Modeling What Matters:

An Integrated Approach to BIM for High-Performance Buildings

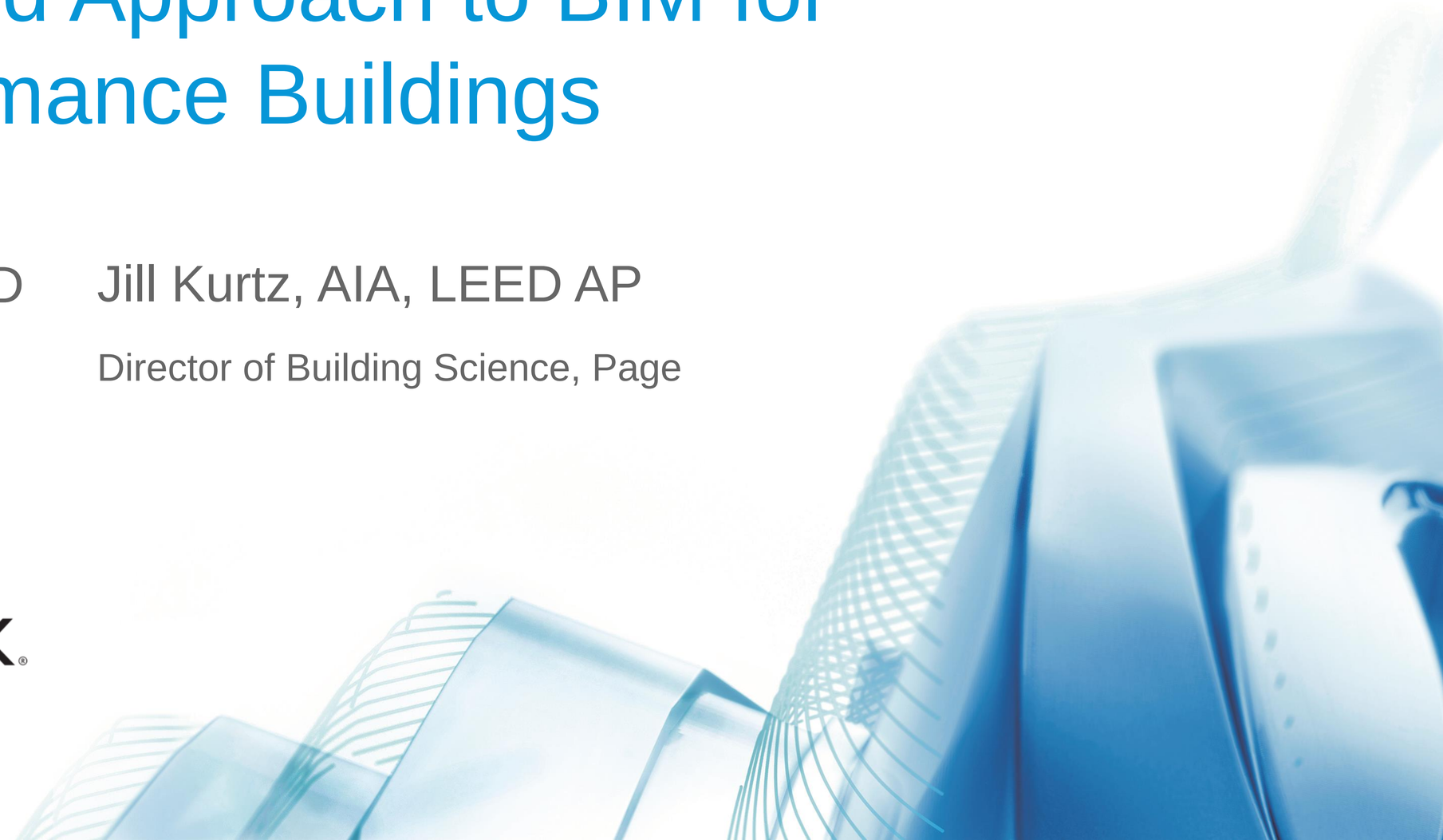
Duygu Yenerim, PhD

BIM Manager, Page

Jill Kurtz, AIA, LEED AP

Director of Building Science, Page

AUTODESK. UNIVERSITY



About the speaker

Duygu Yenerim, PhD

Texas A&M University, PhD in Architecture

Middle East Technical University, M Architecture

PhD research focuses on the capabilities and benefits of utilizing BIM to aid low-income residents in building more sustainable and energy efficient homes. She has been working with Page since 2014 where she is a BIM Manager.

About the speaker

Jill Kurtz, AIA LEED AP

University of Pennsylvania, M Environmental Building Design

Union University, M Intercultural Studies

Kansas State University, B Architecture

Combines a research-based approach with a client-centric mindset in her leadership as Director of Page’s Building Science practice. She leverages her strengths as a systems thinker and her ability to “speak engineer” to work across the firm’s interdisciplinary practices to integrate building performance analysis into project delivery methods and tools.

Context

Process

Implementation

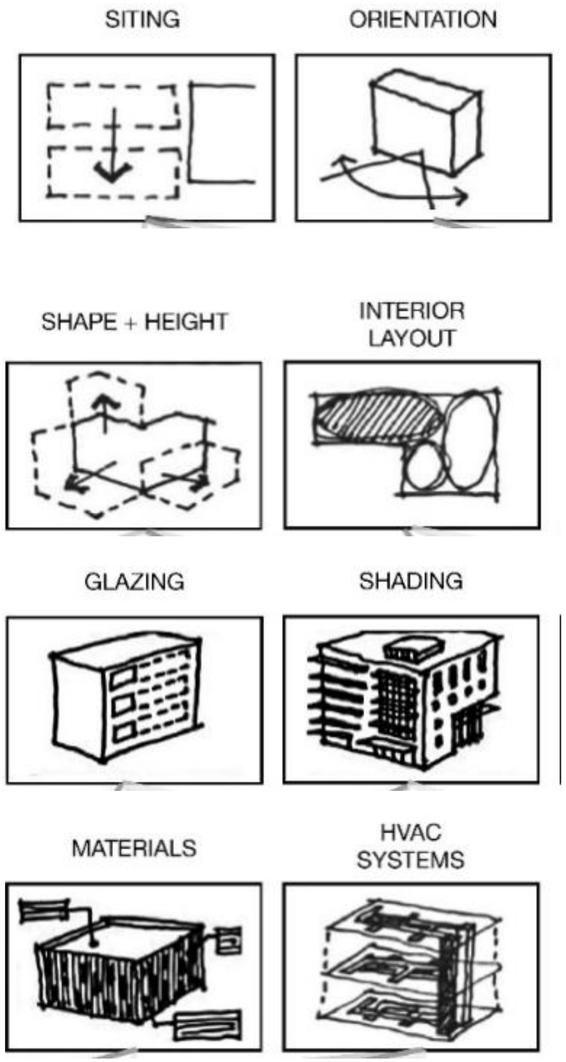
Next steps

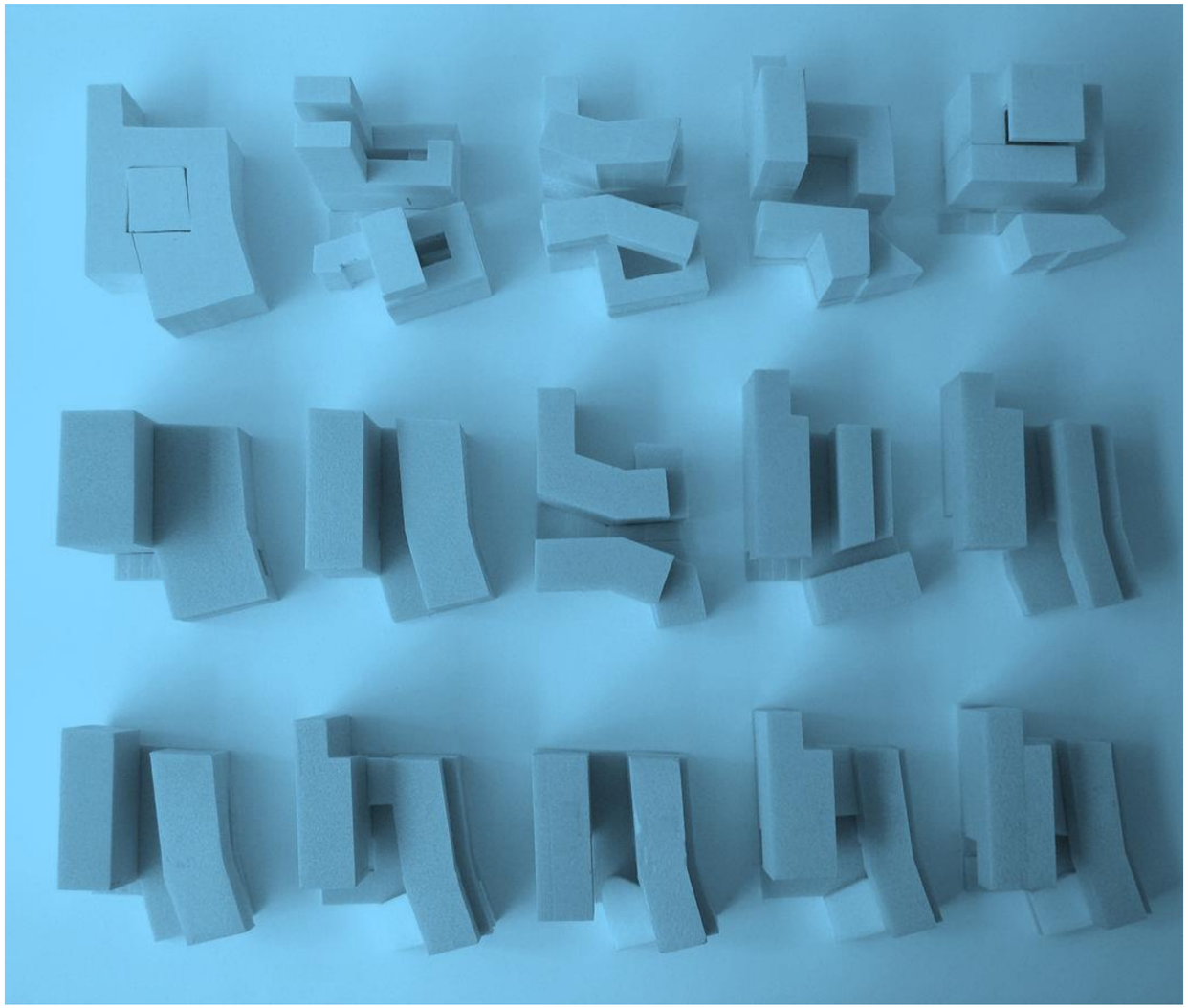
How do we create higher performing buildings?

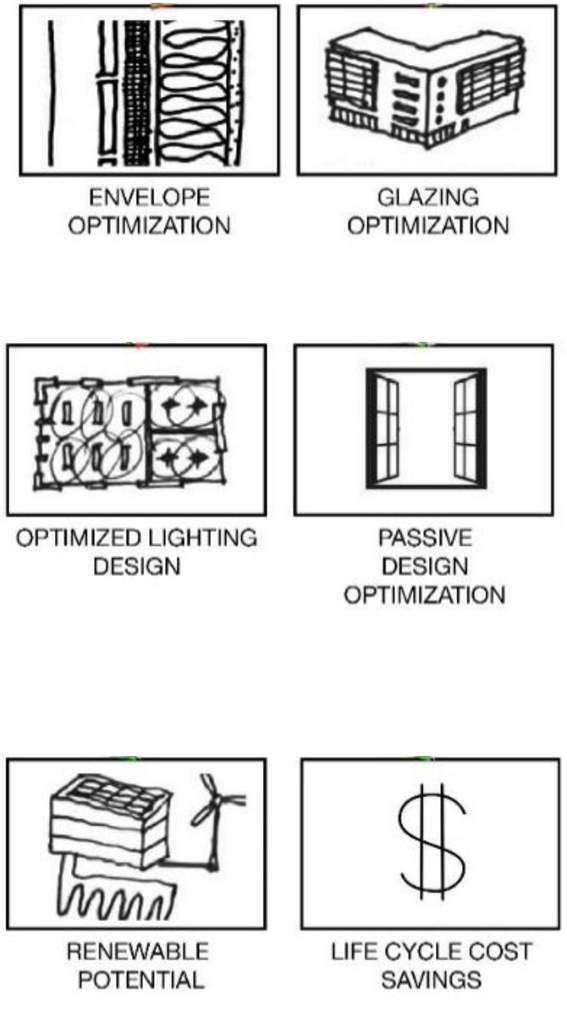
UT Dell Medical School, Health Learning Building, Austin, TX

design decision

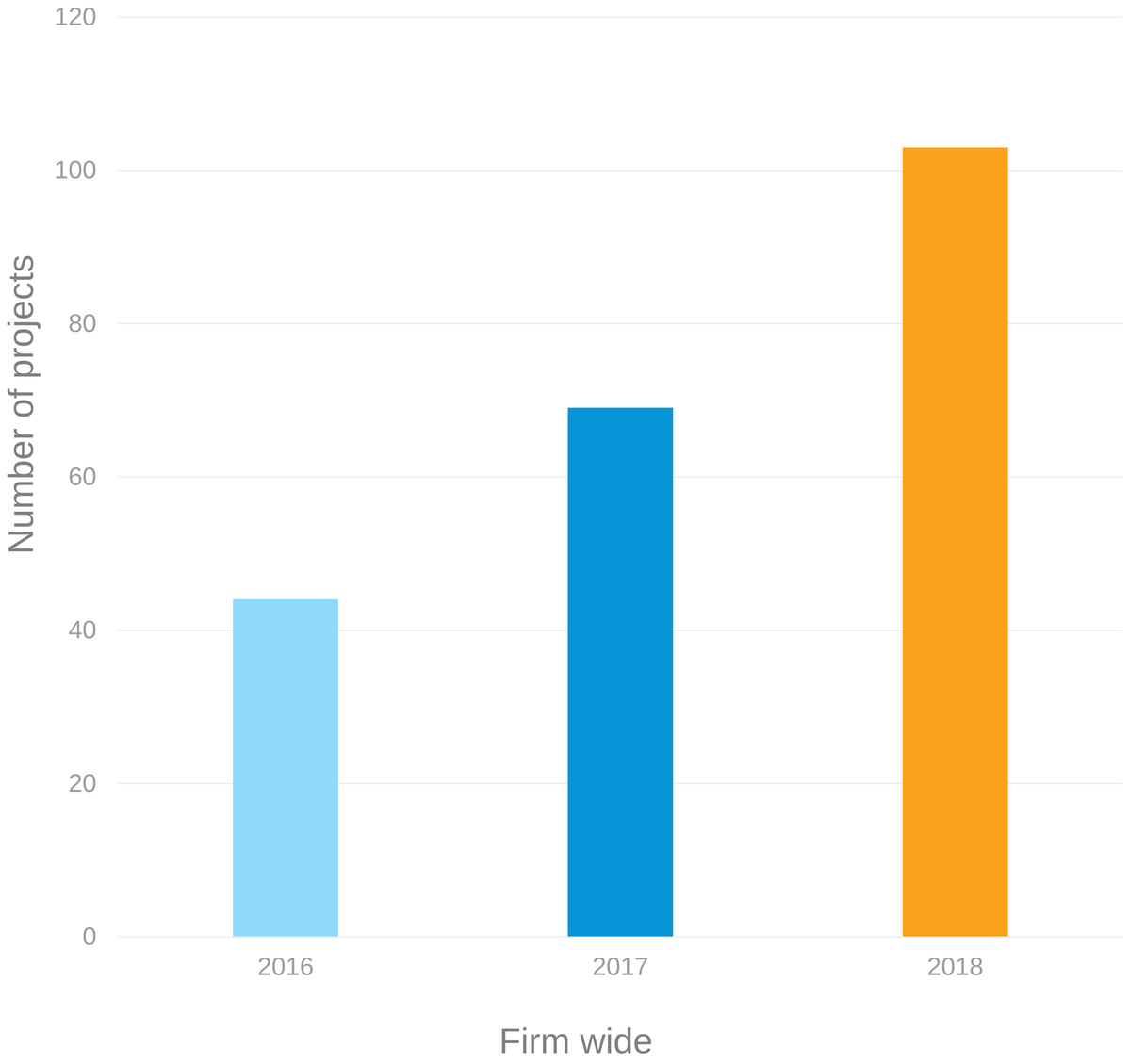
energy feedback



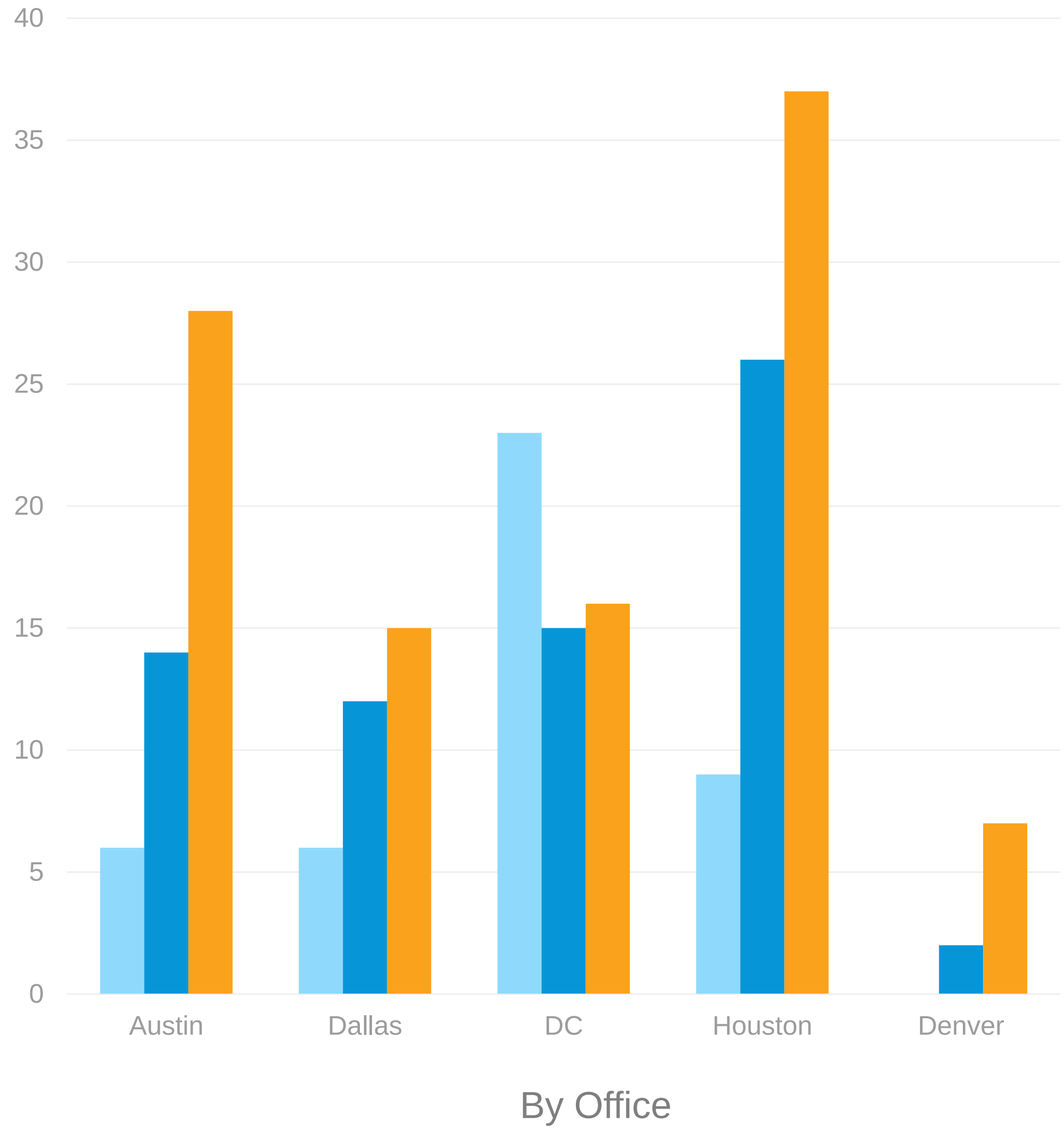




AIA 2030 Reporting



Firm wide



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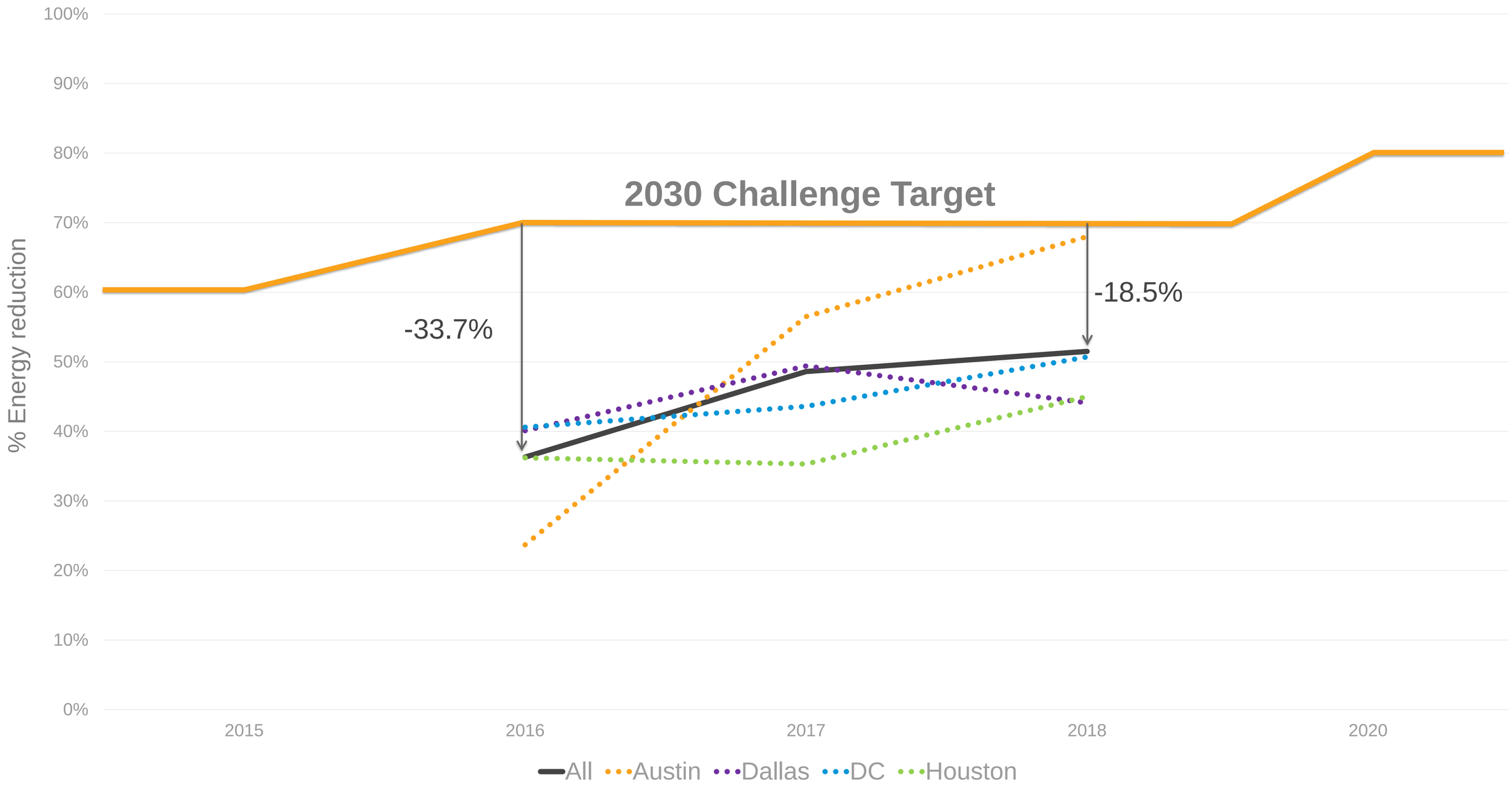
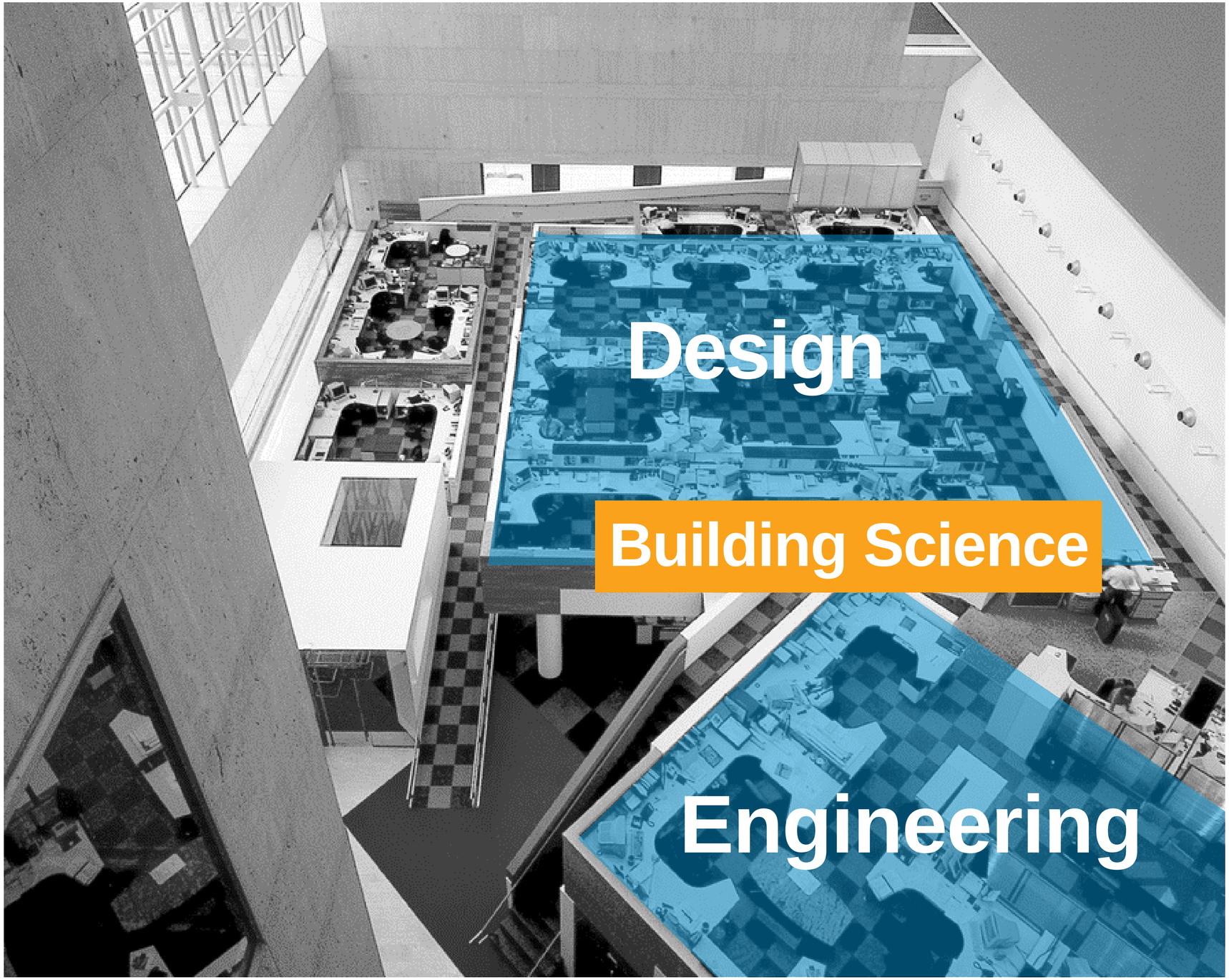
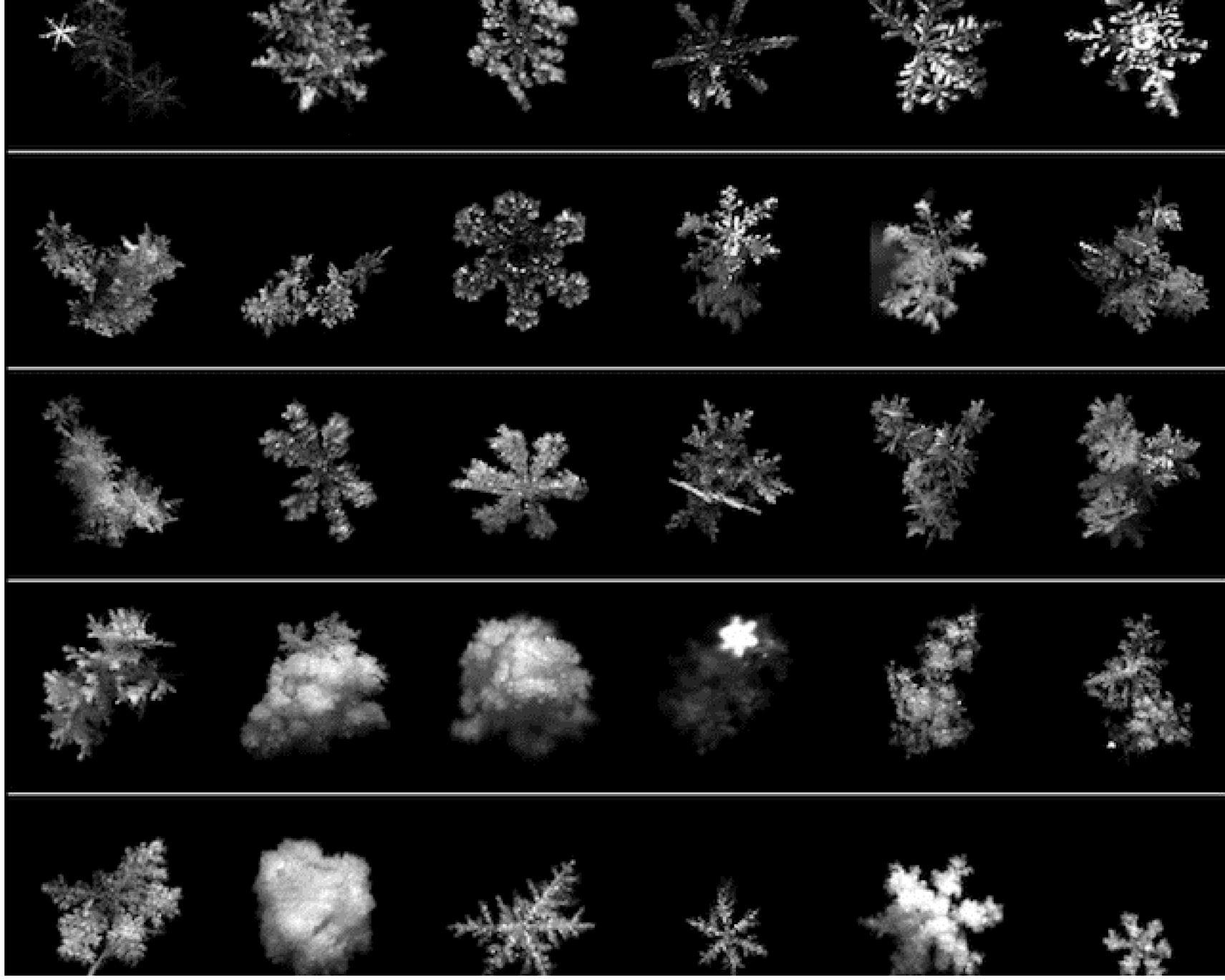

