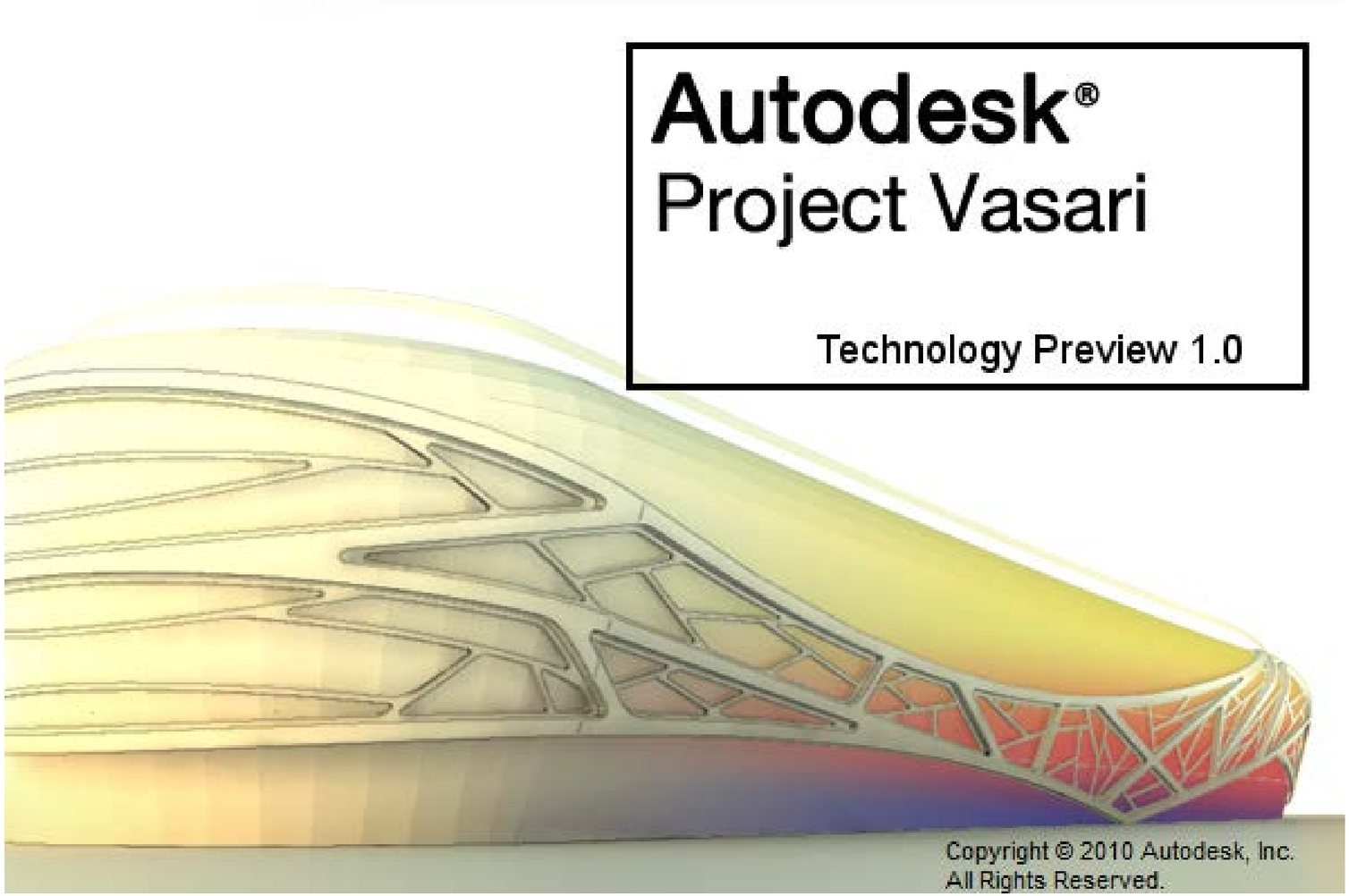




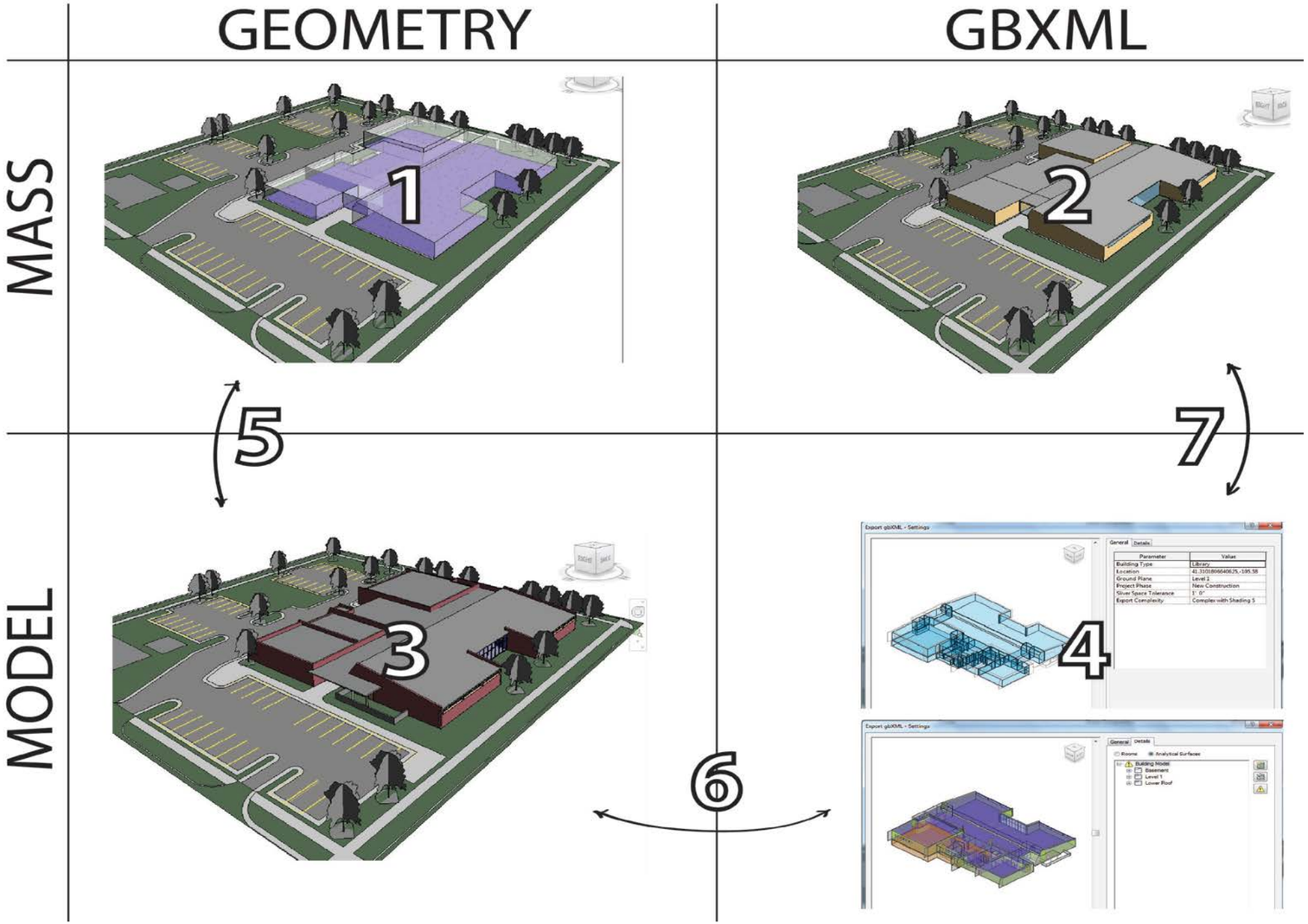




Last Time I Was Here

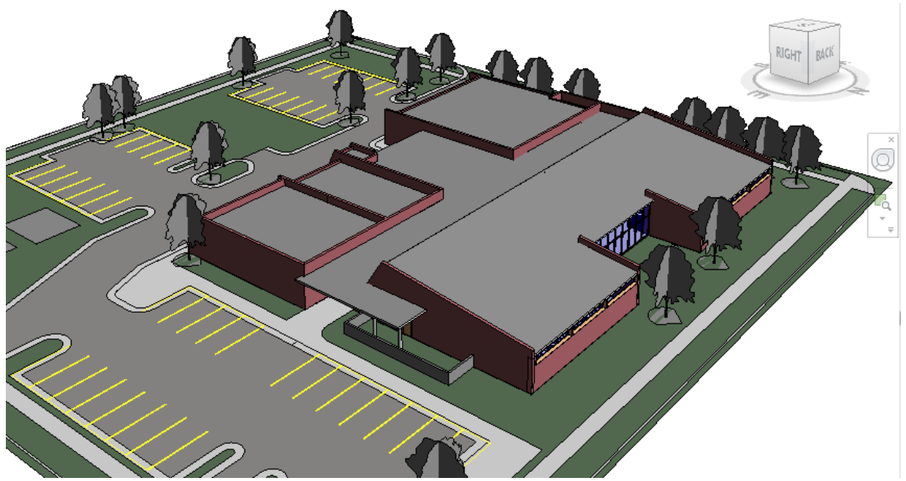


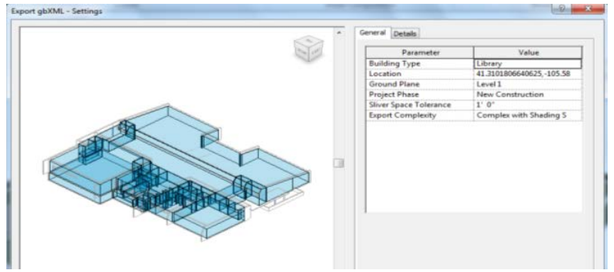
Data Flow

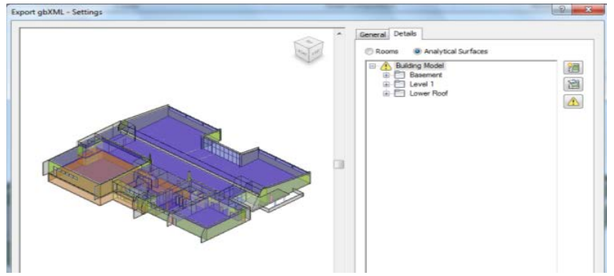


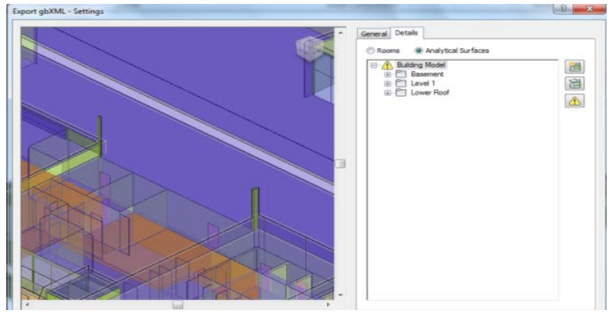
Geometry Translation Guide		
Analysis Type	**Early**	**Detailed**
Solar	Ecotect (1,4) Vasari (1)	Ecotect (3,5,6)
Daylighting	Ecotect (4) Ecotect/Radiance (3,4,6)	3DS Max (3) Ecotect/Radiance (3,6)
Energy	Ecotect (2) Vasari/GBS (2) DOE2/E+/Other (2)	All (2,7)

Data Flow – Model Geometry and gbXML

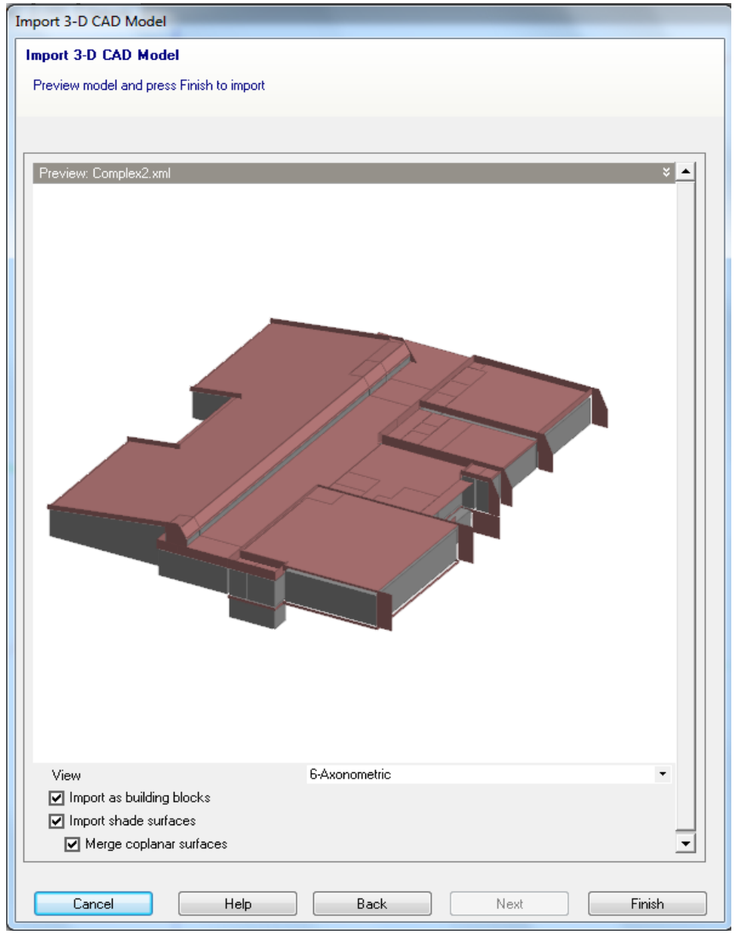


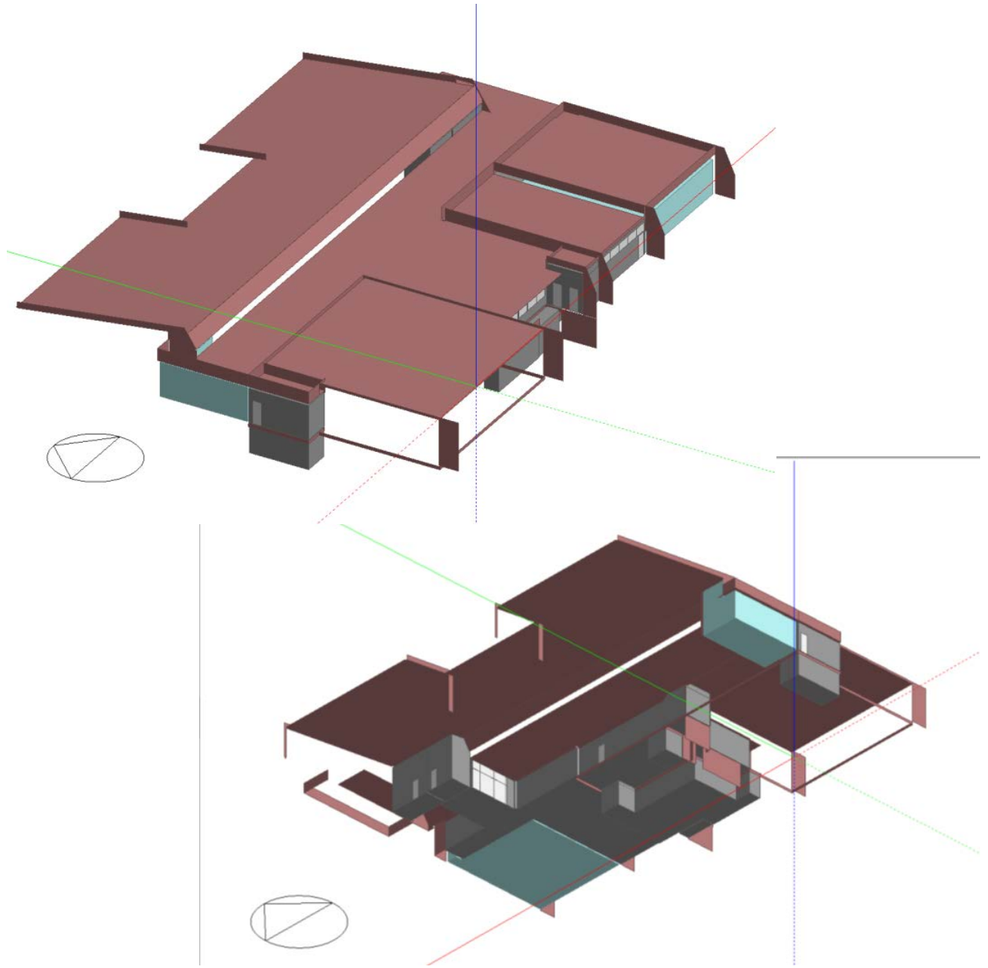




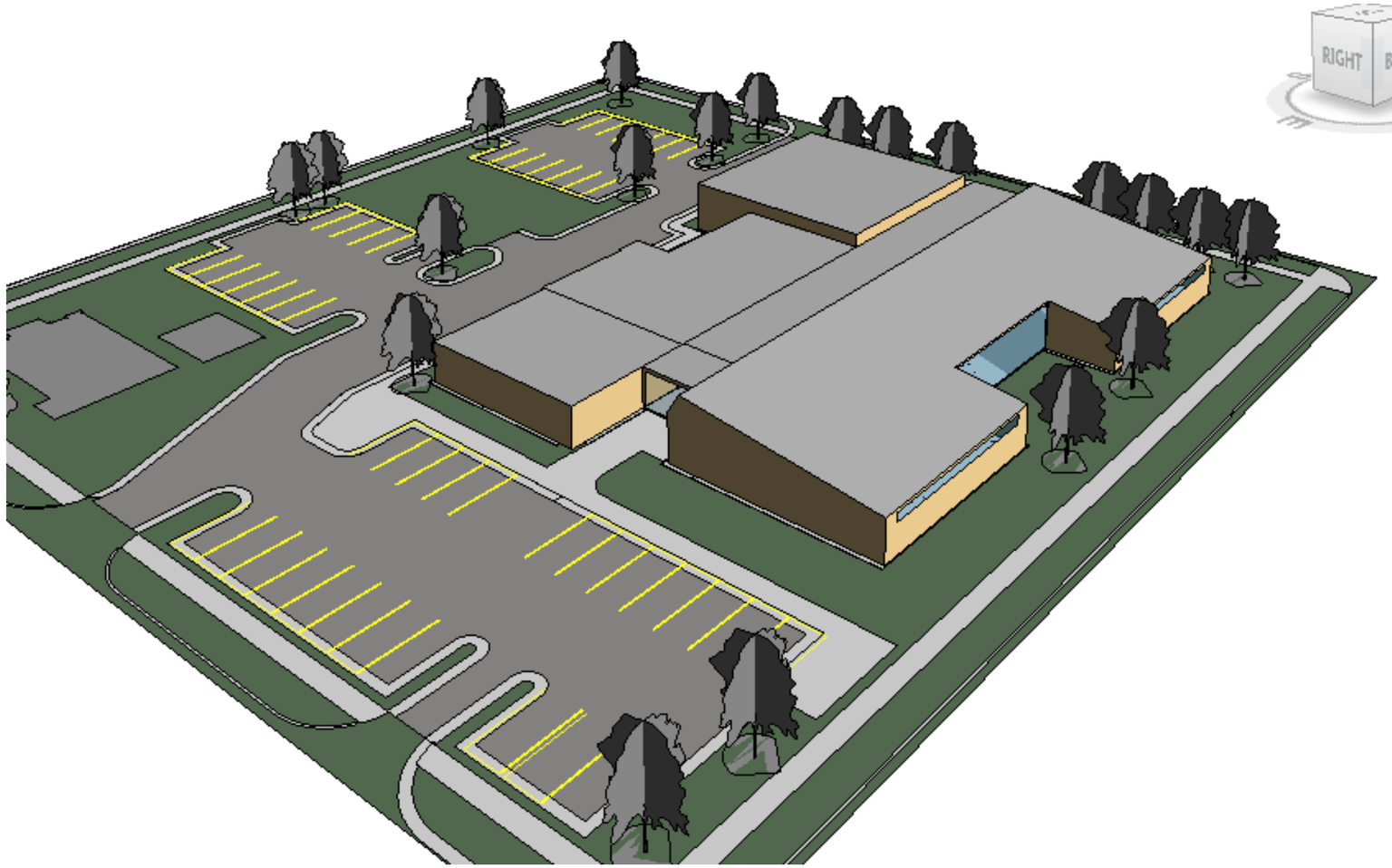


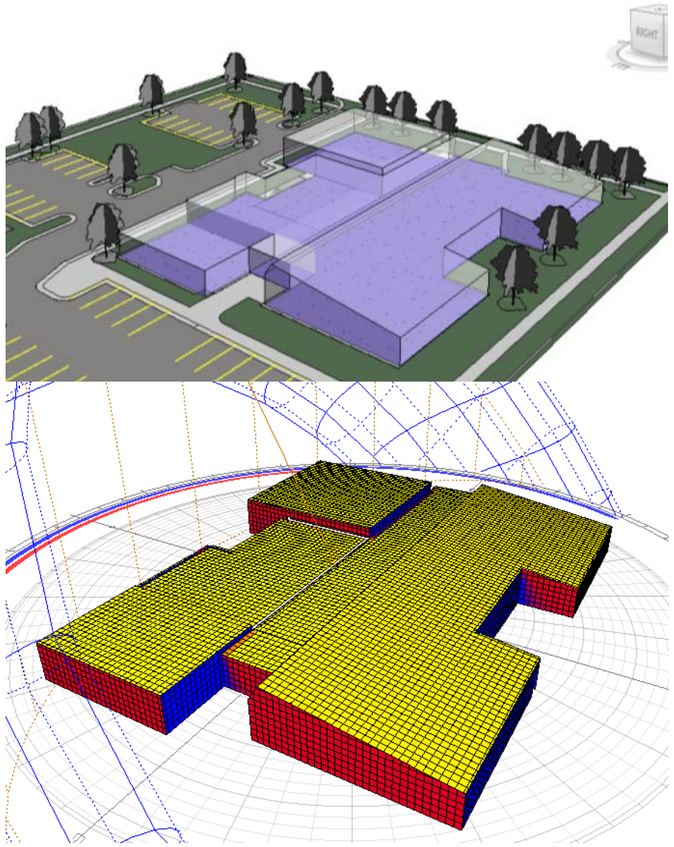
Data Flow – gbXML Interoperability Issues



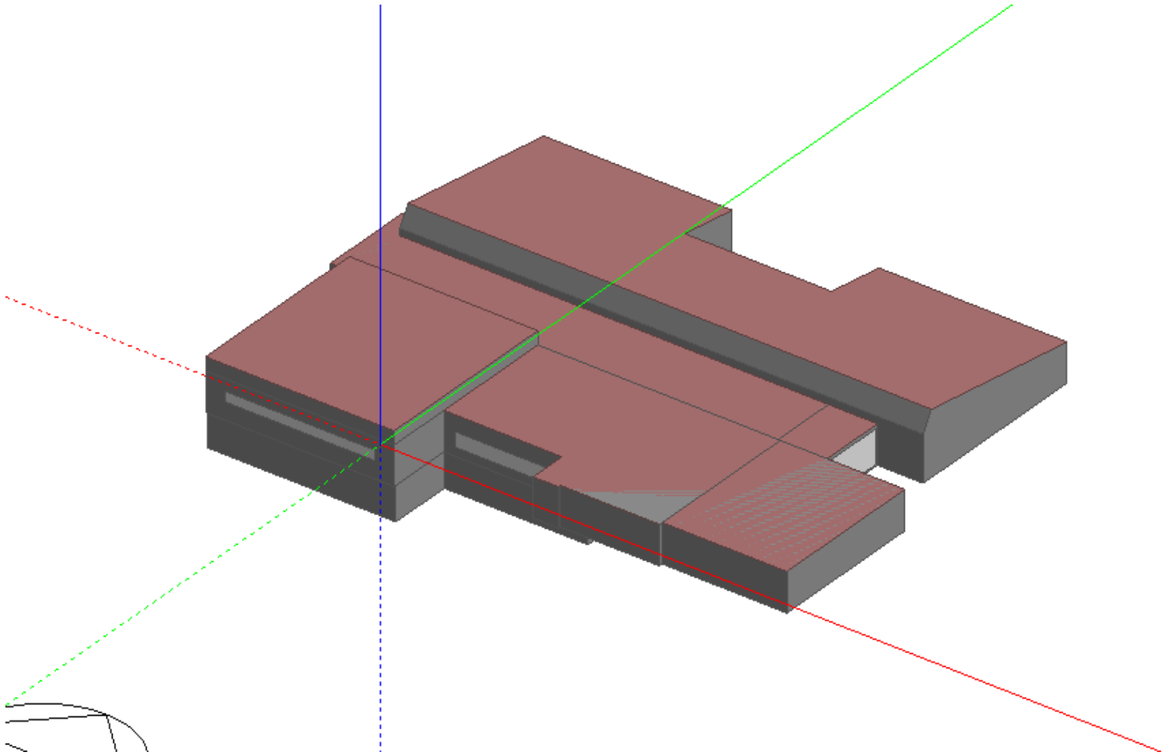


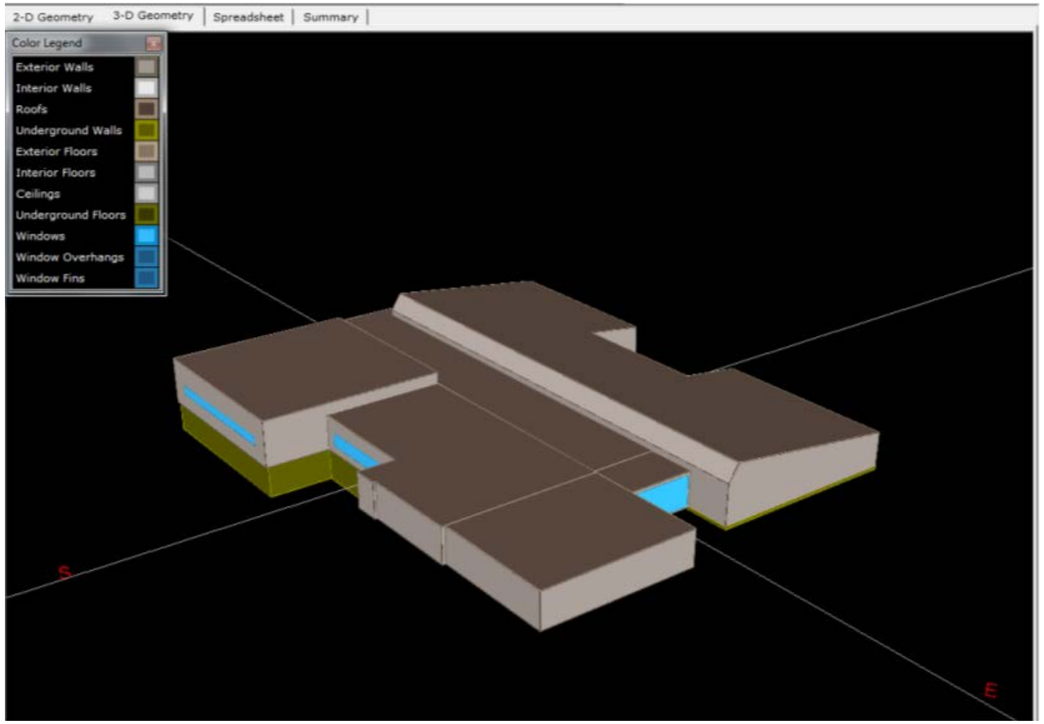
Data Flow – Massing





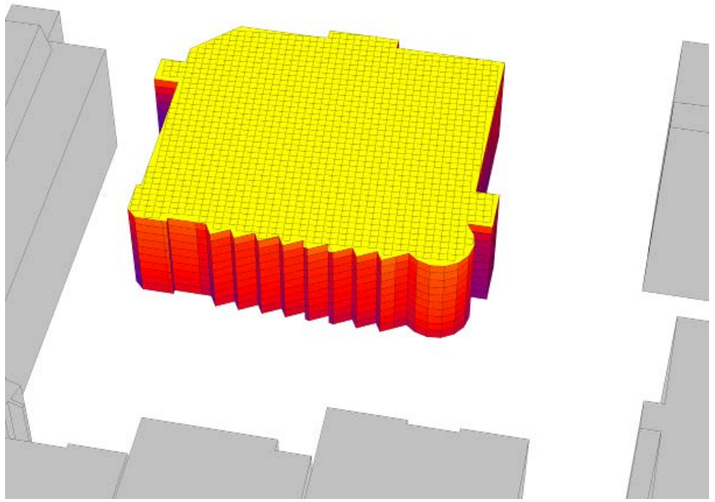
Data Flow – Massing energy analysis

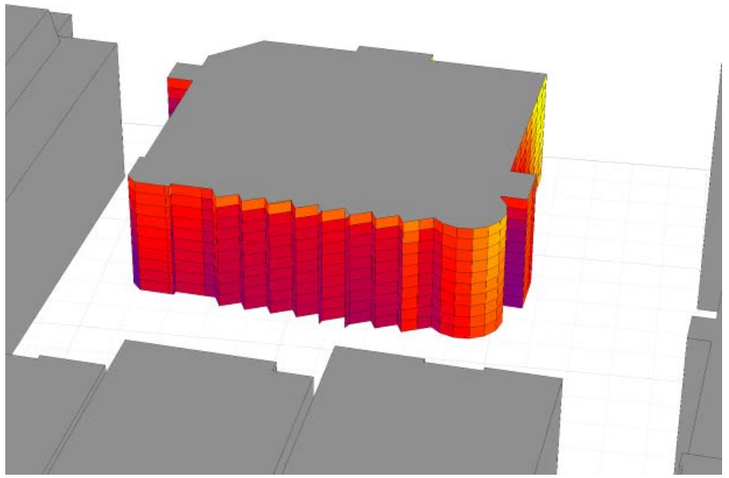


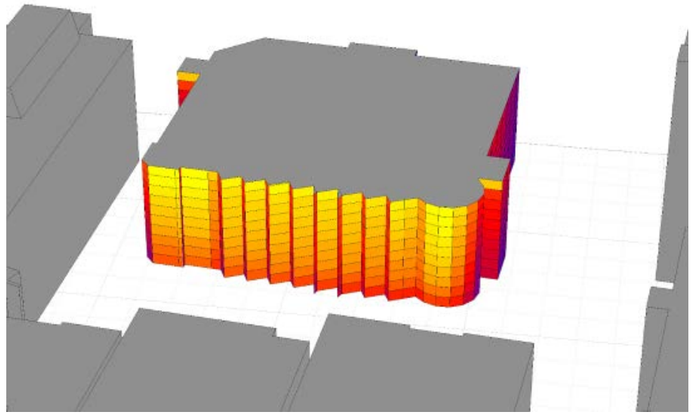


University of Wyoming – Student Design Project

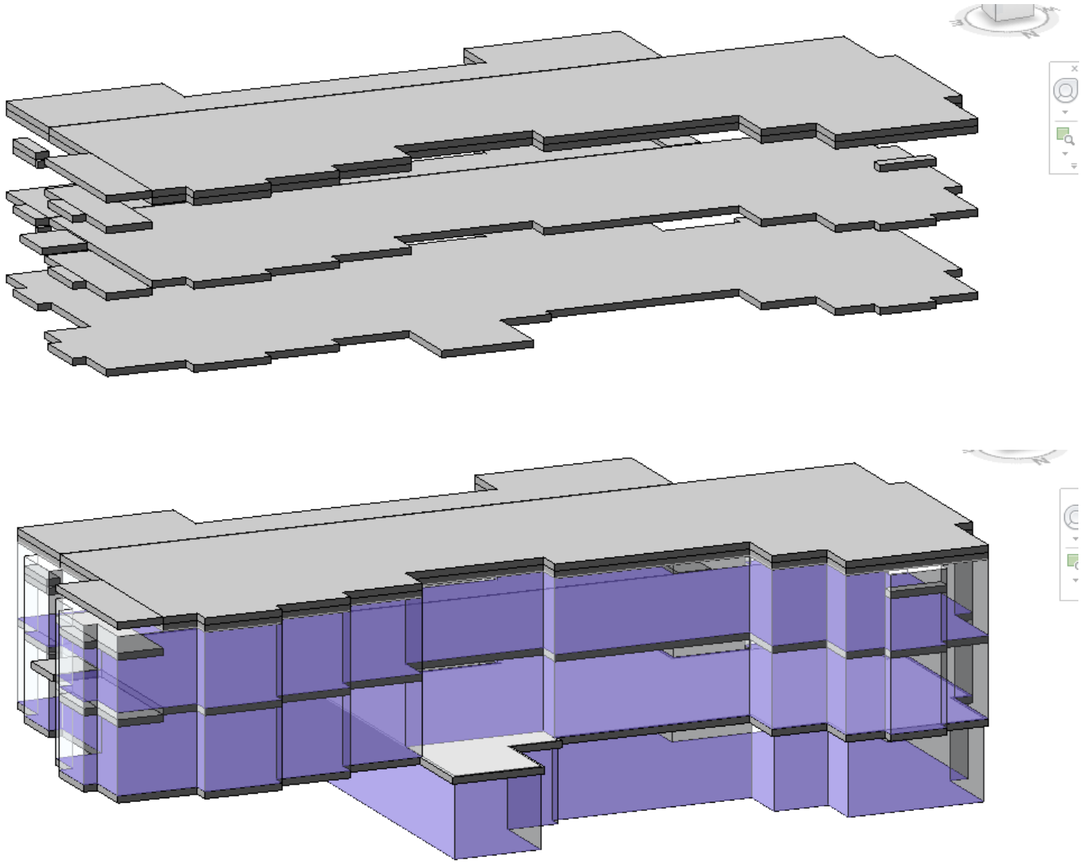
University of Wyoming – Student Design Project

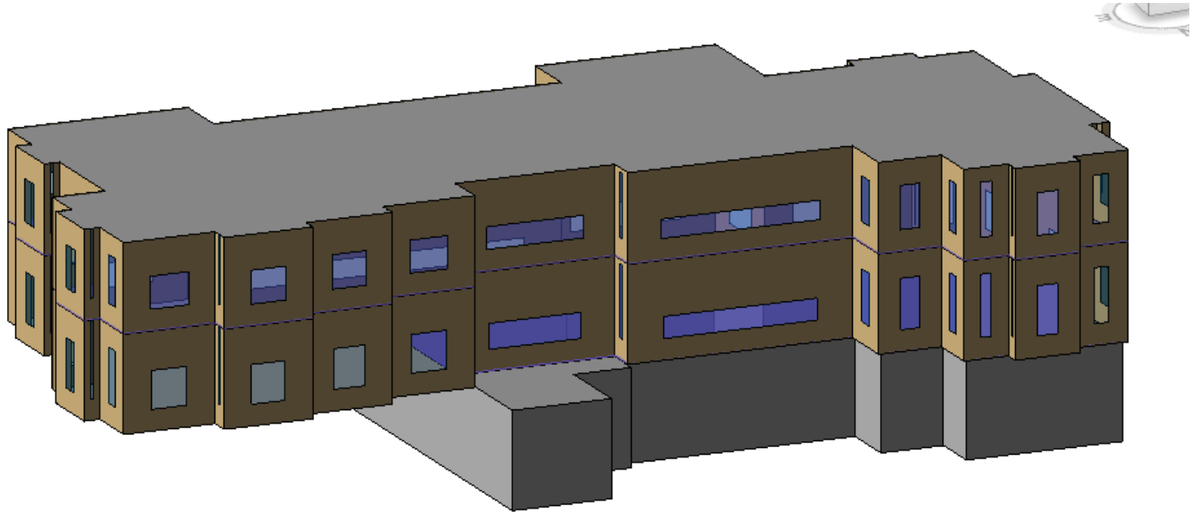


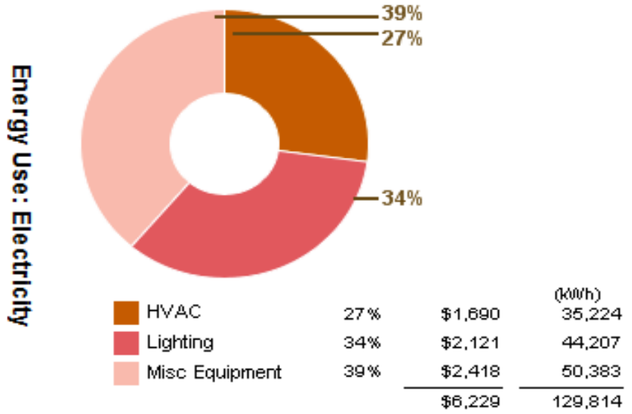




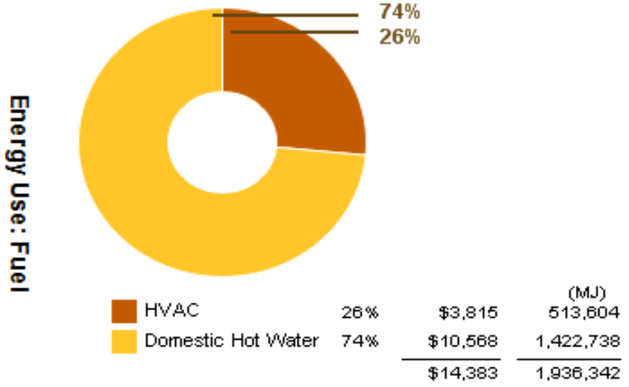
Archicad Example



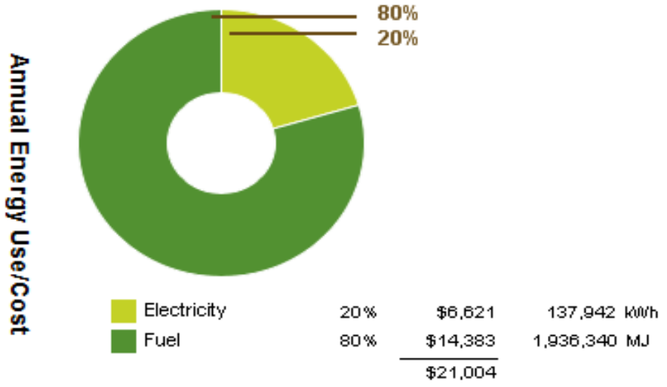




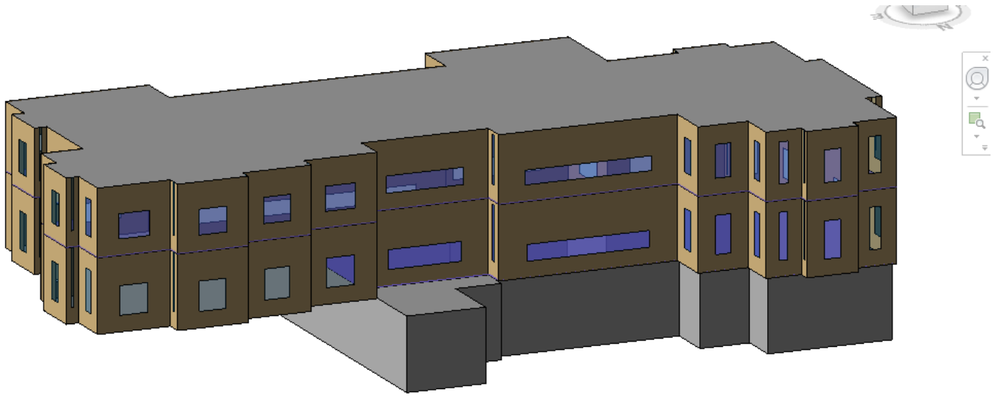
			(kWh)
HVAC	27%	$1,690	35,224
Lighting	34%	$2,121	44,207
Misc Equipment	39%	$2,418	50,383
		$6,229	129,814



			(MJ)
HVAC	26%	$3,815	513,604
Domestic Hot Water	74%	$10,568	1,422,738
		$14,383	1,936,342



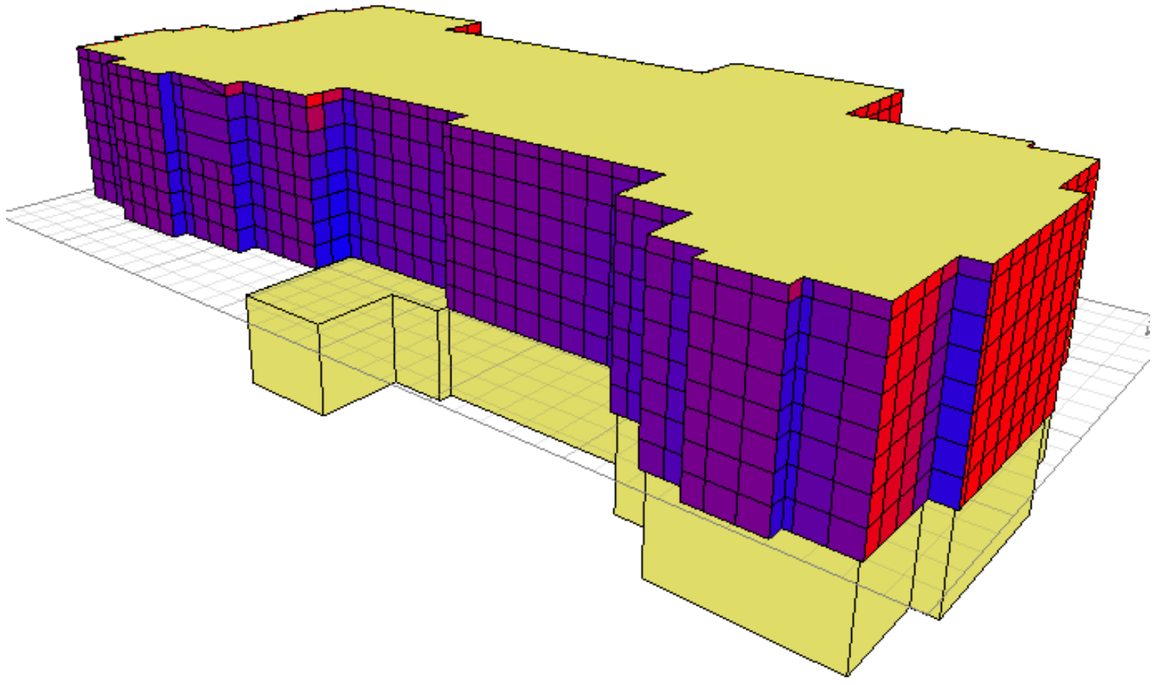
Electricity	20%	$6,621	137,942	kWh
Fuel	80%	$14,383	1,936,340	MJ
		$21,004		