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Energy reduction
2030 Challenge Target
-33.7%
-18.5%
2015
2016
2017
2018
2020
All
Austin
Dallas
DC
Houston

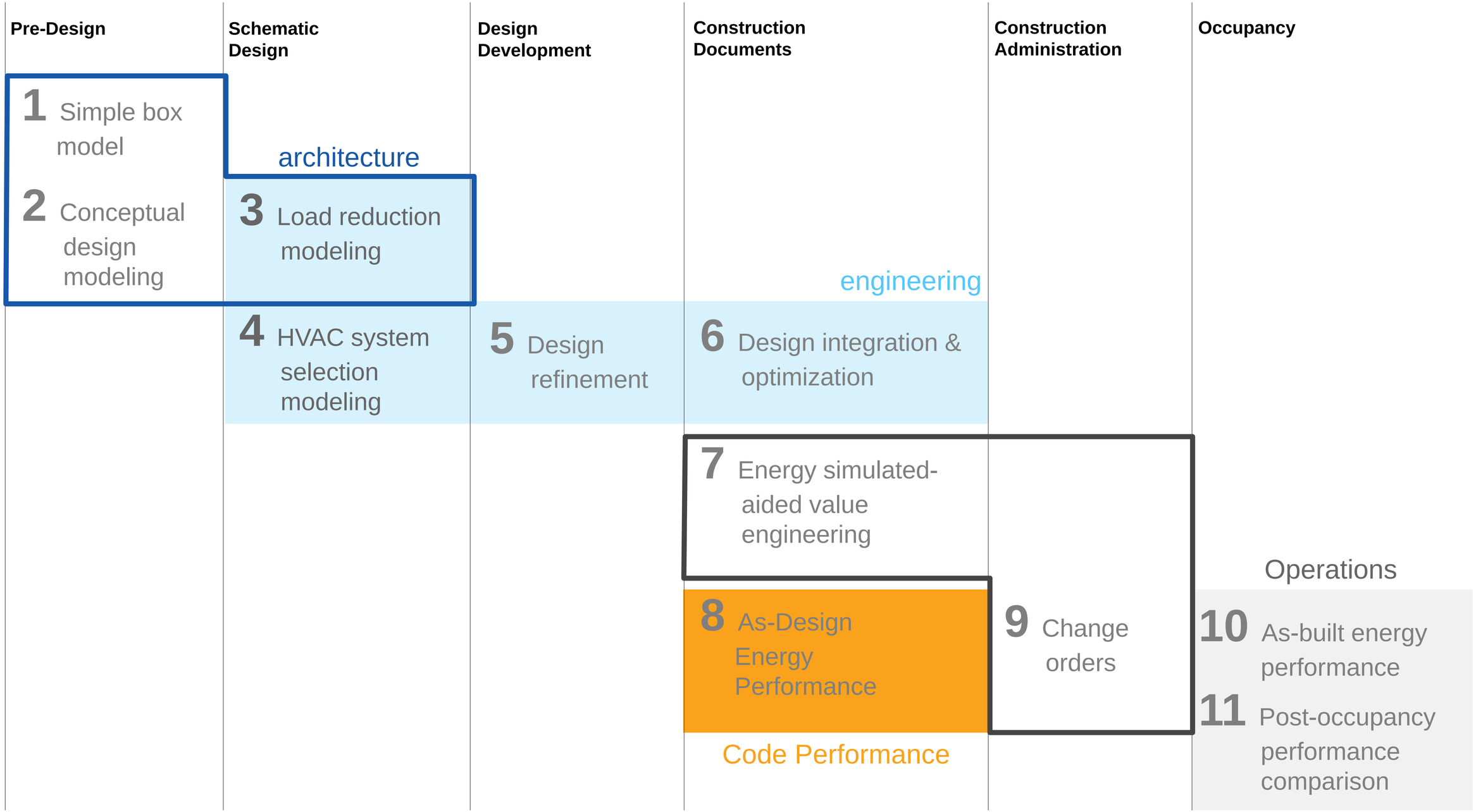
How do we use energy modeling as a ***design tool?***

How do we run models ***earlier and more often?***


Design
Building Science
Engineering

SNOW =




Pre-Design
Schematic Design
Design Development
Construction Documents
Construction Administration
Occupancy
1 Simple box model
2 Conceptual design modeling
architecture
3 Load reduction modeling
4 HVAC system selection modeling
5 Design refinement
engineering
6 Design integration & optimization
7 Energy simulated-aided value engineering
8 As-Design Energy Performance
Code Performance
9 Change orders
Operations
10 As-built energy performance
11 Post-occupancy performance comparison

Pre-Design

Schematic Design

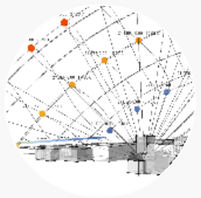
Design Development

Construction Documents

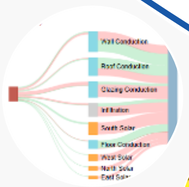
Construction Administration

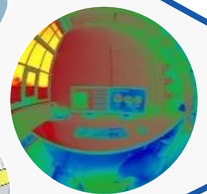
Design Opportunities

Climate
Passive Opportunities
Massing Optimization

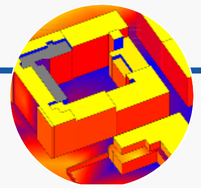


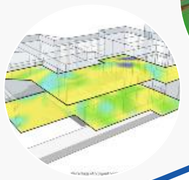
Glazing Optimization
Solar Access
Building Envelope
Energy Benchmarking



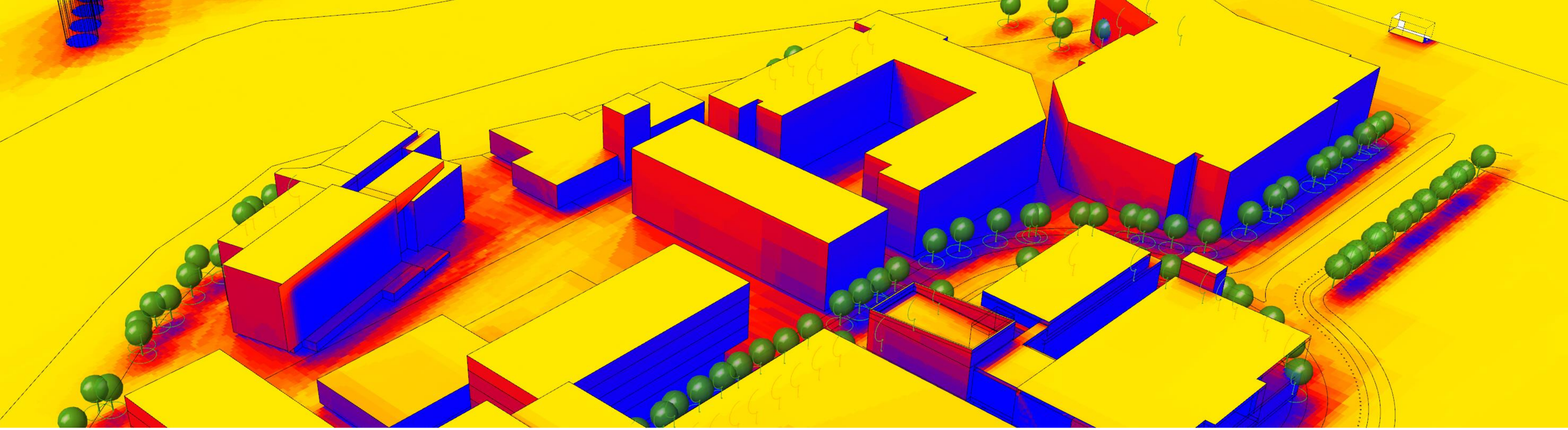


Shading
Daylight / Glare
Energy Optimization
Thermal Comfort





Cost of Design Changes



Building Performance Analysis (BPA)

Ability to estimate the impact performance of a design solution

Performance measures are investigated with actual quantifiable data and not rules-of-thumb;

Use detailed building models to simulate, analyze and predict behavior of the system;

Can produce an evaluation of multiple design alternatives.

Answers to clearly defined questions

WHAT IS THE DESIGN GOAL?

Energy cost savings, Improved energy performance, Peak load reduction, Glare reduction, Cost, etc.

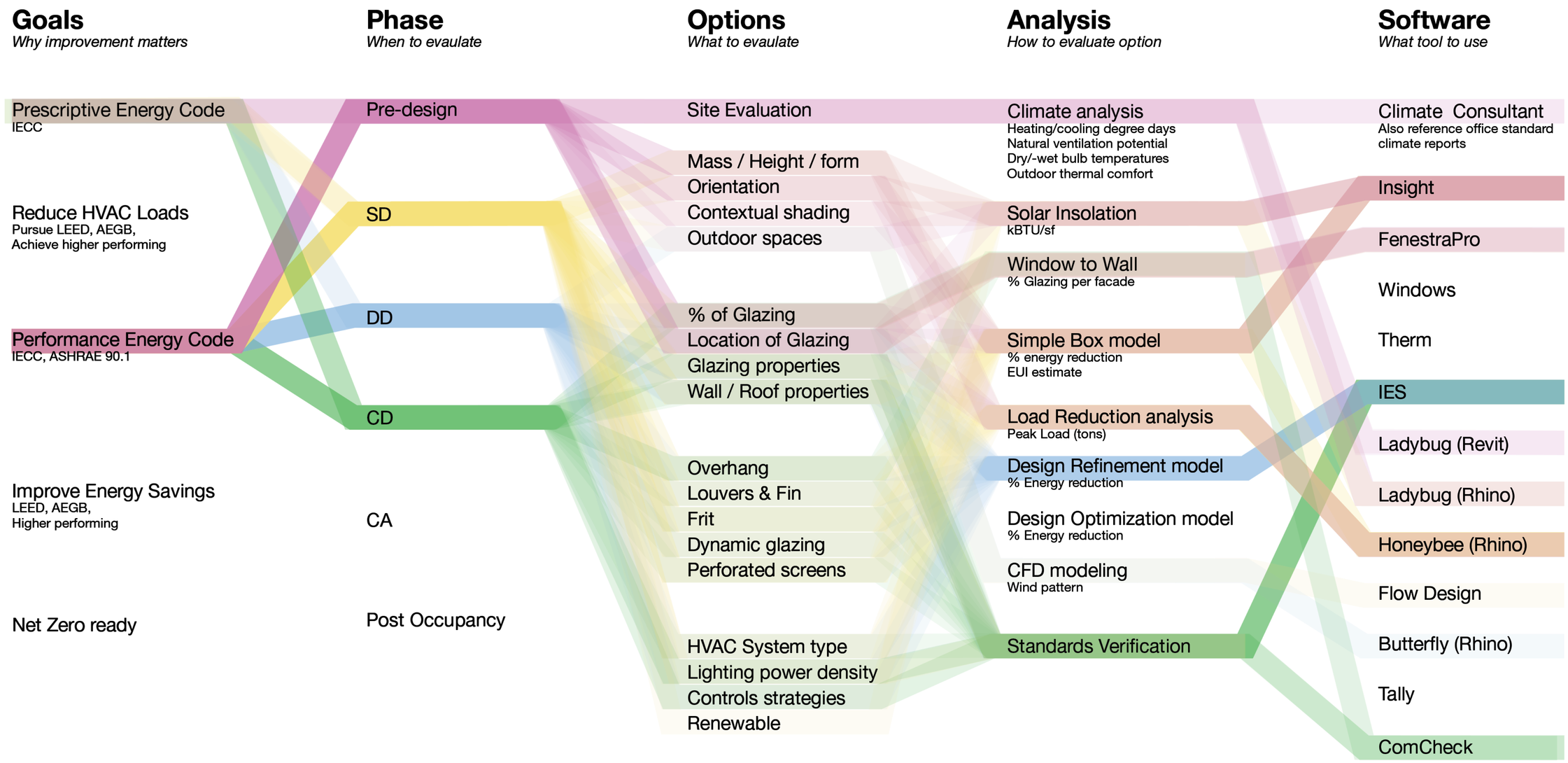
WHAT ARE THE DESIGN OPTIONS TO COMPARE?

Building orientations, Building masses, Window to Wall ratio variation, Glazing types, etc.

WHAT IS THE PERFORMANCE TO MEASURE?

kWh / year or EUI, BTUs / sf, % of floor area with glare, etc

Pre-Design	Schematic Design	Design Development	Construction Documents	Construction Administration	Occupancy
		Energy			
		Daylight			
		Carbon			
		Comfort			
		Cost			


Goals
Why improvement matters
Phase
When to evaulate
Options
What to evaulate
Analysis
How to evaluate option
Software
What tool to use
Prescriptive Energy Code
IECC
Reduce HVAC Loads
Pursue LEED, AEGB,
Achieve higher performing
Performance Energy Code
IECC, ASHRAE 90.1
Improve Energy Savings
LEED, AEGB,
Higher performing
Net Zero ready
Pre-design
SD
DD
CD
CA
Post Occupancy
Site Evaluation
Mass / Height / form
Orientation
Contextual shading
Outdoor spaces
% of Glazing
Location of Glazing
Glazing properties
Wall / Roof properties
Overhang
Louvers & Fin
Frit
Dynamic glazing
Perforated screens
HVAC System type
Lighting power density
Controls strategies
Renewable
Climate analysis
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Natural ventilation potential
Dry/-wet bulb temperatures
Outdoor thermal comfort
Solar Insolation
kBTU/sf
Window to Wall
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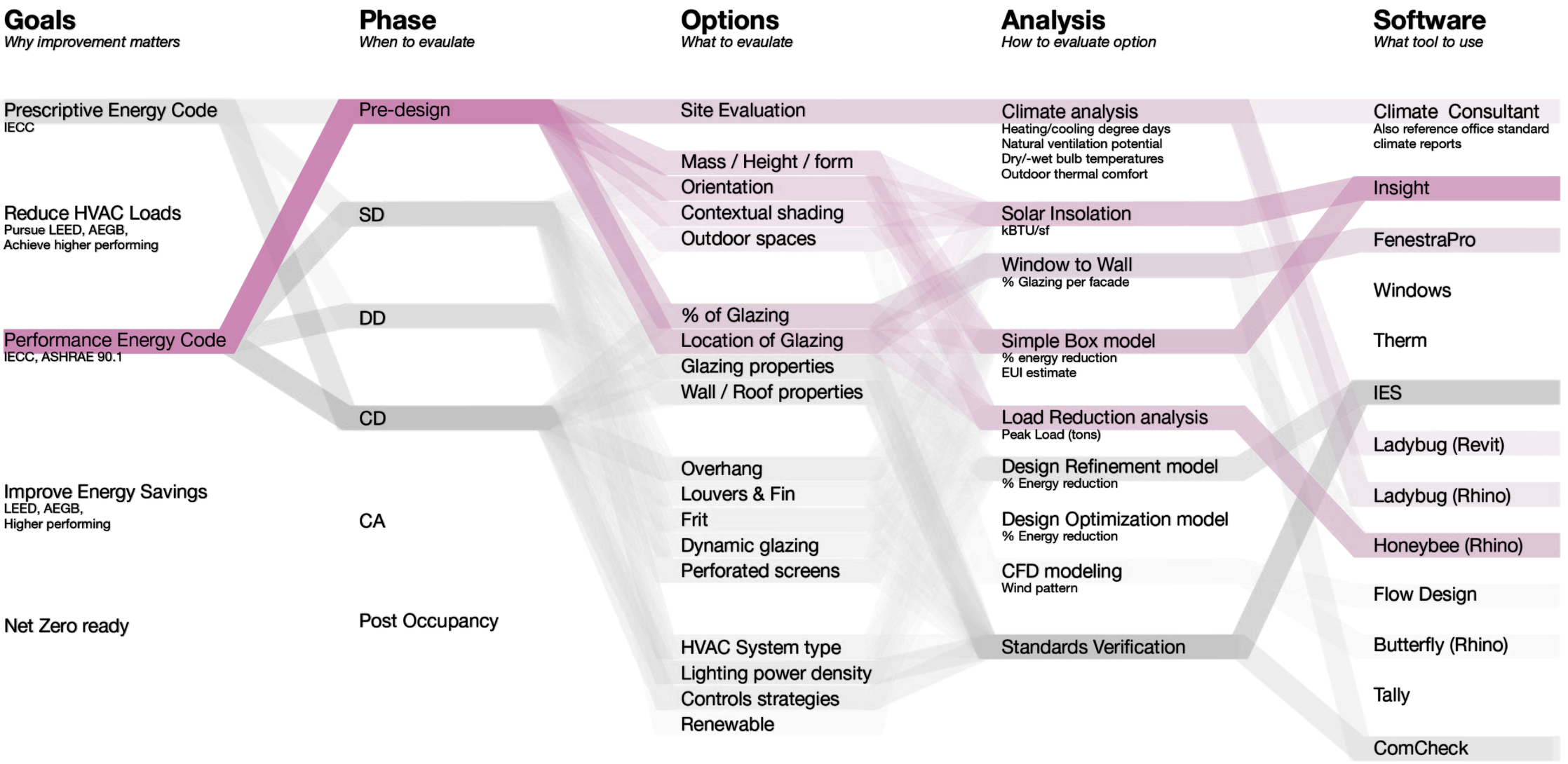
Simple Box model
% energy reduction
EUI estimate
Load Reduction analysis
Peak Load (tons)
Design Refinement model
% Energy reduction
Design Optimization model
% Energy reduction
CFD modeling
Wind pattern
Standards Verification
Climate Consultant
Also reference office standard
climate reports
Insight
FenestraPro
Windows
Therm
IES
Ladybug (Revit)
Ladybug (Rhino)
Honeybee (Rhino)
Flow Design
Butterfly (Rhino)
Tally
ComCheck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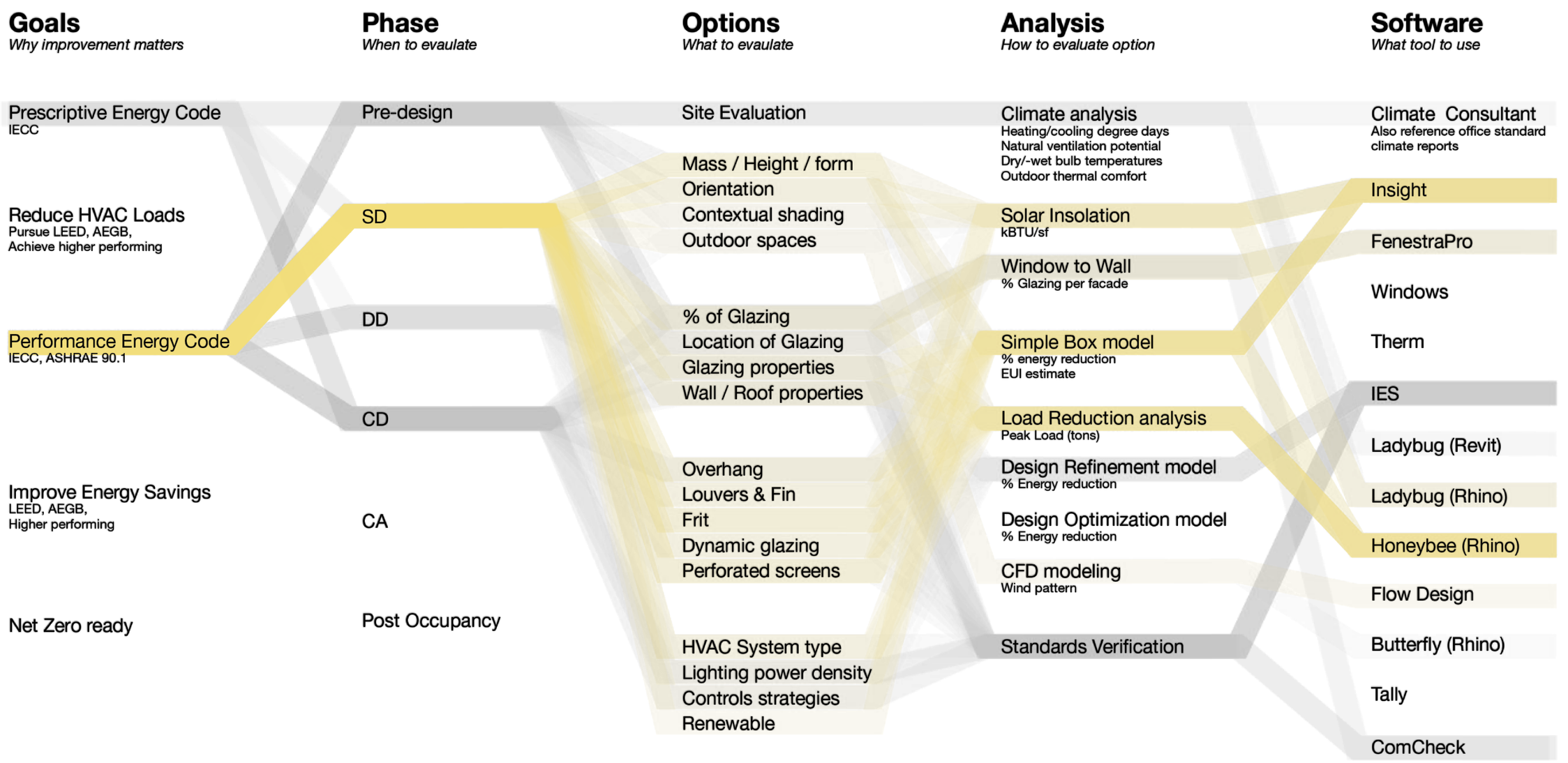
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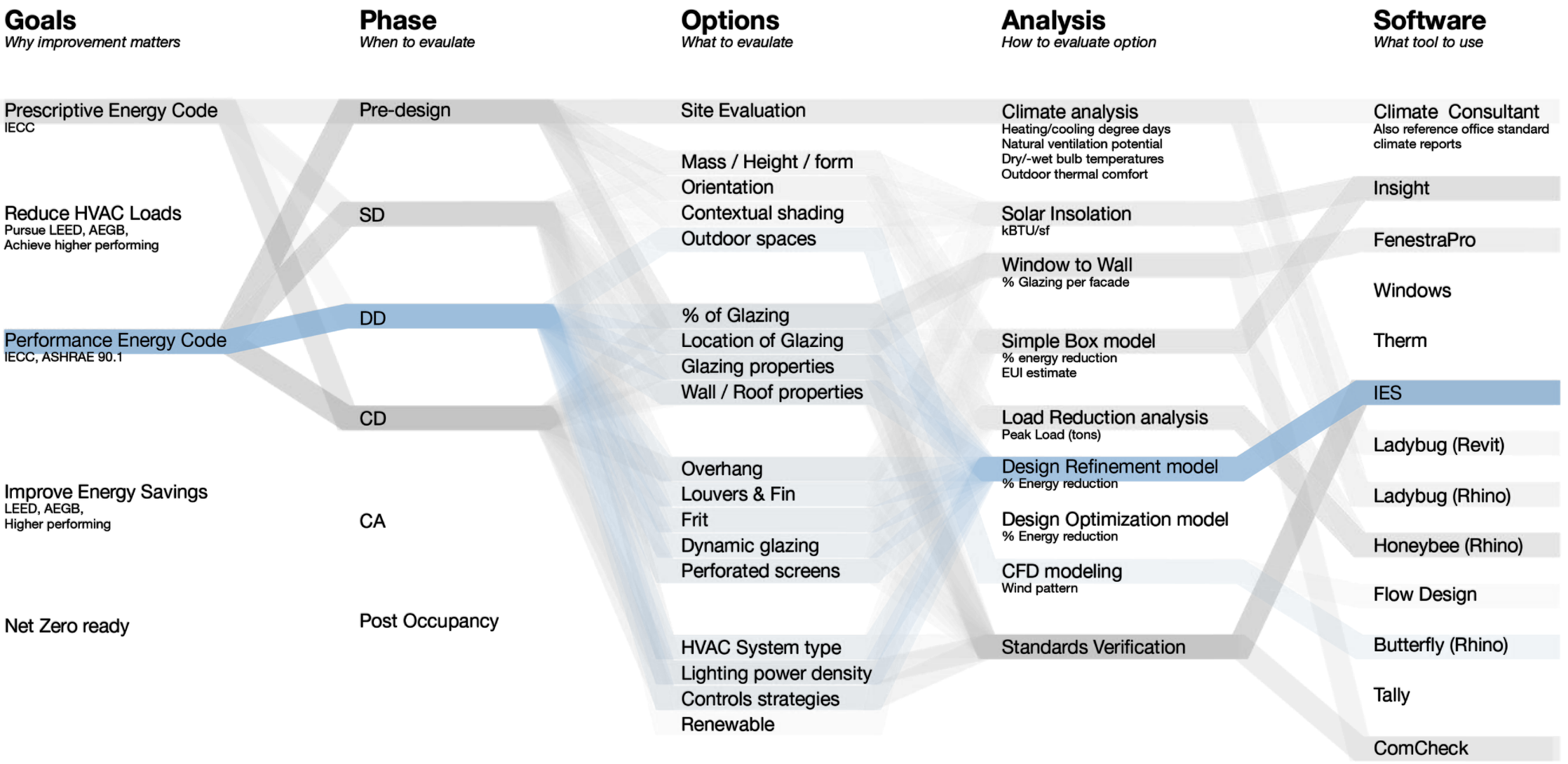
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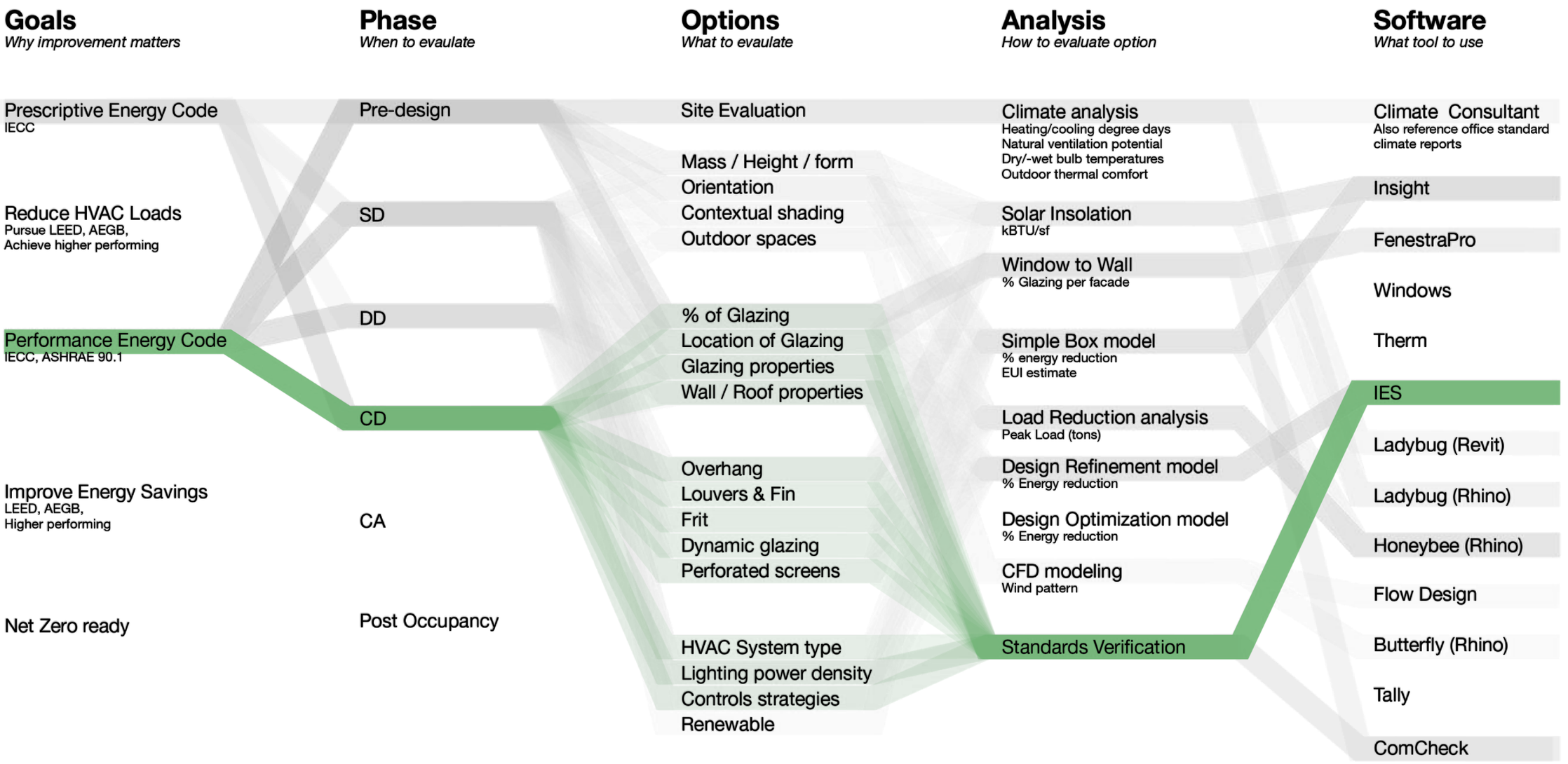
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Current: Our design process is dictated by our technology.