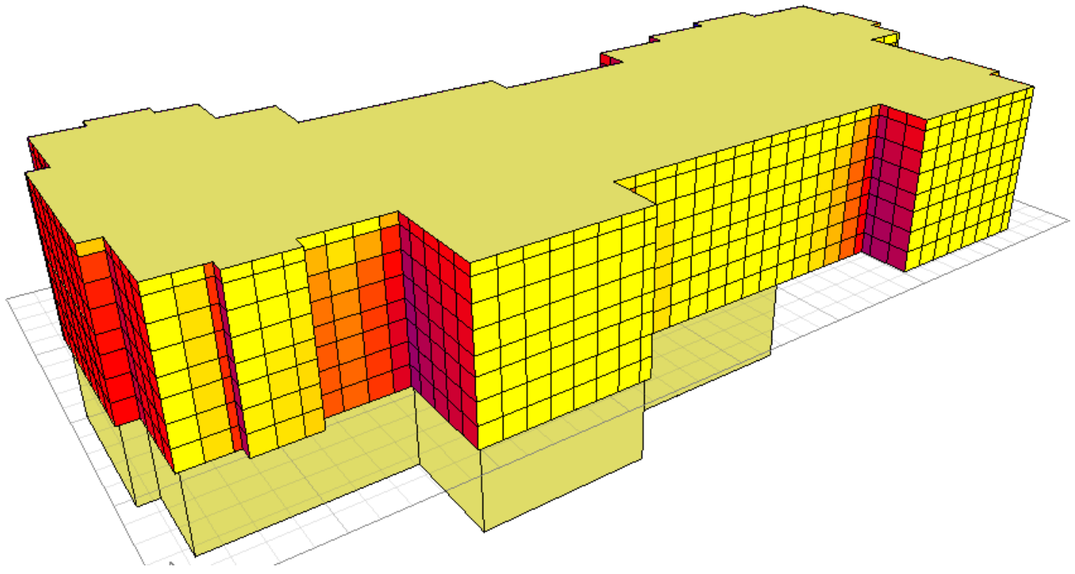


Double Glazed = $14,383 Fuel

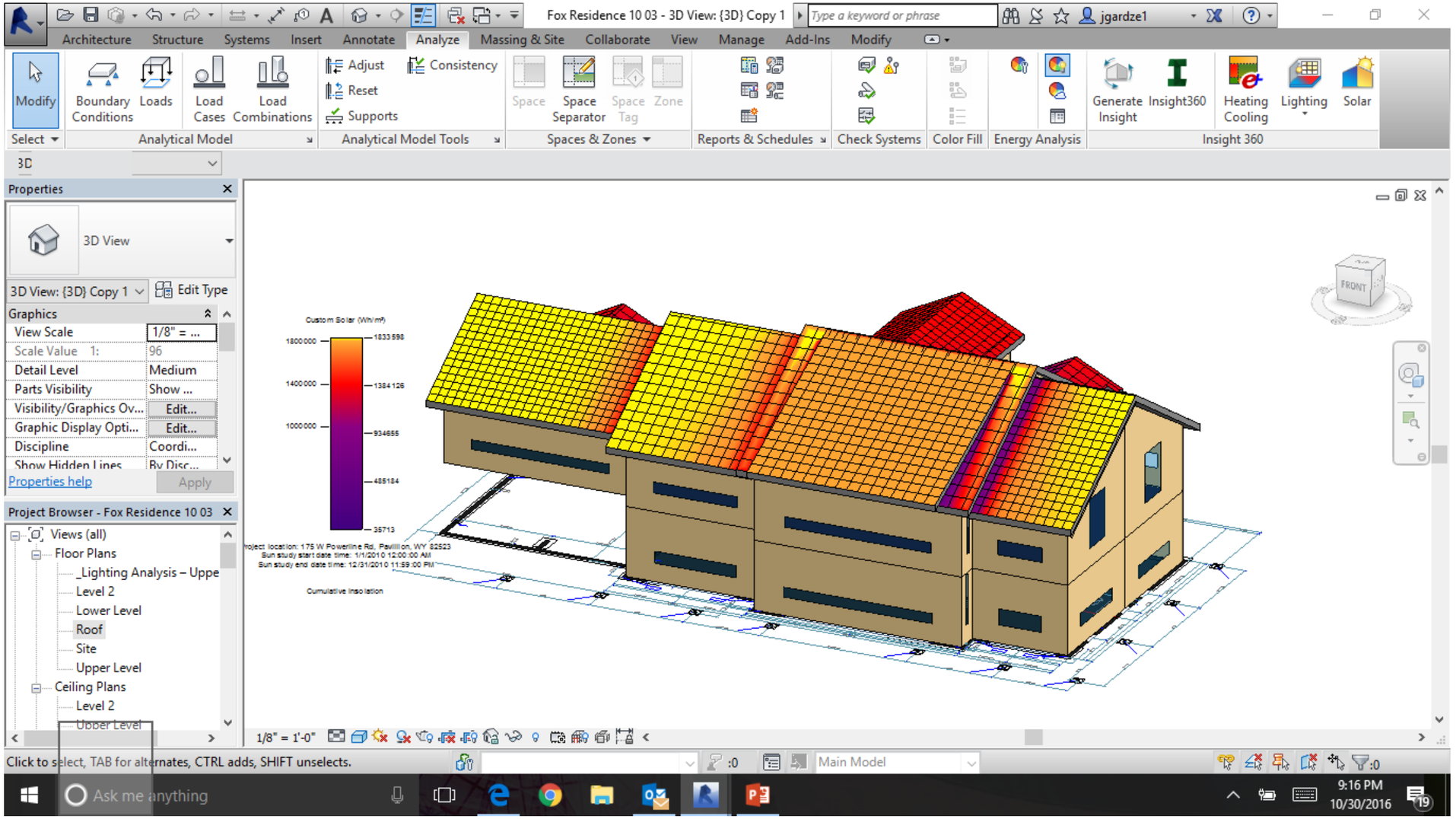
Triple Glazed = $13,830 Fuel

Quad Glazed = $13,708 Fuel

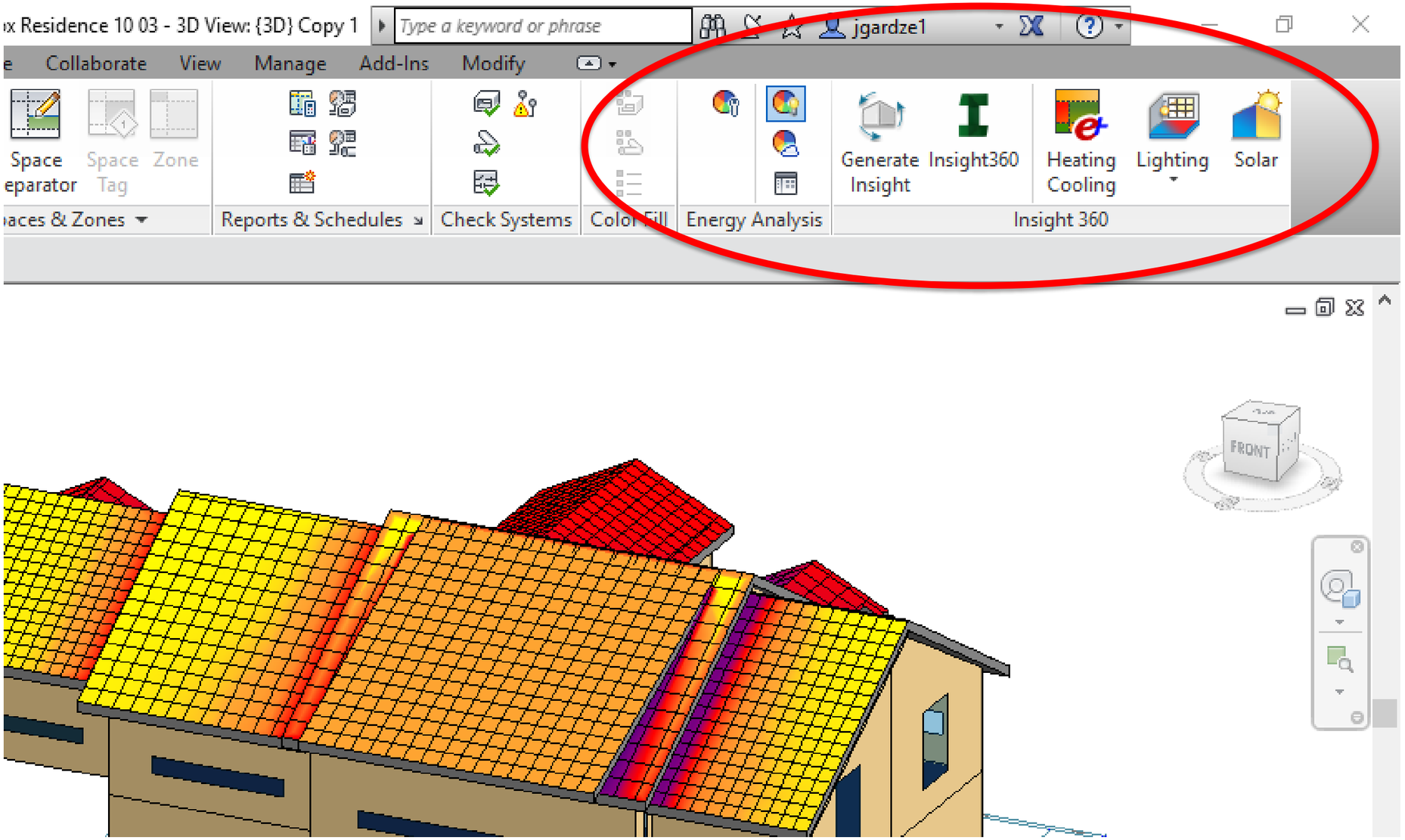


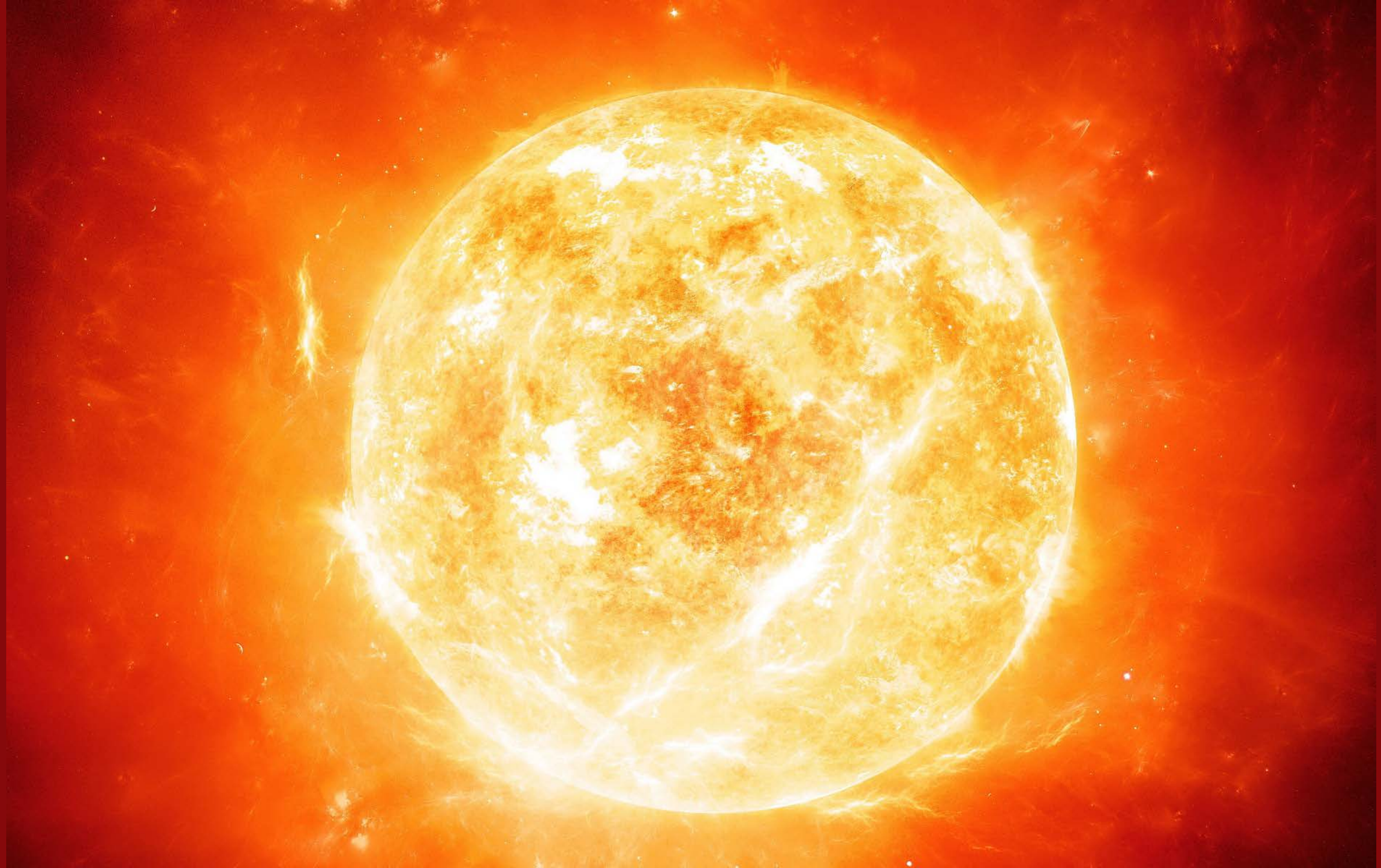


Today

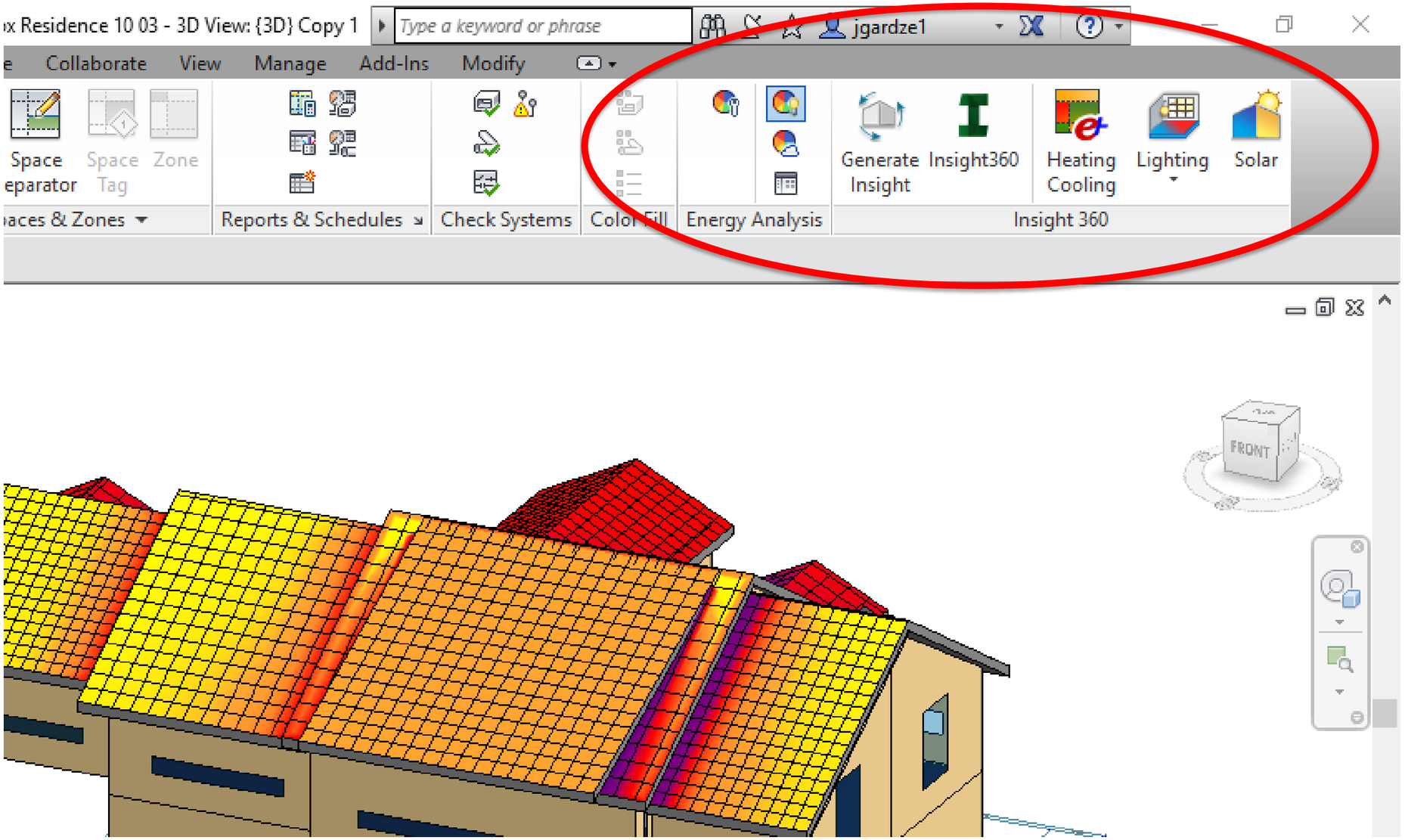

Fox Residence 10 03 - 3D View: {3D} Copy 1
Type a keyword or phrase
jgardze1
Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Modify
Modify
Boundary Conditions
Loads
Load Cases
Load Combinations
Adjust
Consistency
Reset
Supports
Space
Space Separator
Space Tag
Zone
Generate Insight
Insight360
Heating Cooling
Lighting
Solar
Select
Analytical Model
Analytical Model Tools
Spaces & Zones
Reports & Schedules
Check Systems
Color Fill
Energy Analysis
Insight 360
3D
Properties
3D View
3D View: {3D} Copy 1
Edit Type
Graphics
View Scale
1/8" = ...
Scale Value 1:
96
Detail Level
Medium
Parts Visibility
Show ...
Visibility/Graphics Ov...
Edit...
Graphic Display Opti...
Edit...
Discipline
Coordi...
Show Hidden Lines
By Disc...
Properties help
Apply
Project Browser - Fox Residence 10 03
Views (all)
Floor Plans
_Lighting Analysis – Uppe
Level 2
Lower Level
Roof
Site
Upper Level
Ceiling Plans
Level 2
Custom Solar (Wh/m²)
1800000
1400000
1000000
1833598
1384126
934655
485184
35713
Cumulative Insolation
FRONT
1/8" = 1'-0"
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.
Main Model
Ask me anything
9:16 PM
10/30/2016

All together now





Net Zero House



Fox Residence 10 03 - 3D View: 3D Energy M...

Type a keyword or phrase

jgardze1

Architecture | Structure | Systems | Insert | Annotate | Analyze | Massing & Site | Collaborate | View | Manage | Add-Ins | Modify

Modify | Boundary Conditions | Loads | Load Cases | Load Combinations | Adjust | Reset | Supports | Consistency | Space | Space Separator | Space Tag | Zone | Generate Insight | Insight360 | Heating Cooling | Lighting | Solar

Select | Analytical Model | Analytical Model Tools | Spaces & Zones | Reports & Schedules | Check Systems | Color Fill | Energy Analysis | Insight 360

3D

Properties

3D View

3D View: 3D Energy M | Edit Type

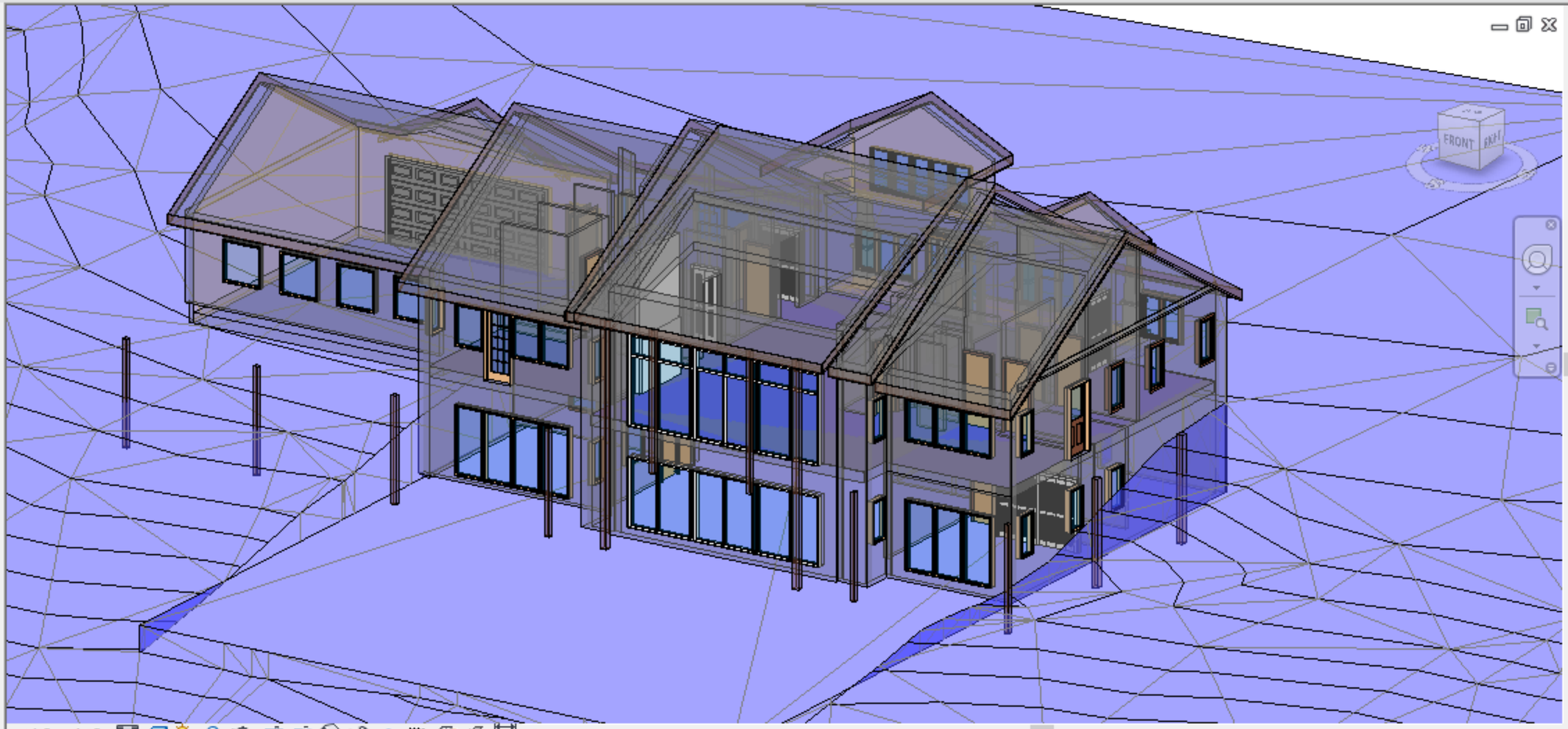
Graphics

View Scale	1/8" = ...
Scale Value 1:	96
Detail Level	Medium
Parts Visibility	Show ...
Visibility/Graphics Ov...	Edit...
Graphic Display Opti...	Edit...
Discipline	Coordi...
Show Hidden Lines	By Disc...

Properties help | Apply

Project Browser - Fox Residence 10 03

- Views (all)
  - Floor Plans
    - _Lighting Analysis – Uppe
    - Level 2
    - Lower Level
    - Roof
    - Site
    - Upper Level
  - Ceiling Plans
    - Level 2
    - Upper Level



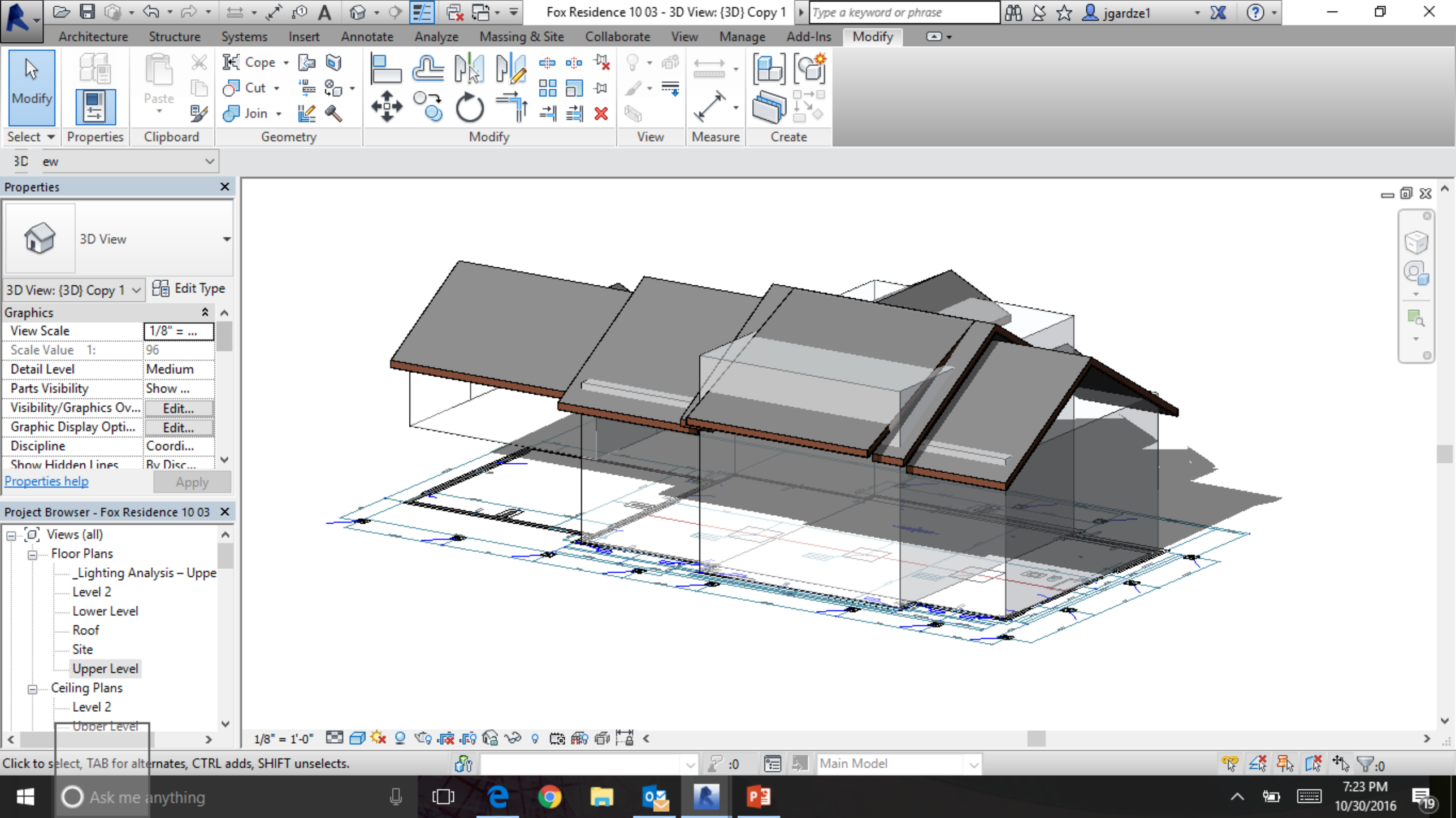
1/8" = 1'-0"

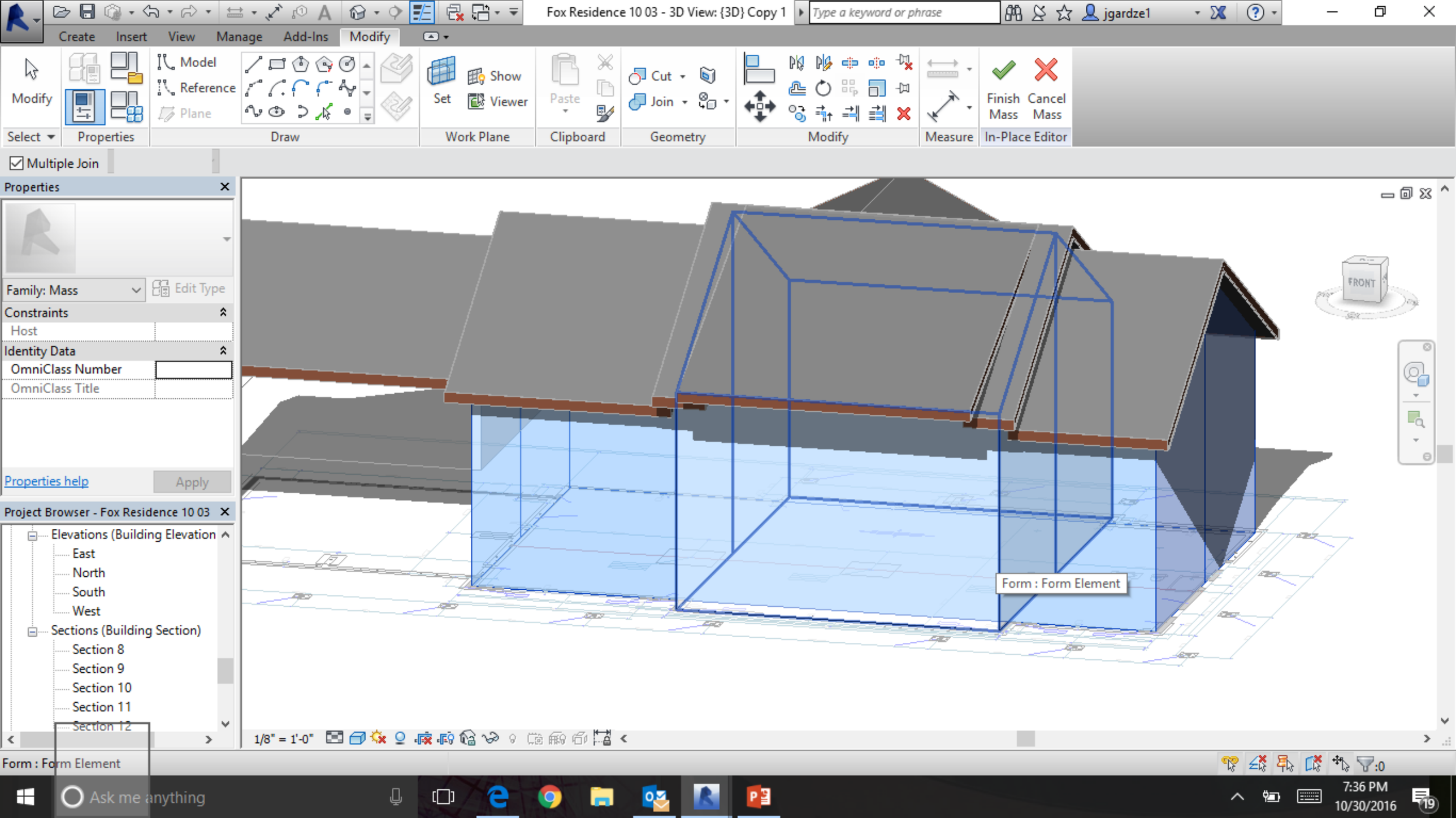
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.