Goal: Our technology should support our design process.

design decision ⟷ energy feedback

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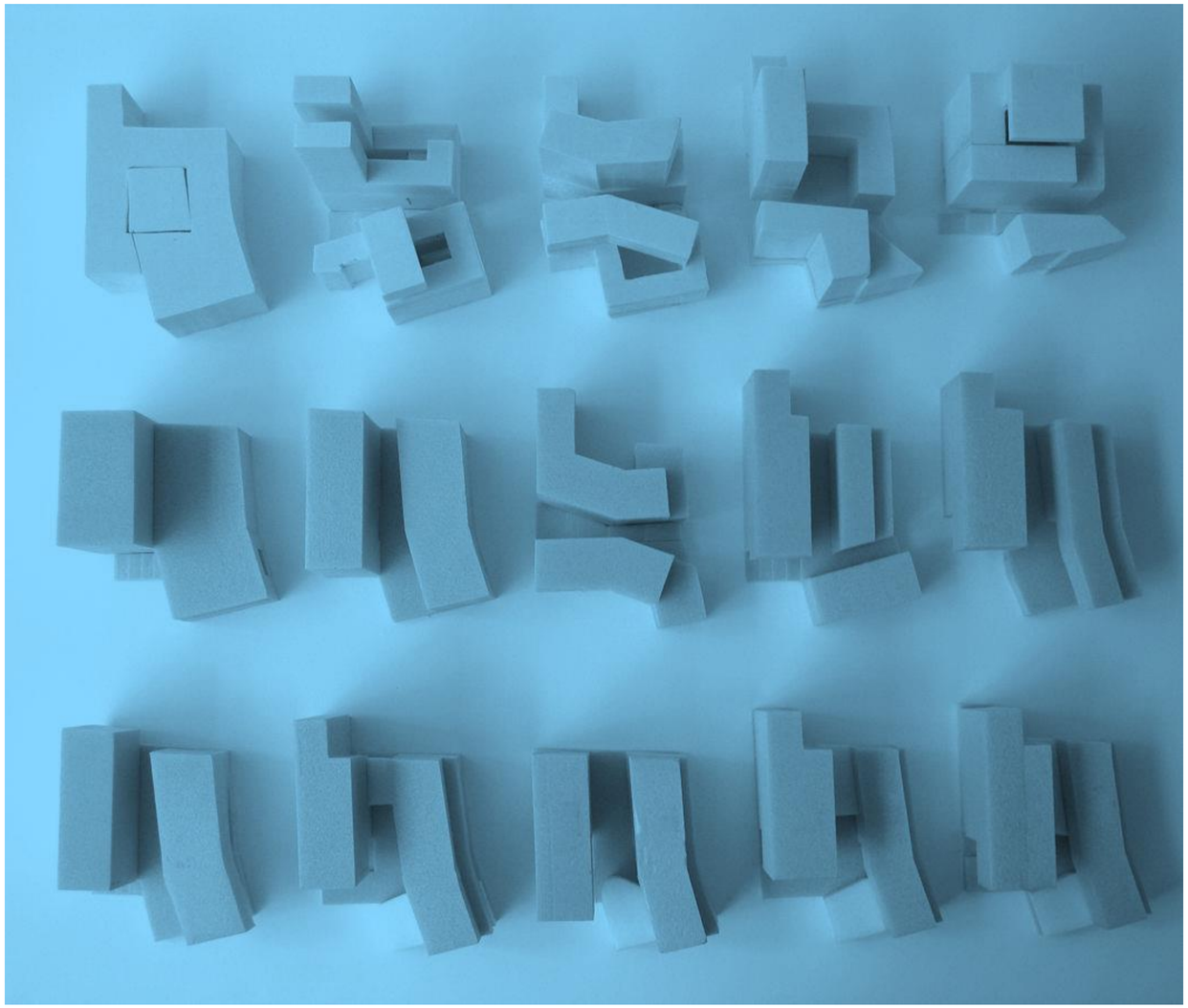

AUTODESK INSIGHT 360

FenestraPro

tally

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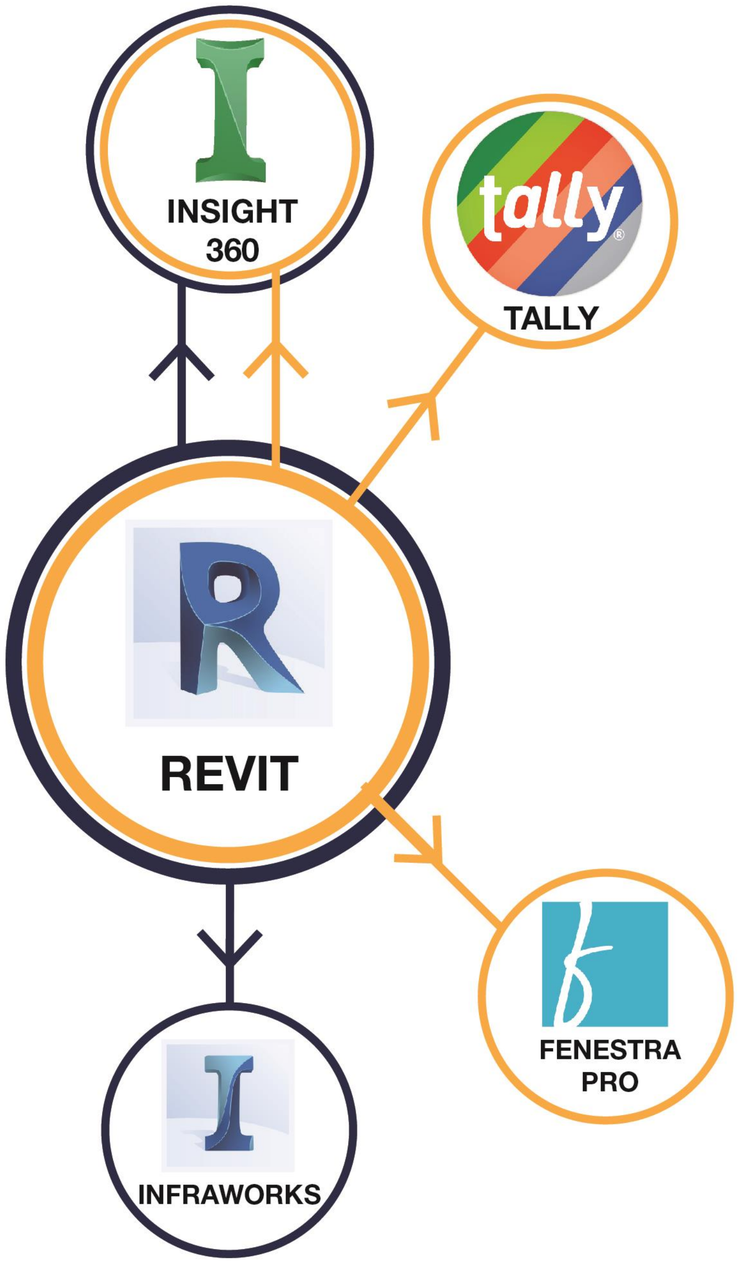
HONEYBEE

LADYBUG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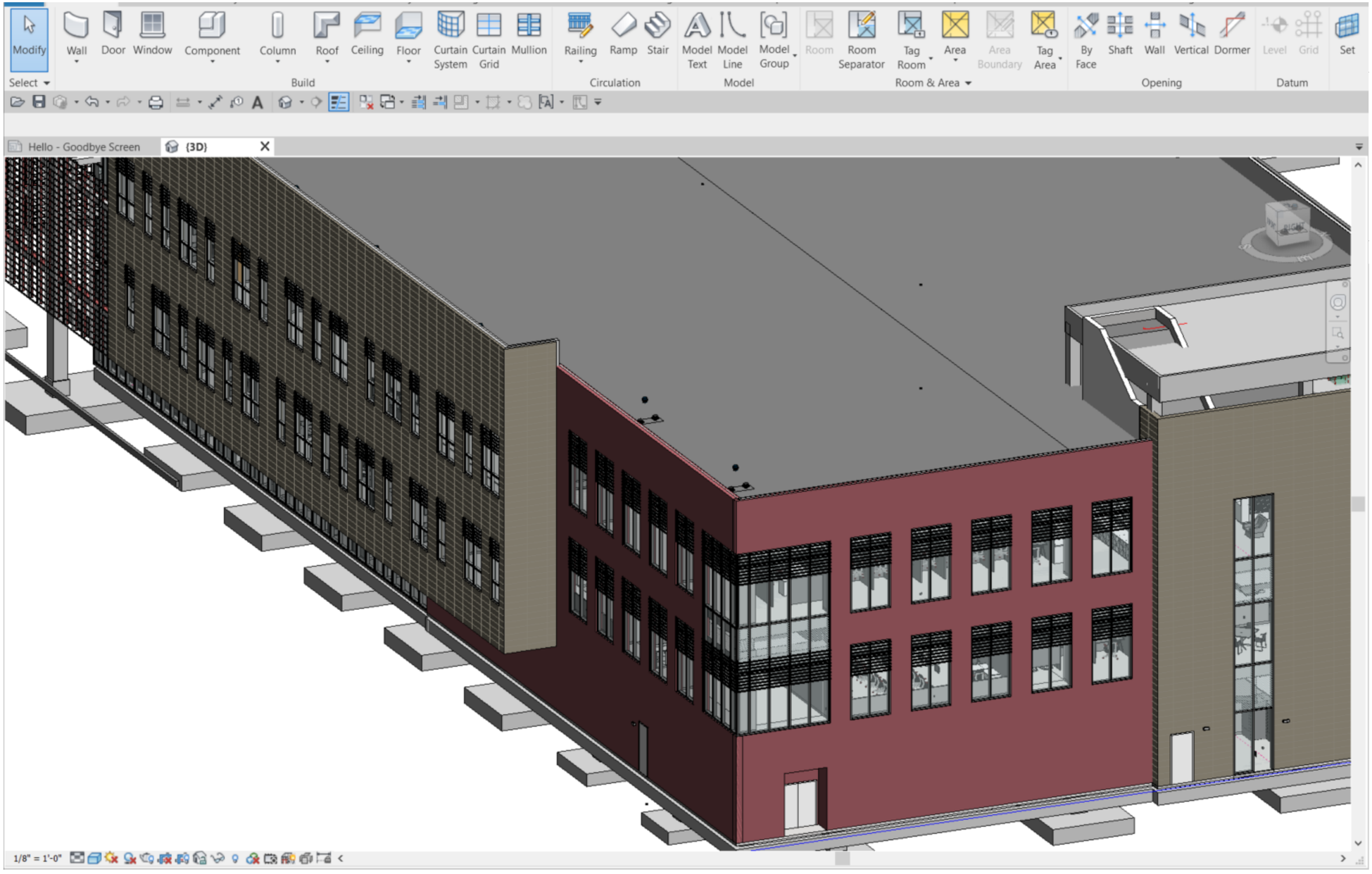
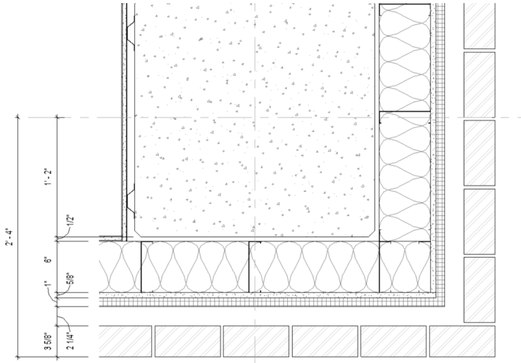
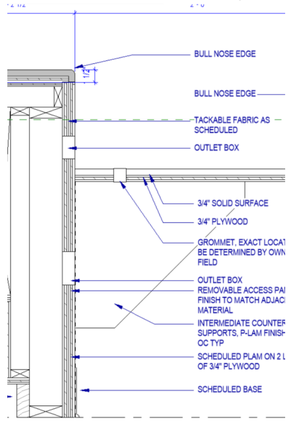
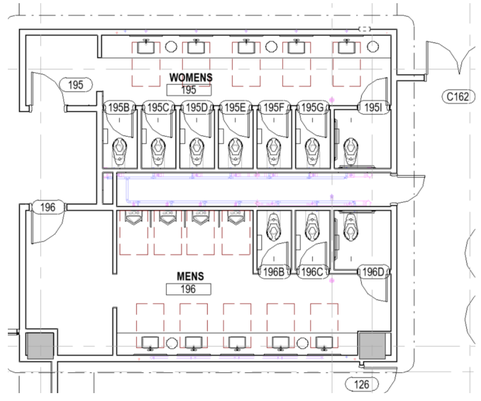

Modify
Wall
Door
Window
Component
Column
Roof
Ceiling
Floor
Curtain System
Curtain Grid
Mullion
Railing
Ramp
Stair
Model Text
Model Line
Model Group
Room
Room Separator
Tag Room
Area
Area Boundary
Tag Area
By Face
Shaft
Wall
Vertical
Dormer
Level
Grid
Set
Select
Build
Circulation
Model
Room & Area
Opening
Datum
Hello - Goodbye Screen
{3D}
1/8" = 1'-0"




BULL NOSE EDGE
BULL NOSE EDGE
TACKABLE FABRIC AS SCHEDULED
OUTLET BOX
3/4" SOLID SURFACE
3/4" PLYWOOD
GROMMET, EXACT LOCAT BE DETERMINED BY OWN FIELD
OUTLET BOX
REMOVABLE ACCESS PA FINISH TO MATCH ADJAC MATERIAL
INTERMEDIATE COUNTEF SUPPORTS, P-LAM FINISH OC TYP
SCHEDULED PLAM ON 2 L OF 3/4" PLYWOOD
SCHEDULED BASE


WOMENS
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MENS
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196B
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C162
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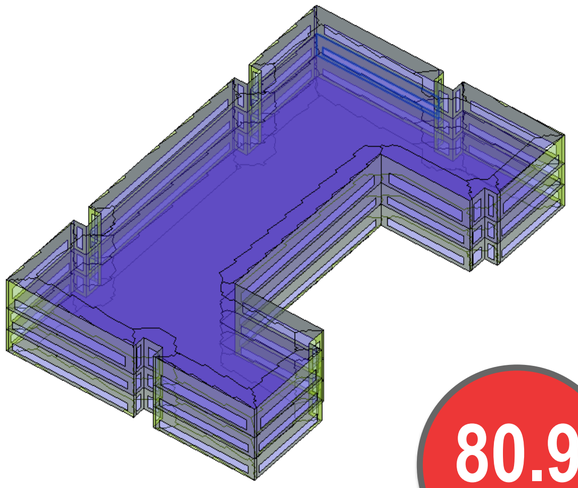
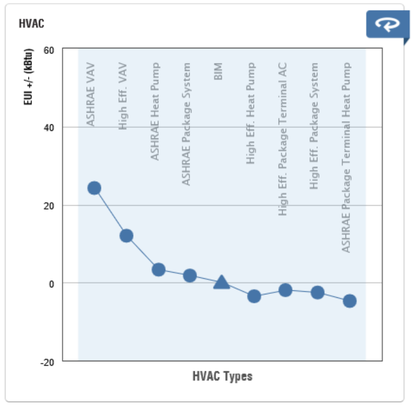
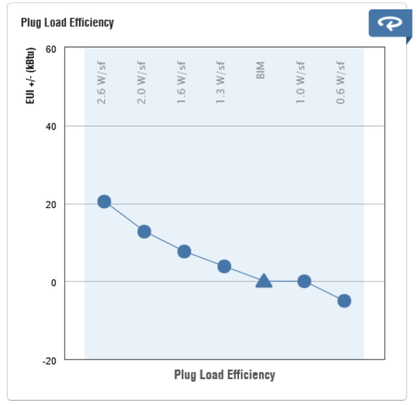
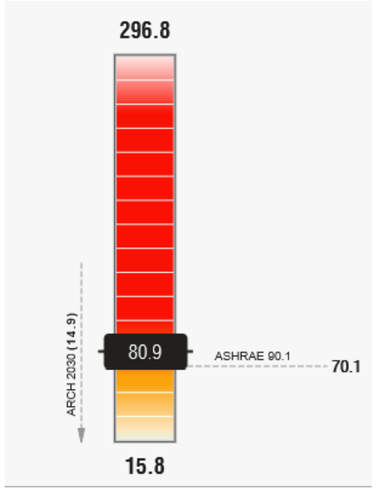


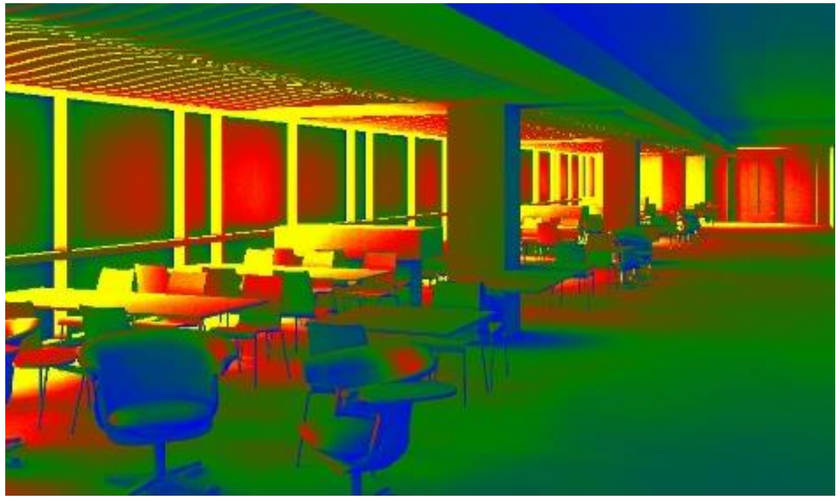
80.9
kBTU / ft2 / yr

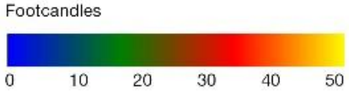




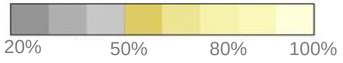
Annual Sunlight Exposure (ASE)
% of floor area receiving over 100 Foot-Candles
for at least 250 annual occupied hours



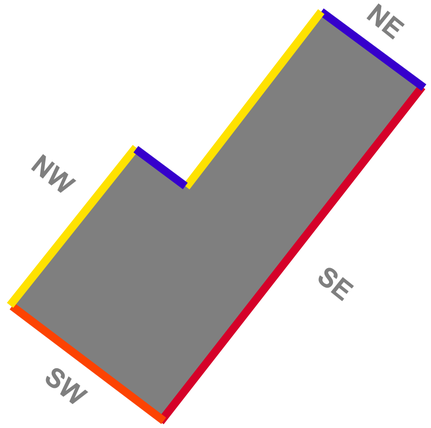




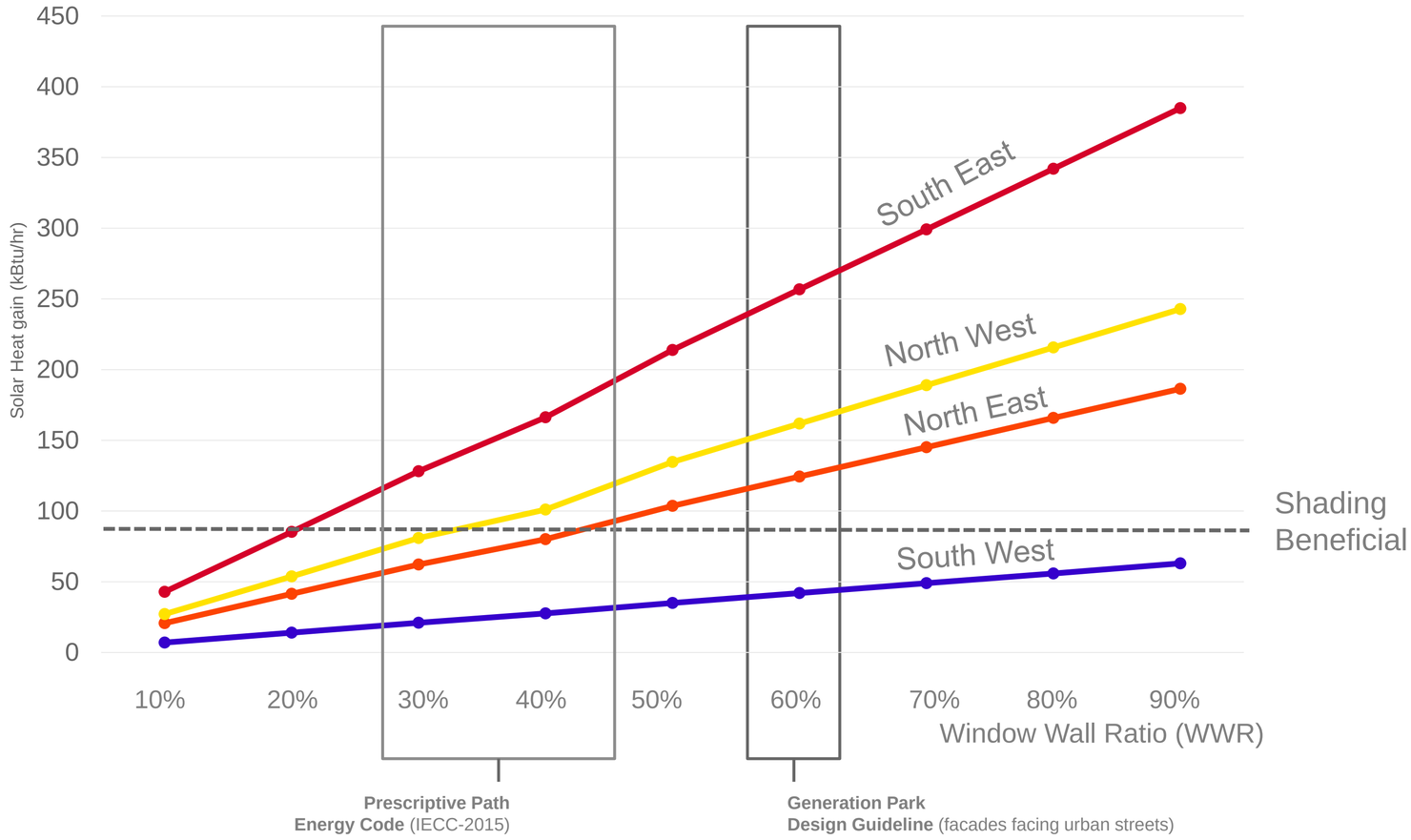
Spatial Daylight Autonomy (SDA)
% of floor area receiving at least 30 Foot-Candles for at least
50% of annual occupied hours