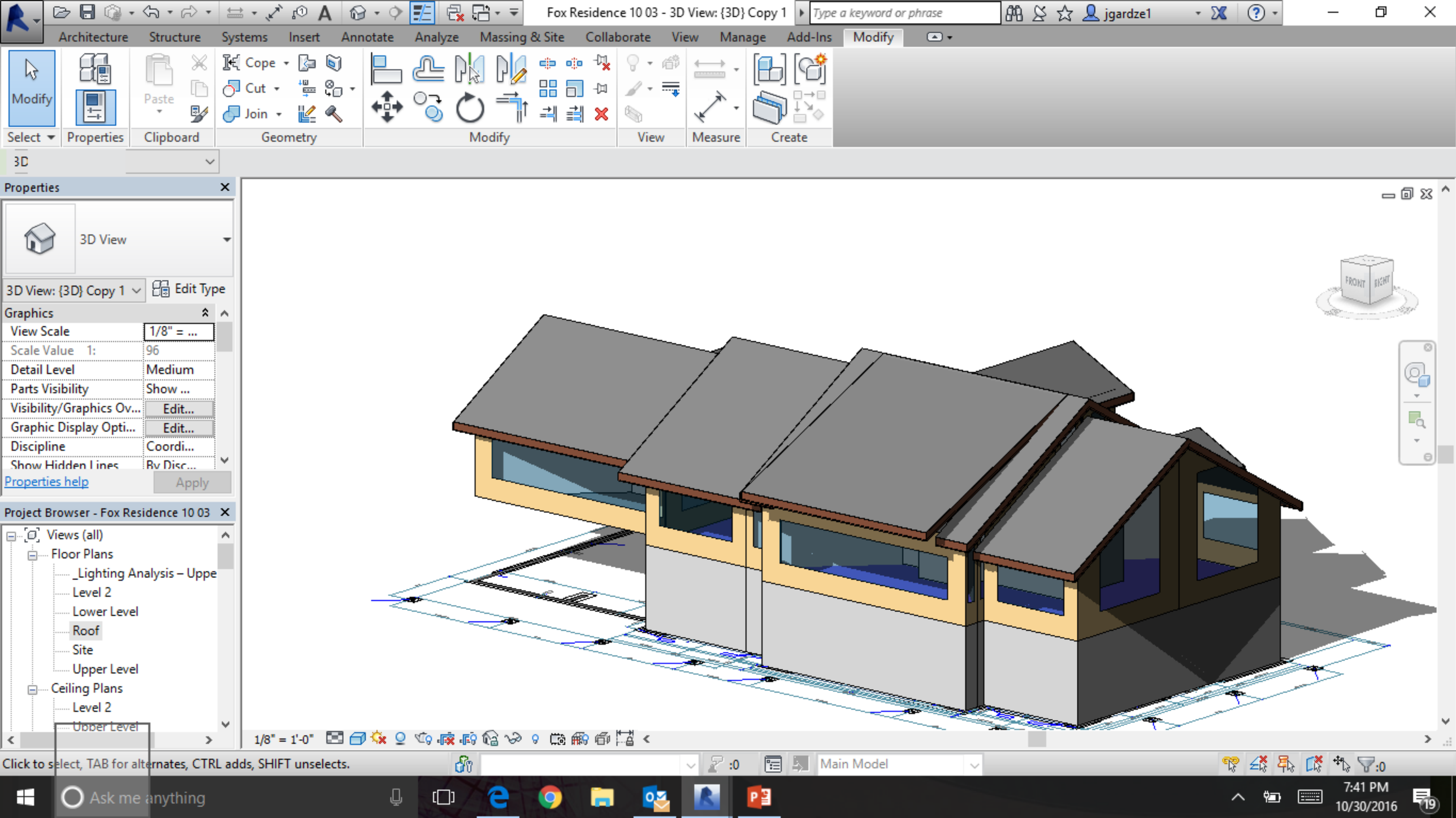
:0 | Main Model | :0

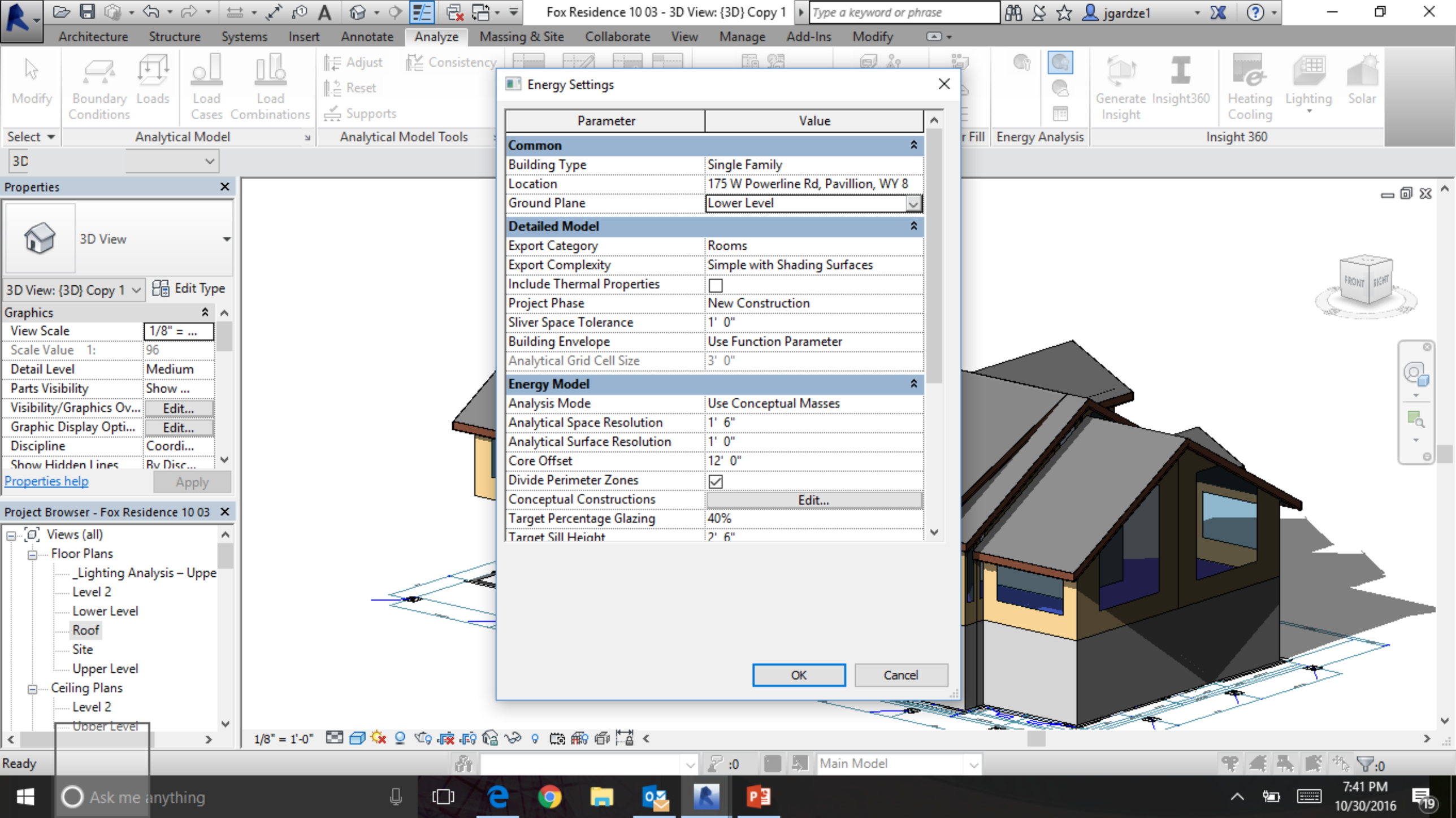
Ask me anything

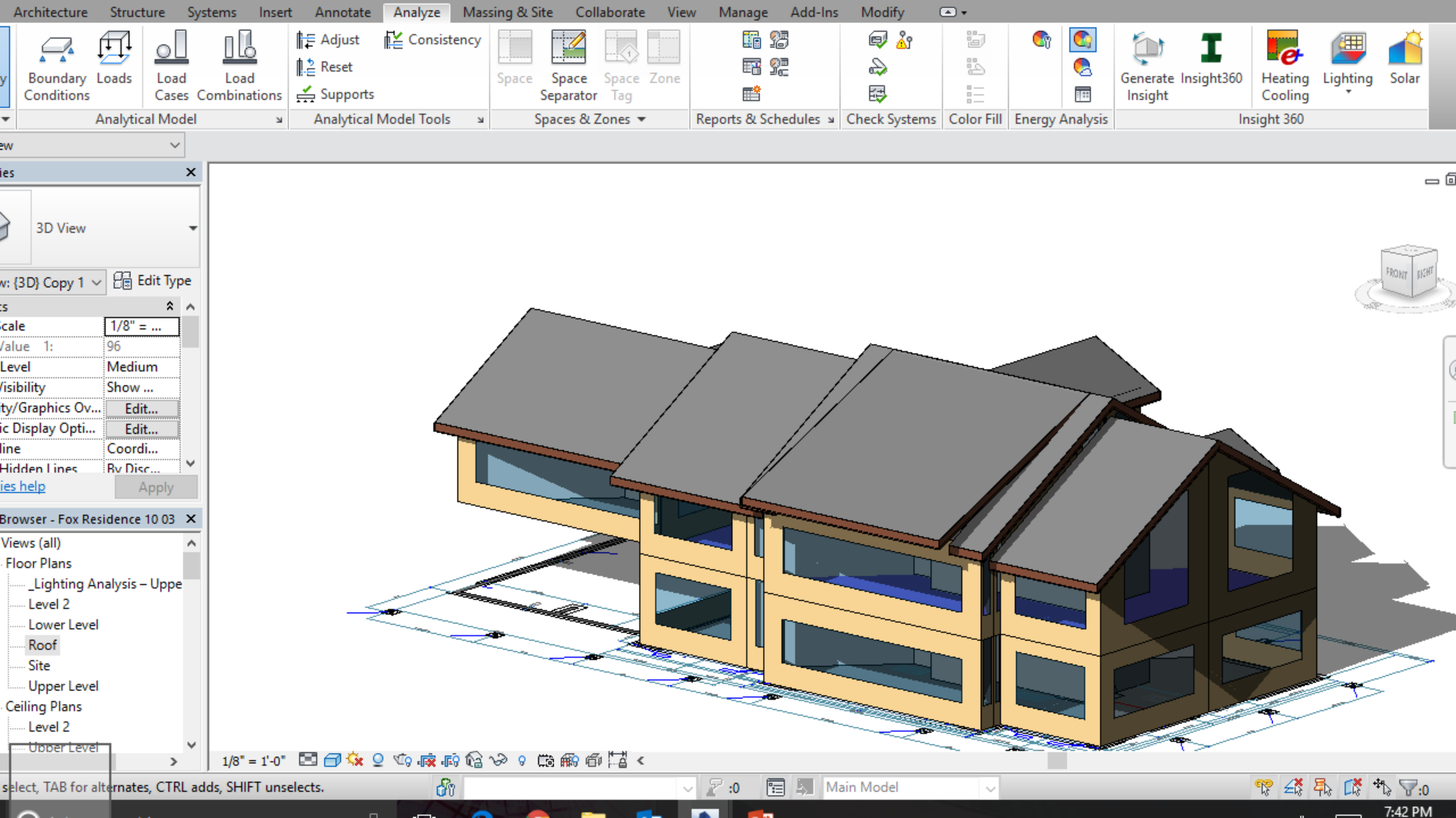
7:44 PM
10/30/2016


Fox Residence 10 03 - 3D View: {3D} Copy 1
Type a keyword or phrase
jgardze1
Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Modify
Modify
Select
Properties
Paste
Clipboard
Cope
Cut
Join
Geometry
Modify
View
Measure
Create
3D ew
Properties
3D View
3D View: {3D} Copy 1
Edit Type
Graphics
View Scale
1/8" = ...
Scale Value 1:
96
Detail Level
Medium
Parts Visibility
Show ...
Visibility/Graphics Ov...
Edit...
Graphic Display Opti...
Edit...
Discipline
Coordi...
Show Hidden Lines
By Disc...
Properties help
Apply
Project Browser - Fox Residence 10 03
Views (all)
Floor Plans
_Lighting Analysis – Uppe
Level 2
Lower Level
Roof
Site
Upper Level
Ceiling Plans
Level 2
Upper Level
1/8" = 1'-0"
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.
:0
Main Model
:0
Ask me anything
7:23 PM
10/30/2016


Fox Residence 10 03 - 3D View: {3D} Copy 1
Type a keyword or phrase
jgardze1
Create
Insert
View
Manage
Add-Ins
Modify
Modify
Model
Reference
Plane
Set
Show
Viewer
Paste
Cut
Join
Finish Mass
Cancel Mass
Select
Properties
Draw
Work Plane
Clipboard
Geometry
Modify
Measure
In-Place Editor
Multiple Join
Properties
Family: Mass
Edit Type
Constraints
Host
Identity Data
OmniClass Number
OmniClass Title
Properties help
Apply
Project Browser - Fox Residence 10 03
Elevations (Building Elevation
East
North
South
West
Sections (Building Section)
Section 8
Section 9
Section 10
Section 11
Section 12
FRONT
Form : Form Element
1/8" = 1'-0"
Form : Form Element
Ask me anything
7:36 PM
10/30/2016


Fox Residence 10 03 - 3D View: {3D} Copy 1
Type a keyword or phrase
jgardze1
Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Modify
Modify
Select
Properties
Paste
Clipboard
Cope
Cut
Join
Geometry
Modify
View
Measure
Create
3D
Properties
3D View
3D View: {3D} Copy 1
Edit Type
Graphics
View Scale
1/8" = ...
Scale Value 1:
96
Detail Level
Medium
Parts Visibility
Show ...
Visibility/Graphics Ov...
Edit...
Graphic Display Opti...
Edit...
Discipline
Coordi...
Show Hidden Lines
By Disc...
Properties help
Apply
Project Browser - Fox Residence 10 03
Views (all)
Floor Plans
_Lighting Analysis – Uppe
Level 2
Lower Level
Roof
Site
Upper Level
Ceiling Plans
Level 2
Upper Level
FRONT
RIGHT
1/8" = 1'-0"
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.
Main Model
Ask me anything
7:41 PM
10/30/2016


Fox Residence 10 03 - 3D View: {3D} Copy 1
Type a keyword or phrase
jgardze1
Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Modify
Modify
Boundary Conditions
Loads
Load Cases
Load Combinations
Adjust
Consistency
Reset
Supports
Select
Analytical Model
Analytical Model Tools
Energy Analysis
Generate Insight
Insight360
Heating Cooling
Lighting
Solar
Insight 360
3D
Properties
3D View
3D View: {3D} Copy 1
Edit Type
Graphics
View Scale
1/8" = ...
Scale Value 1:
96
Detail Level
Medium
Parts Visibility
Show ...
Visibility/Graphics Ov...
Edit...
Graphic Display Opti...
Edit...
Discipline
Coordi...
Show Hidden Lines
By Disc...
Properties help
Apply
Project Browser - Fox Residence 10 03
Views (all)
Floor Plans
_Lighting Analysis – Uppe
Level 2
Lower Level
Roof
Site
Upper Level
Ceiling Plans
Level 2
Upper Level
Energy Settings
Parameter
Value
Common
Building Type
Single Family
Location
175 W Powerline Rd, Pavillion, WY 8
Ground Plane
Lower Level
Detailed Model
Export Category
Rooms
Export Complexity
Simple with Shading Surfaces
Include Thermal Properties
Project Phase
New Construction
Sliver Space Tolerance
1' 0"
Building Envelope
Use Function Parameter
Analytical Grid Cell Size
3' 0"
Energy Model
Analysis Mode
Use Conceptual Masses
Analytical Space Resolution
1' 6"
Analytical Surface Resolution
1' 0"
Core Offset
12' 0"
Divide Perimeter Zones
Conceptual Constructions
Edit...
Target Percentage Glazing
40%
Target Sill Height
2' 6"
OK
Cancel
FRONT
RIGHT
1/8" = 1'-0"
Ready
Main Model
Ask me anything
7:41 PM
10/30/2016


Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Modify
Boundary Conditions
Loads
Load Cases
Load Combinations
Analytical Model
Adjust
Reset
Supports
Consistency
Analytical Model Tools
Space
Space Separator
Space Tag
Zone
Spaces & Zones
Reports & Schedules
Check Systems
Color Fill
Energy Analysis
Generate Insight
Insight360
Heating Cooling
Lighting
Solar
Insight 360
3D View
Edit Type
Scale
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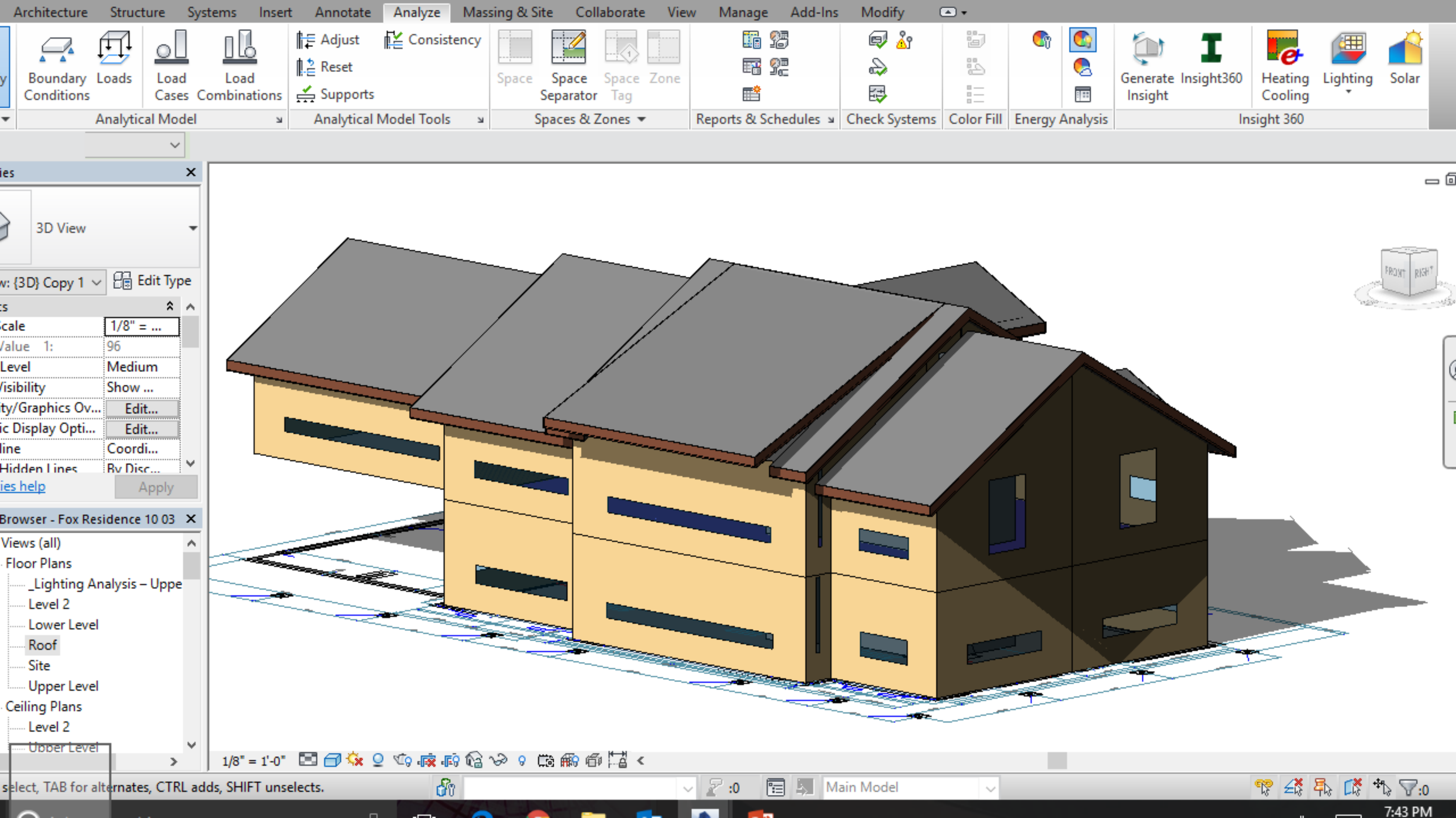
Value 1:
96
Level
Medium
Visibility
Show ...
Edit...
Edit...
Coordi...
Apply
Browser - Fox Residence 10 03
Views (all)
Floor Plans
_Lighting Analysis – Uppe
Level 2
Lower Level
Roof
Site
Upper Level
Ceiling Plans
Level 2
FRONT
RIGHT
1/8" = 1'-0"
Main Model


Architecture
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Massing & Site
Collaborate
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Add-Ins
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Boundary Conditions
Loads
Load Cases
Load Combinations
Analytical Model
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Supports
Consistency
Analytical Model Tools
Space
Space Separator
Space Tag
Zone
Spaces & Zones
Reports & Schedules
Check Systems
Color Fill
Energy Analysis
Generate Insight
Insight360
Heating Cooling
Lighting
Solar
Insight 360
3D View
Edit Type
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1/8" = ...
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96
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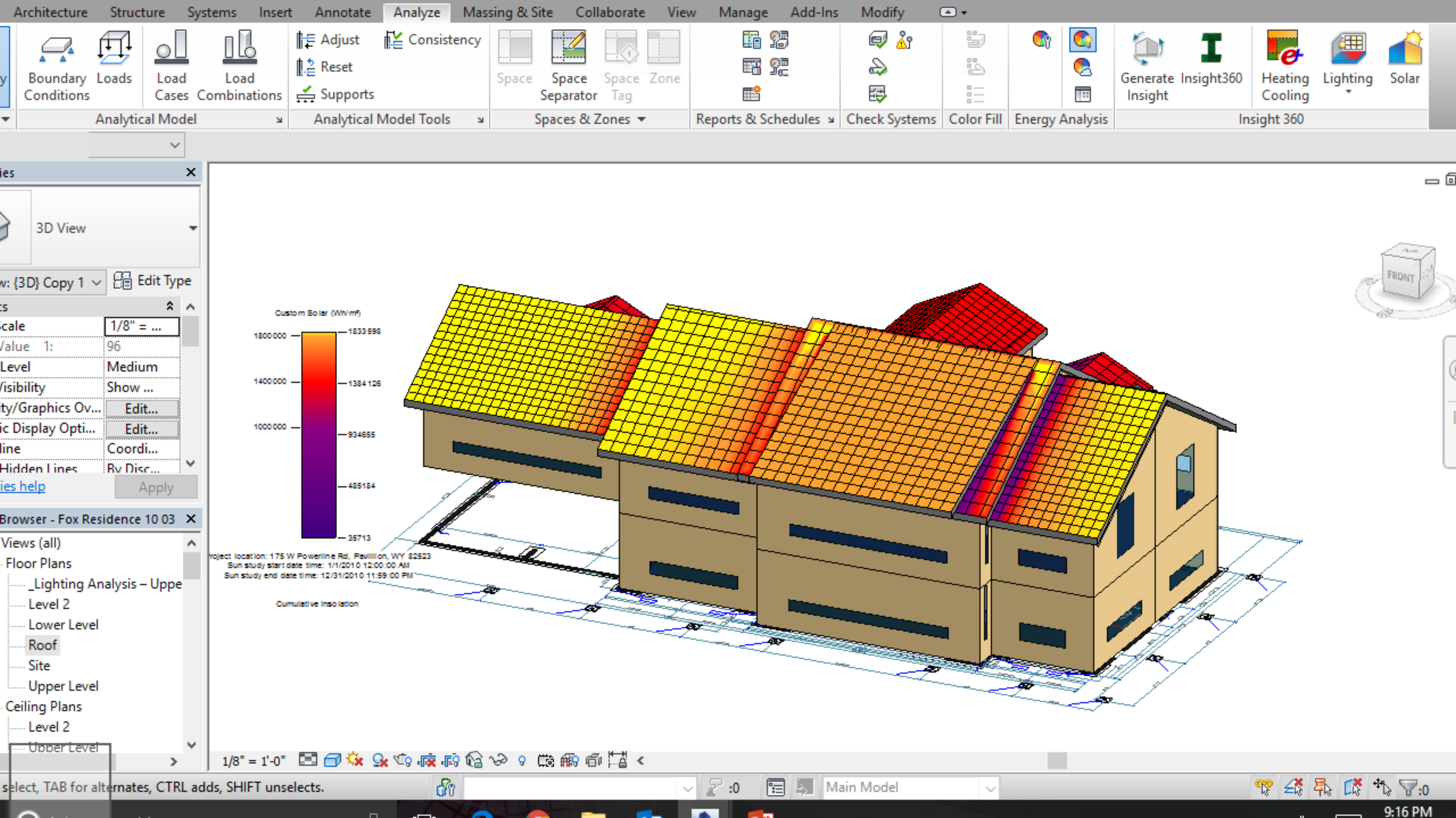
Apply
Browser - Fox Residence 10 03
Views (all)
Floor Plans
_Lighting Analysis – Uppe
Level 2
Lower Level
Roof
Site
Upper Level
Ceiling Plans
Level 2
1/8" = 1'-0"
Main Model


Architecture
Structure
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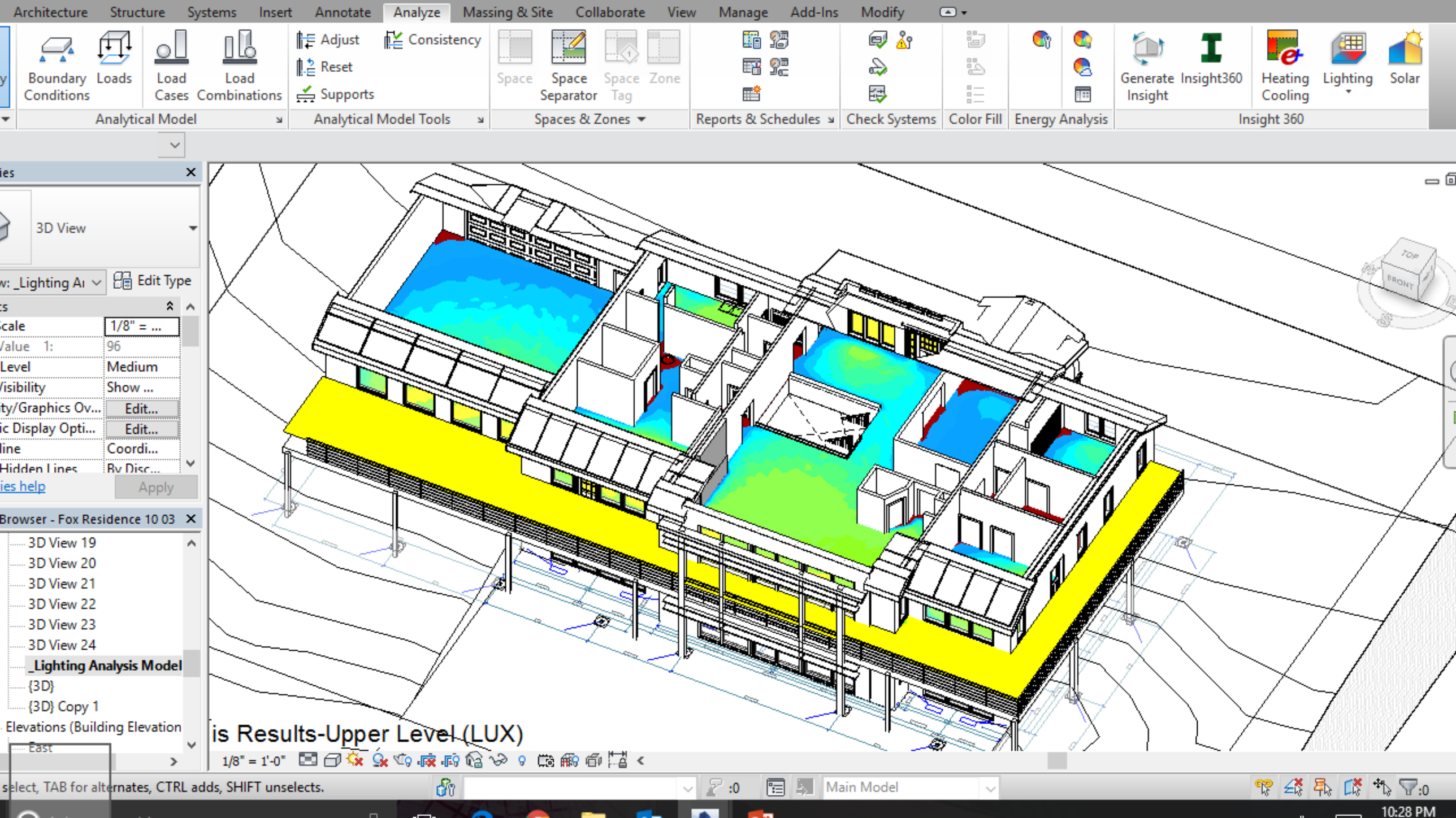
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Modify
Boundary Conditions
Loads
Load Cases
Load Combinations
Analytical Model
Adjust
Reset
Supports
Consistency
Analytical Model Tools
Space
Space Separator
Space Tag
Zone
Spaces & Zones
Reports & Schedules
Check Systems
Color Fill
Energy Analysis
Generate Insight
Insight360
Heating Cooling
Lighting
Solar
Insight 360
3D View
Edit Type
Scale
1/8" = ...
Value 1:
96
Level
Medium
Visibility
Show ...
Edit...
Edit...
Coordi...
Apply
Browser - Fox Residence 10 03
Views (all)
Floor Plans
_Lighting Analysis – Uppe
Level 2
Lower Level
Roof
Site
Upper Level
Ceiling Plans
Level 2
Custom Solar (Wh/m²)
1800000
1400000
1000000
1833598
1384126
934655
485184
35713
Project location: 175 W Powerline Rd, Pavillion, WY 82523
Sun study start date time: 1/1/2010 12:00:00 AM
Sun study end date time: 12/31/2010 11:59:00 PM
Cumulative Insolation
FRONT
1/8" = 1'-0"
Main Model
9:16 PM


Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Modify
Boundary Conditions
Loads
Load Cases
Load Combinations
Analytical Model
Adjust
Reset
Supports
Consistency
Analytical Model Tools
Space
Space Separator
Space Tag
Zone
Spaces & Zones
Reports & Schedules
Check Systems
Color Fill
Energy Analysis
Generate Insight
Insight360
Heating Cooling
Lighting
Solar
Insight 360
3D View
Edit Type
Scale
1/8" = ...
Value 1:
96
Level
Medium
Visibility
Show ...
Edit...
Edit...
Coordi...
Apply
Browser - Fox Residence 10 03
3D View 19
3D View 20
3D View 21
3D View 22
3D View 23
3D View 24
_Lighting Analysis Model
{3D}
{3D} Copy 1
Elevations (Building Elevation
East
is Results-Upper Level (LUX)
1/8" = 1'-0"
select, TAB for alternates, CTRL adds, SHIFT unselects.
Main Model
10:28 PM

Interoperability

Export both detailed and mass gbxml

Fox Residence 10 03 - 3D View: 3D Energy M...

Type a keyword or phrase

jgardze1

Architecture | Structure | Systems | Insert | Annotate | Analyze | Massing & Site | Collaborate | View | Manage | Add-Ins | Modify

Modify | Boundary Conditions | Loads | Load Cases | Load Combinations | Adjust | Reset | Supports | Consistency | Space | Space Separator | Space Tag | Zone | Generate Insight | Insight360 | Heating Cooling | Lighting | Solar

Select | Analytical Model | Analytical Model Tools | Spaces & Zones | Reports & Schedules | Check Systems | Color Fill | Energy Analysis | Insight 360

3D

Properties

3D View

3D View: 3D Energy M | Edit Type

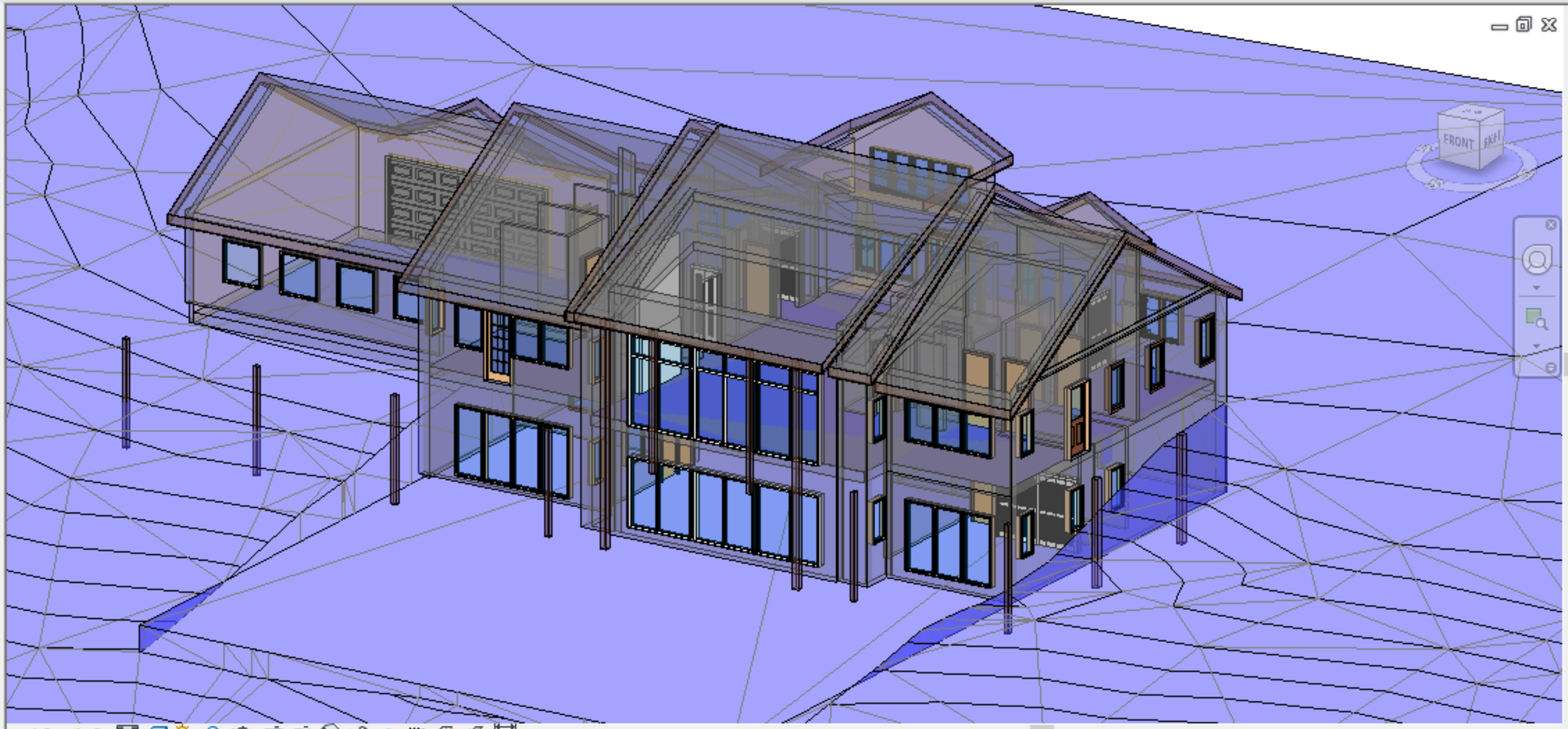
Graphics

View Scale	1/8" = ...
Scale Value 1:	96
Detail Level	Medium
Parts Visibility	Show ...
Visibility/Graphics Ov...	Edit...
Graphic Display Opti...	Edit...
Discipline	Coordi...
Show Hidden Lines	By Disc...

Properties help | Apply

Project Browser - Fox Residence 10 03

- Views (all)
  - Floor Plans
    - _Lighting Analysis – Uppe
    - Level 2
    - Lower Level
    - Roof
    - Site
    - Upper Level
  - Ceiling Plans
    - Level 2
    - Upper Level



1/8" = 1'-0"

Click to select, TAB for alternates, CTRL adds, SHIFT unselects.

:0 | Main Model | :0

Ask me anything

7:44 PM
10/30/2016

DesignBuilder - Untitled 1.dsb - Layout - Untitled, Building 1

File Edit Go View Tools Help

View rotation: Axonometric | Normal

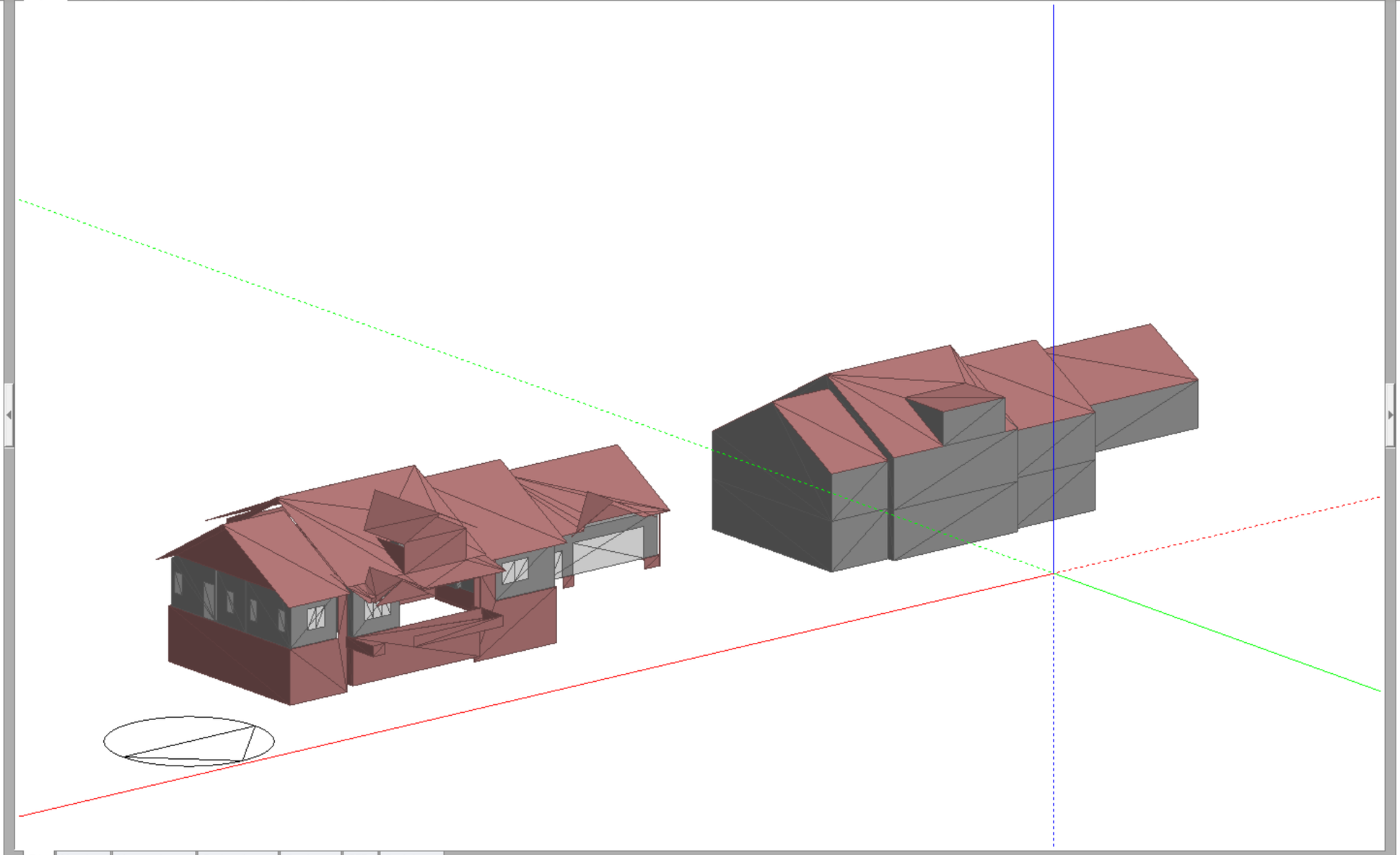
Navigate, Site

Site

- Untitled
  - Building 1
    - Block 1
      - 2 Bath 1
    - Block 10
      - Zone 1
    - Block 2
      - Zone 1
    - Block 3
      - Zone 1
    - Block 4
      - Zone 1
    - Block 5
      - Zone 1
    - Block 6
      - Zone 1
    - Block 7
      - Zone 1
    - Block 8
      - Mass Zone
    - Block 9
      - Zone 1
    - Shading plane 00
    - Shading plane 00
    - Shading plane 00
    - Shading plane 00
    - Shading plane 00
    - Shading plane 00
    - Shading plane 00
    - Shading plane 00
    - Shading plane 00
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 02
    - Shading plane 02
    - Shading plane 02
    - Shading plane 02
    - Shading plane 02
    - Shading plane 02
    - Shading plane 02
    - Shading plane 02
    - Shading plane 02
    - Shading plane 02
    - Shading plane 03

Untitled, Building 1

Layout | Activity | Construction | Openings | Lighting | HVAC | CFD | Options



Edit | Visualise | Heating design | Cooling design | Simulation | CFD | Daylighting

Info, Help

Help | Data

Edit Building Layout

Use this screen to add, edit or delete blocks in the current building. You can also copy, move or delete openings.

Import 2-D drawing file

Import 3-D CAD model

Add block to draw a new block

To change the dimensions of an existing block, you must first select the block you want to work with. Then use one of the 'Cut', 'Drag face' or 'Stretch' commands.

To add or edit partitions or to draw void perimeters such as courtyards you should go to the block first by double-clicking on it.

Navigation

Go to block level by double-clicking on the appropriate block in the Model view or single-clicking on the block in the Navigator list.

Load data (new building defaults)

Edit building layout - add, edit or delete blocks in the current building...

X = 107.151ft Y = 69.548ft Z = 0.000ft

Ask me anything

10:55 PM
11/1/2016

DesignBuilder - Untitled 1.dsb - Layout - Untitled, Building 1

File Edit Go View Tools Help

View rotation: Axonometric | Normal

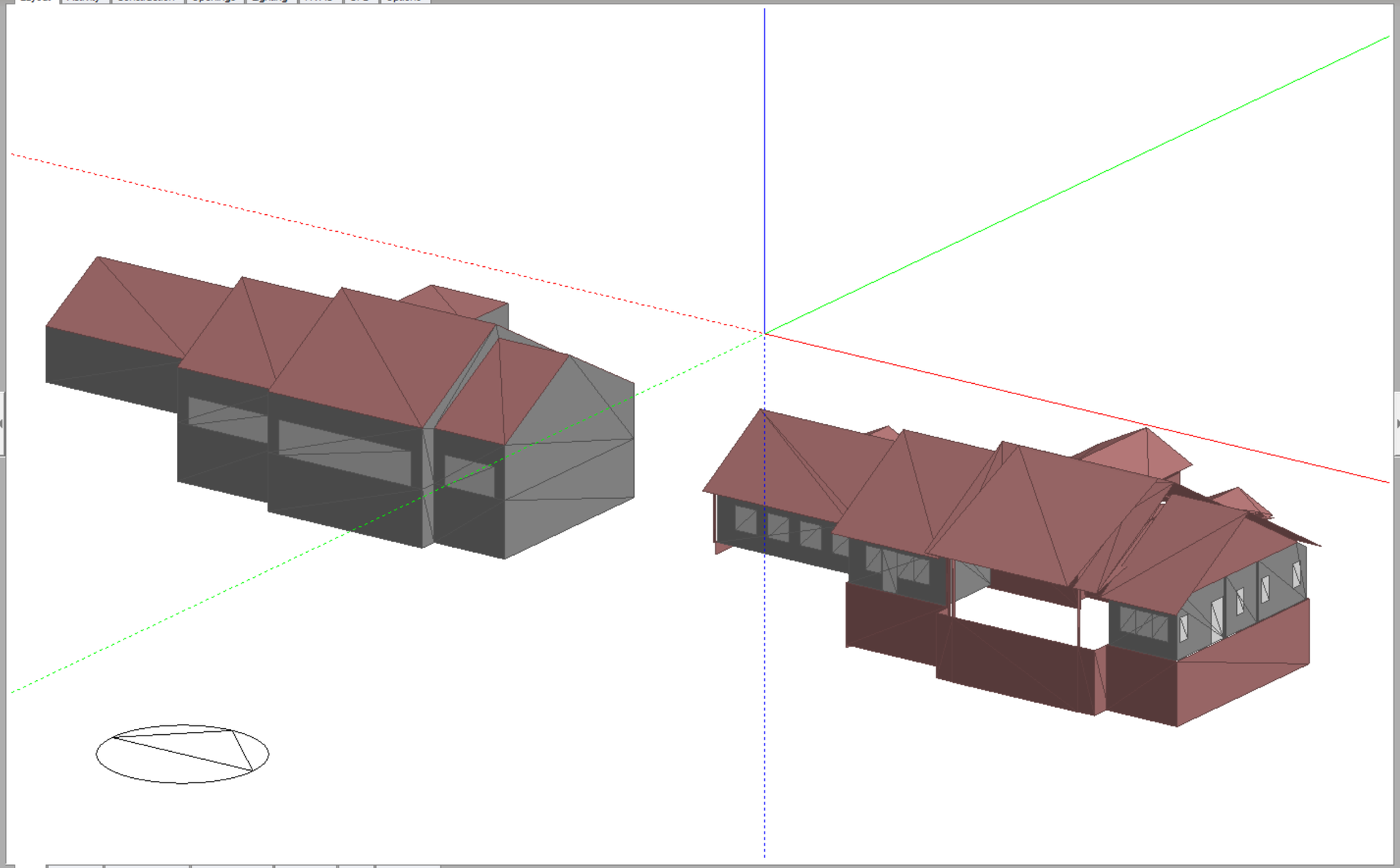
Navigate, Site

Site

- Untitled
  - Building 1
    - Block 1
      - 2 Bath 1
    - Block 10
      - Zone 1
    - Block 2
      - Zone 1
    - Block 3
      - Zone 1
    - Block 4
      - Zone 1
    - Block 5
      - Zone 1
    - Block 6
      - Zone 1
    - Block 7
      - Zone 1
    - Block 8
      - Mass Zone
    - Block 9
      - Zone 1
    - Shading plane 00
    - Shading plane 00
    - Shading plane 00
    - Shading plane 00
    - Shading plane 00
    - Shading plane 00
    - Shading plane 00
    - Shading plane 00
    - Shading plane 00
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 01
    - Shading plane 02
    - Shading plane 02
    - Shading plane 02
    - Shading plane 02
    - Shading plane 02
    - Shading plane 02
    - Shading plane 02
    - Shading plane 02
    - Shading plane 02
    - Shading plane 02
    - Shading plane 03

Untitled, Building 1

Layout | Activity | Construction | Openings | Lighting | HVAC | CFD | Options



Edit | Visualise | Heating design | Cooling design | Simulation | CFD | Daylighting

Info, Help

Help | Data

Edit Building Layout

Use this screen to add, edit or delete blocks in the current building. You can also copy, move or delete openings.

Import 2-D drawing file

Import 3-D CAD model

Add block to draw a new block

To change the dimensions of an existing block, you must first select the block you want to work with. Then use one of the 'Cut', 'Drag face' or 'Stretch' commands.

To add or edit partitions or to draw void perimeters such as courtyards you should go to the block first by double-clicking on it.

Navigation

Go to block level by double-clicking on the appropriate block in the Model view or single-clicking on the block in the Navigator list.

Load data (new building defaults)

Edit building layout - add, edit or delete blocks in the current building...