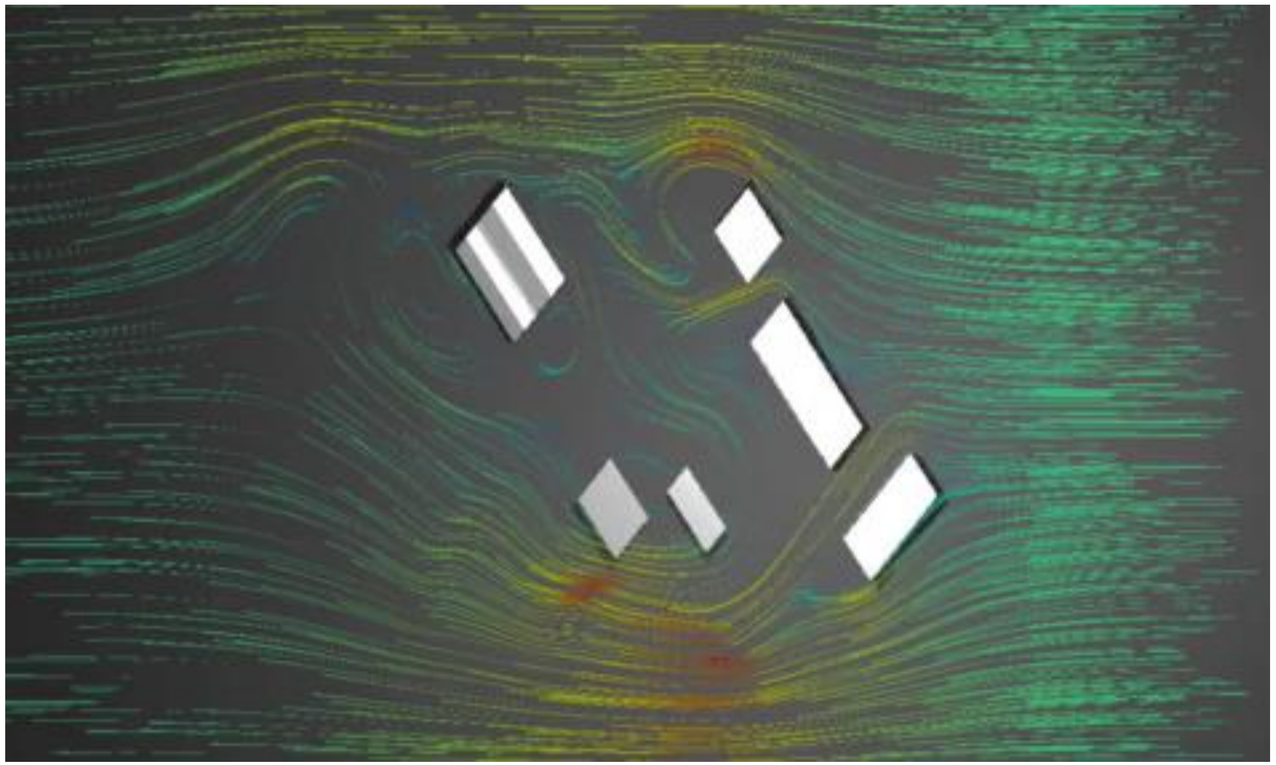


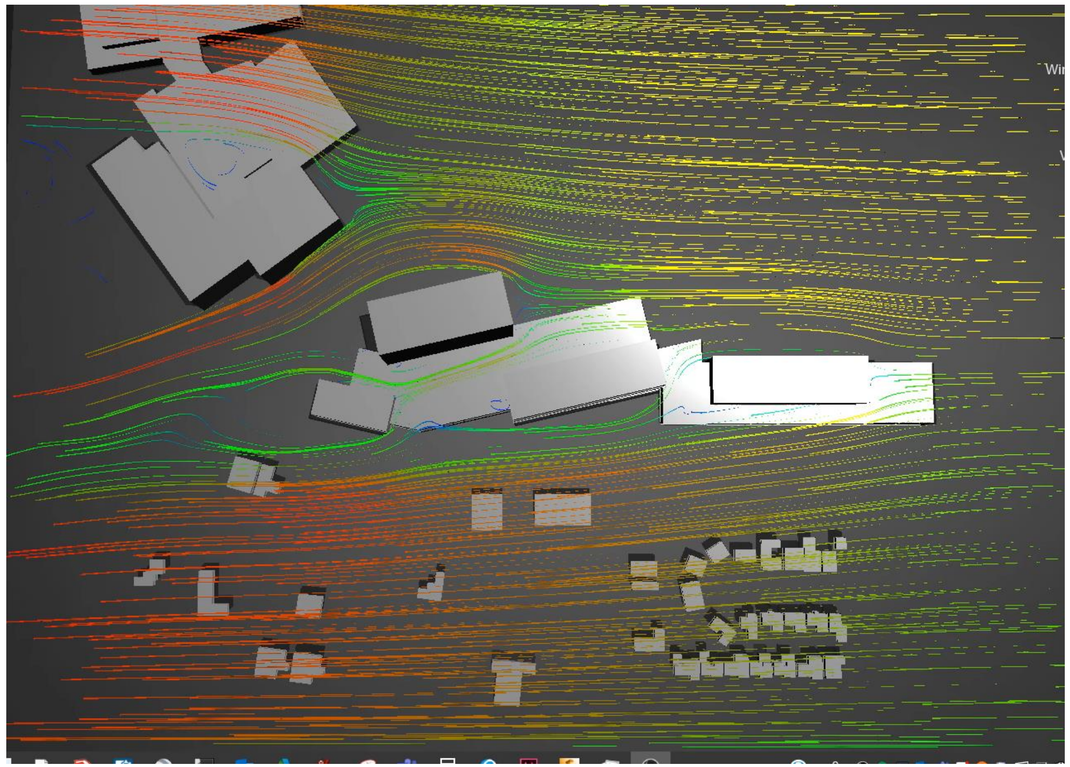
AUTODESK®
INSIGHT 360™



FenestraPro

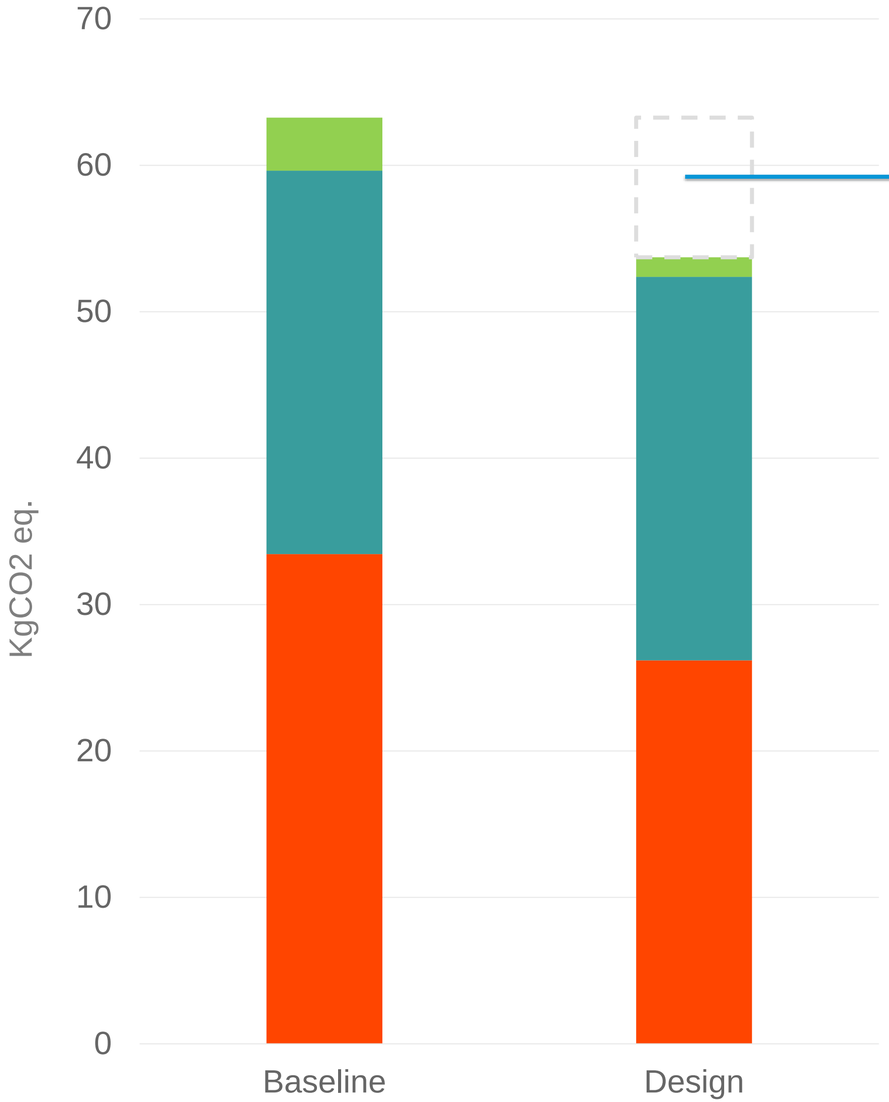






AUTODESK®

FLOW DESIGN

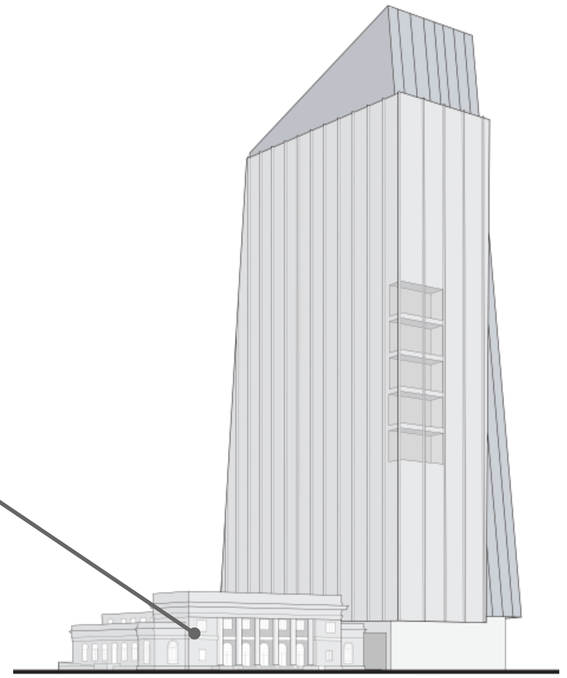


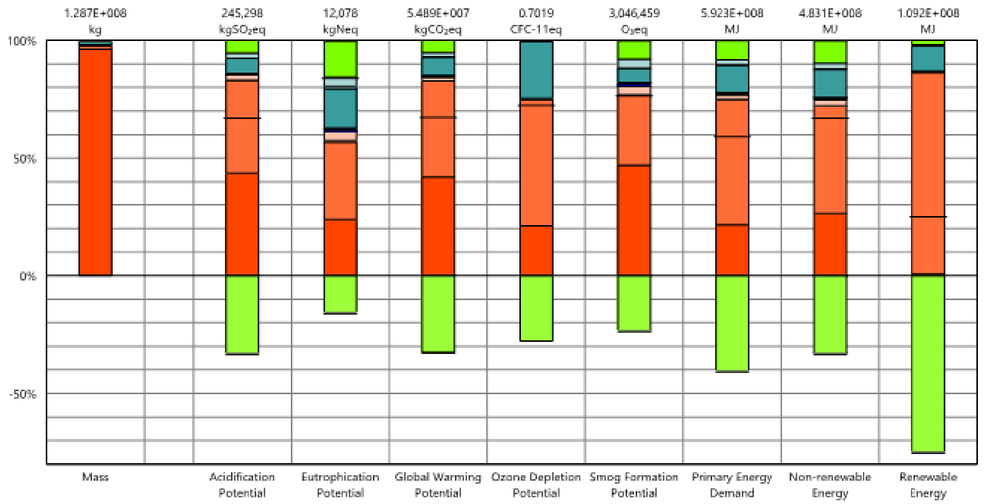
20%Carbon Reduction

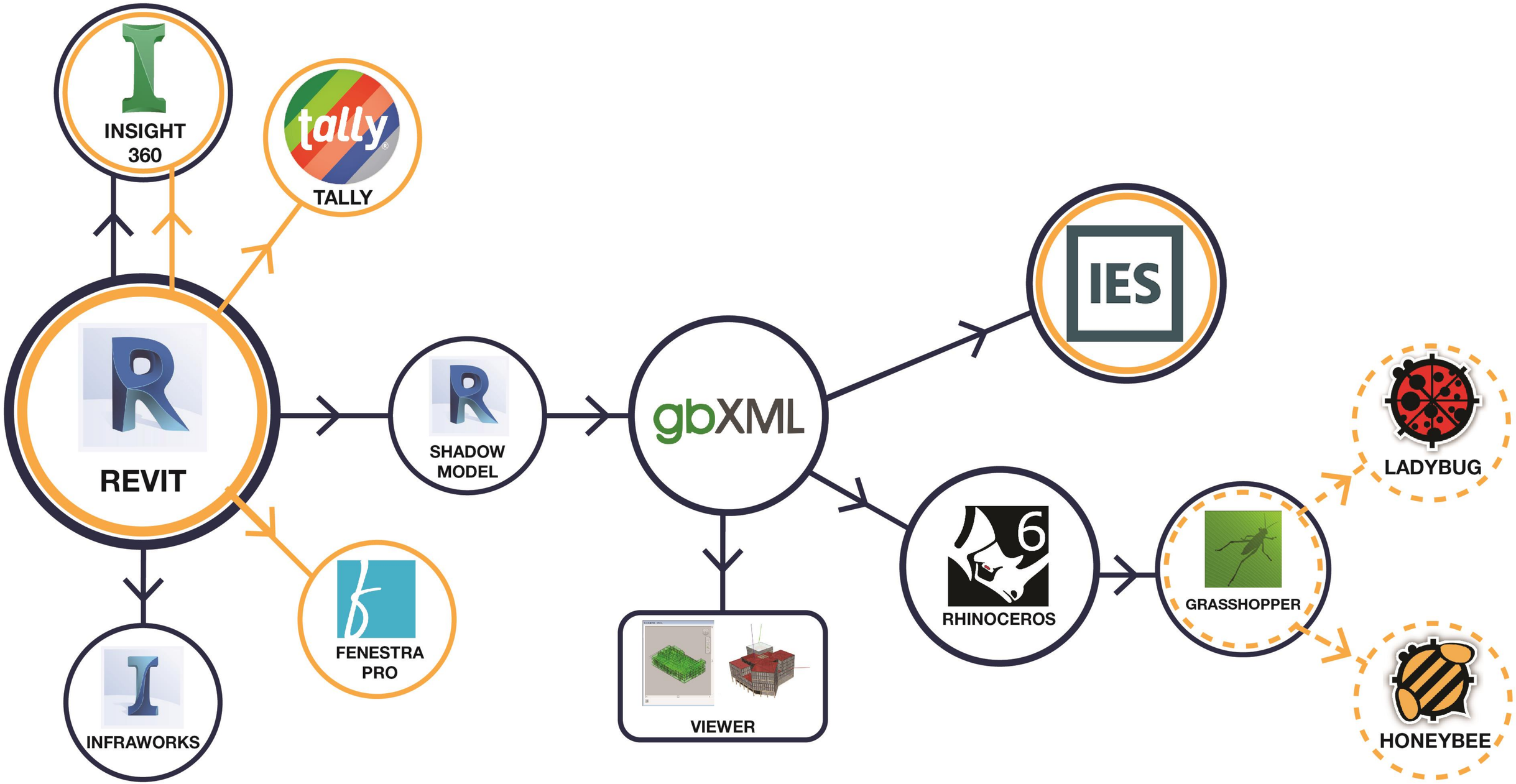
Historic CTJ

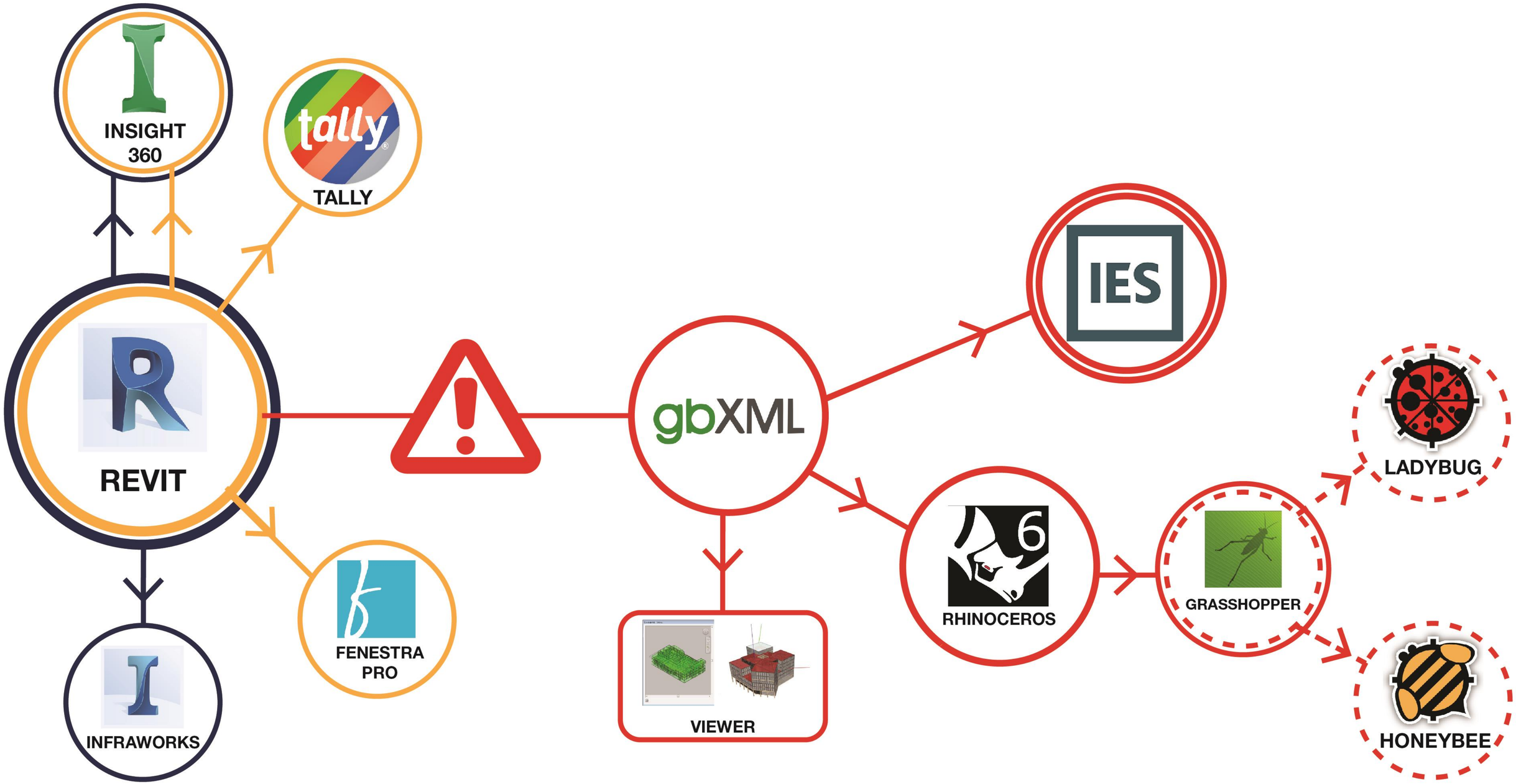
Tower Envelope

Concrete

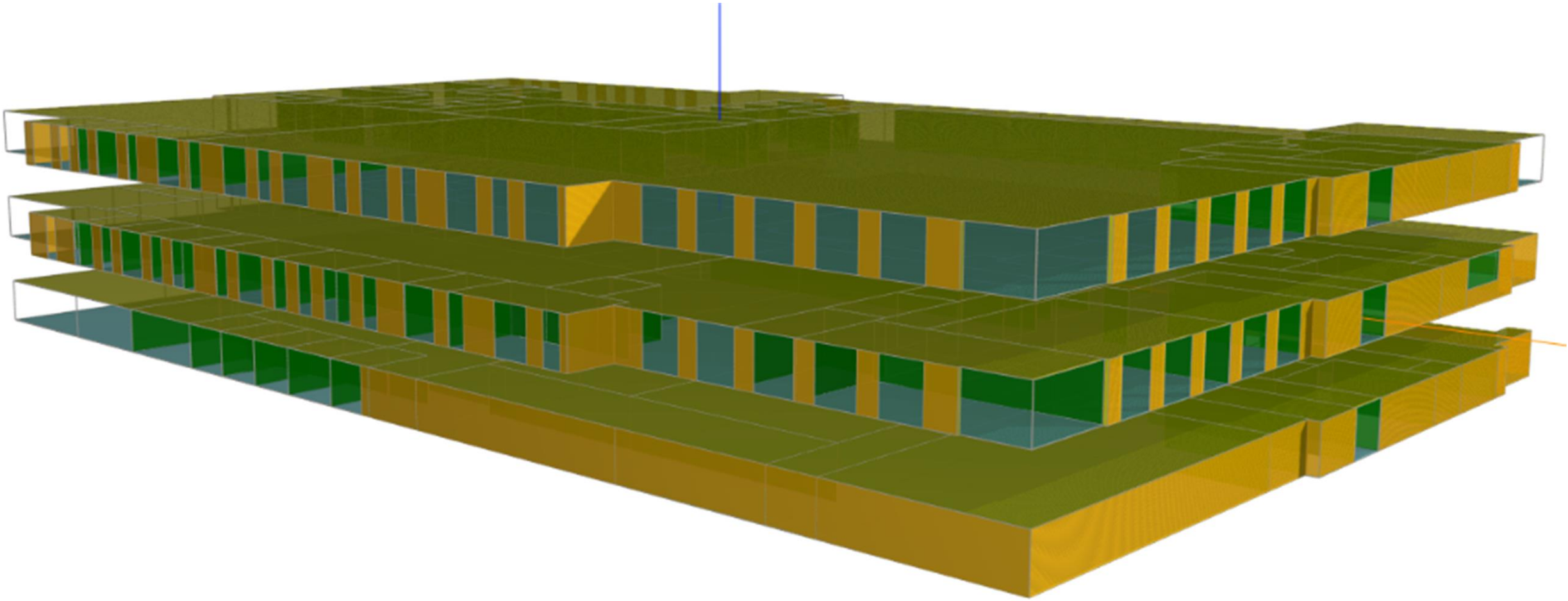




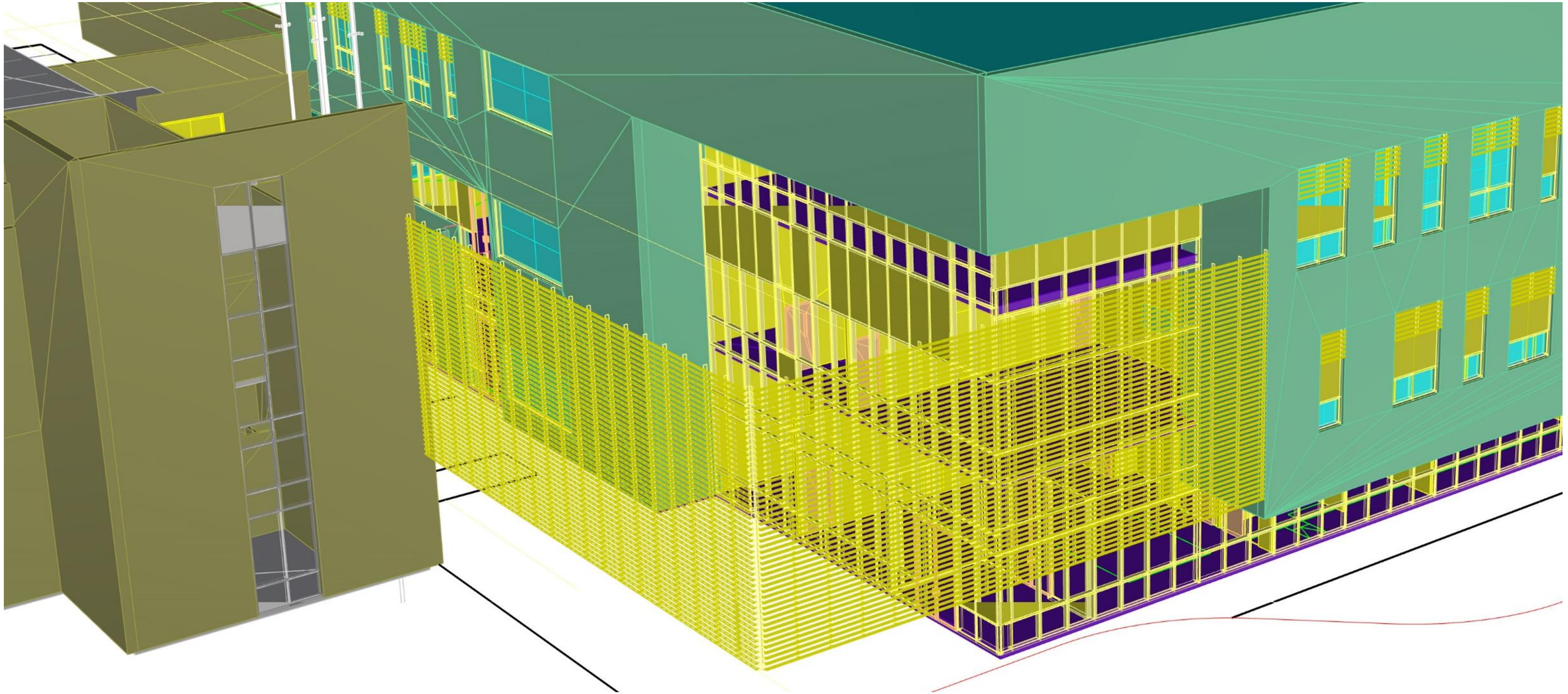

INSIGHT 360
TALLY
REVIT
SHADOW MODEL
gbXML
IES
LADYBUG
RHINOCEROS
GRASSHOPPER
HONEYBEE
FENESTRA PRO
INFRAWORKS
VIEWER


INSIGHT 360
TALLY
REVIT
INFRAWORKS
FENESTRA PRO
gbXML
VIEWER
IES
RHINOCERos
GRASSHOPPER
LADYBUG
HONEYBEE

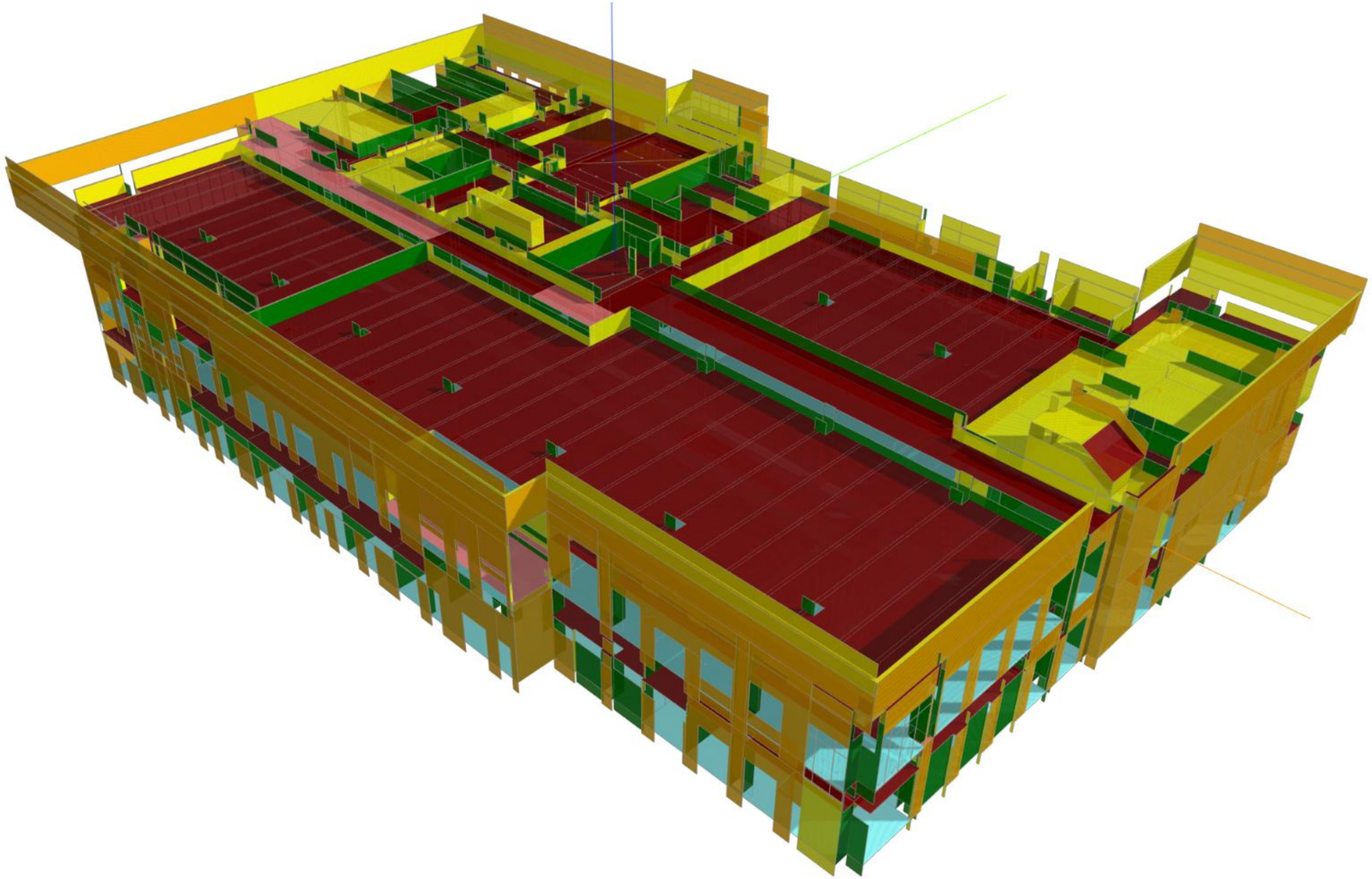
Problem Exterior walls not properly defined.



Problem Ceilings are bounding.

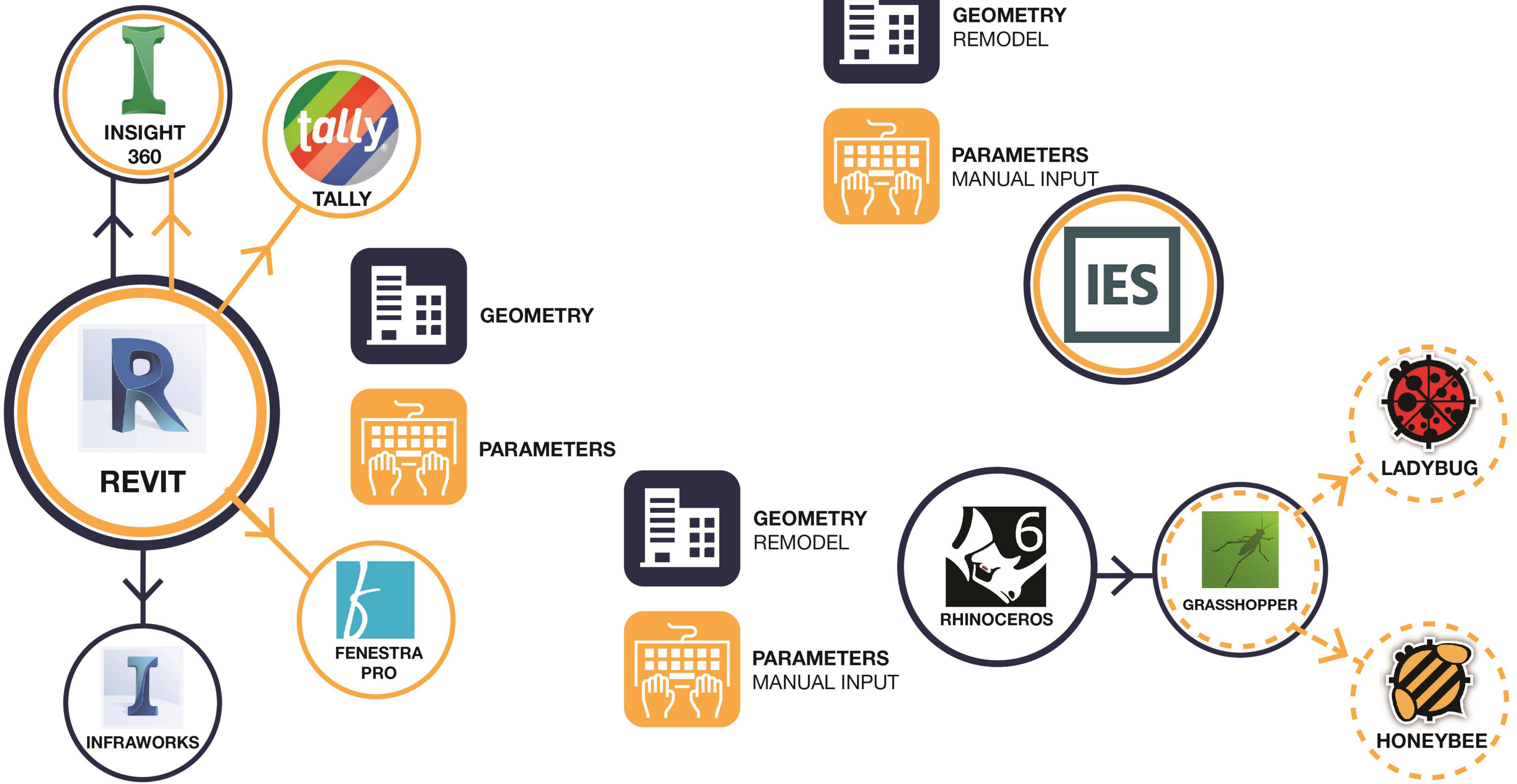


Problem Revit Geometry too heavy with details / mullions



Problem Missing areas when imported into IESVE

Problem Information for ComCheck (WWR) not easily accessible


INSIGHT 360
TALLY
REVIT
INFRAWORKS
FENESTRA PRO
GEOMETRY
PARAMETERS
GEOMETRY REMODEL
PARAMETERS MANUAL INPUT
GEOMETRY REMODEL
PARAMETERS MANUAL INPUT
IES
RHINOCEROS
GRASSHOPPER
LADYBUG
HONEYBEE

Context

Process

Implementation

Next steps

1	2	3	4	5
SCOPING	**MAPPING**	**INPUT**	**SOLUTIONS**	**REFINEMENT**
Define the issues & goals	Identify metrics & processes	Engage stakeholders	Create improved processes	Update standards & processes for improvement

Chris Luz

BIM Manager +
Mechanical Eng.

Duygu Yenerim

BIM Manager +
Project Architect

Shreejay Tuladhar

Building Performance
Analyst

Jerel Gue

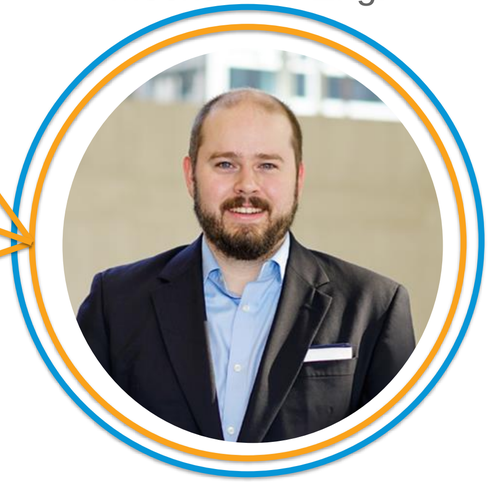
Model Manager+
Designer

Jill Kurtz

Director Building Science +
Project Manager

Jimmy Principe

BIM Coordinator +
Mechanical Eng.



SCOPING

1 2 3 4 5

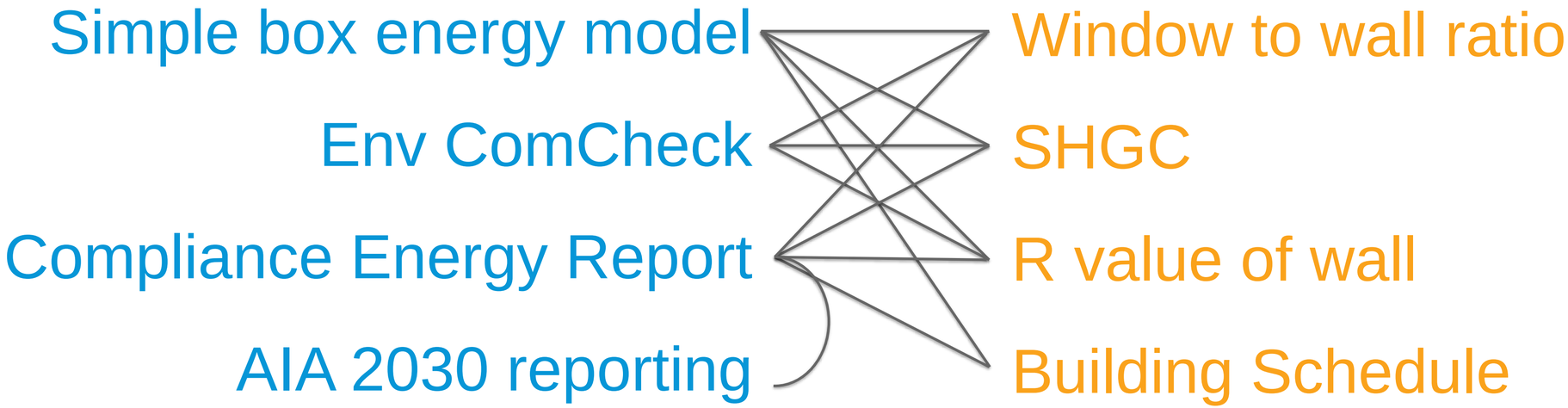
What information do we need ***when*** to make more environmentally informed design decisions?

SCOPING

1 2 3 4 5

Outputs

Inputs



Parameters

Climate
Enclosure
General
Electrical
Site
Mechanical

Organizer

Frequency
Type