X = 37.268ft Y = 50.662ft Z = 0.000ft

Ask me anything

10:57 PM
11/1/2016

DesignBuilder - Pavilion.dsb - Layout - Untitled, Building 1

File Edit Go View Tools Help

View rotation: Axonometric | Normal

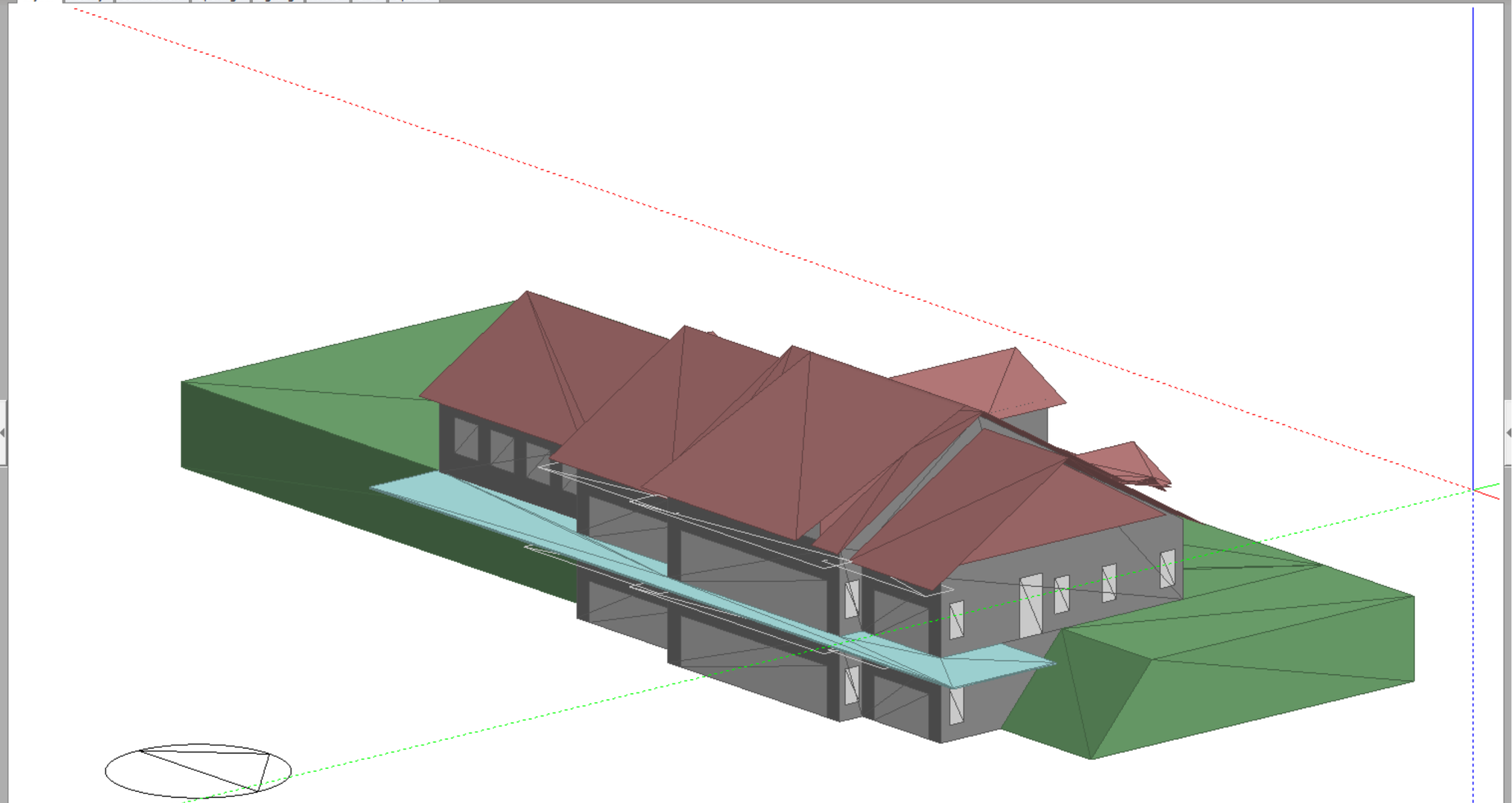
Navigate, Site

Site

- Untitled
  - **Building 1**
    - Basment
      - **Mass Zone - Mass 1 : Lower Level**
    - Component block 1
    - Component block 2
    - Component block 3
    - Garage
      - **Zone 1**
    - Level 1
      - **Zone 1**
        - Floor - 2178.65 ft2
        - Wall - 368.19 ft2 - 0.0°
          - External - 266.86 ft2
          - Window (External) 8.00 ft2
          - Window (External) 8.00 ft2
          - Window (External) 8.00 ft2
          - Window (External) 12.00 ft2
          - Window (External) 12.00 ft2
          - Door (External) 13.33 ft2
          - Window (External) 8.00 ft2
          - Window (External) 8.00 ft2
          - Window (External) 8.00 ft2
          - Window (External) 8.00 ft2
          - Window (External) 8.00 ft2
        - Wall - 130.42 ft2 - 90.0°
        - Wall - 130.42 ft2 - 270.0°
        - Wall - 168.60 ft2 - 0.0°
        - Wall (with hole) - 123.20 ft2, 270.0°
        - Wall - 168.60 ft2 - 180.0°
        - Wall - 277.36 ft2 - 180.0°
        - Wall - 115.96 ft2 - 180.0°
        - Wall - 457.61 ft2 - 90.0°
        - Wall - 115.96 ft2 - 0.0°
        - External roof - 30° Slope 446.10 ft2
        - Wall - 37.49 ft2 - 270.0°
        - Wall - 37.49 ft2 - 90.0°
        - Roof - 159.03 ft2
        - External roof - 29° Slope 253.81 ft2
        - External roof - 29° Slope 253.81 ft2
        - External roof - 30° Slope 629.24 ft2
        - External roof - 29° Slope 369.04 ft2
        - External roof - 29° Slope 369.04 ft2
        - Inter-block partition - 334.40 ft2 (Garage, Zone 1)
    - Shading plane 001
    - Shading plane 002
    - Shading plane 003
    - Shading plane 004
    - Shading plane 005
    - Shading plane 006
    - Shading plane 007
    - Shading plane 008
    - Shading plane 009

Untitled, Building 1

Layout | Activity | Construction | Openings | Lighting | HVAC | CFD | Options



Edit | Visualise | Heating design | Cooling design | Simulation | CFD | Daylighting

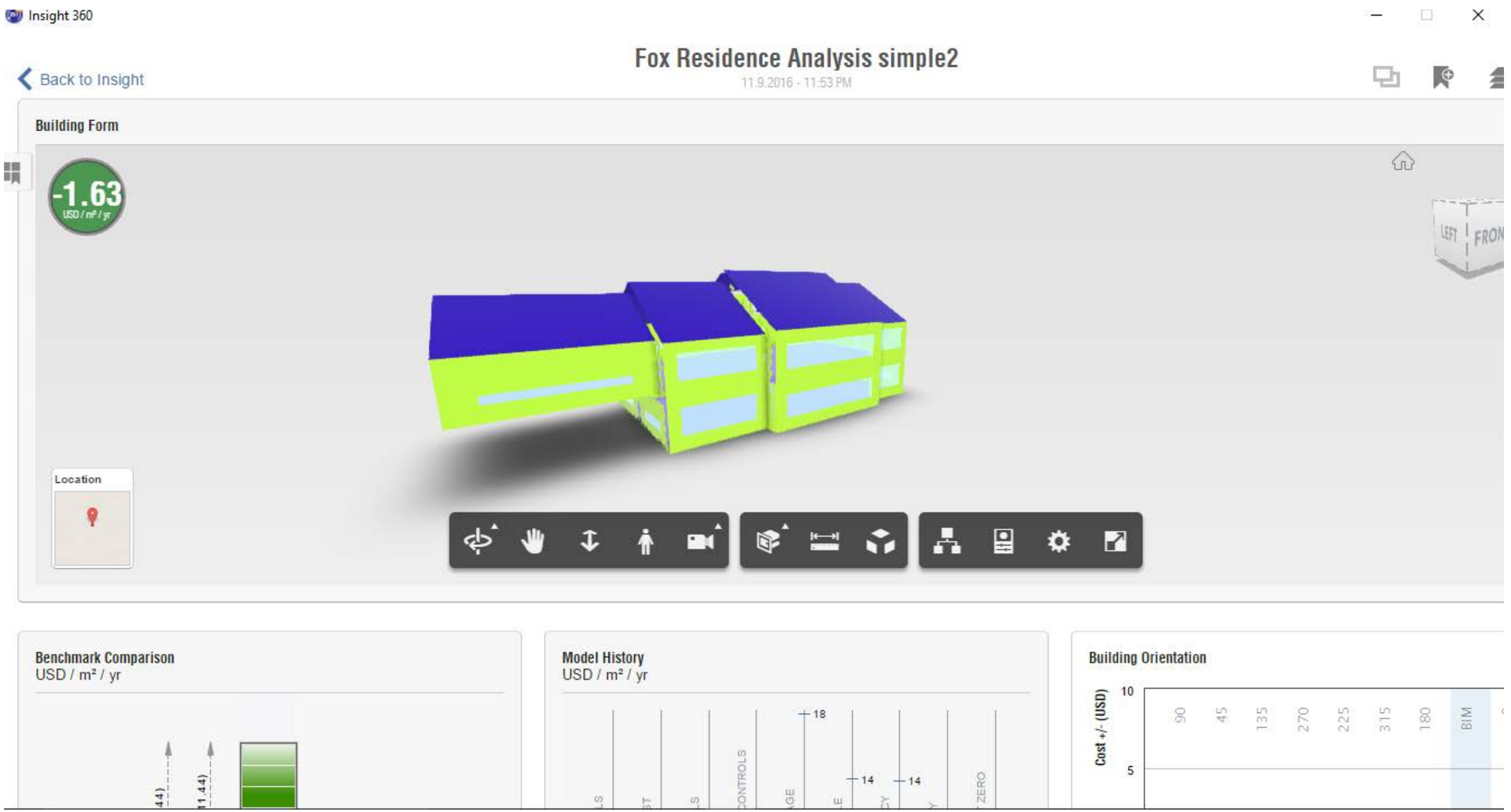
Edit building layout - add, edit or delete blocks in the current building...

X = -65.796ft Y = -48.573ft Z = -33.989ft

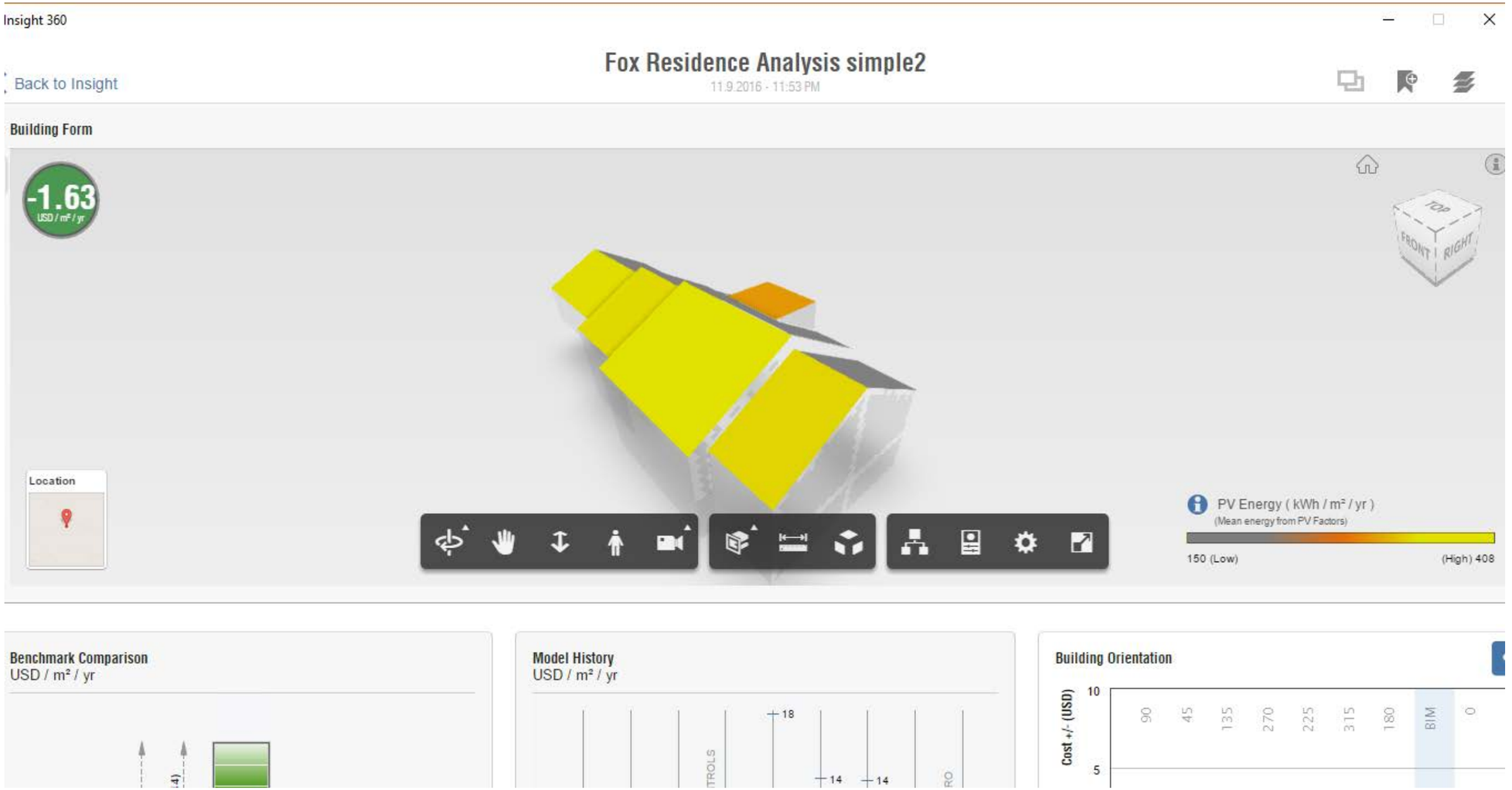
Ask me anything

2:40 AM 11/2/2016

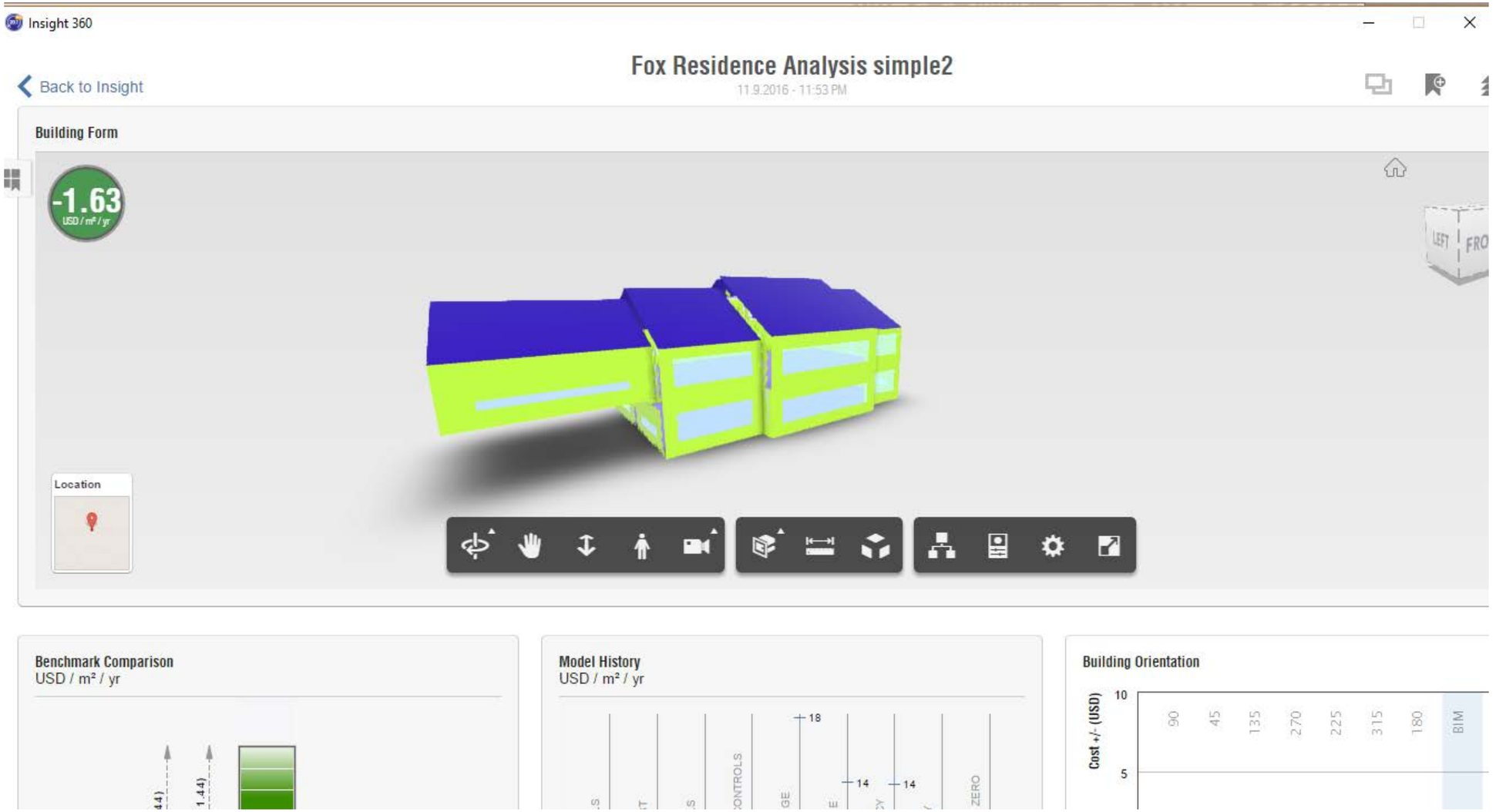
Insight 360


Insight 360
Back to Insight
Fox Residence Analysis simple2
11.9.2016 - 11:53 PM
Building Form
-1.63
USD / m² / yr
Location
Benchmark Comparison
USD / m² / yr
Model History
USD / m² / yr
18
14
14
Building Orientation
Cost +/- (USD)
10
5
90
45
135
270
225
315
180
BIM

Insight 360


Insight 360
Back to Insight
Fox Residence Analysis simple2
11.9.2016 - 11:53 PM
Building Form
-1.63
USD / m² / yr
Location
PV Energy (kWh / m² / yr)
(Mean energy from PV Factors)
150 (Low)
(High) 408
Benchmark Comparison
USD / m² / yr
Model History
USD / m² / yr
Building Orientation
Cost +/- (USD)
10
5
90
45
135
270
225
315
180
BIM
0

Tool Should Teach you the Fundamentals



Insight 360 Does That

Insight 360

area) interacts with window properties to impact daylighting, heating & cooling.

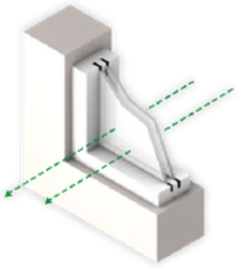
Current Setting:
30%

impact depends on other factors, such as window size and solar heat gain properties.

Current Setting:
2/3 Win Height

heat transfer & solar heat gain into the building, along with other factors.

Current Setting:
Trp LoE



WWR - Western Walls

Window-Wall-Ratio (glazing area / gross wall area) interacts with window properties to impact daylighting, heating & cooling.

Current Setting:
15%

Window Shades - West

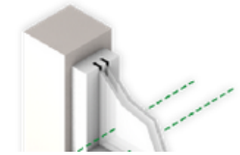
Shades can reduce HVAC energy use. The impact depends on other factors, such as window size and solar heat gain properties.

Current Setting:
2/3 Win Height

Window Glass - West

Glass properties control the amount of daylight, heat transfer & solar heat gain into the building, along with other factors.

Current Setting:
Trp LoE



Part III

It’s the economy, stupid

Retrofit existing roofs
But how much will it cost?


PV Prices
2007
$3.50/watt
2013
$0.64/watt

ebay Shop by category | Search... | All Categories | Sea

Back to home page | Listed in category: Home & Garden > Home Improvement > Electrical & Solar > Alternative & Solar Energy > Solar Panels > See more Framed 320w Watts 24v Volts Polycrystalline So...

New Framed 320W Watts 24V Volts Polycrystalline Solar Panel Made In USA!

New; $0.37/watt Ships Next Business Day; 2K Units Sold!

218 viewed per day ★★★★★ 1 product rating

Item condition: **New**

Quantity: 1 More than 10 available / **544 sold**

Price: **US $119.00**

Buy It Now

Add to cart

Best Offer: **Make Offer**

529 watching

Add to watch list

Add to collection

544 sold	More than 76% sold	25 inquiries

| Add

Seller information

minidiscmini (8971 ★) me

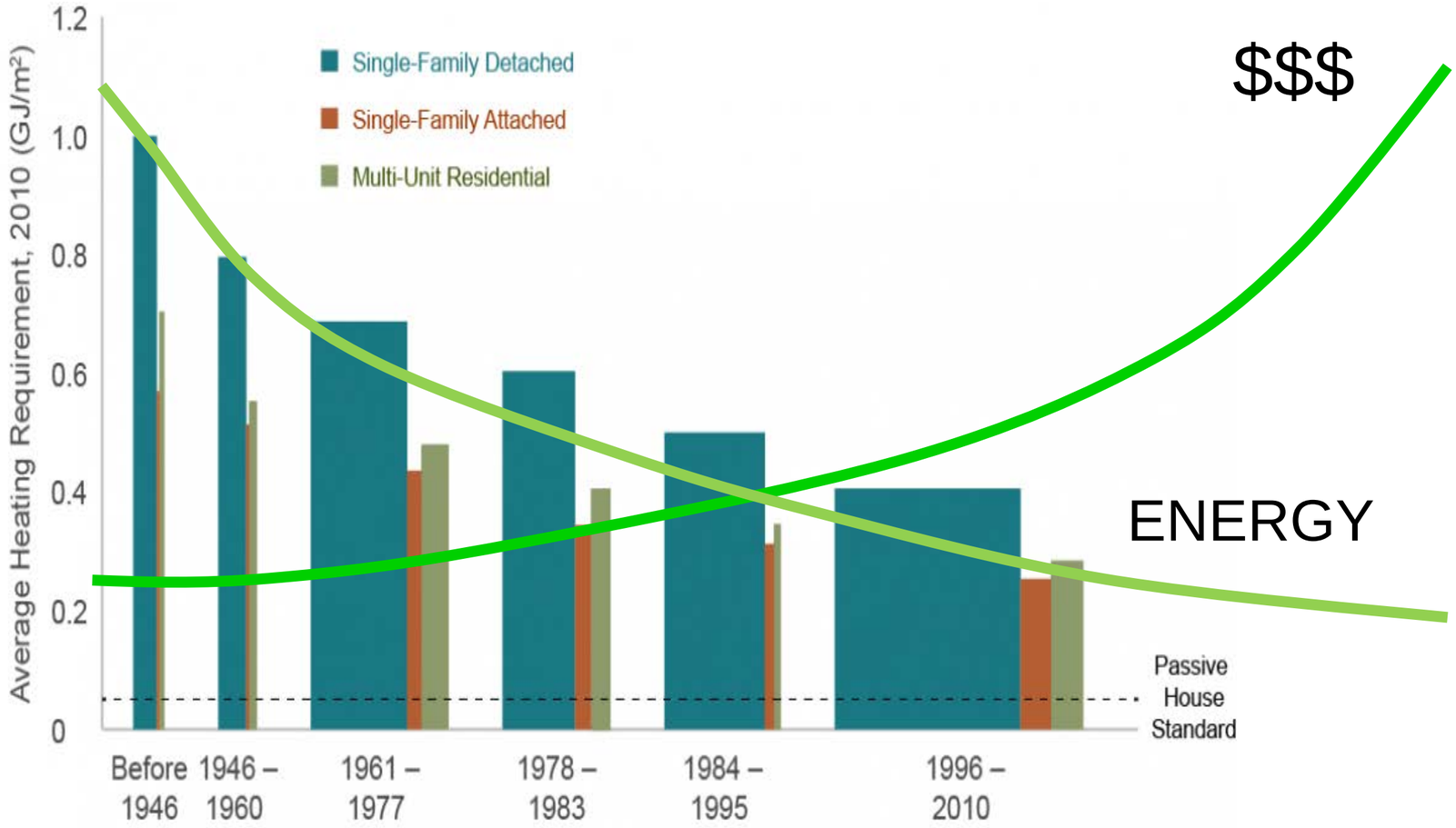
100% Positive feedback

Follow this seller

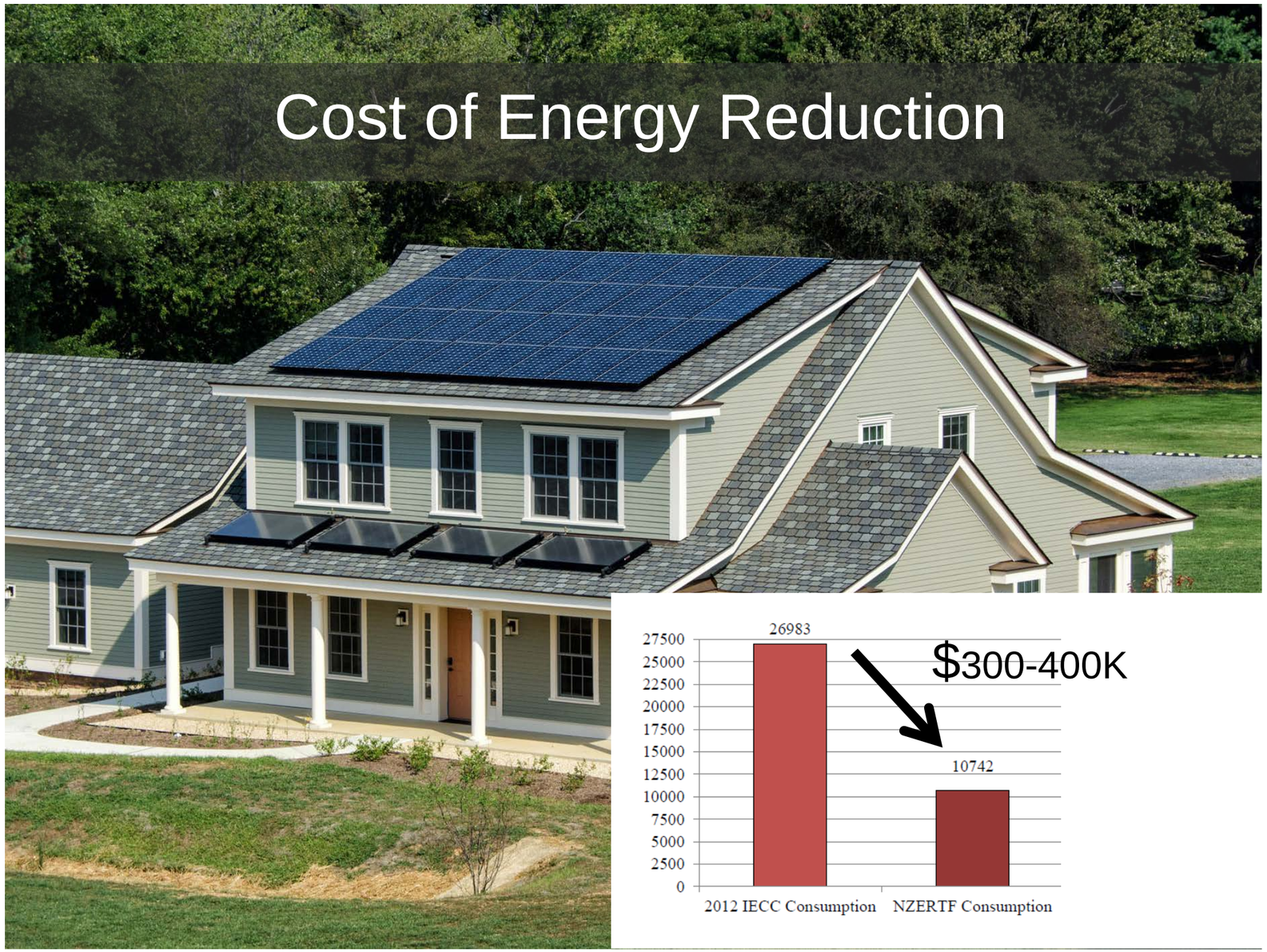
Visit store: Solarblvd

See other items

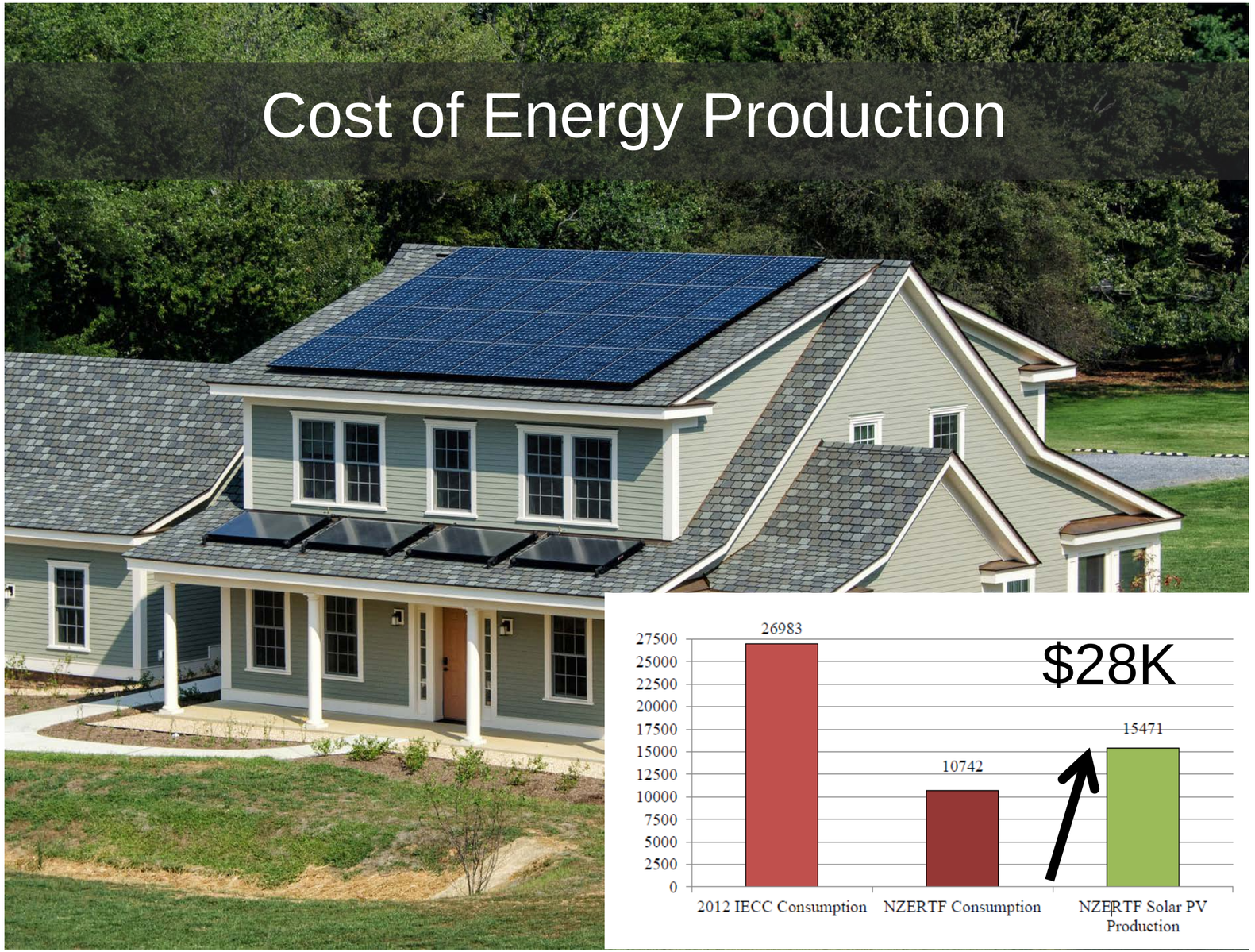
Meanwhile, Reduction is Costly

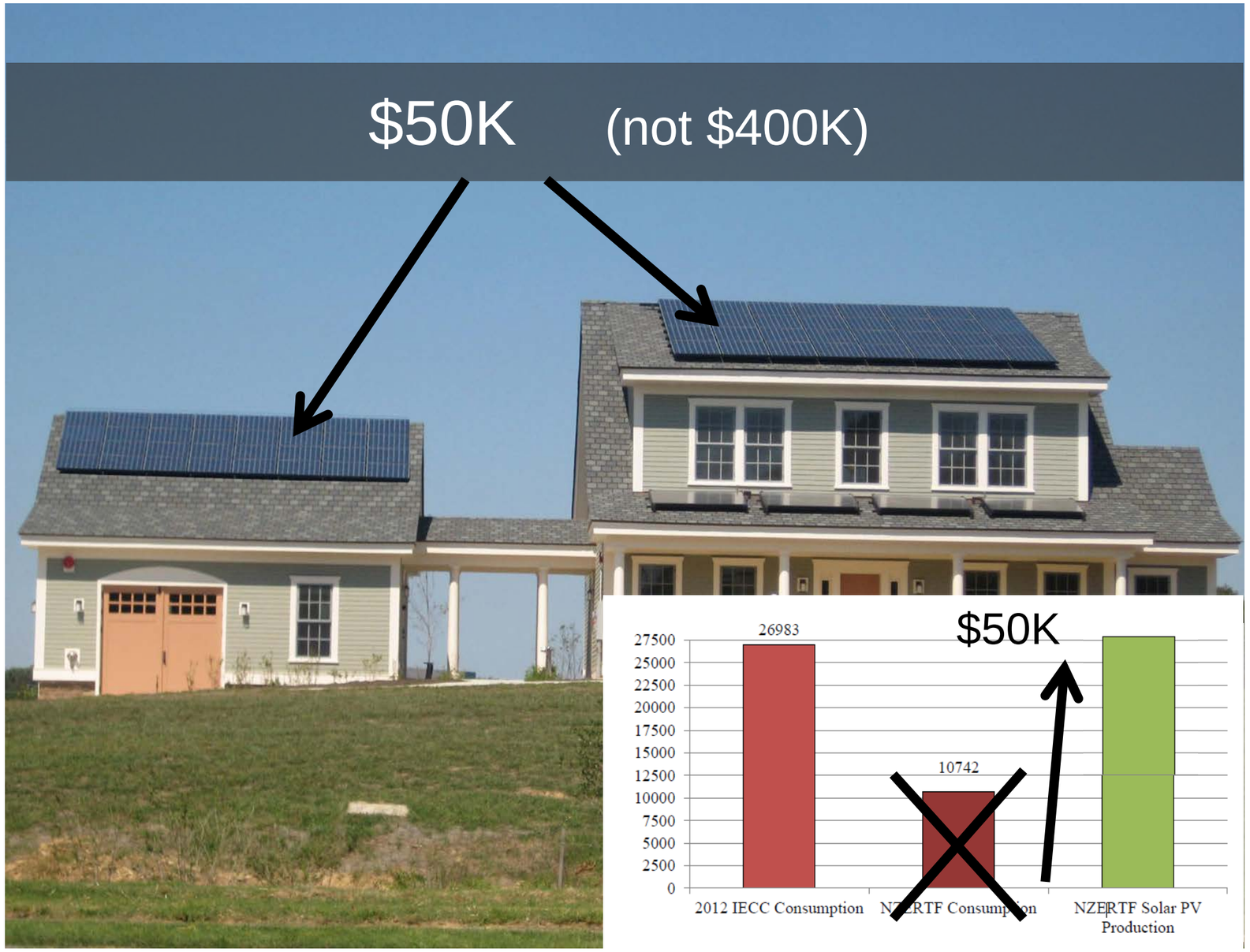


Cost of Energy Reduction

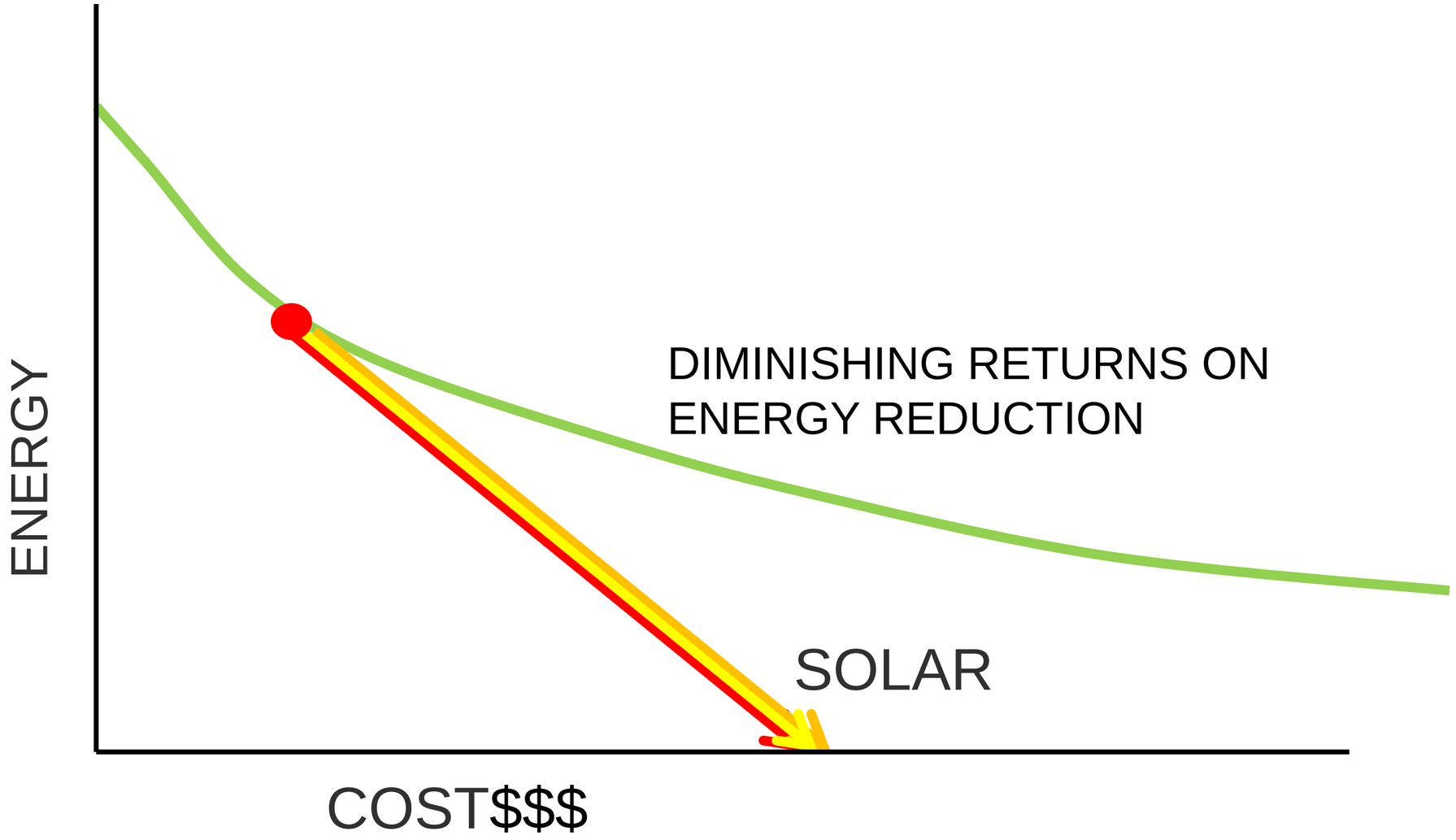


Cost of Energy Production




$50K
(not $400K)
$50K
26983
10742
27500
25000
22500
20000
17500
15000
12500
10000
7500
5000
2500
0
2012 IECC Consumption
NZERTF Consumption
NZERTF Solar PV Production

SOLAR MAKES ENE



Solar Thermal Problem:

Solar Energy is most available when it is least needed

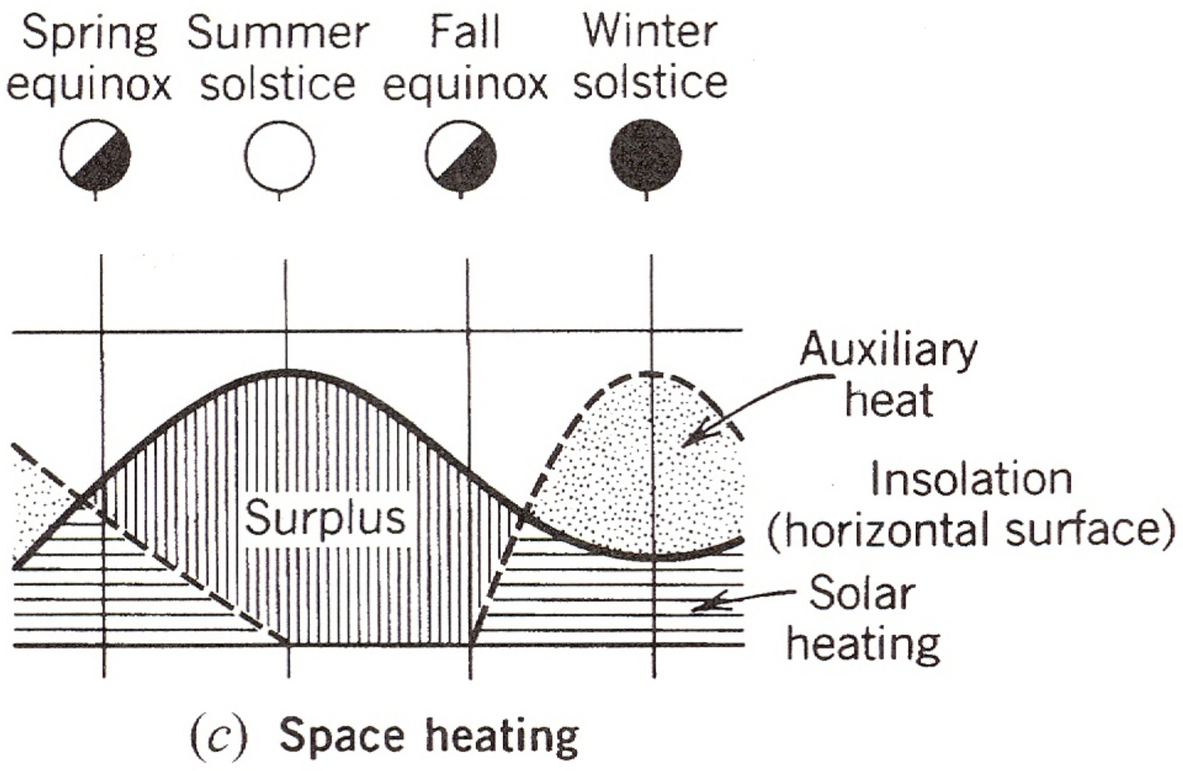
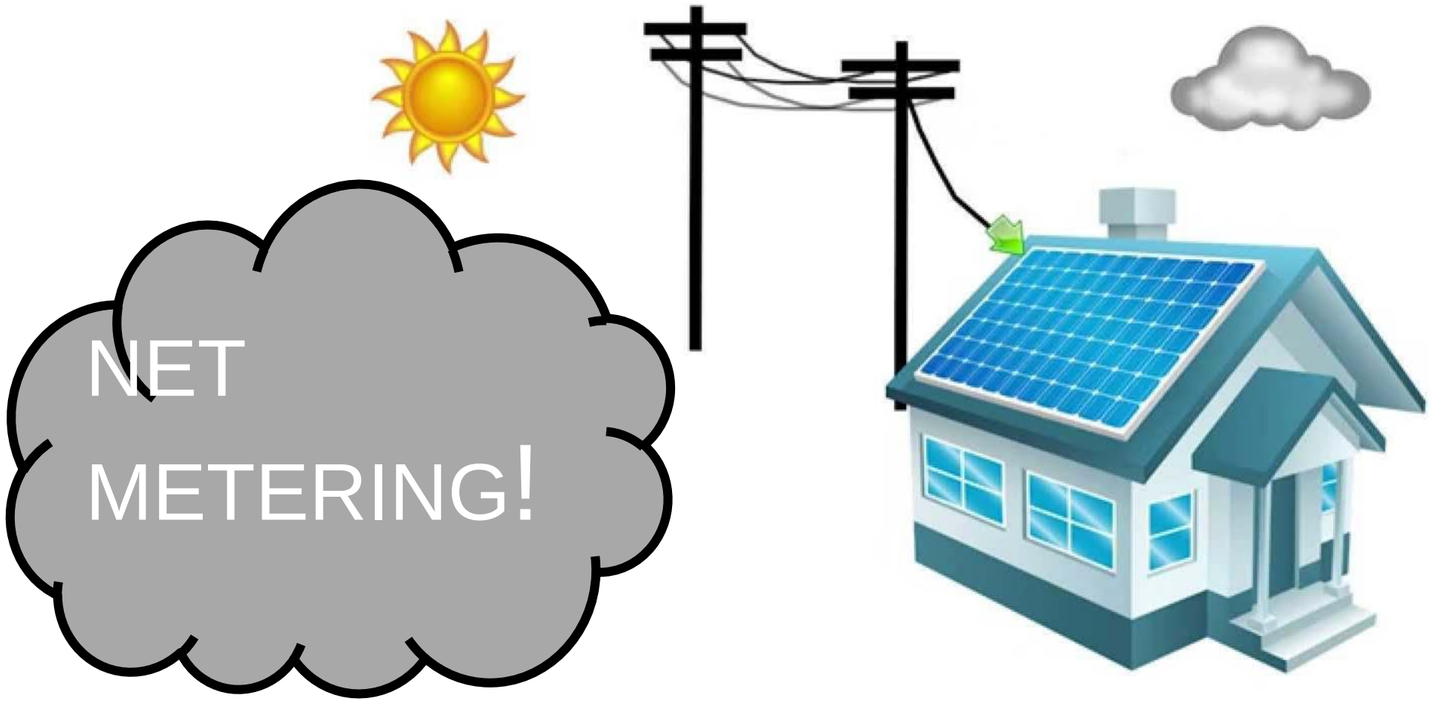
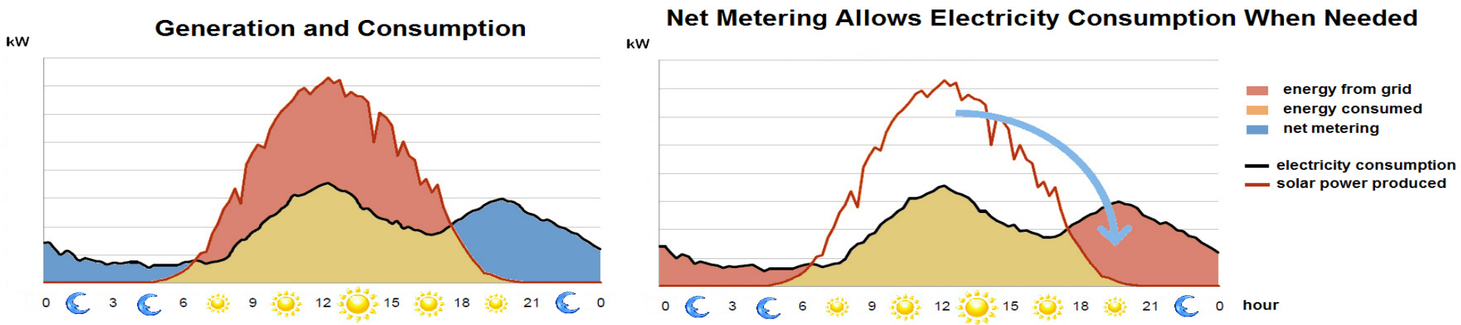