Filter
Source

ENCLOSURE						
Wall (exterior)						
Graphic		X - G				
Wall: Type	9	X			Revit	
Wall: R value	10	X			Revit	
WWR (total)	15	X		Dynamo	Revit	
Shading Strategy	10	X				
Glazing						
U Value	8	X			Revit	
SHGC	8	X			Revit	
Tvis	9	X			Revit	
Roof						
R Value	7	X			Revit	
SRI	6	X		User Input	Revit	
Foundation Type		Y				
ELECTRICAL						
Speciality Equipment (Non-Receptacle Process loads)	5		Y - by room			
Receptacle	4	X		User Input		
Interior: Lighting Power density	7	X		User Input	Revit	X
Exterior: Lighting Power Density	2	X		User Input	Revit	
Controls Daylight	7	X	Y - by room	User Input	Insight/IES	
Controls Occupant	6	X	Y - by room	User Input	Insight/IES	

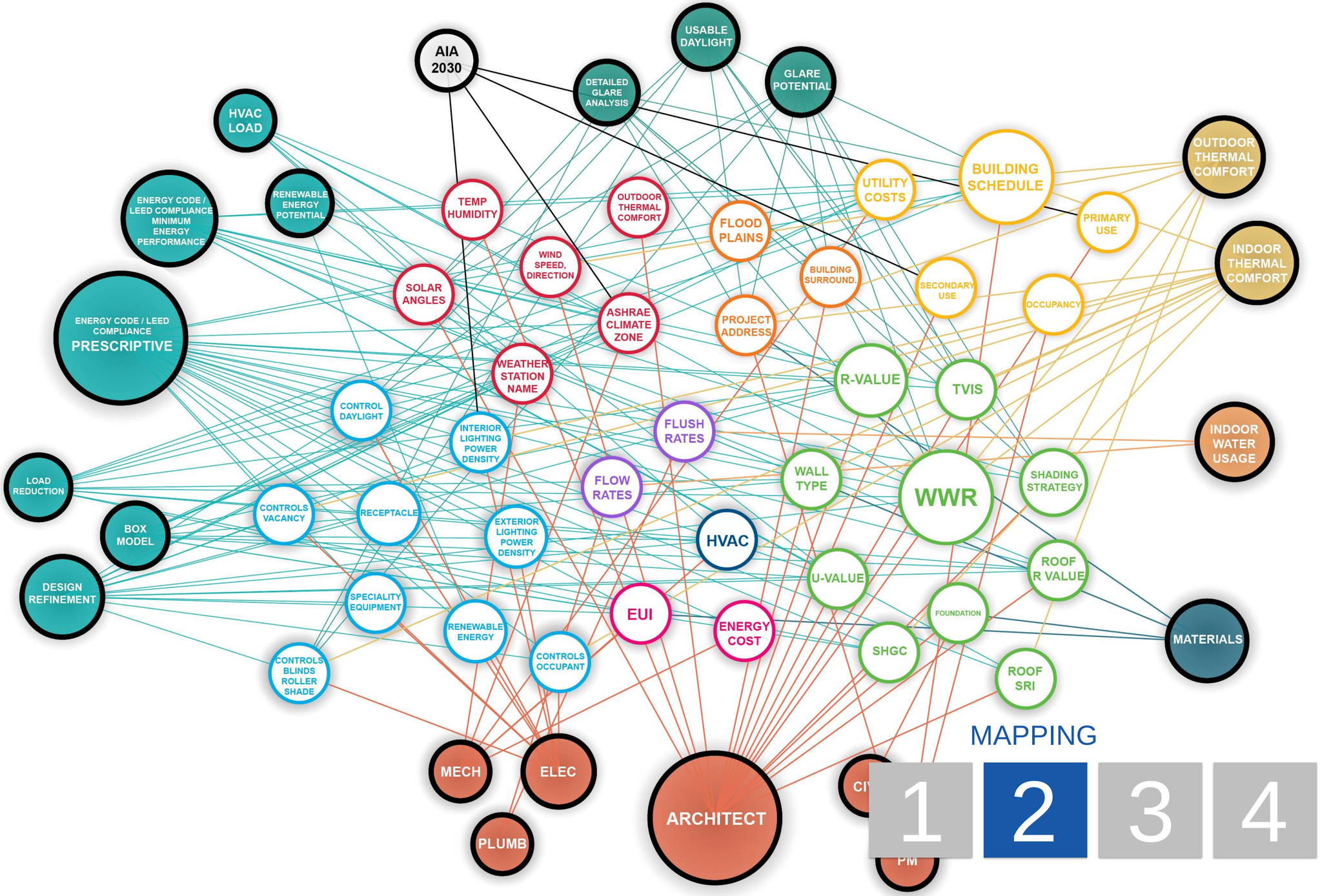
Outputs

Energy
Comfort
Daylight
Carbon

Energy					
EED Compliance	ASHRAE 209 Modeling Cycles				
Minimum Energy Performance	1 - Simple Box model	3 - Load Reduction model	5 - Design Refinment model	HVAC Load Calculations	Renewable Energy Potential
ASHRAE 90.1	*ASHRAE 209*	*ASHRAE 209*	*ASHRAE 209*		
X					
X	X	X	X	X	
X	X	X	X	X	
X		X			
X	X	X	X	X	
X	X	X			
X					
X	X	X	X		
X					
X			X		
X			X		
X			X		
X					
X			X		
X			X		

MAPPING

1 2 3 4 5

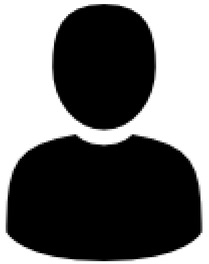

AIA 2030
USABLE DAYLIGHT
DETAILED GLARE ANALYSIS
GLARE POTENTIAL
HVAC LOAD
ENERGY CODE / LEED COMPLIANCE MINIMUM ENERGY PERFORMANCE
RENEWABLE ENERGY POTENTIAL
TEMP HUMIDITY
OUTDOOR THERMAL COMFORT
FLOOD PLAINS
UTILITY COSTS
BUILDING SCHEDULE
OUTDOOR THERMAL COMFORT
PRIMARY USE
INDOOR THERMAL COMFORT
WIND SPEED, DIRECTION
BUILDING SURROUND.
SECONDARY USE
OCCUPANCY
SOLAR ANGLES
ASHRAE CLIMATE ZONE
PROJECT ADDRESS
ENERGY CODE / LEED COMPLIANCE PRESCRIPTIVE
WEATHER STATION NAME
R-VALUE
TVIS
CONTROL DAYLIGHT
INTERIOR LIGHTING POWER DENSITY
FLUSH RATES
INDOOR WATER USAGE
LOAD REDUCTION
FLOW RATES
WALL TYPE
WWR
SHADING STRATEGY
CONTROLS VACANCY
RECEPTACLE
EXTERIOR LIGHTING POWER DENSITY
HVAC
BOX MODEL
U-VALUE
ROOF R VALUE
DESIGN REFINEMENT
SPECIALITY EQUIPMENT
EUI
FOUNDATION
MATERIALS
RENEWABLE ENERGY
ENERGY COST
SHGC
CONTROLS BLINDS ROLLER SHADE
CONTROLS OCCUPANT
ROOF SRI
MECH
ELEC
ARCHITECT
PLUMB
MAPPING
1
2
3
4
5