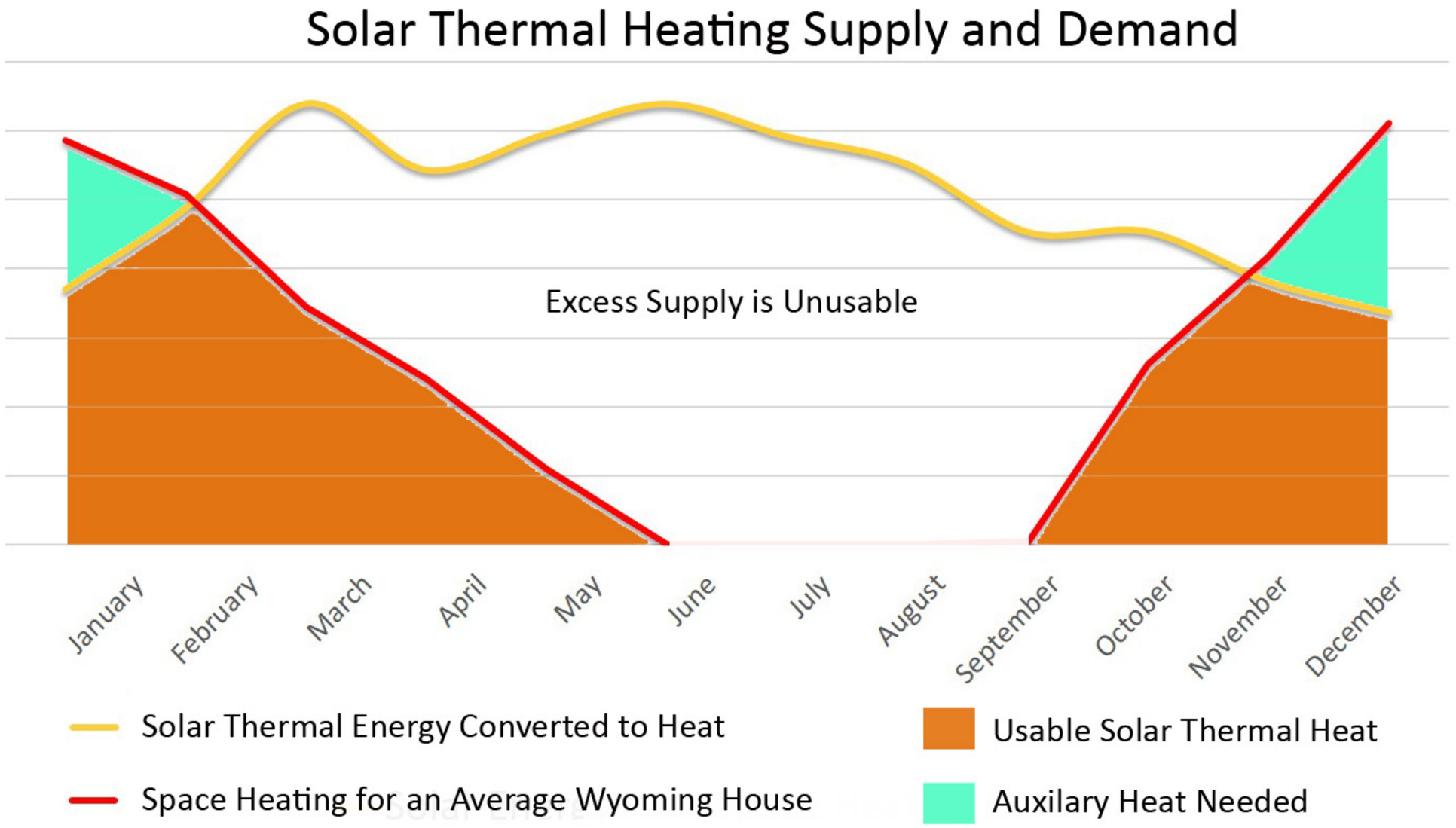
Fig. 21.25 *Comparison of the pattern of solar energy supply (on a horizontal surface) to various patterns of heating needs.*

Grid Tie

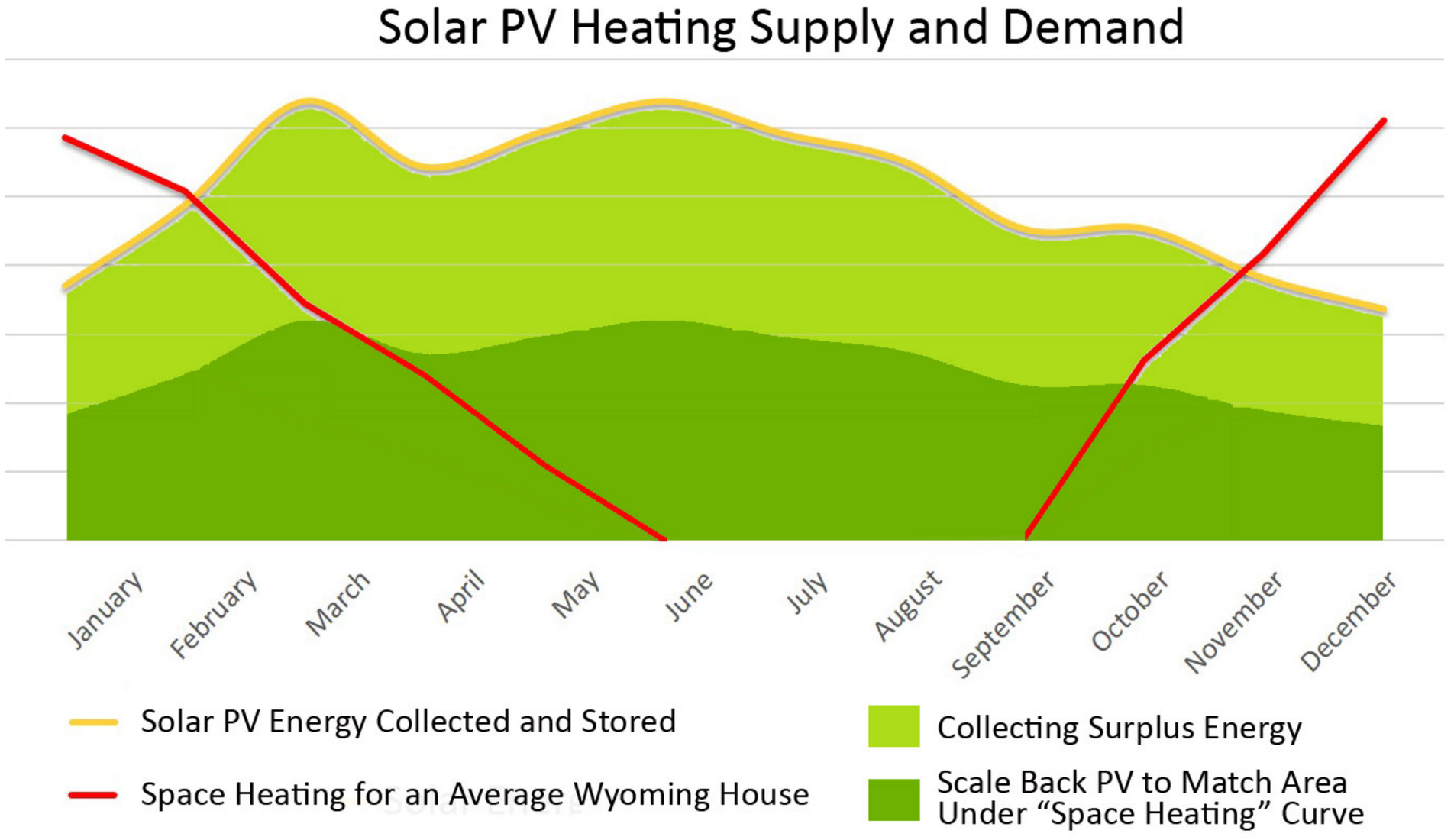

NET
METERING!


Generation and Consumption
kW
0 3 6 9 12 15 18 21 0
Net Metering Allows Electricity Consumption When Needed
kW
0 3 6 9 12 15 18 21 0
hour
energy from grid
energy consumed
net metering
electricity consumption
solar power produced

Energy Efficiencies

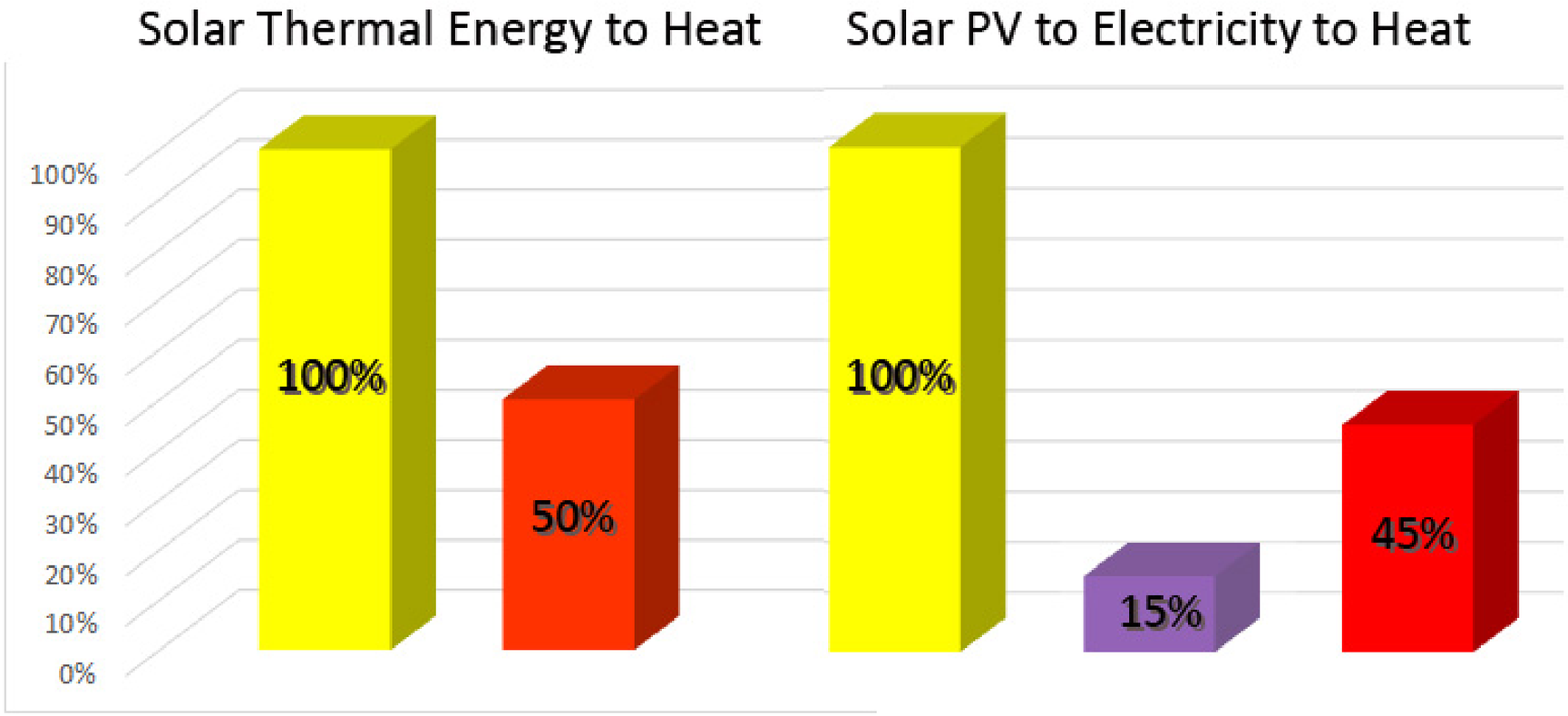


Energy Efficiencies

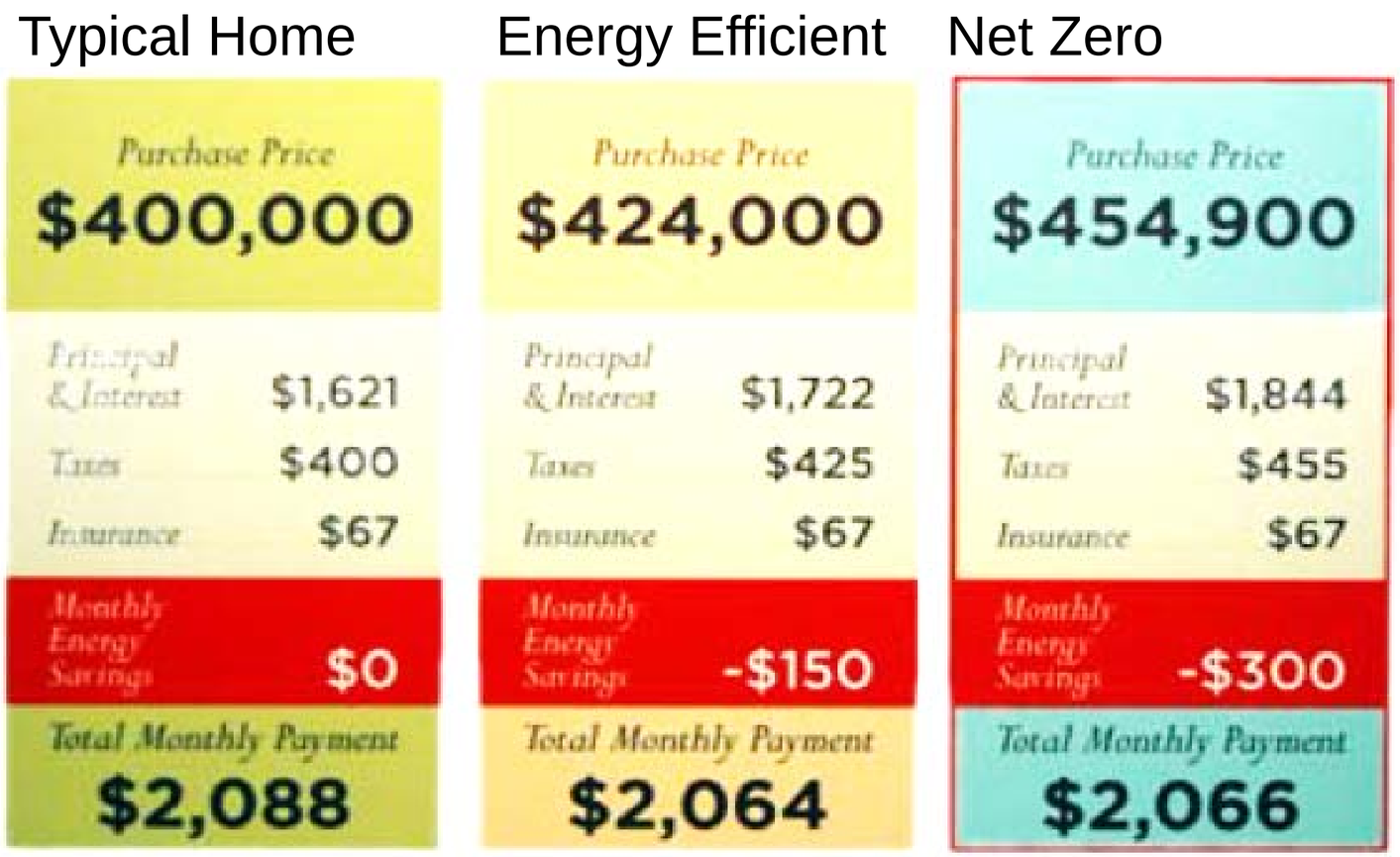


Energy Efficiencies for PV and Active Solar Heating (2013)

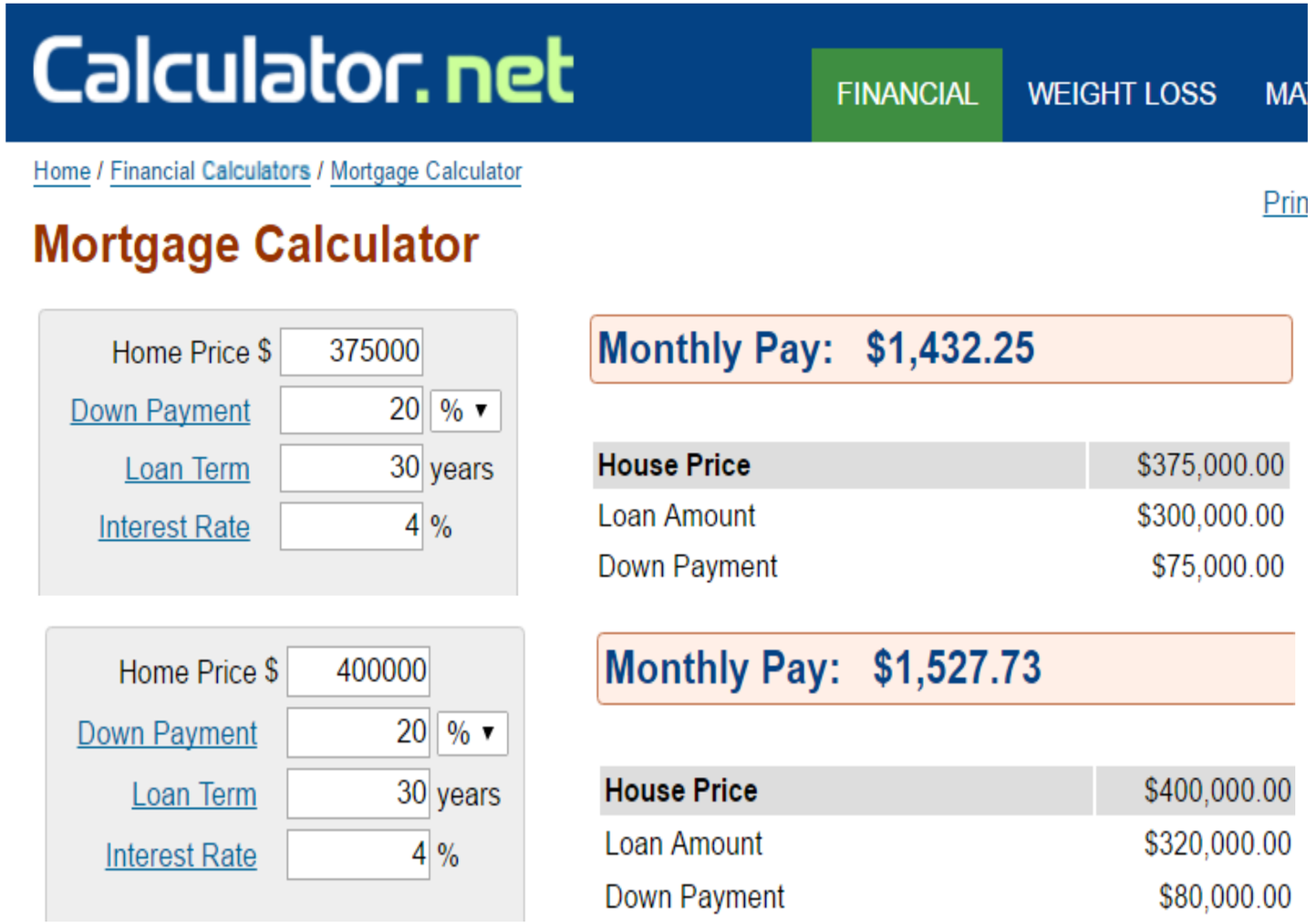
Solar PV = 15%
Solar Thermal = 50%



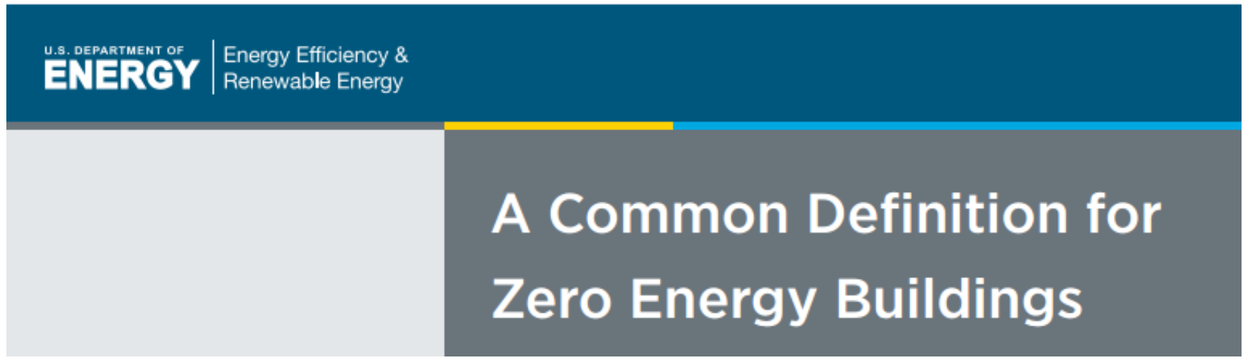
Financing


Typical Home
Purchase Price
$400,000
Principal & Interest
$1,621
Taxes
$400
Insurance
$67
Monthly Energy Savings
$0
Total Monthly Payment
$2,088
Energy Efficient
Purchase Price
$424,000
Principal & Interest
$1,722
Taxes
$425
Insurance
$67
Monthly Energy Savings
-$150
Total Monthly Payment
$2,064
Net Zero
Purchase Price
$454,900
Principal & Interest
$1,844
Taxes
$455
Insurance
$67
Monthly Energy Savings
-$300
Total Monthly Payment
$2,066

Financing


Calculator.net
FINANCIAL
WEIGHT LOSS
MA
Home / Financial Calculators / Mortgage Calculator
Prin
Mortgage Calculator
Home Price $ 375000
Down Payment 20 %
Loan Term 30 years
Interest Rate 4 %
Monthly Pay: $1,432.25
House Price $375,000.00
Loan Amount $300,000.00
Down Payment $75,000.00
Home Price $ 400000
Down Payment 20 %
Loan Term 30 years
Interest Rate 4 %
Monthly Pay: $1,527.73
House Price $400,000.00
Loan Amount $320,000.00
Down Payment $80,000.00

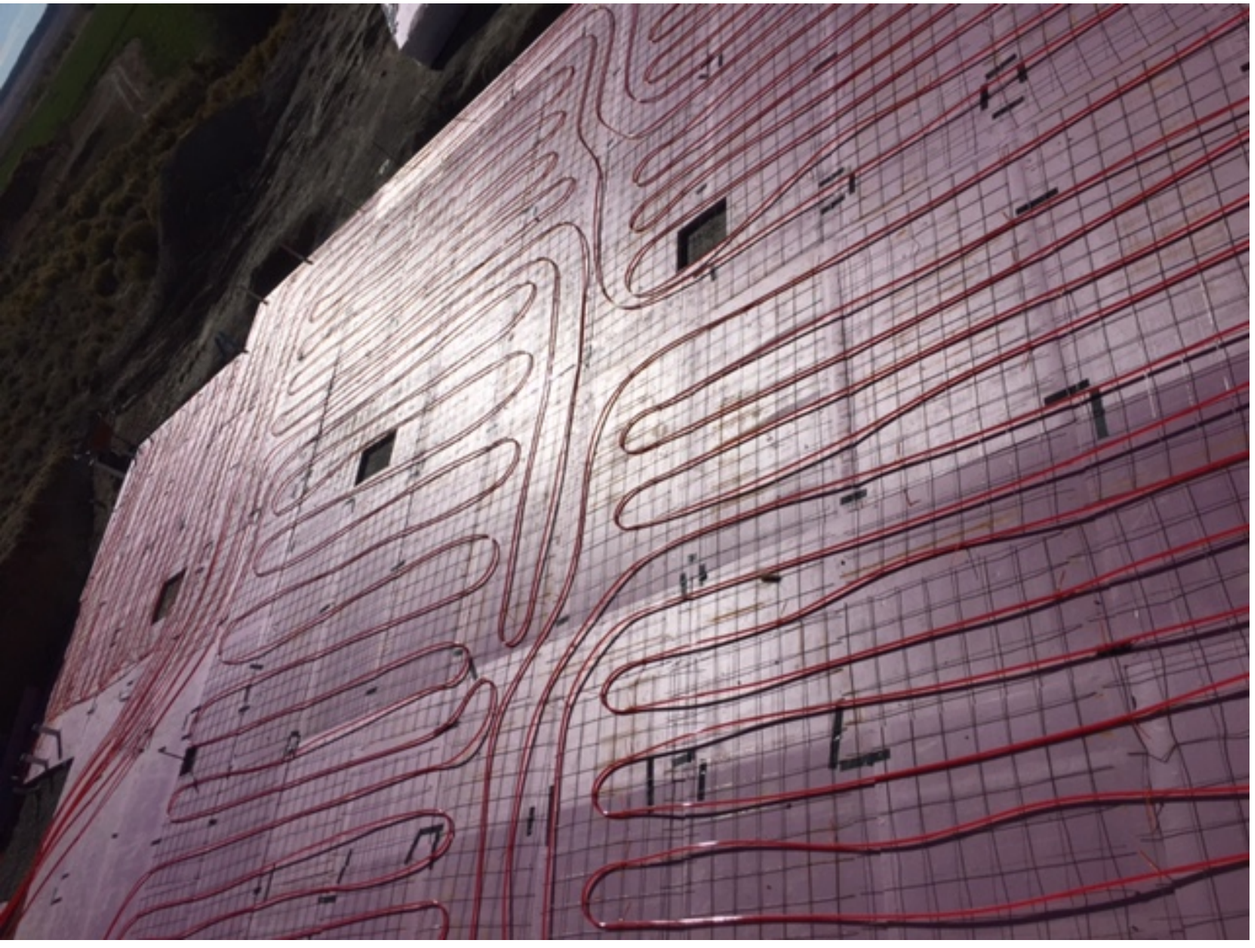
Weighted Energy Options



Energy Form	Source Energy Conversion Factor (r)
Imported Electricity	3.15
Exported Renewable Electricity	3.15
Natural Gas	1.09
Fuel Oil (1,2,4,5,6,Diesel, Kerosene)	1.19
Propane & Liquid Propane	1.15
Steam	1.45
Hot Water	1.35
Chilled Water	1.04
Coal or Other	1.05

Case Study – Aesthetics, Economics, and Ethics

Builder Man Construction



Performance and Cost not tied together

How did I do?

- Your class feedback is critical. Fill out a **class survey** now.
- Use the AU mobile app or fill out a class survey online.
- Give feedback after each session.
- AU speakers will get feedback in real-time.
- **Your feedback results in better classes and a better AU experience.**