INPUT

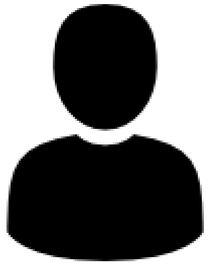
1 2 **3** 4 5

Designers

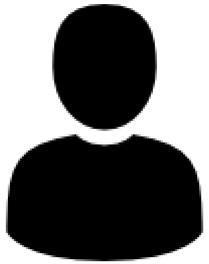
Architects



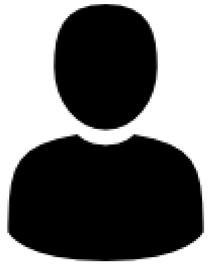
Mechanical Engineers



Electrical Engineers



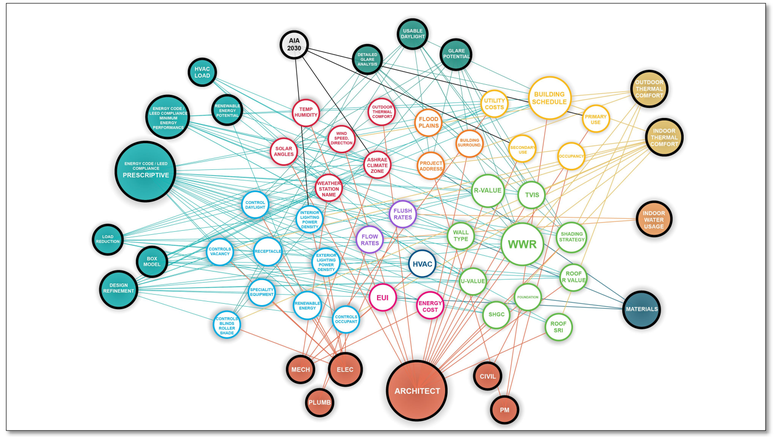
Project Manager



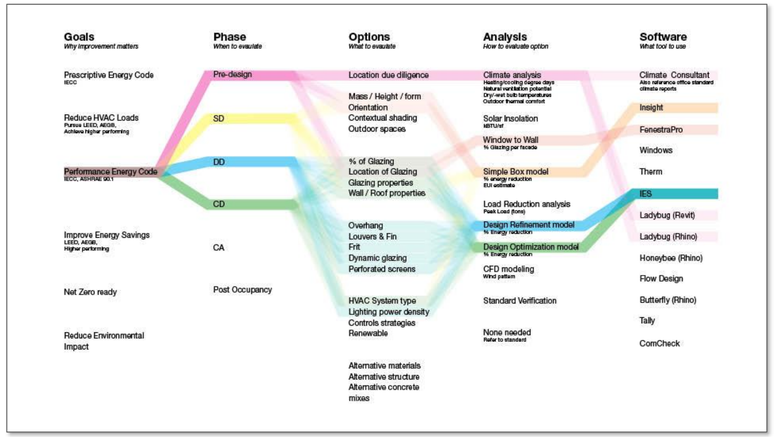
INPUT

1 2 3 4 5

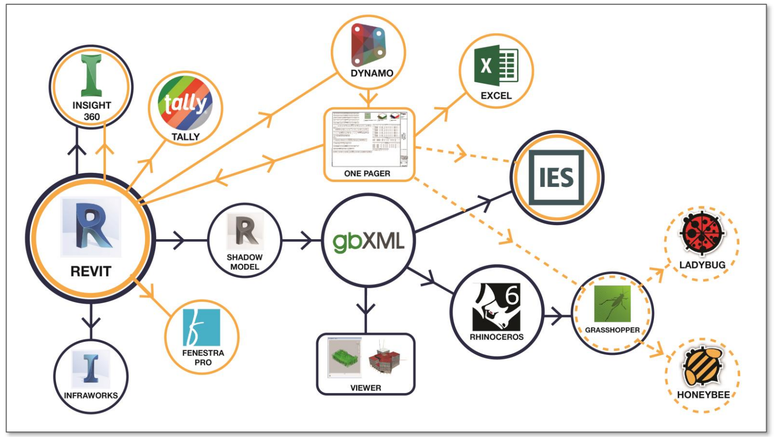
Metrics priority



Metrics Map

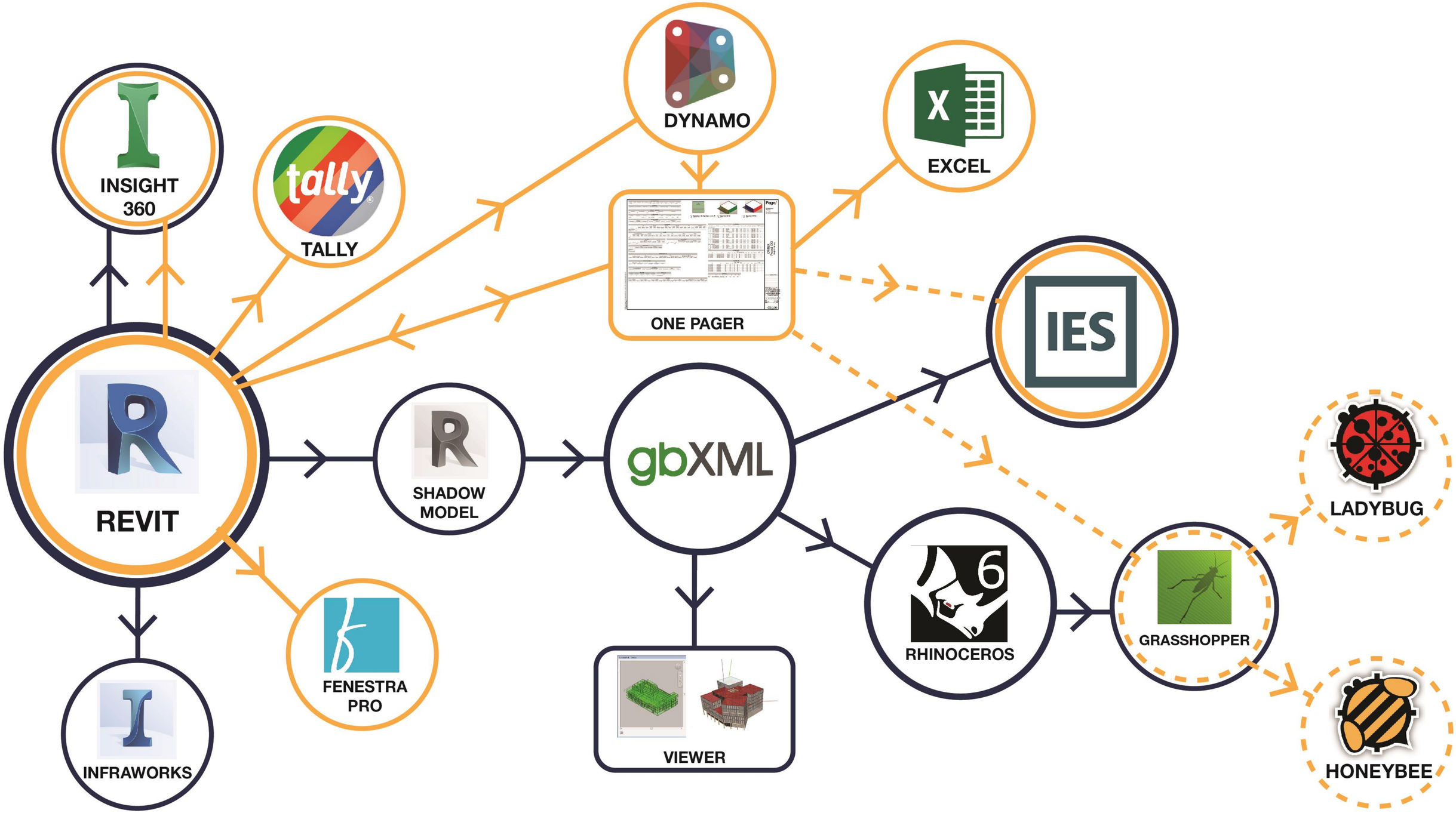


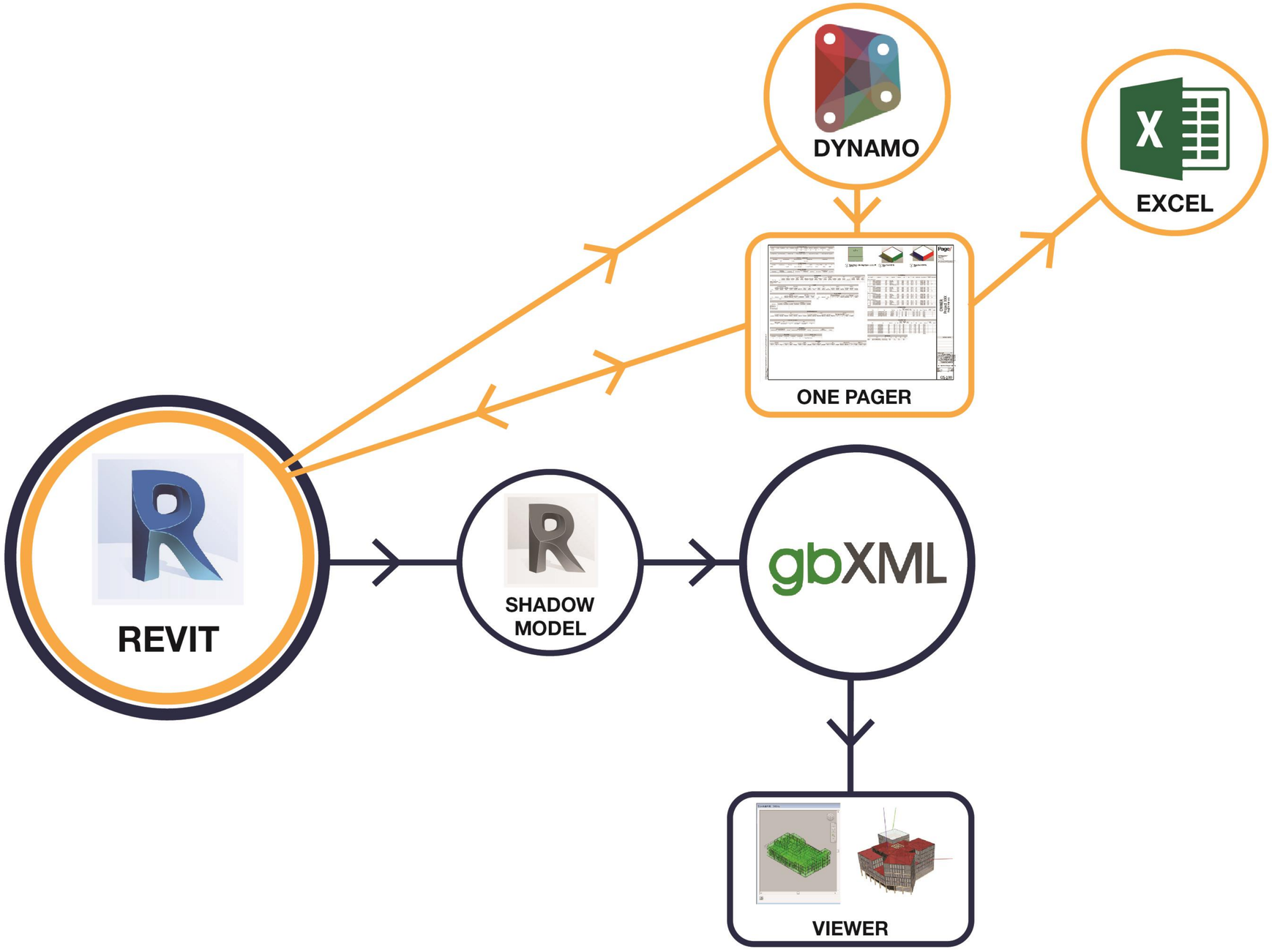
Workflow Improvement

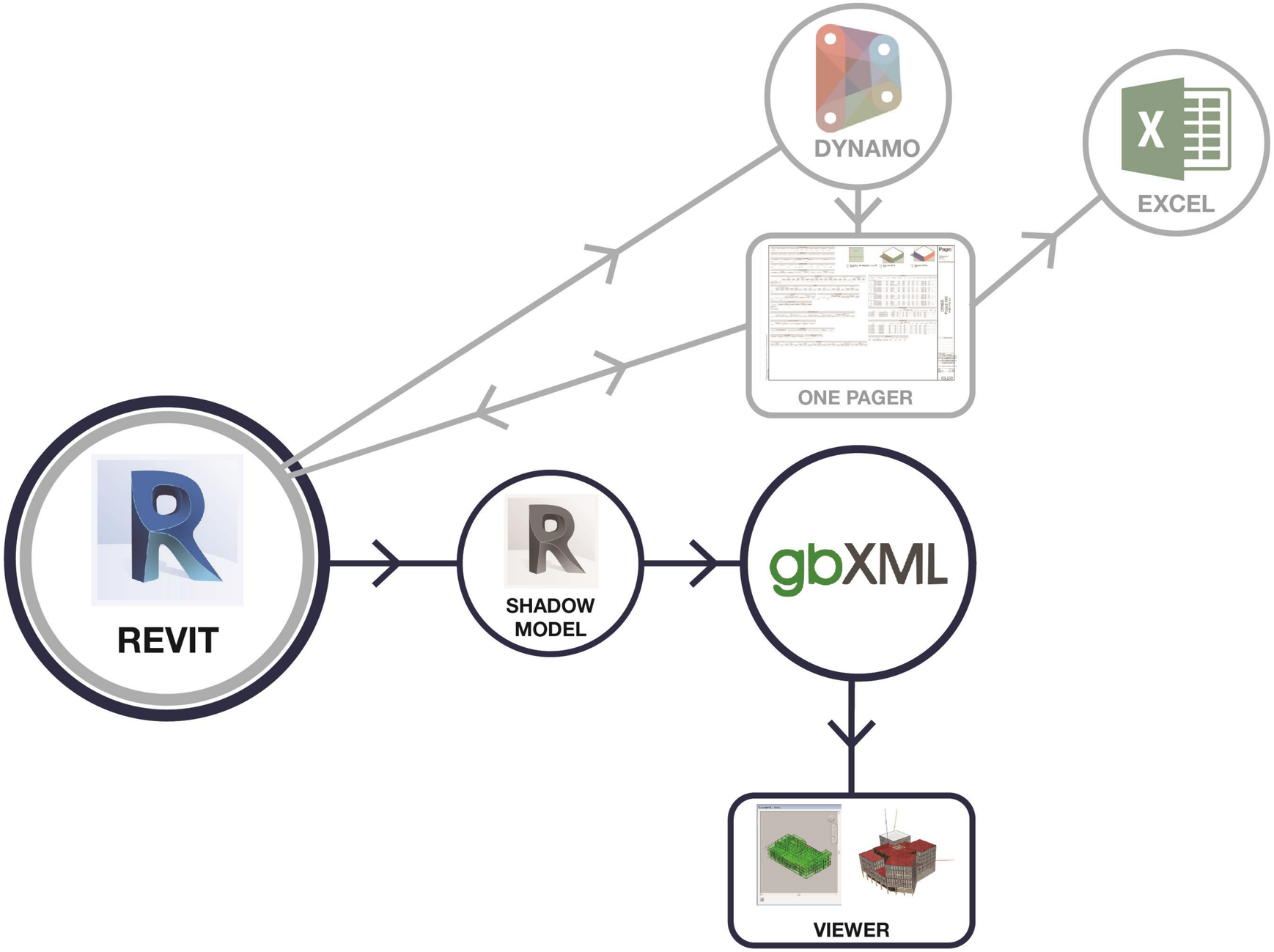


SOLUTIONS

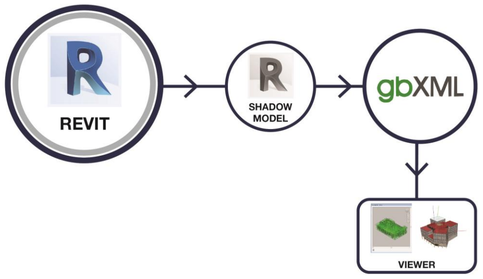
1 2 3 4 5

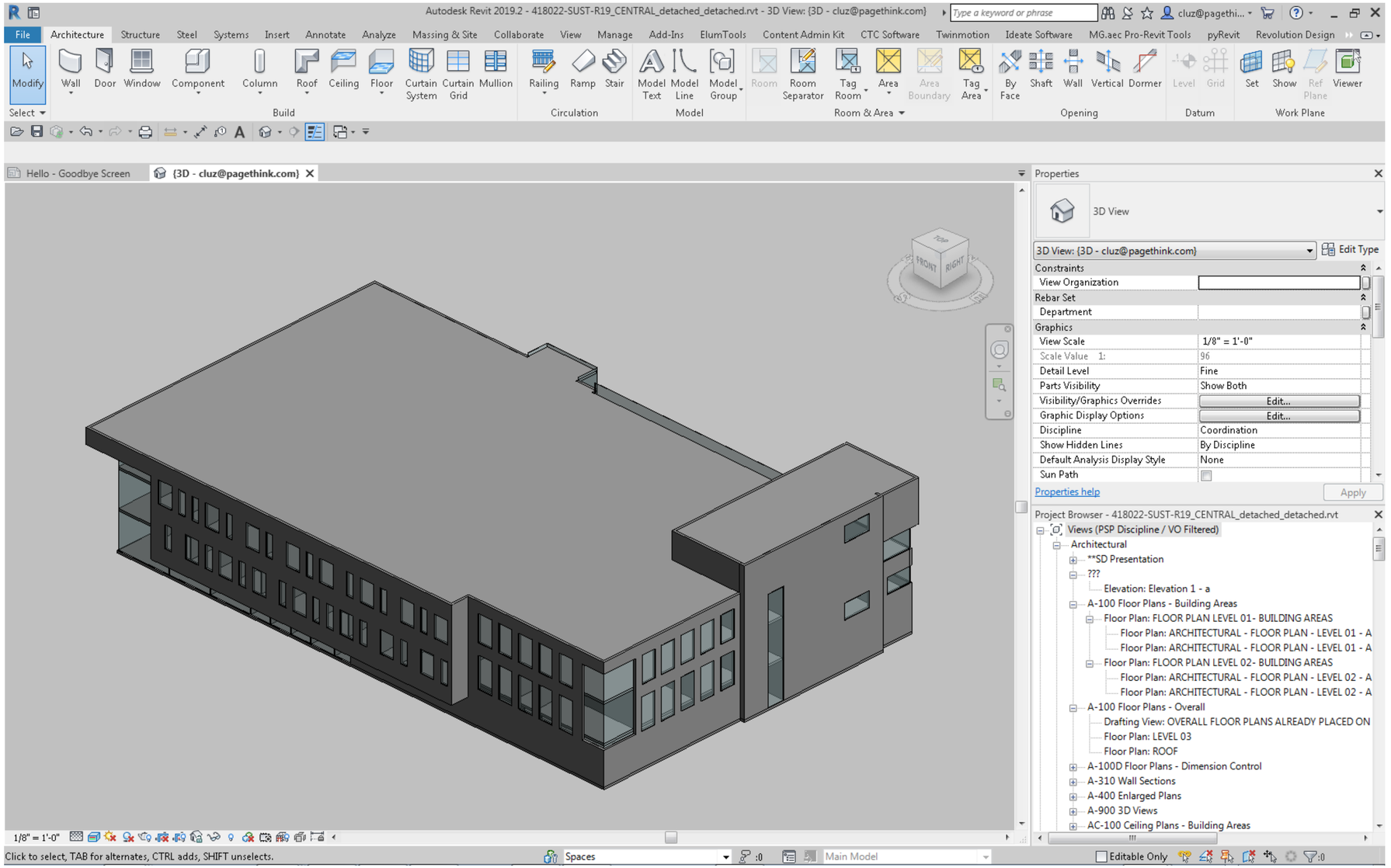

INSIGHT 360
TALLY
DYNAMO
EXCEL
ONE PAGER
IES
REVIT
SHADOW MODEL
gbXML
LADYBUG
RHINOCEROS
GRASSHOPPER
HONEYBEE
FENESTRA PRO
INFRAWORKS
VIEWER


DYNAMO
EXCEL
ONE PAGER
REVIT
SHADOW
MODEL
gbXML
VIEWER

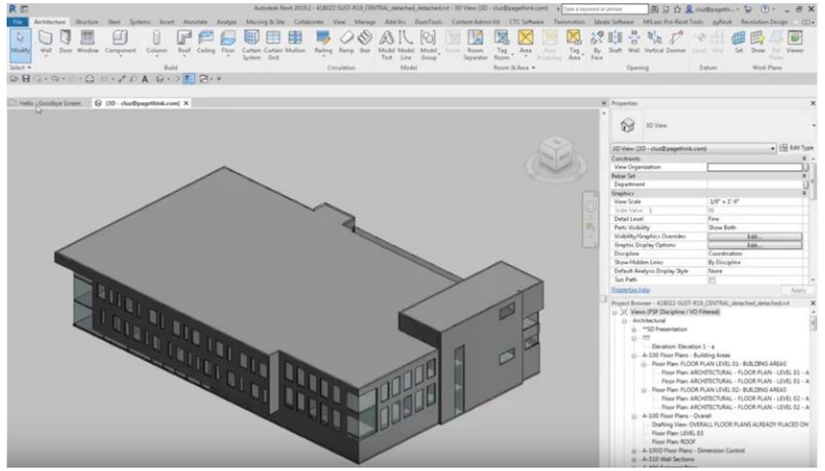

DYNAMO
EXCEL
ONE PAGER
REVIT
SHADOW MODEL
gbXML
VIEWER

Step 1 Create: Save shadow model as a detached model



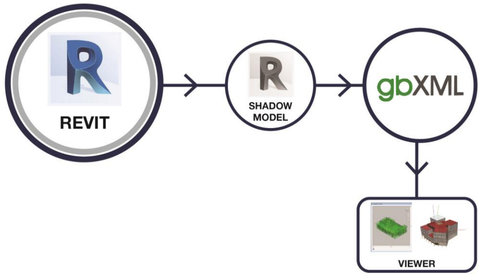


Step 2 **Modeling:** Create spaces for any area to be analyzed.

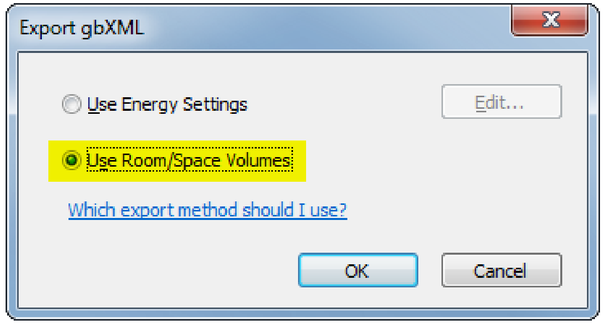


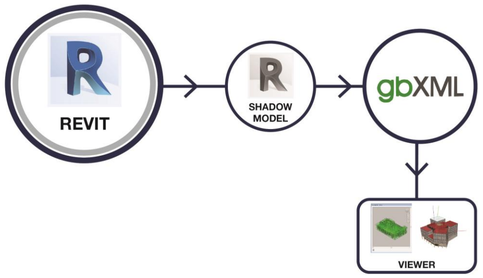
https://www.youtube.com/watch?v=Pk1vzfE3a4k

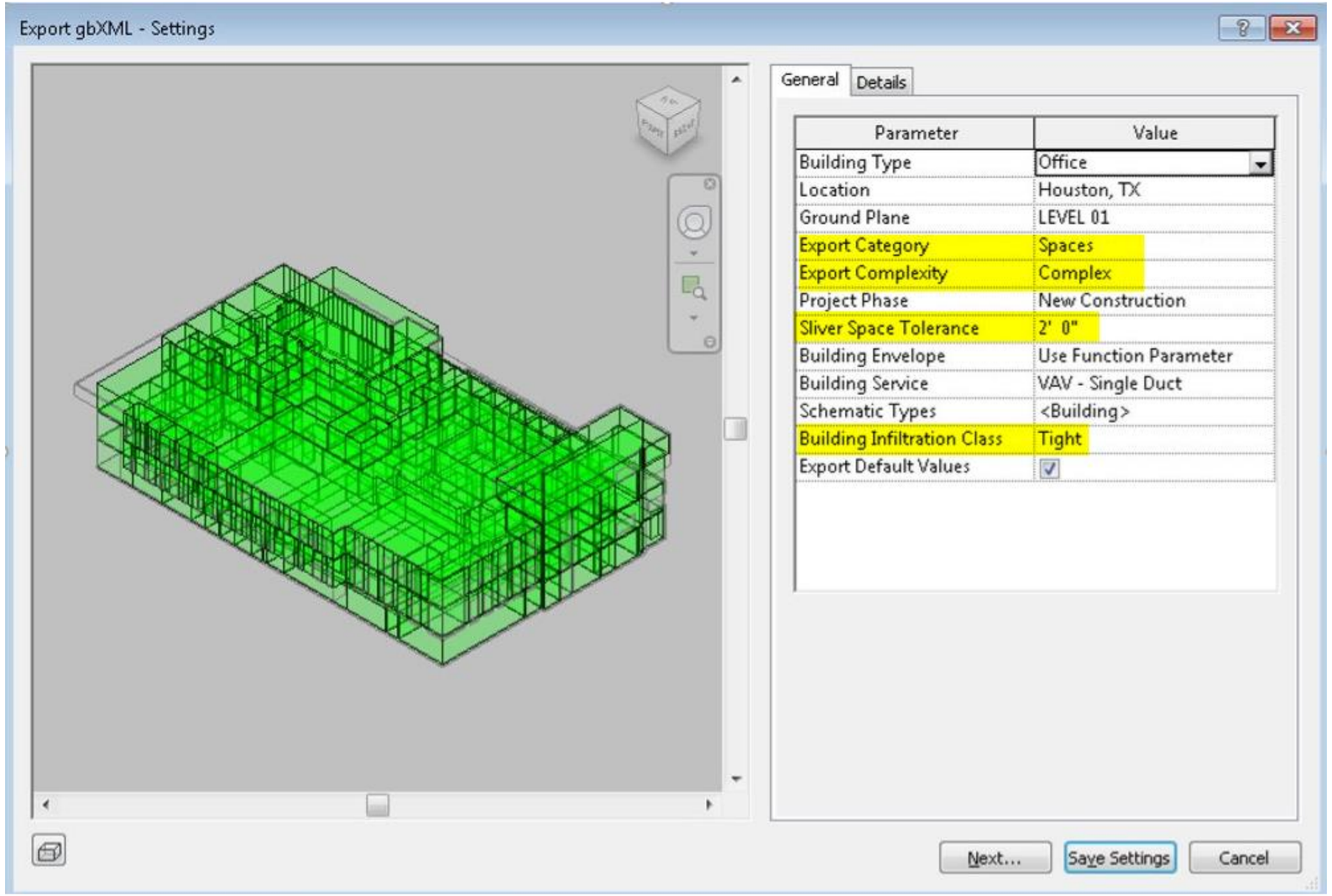
Workflow adopted from ATG and Gausman & Moore



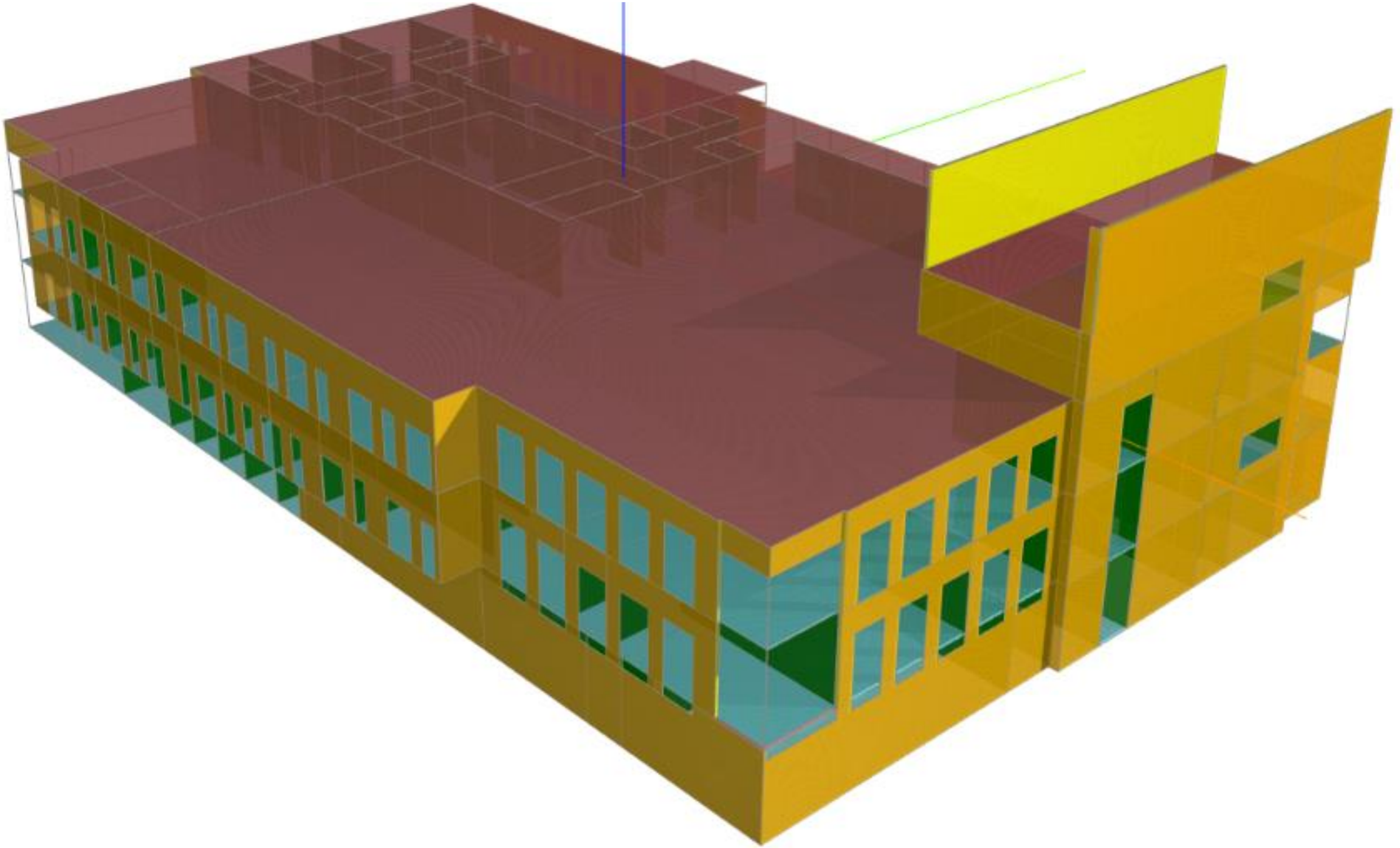
Step 3 **Settings:** Change “export gbXML” settings to Room/Space Volumes
Use the following settings



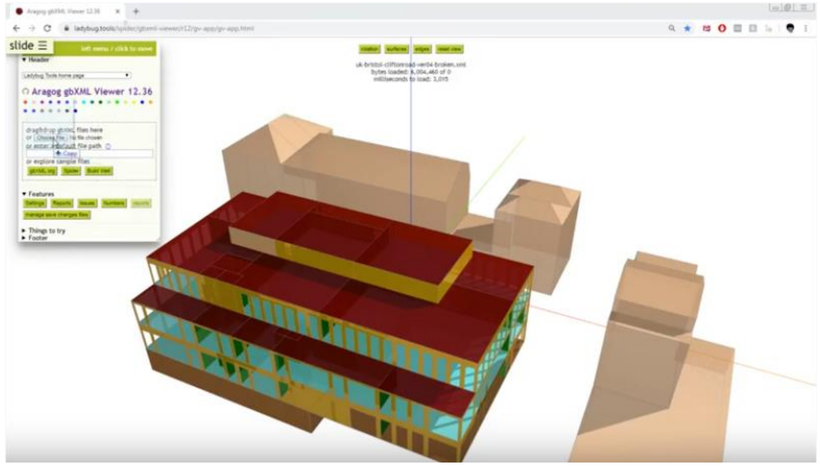




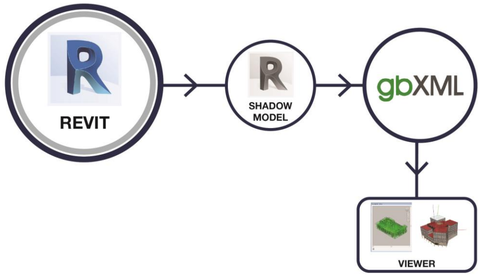
Step 4 Export gbXML



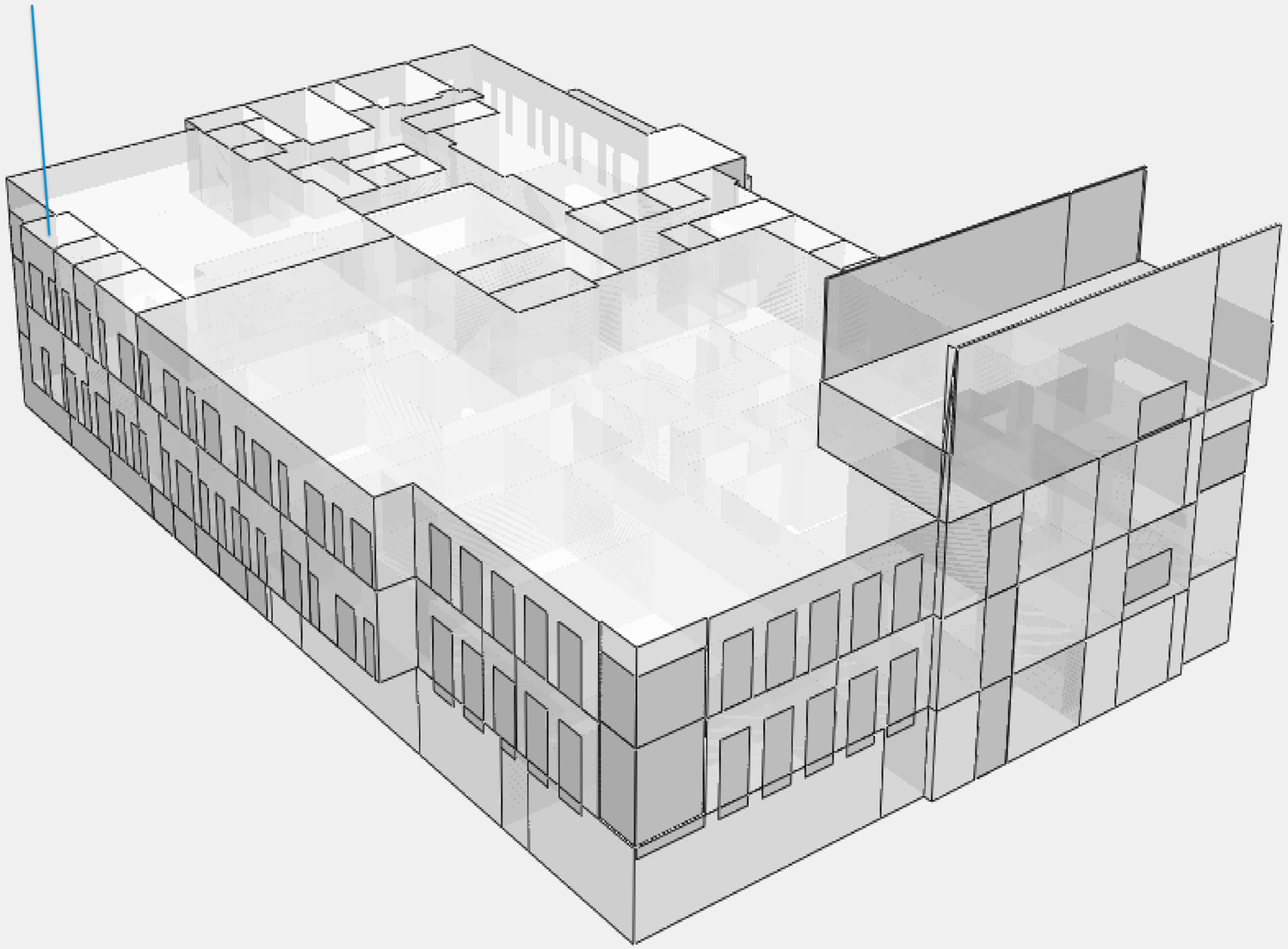
Step 5 Export gbXML and check using ladybug spider viewer for more detail.



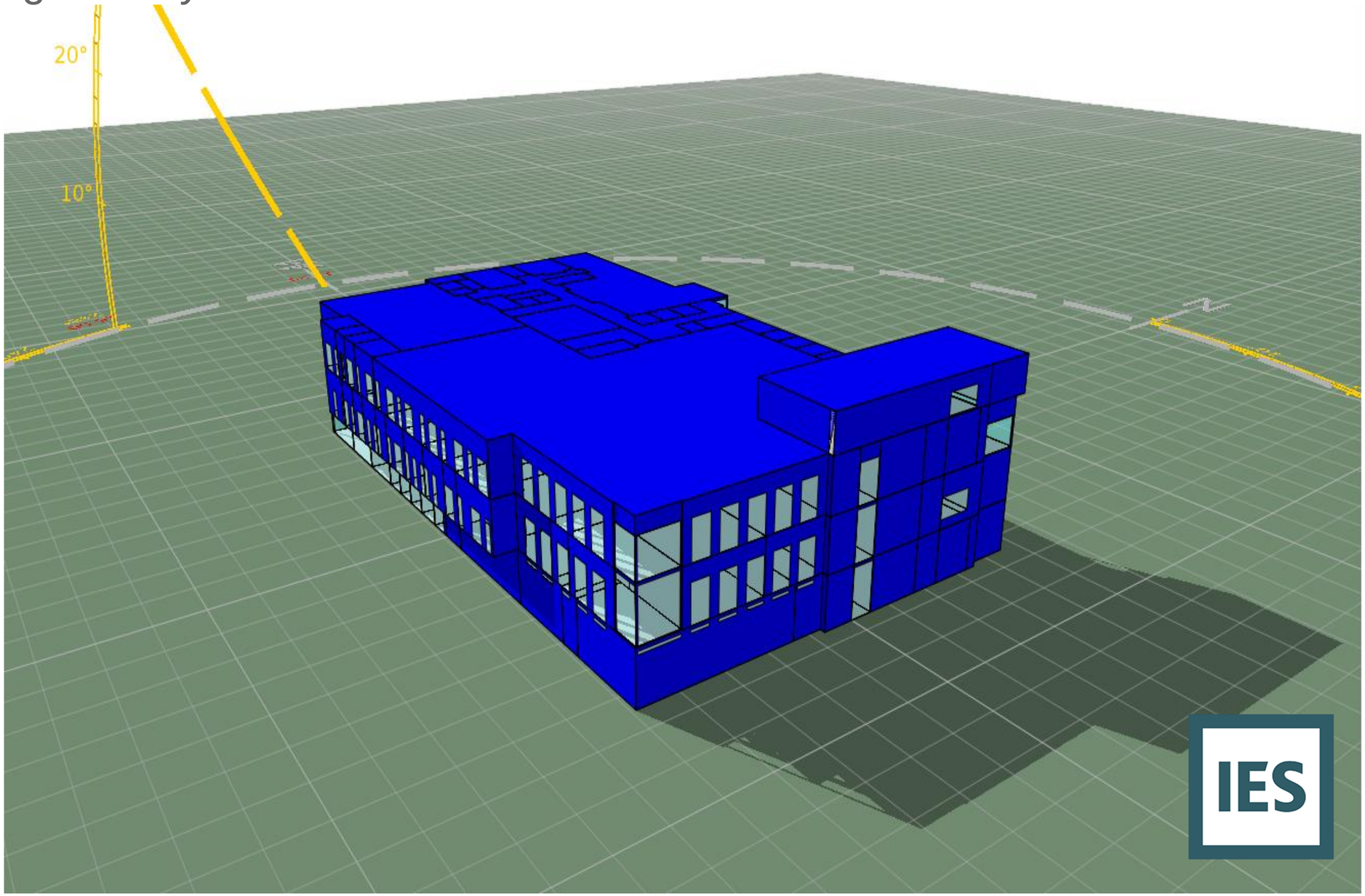
https://www.youtube.com/watch?v=0MXnrlj4iVs

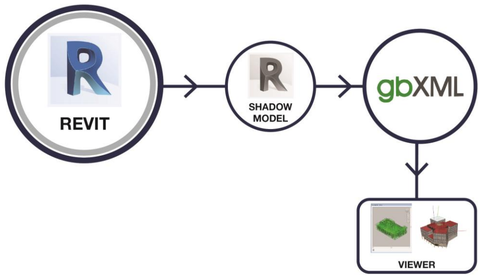


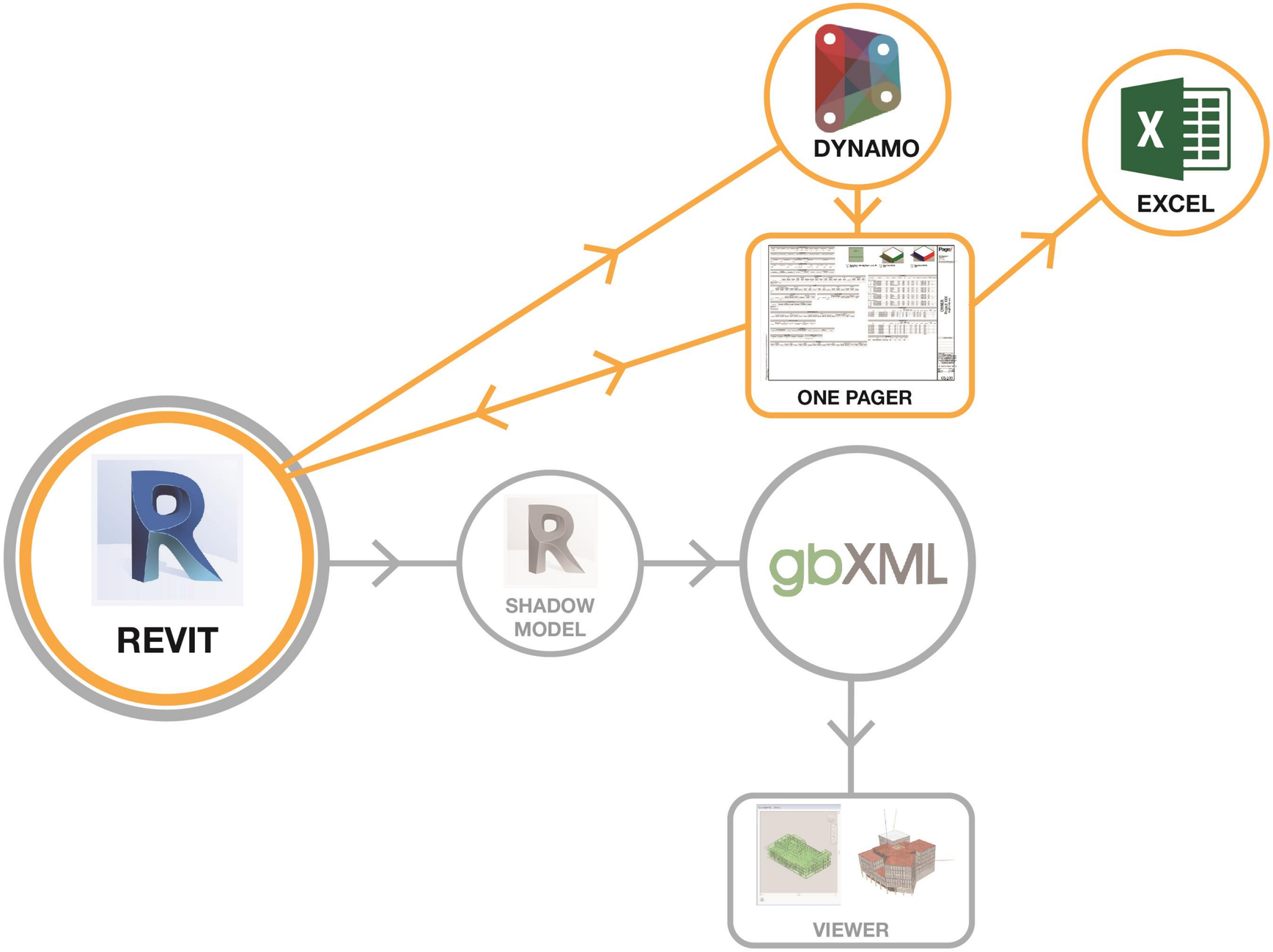
Step 6 Import gbXML into another program.



Step 7 Heal minor geometry issues.

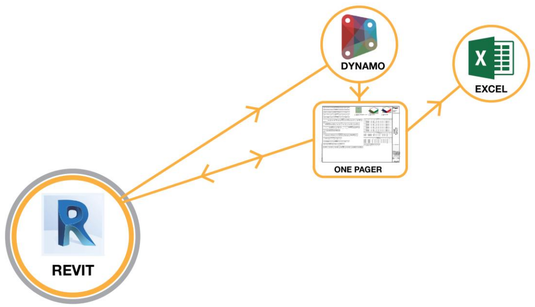


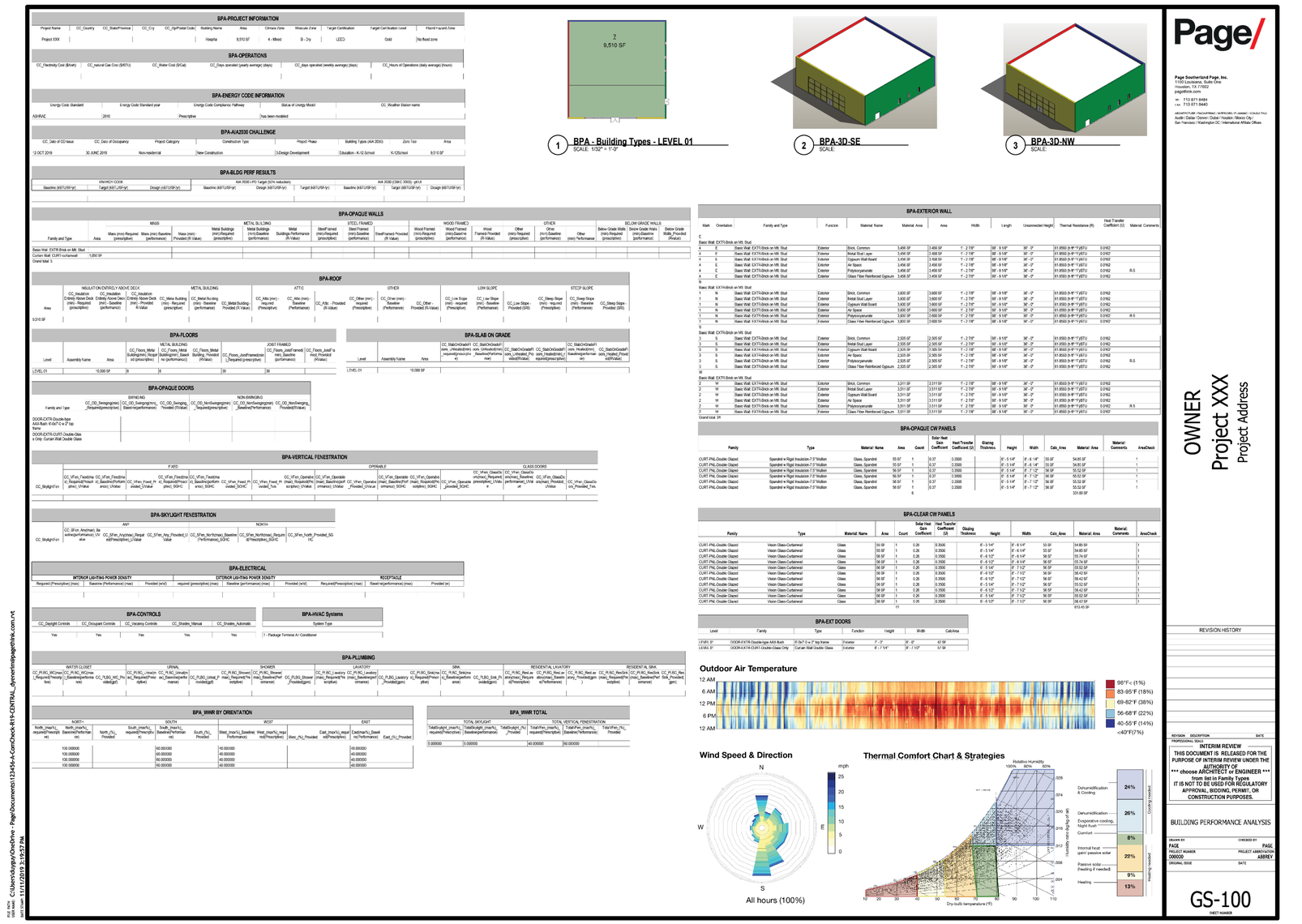



DYNAMO
EXCEL
ONE PAGER
REVIT
SHADOW
MODEL
gbXML
VIEWER

One Page Parameter Sheet

- Lives in Revit, Accessible in Excel
- Editable in both Revit & Excel
- Collection place for performance data:
  - AIA 2030
  - Energy Code Modeling
  - Prescriptive ComCheck
  - Building Performance Modeling (Insight, IESVE)
- QA/QC Tool

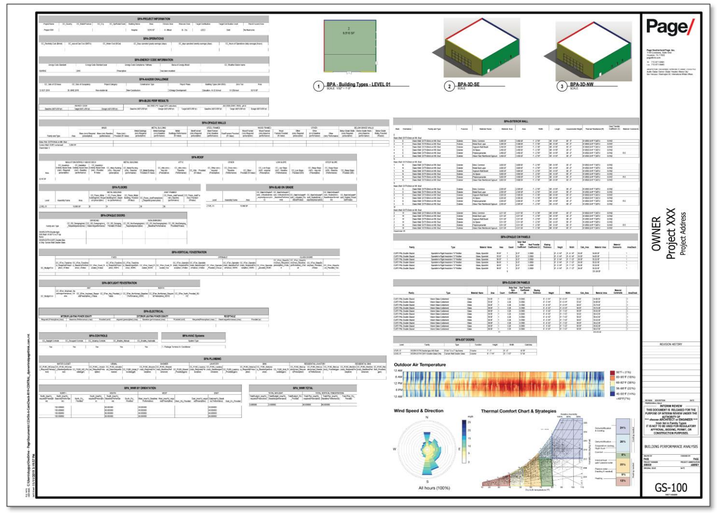


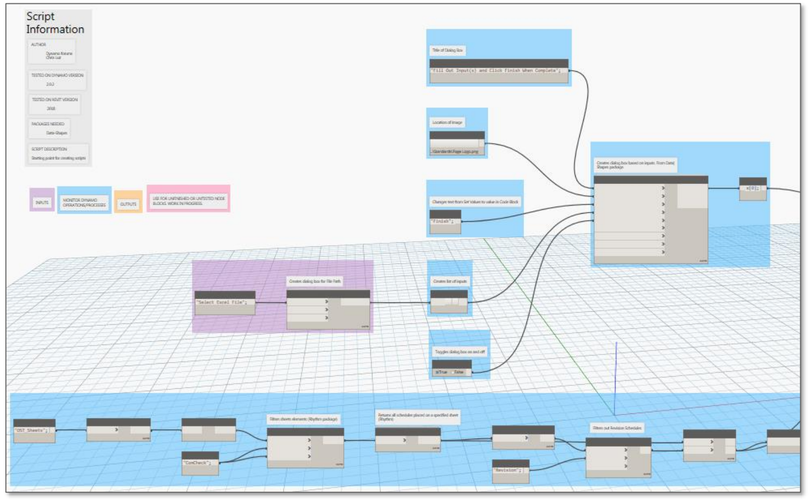


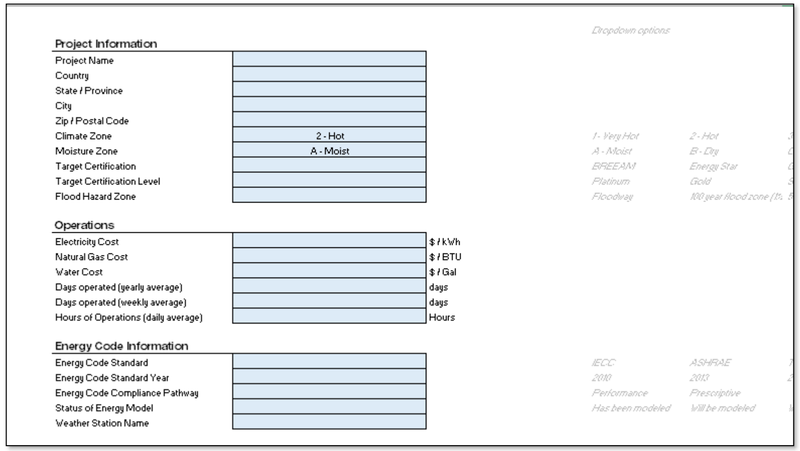
AUTODESK
REVIT

Dynamo

Excel



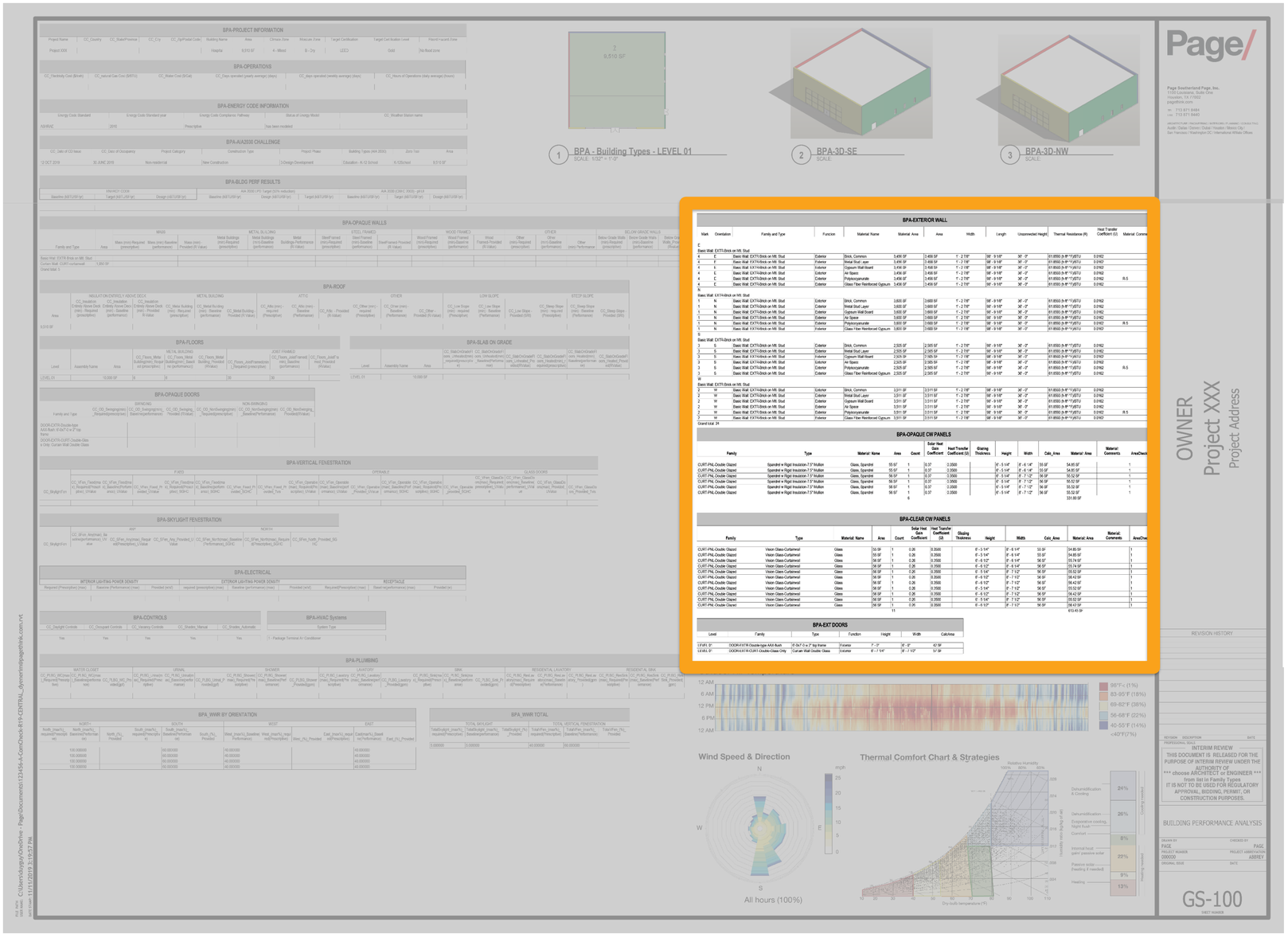


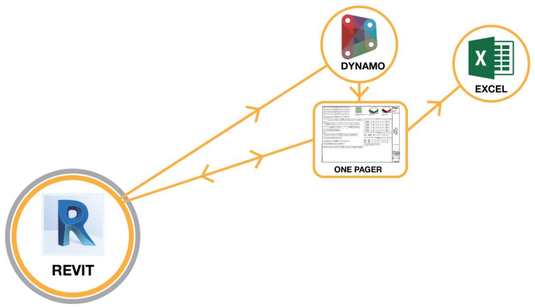


Revit users:
Designers, Project Architects, Engineers

Non- Revit users:
Project Managers, QAQC managers

Item 1 information extracted from the model





Item 1 information extracted from the model

WALLS

BPA-EXTERIOR WALL

Mark	Orientation	Family and Type	Function	Material: Name	Material: Area	Area	Width	Length	Unconnected Height	Thermal Resistance (R)	Heat Transfer Coefficient (U)	Material: Comments
E												
Basic Wall: EXTR-Brick on Mtl. Stud												
4	E	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Brick, Common	3,456 SF	3,456 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
4	E	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Metal Stud Layer	3,456 SF	3,456 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
4	E	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Gypsum Wall Board	3,456 SF	3,456 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
4	E	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Air Space	3,456 SF	3,456 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
4	E	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Polyisocyanurate	3,456 SF	3,456 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	R-5
4	E	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Glass Fiber Reinforced Gypsum	3,456 SF	3,456 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
N												
Basic Wall: EXTR-Brick on Mtl. Stud												
1	N	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Brick, Common	3,600 SF	3,600 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
1	N	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Metal Stud Layer	3,600 SF	3,600 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
1	N	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Gypsum Wall Board	3,600 SF	3,600 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
1	N	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Air Space	3,600 SF	3,600 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
1	N	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Polyisocyanurate	3,600 SF	3,600 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	R-5
1	N	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Glass Fiber Reinforced Gypsum	3,600 SF	3,600 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
S												
Basic Wall: EXTR-Brick on Mtl. Stud												
3	S	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Brick, Common	2,505 SF	2,505 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
3	S	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Metal Stud Layer	2,505 SF	2,505 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
3	S	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Gypsum Wall Board	2,505 SF	2,505 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
3	S	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Air Space	2,505 SF	2,505 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
3	S	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Polyisocyanurate	2,505 SF	2,505 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	R-5
3	S	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Glass Fiber Reinforced Gypsum	2,505 SF	2,505 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
W												
Basic Wall: EXTR-Brick on Mtl. Stud												
2	W	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Brick, Common	3,511 SF	3,511 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
2	W	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Metal Stud Layer	3,511 SF	3,511 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
2	W	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Gypsum Wall Board	3,511 SF	3,511 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
2	W	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Air Space	3,511 SF	3,511 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
2	W	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Polyisocyanurate	3,511 SF	3,511 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	R-5
2	W	Basic Wall: EXTR-Brick on Mtl. Stud	Exterior	Glass Fiber Reinforced Gypsum	3,511 SF	3,511 SF	1' - 2 7/8"	96' - 9 1/8"	36' - 0"	61.8593 (h·ft^2·°F)/BTU	0.0162	
Grand total: 24												

CURTAIN WALL PANELS-OPAQUE

BPA-OPAQUE CW PANELS

Family	Type	Material: Name	Area	Count	Solar Heat Gain Coefficient	Heat Transfer Coefficient (U)	Glazing Thickness	Height	Width	Calc_Area	Material: Area	Material: Comments	AreaCheck
CURT-PNL-Double Glazed	Spandrel w Rigid Insulation-7.5" Mullion	Glass, Spandrel	55 SF	1	0.37	0.3500		6' - 5 1/4"	8' - 6 1/4"	55 SF	54.85 SF		1
CURT-PNL-Double Glazed	Spandrel w Rigid Insulation-7.5" Mullion	Glass, Spandrel	55 SF	1	0.37	0.3500		6' - 5 1/4"	8' - 6 1/4"	55 SF	54.85 SF		1
CURT-PNL-Double Glazed	Spandrel w Rigid Insulation-7.5" Mullion	Glass, Spandrel	56 SF	1	0.37	0.3500		6' - 5 1/4"	8' - 7 1/2"	56 SF	55.52 SF		1
CURT-PNL-Double Glazed	Spandrel w Rigid Insulation-7.5" Mullion	Glass, Spandrel	56 SF	1	0.37	0.3500		6' - 5 1/4"	8' - 7 1/2"	56 SF	55.52 SF		1
CURT-PNL-Double Glazed	Spandrel w Rigid Insulation-7.5" Mullion	Glass, Spandrel	56 SF	1	0.37	0.3500		6' - 5 1/4"	8' - 7 1/2"	56 SF	55.52 SF		1
CURT-PNL-Double Glazed	Spandrel w Rigid Insulation-7.5" Mullion	Glass, Spandrel	56 SF	1	0.37	0.3500		6' - 5 1/4"	8' - 7 1/2"	56 SF	55.52 SF		1
				6							331.80 SF		

CURTAIN WALL PANELS-CLEAR

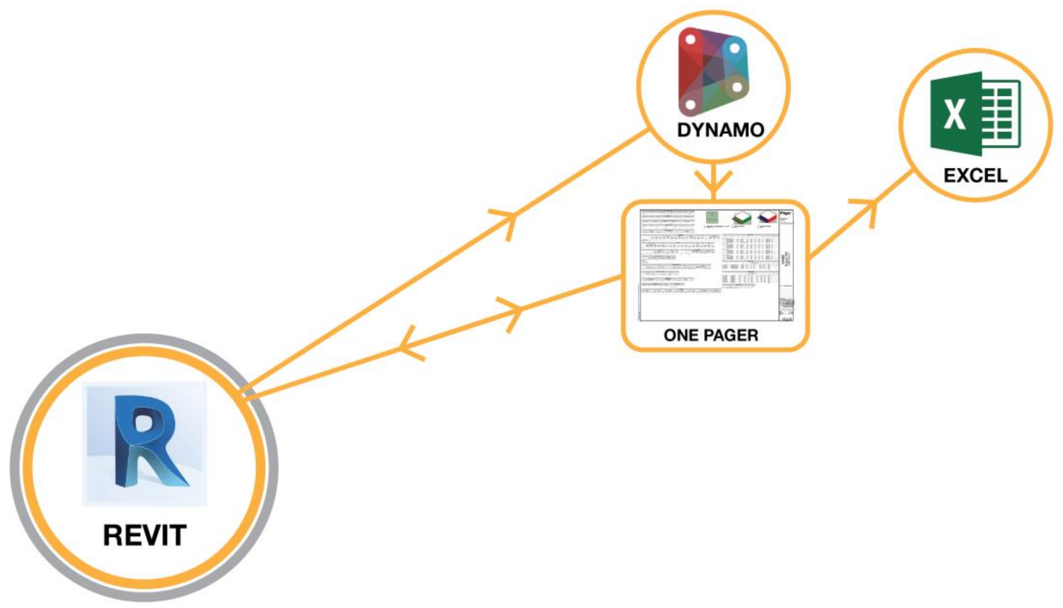
BPA-CLEAR CW PANELS

Family	Type	Material: Name	Area	Count	Solar Heat Gain Coefficient	Heat Transfer Coefficient (U)	Glazing Thickness	Height	Width	Calc_Area	Material: Area	Material: Comments	AreaCheck
CURT-PNL-Double Glazed	Vision Glass-Curtainwall	Glass	55 SF	1	0.26	0.3500		6' - 5 1/4"	8' - 6 1/4"	55 SF	54.85 SF		1
CURT-PNL-Double Glazed	Vision Glass-Curtainwall	Glass	55 SF	1	0.26	0.3500		6' - 5 1/4"	8' - 6 1/4"	55 SF	54.85 SF		1
CURT-PNL-Double Glazed	Vision Glass-Curtainwall	Glass	56 SF	1	0.26	0.3500		6' - 6 1/2"	8' - 6 1/4"	56 SF	55.74 SF		1
CURT-PNL-Double Glazed	Vision Glass-Curtainwall	Glass	56 SF	1	0.26	0.3500		6' - 6 1/2"	8' - 6 1/4"	56 SF	55.74 SF		1
CURT-PNL-Double Glazed	Vision Glass-Curtainwall	Glass	56 SF	1	0.26	0.3500		6' - 5 1/4"	8' - 7 1/2"	56 SF	55.52 SF		1
CURT-PNL-Double Glazed	Vision Glass-Curtainwall	Glass	56 SF	1	0.26	0.3500		6' - 6 1/2"	8' - 7 1/2"	56 SF	56.42 SF		1
CURT-PNL-Double Glazed	Vision Glass-Curtainwall	Glass	56 SF	1	0.26	0.3500		6' - 6 1/2"	8' - 7 1/2"	56 SF	56.42 SF		1
CURT-PNL-Double Glazed	Vision Glass-Curtainwall	Glass	56 SF	1	0.26	0.3500		6' - 5 1/4"	8' - 7 1/2"	56 SF	55.52 SF		1
CURT-PNL-Double Glazed	Vision Glass-Curtainwall	Glass	56 SF	1	0.26	0.3500		6' - 6 1/2"	8' - 7 1/2"	56 SF	56.42 SF		1
CURT-PNL-Double Glazed	Vision Glass-Curtainwall	Glass	56 SF	1	0.26	0.3500		6' - 5 1/4"	8' - 7 1/2"	56 SF	55.52 SF		1
CURT-PNL-Double Glazed	Vision Glass-Curtainwall	Glass	56 SF	1	0.26	0.3500		6' - 6 1/2"	8' - 7 1/2"	56 SF	56.42 SF		1
				11							613.45 SF		

DOORS

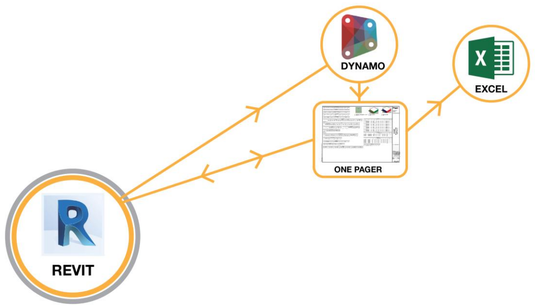
BPA-EXT DOORS

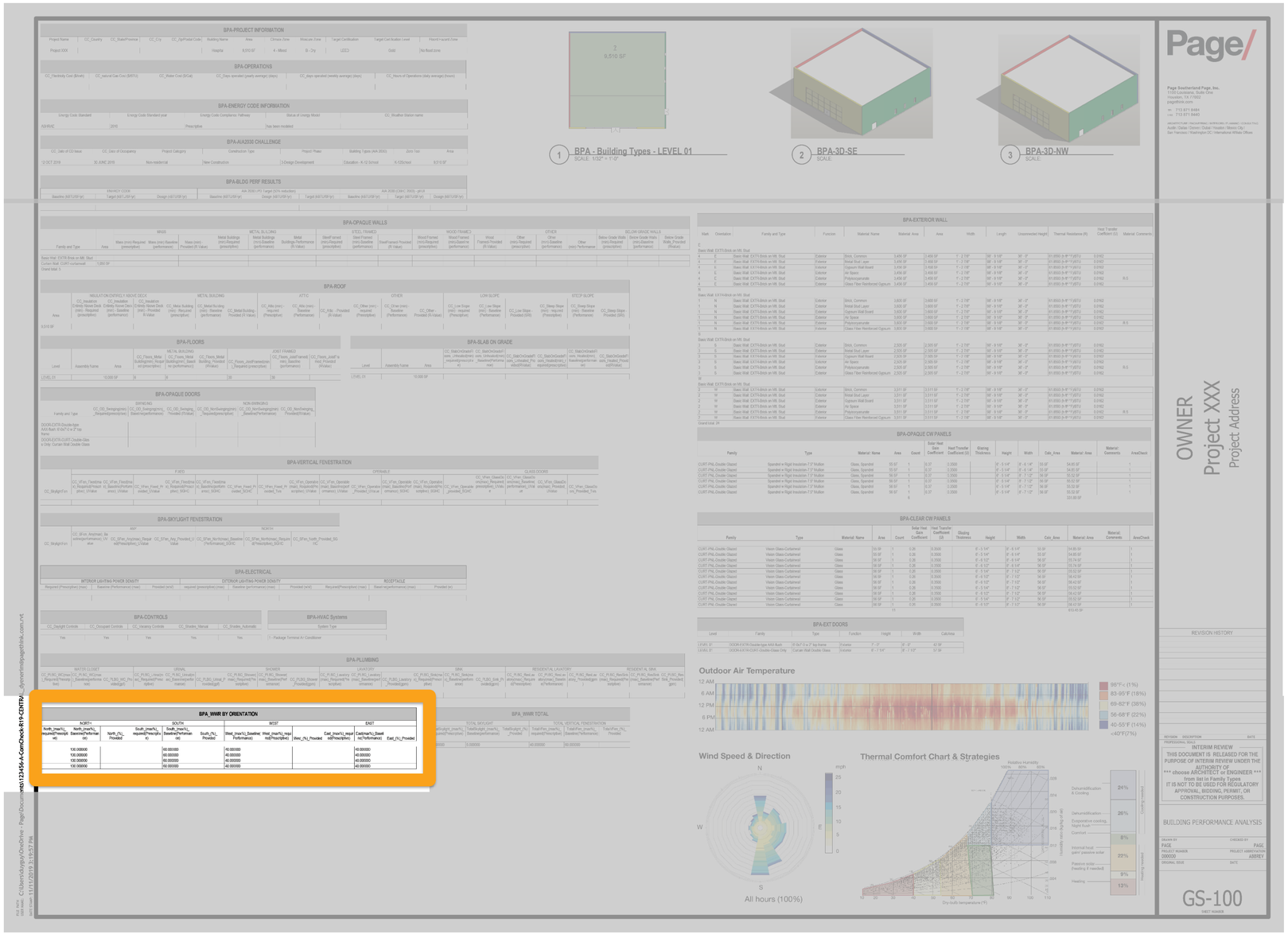
Level	Family	Type	Function	Height	Width	CalcArea
LEVEL 01	DOOR-EXTR-Double-type AAX-flush	6'-0x7'-0 w 2" top frame	Exterior	7' - 0"	6' - 0"	42 SF
LEVEL 01	DOOR-EXTR-CURT-Double-Glass Only	Curtain Wall Double Glass	Exterior	6' - 7 1/4"	8' - 7 1/2"	57 SF



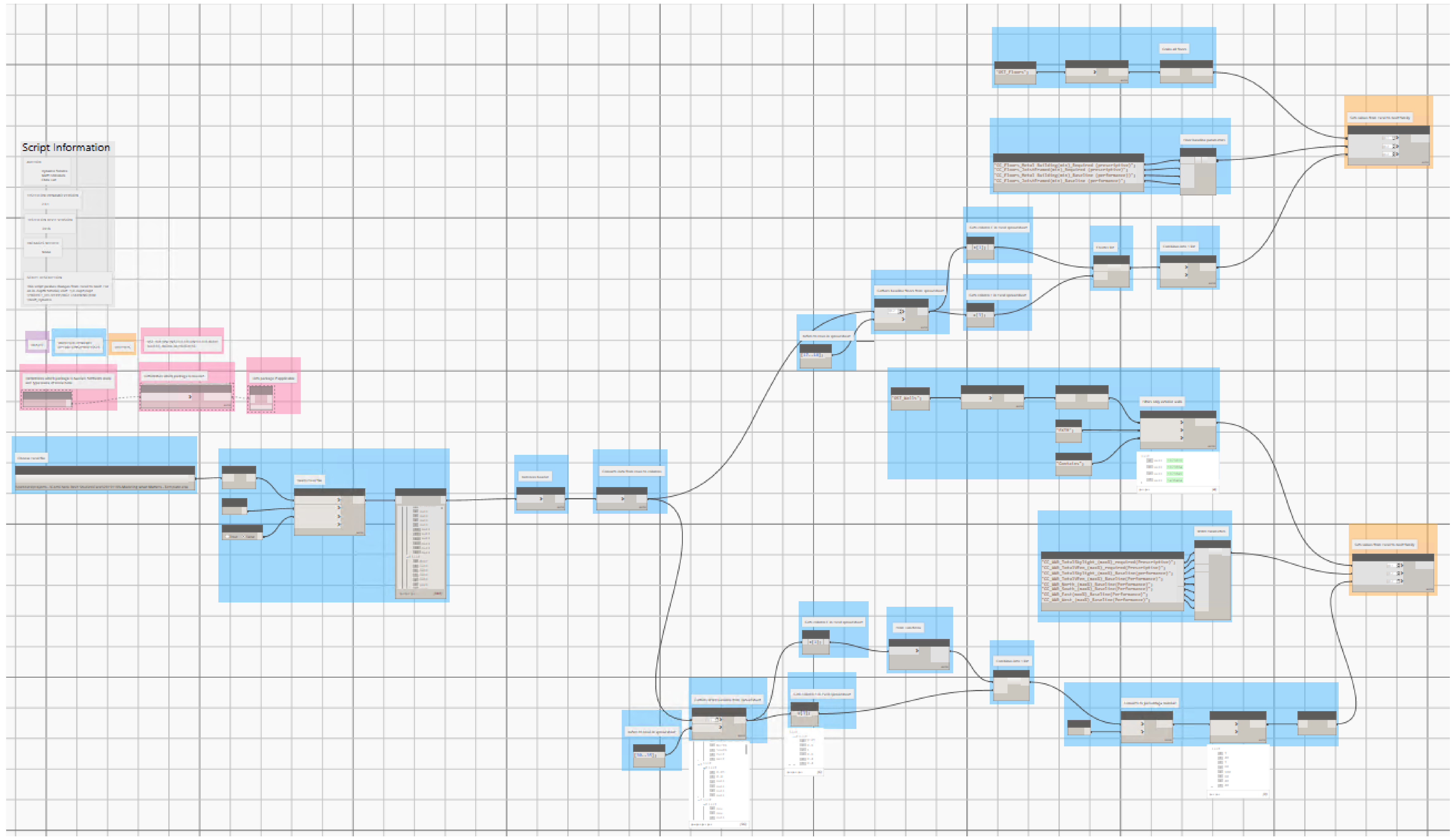
Item 2 information extracted from model with help of Dynamo

WINDOW TO WALL RATIO

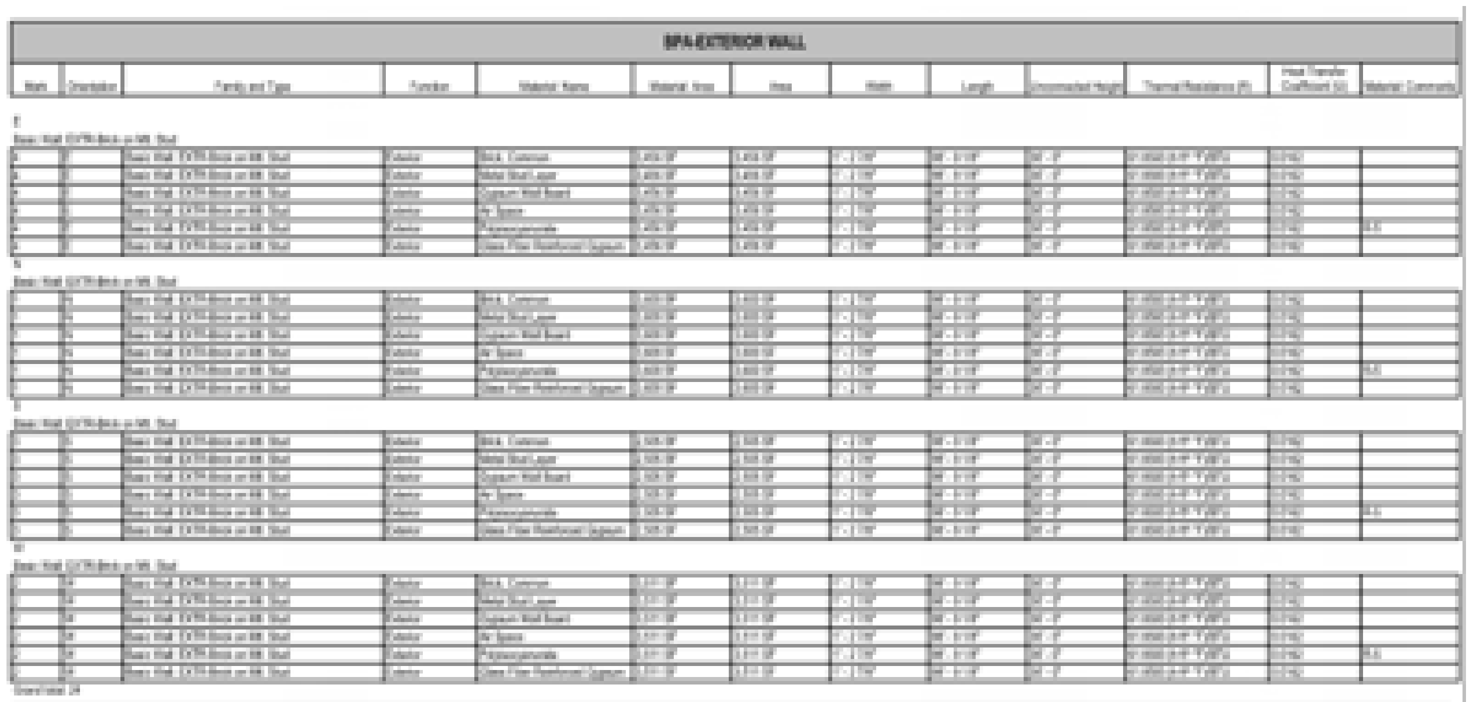




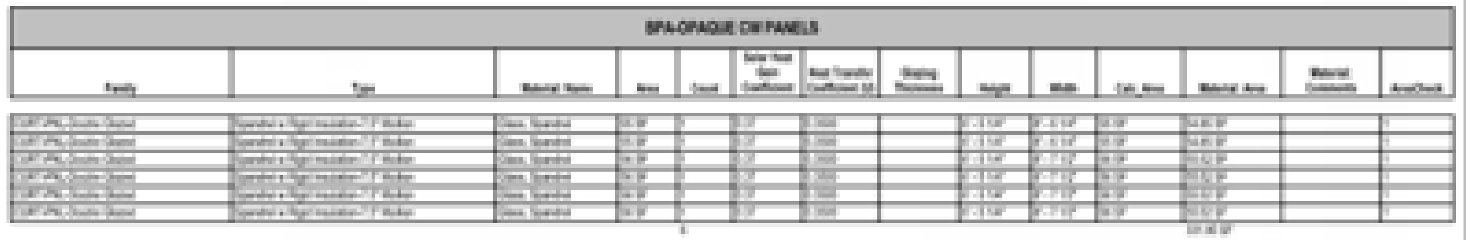
Item 2 information extracted from model with help of Dynamo



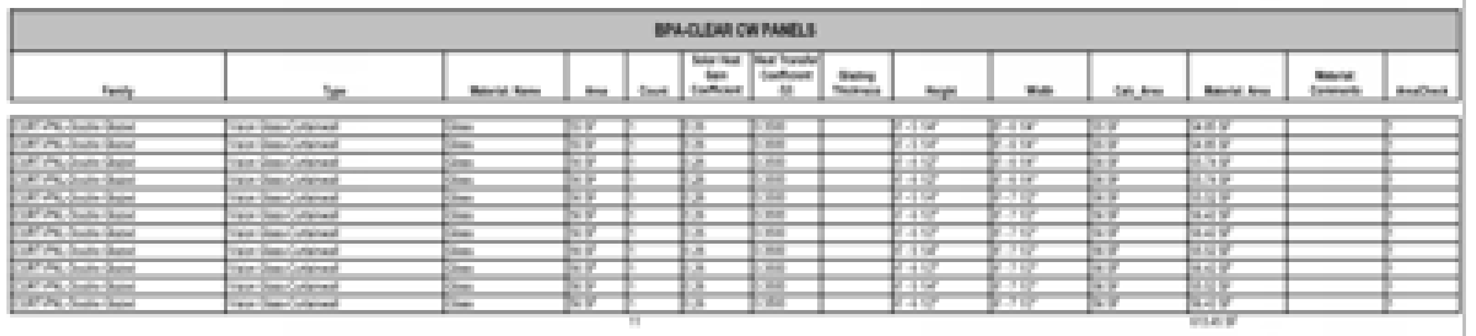
WALLS



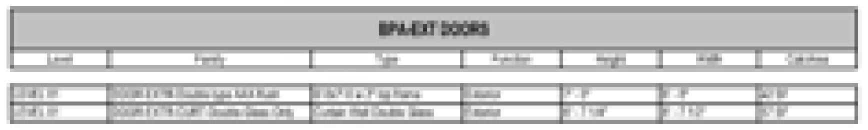
CURTAIN WALL PANELS-OPAQUE



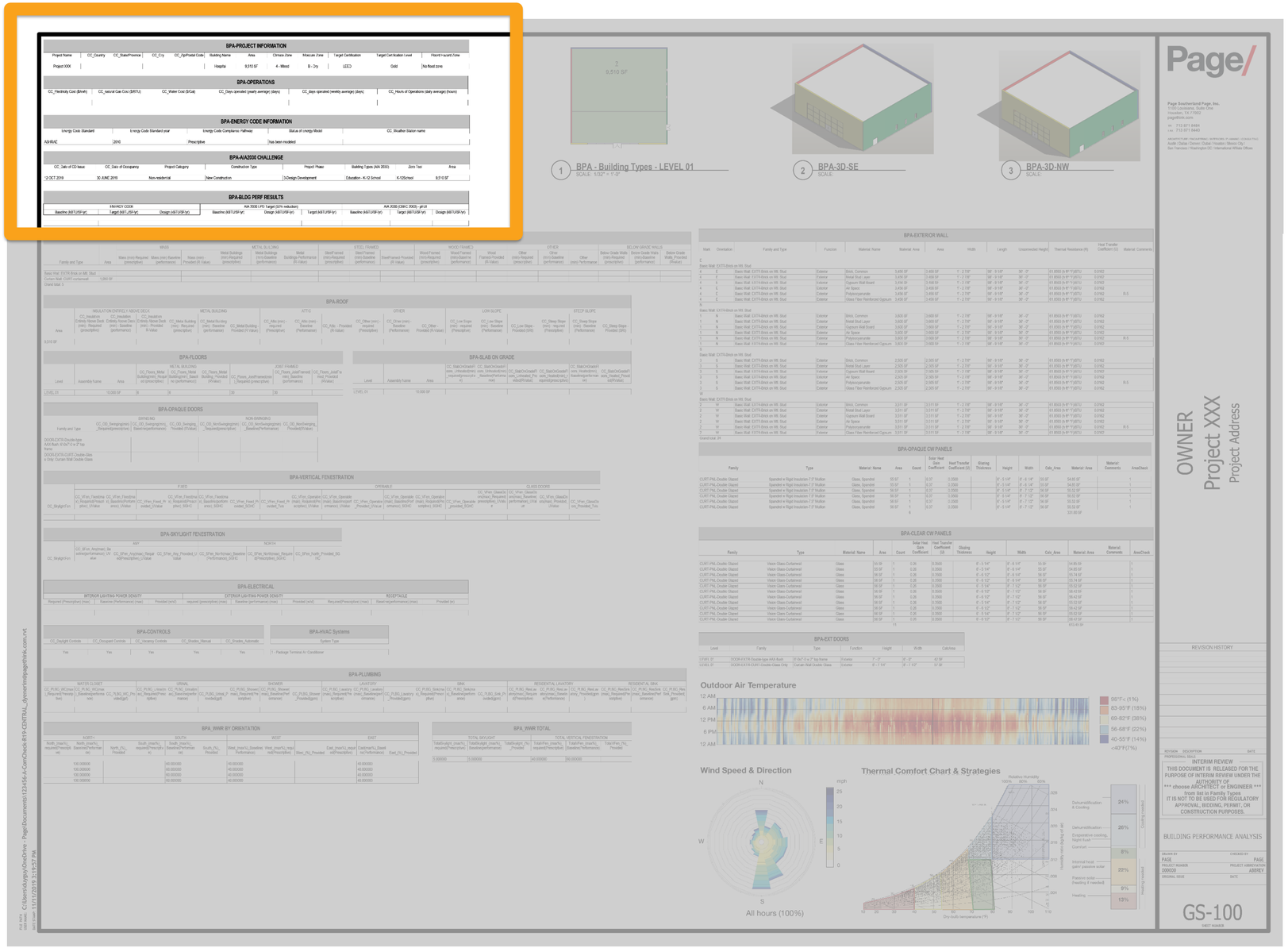
CURTAIN WALL PANELS-CLEAR

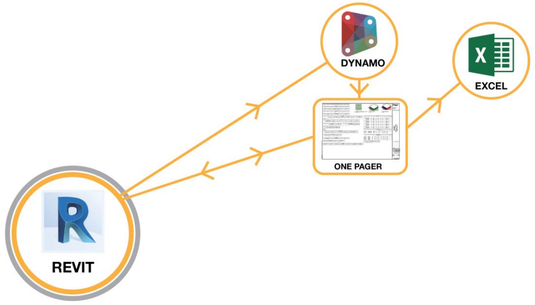


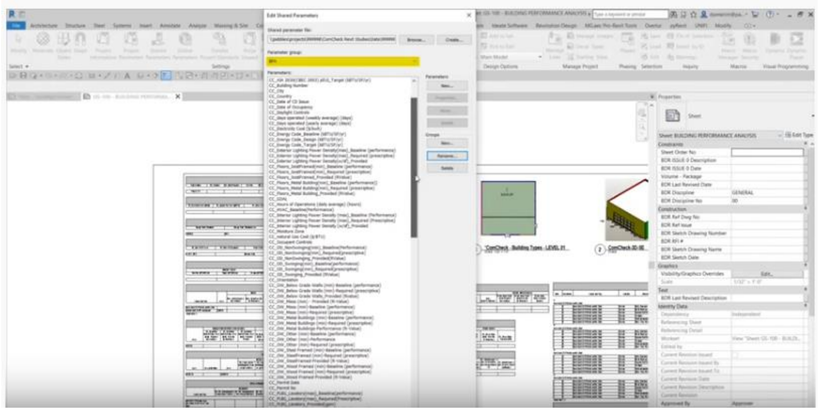
DOORS



Item 3 information that requires user manual input in Revit.







BPA Shared Parameters

https://www.youtube.com/watch?v=sGQGYenZTGw

Item 3 information that requires user manual input in Revit.

BPA-PROJECT INFORMATION											
Project Name	CC_Country	CC_State/Province	CC_City	CC_Zip/Postal Code	Building Name	Area	Climate Zone	Moisture Zone	Target Certification	Target Certification Level	Floord Hazard Zone
Project XXX					Hospital	9,510 SF	4 - Mixed	B - Dry	LEED	Gold	No flood zone

BPA-OPERATIONS					
CC_Electricity Cost ($/kwh)	CC_natural Gas Cost ($/BTU)	CC_Water Cost ($/Gal)	CC_Days operated (yearly average) (days)	CC_days operated (weekly average) (days)	CC_Hours of Operations (daily average) (hours)

BPA-ENERGY CODE INFORMATION				
Energy Code Standard	Energy Code Standard year	Energy Code Compliance Pathway	Status of Energy Model	CC_Weather Station name
ASHRAE	2010	Prescriptive	has been modeled	

BPA-AIA2030 CHALLENGE							
CC_Date of CD Issue	CC_Date of Occupancy	Project Category	Construction Type	Project Phase	Building Types (AIA 2030)	Zero Tool	Area
12 OCT 2019	30 JUNE 2019	Non-residential	New Construction	3-Design Development	Education - K-12 School	K-12School	9,510 SF

BPA-BLDG PERF RESULTS								
ENERGY CODE			AIA 2030 LPD Target (50% reduction)			AIA 2030 (CBEC 2003) - pEUI		
Baseline (kBTU/SF/yr)	Target (kBTU/SF/yr)	Design (kBTU/SF/yr)	Baseline (kBTU/SF/yr)	Design (kBTU/SF/yr)	Target (kBTU/SF/yr)	Baseline (kBTU/SF/yr)	Target (kBTU/SF/yr)	Design (kBTU/SF/yr)

BPA-ELECTRICAL								
INTERIOR LIGHTING POWER DENSITY			EXTERIOR LIGHTING POWER DENSITY			RECEPTACLE		
Required (Prescriptive) (max)	Baseline (Performance) (max)	Provided (w/sf)	required (prescriptive) (max)	Baseline (performance) (max)	Provided (w/sf)	Required(Prescriptive) (max)	Baseline(performance) (max)	Provided (w)

BPA-CONTROLS				
CC_Daylight Controls	CC_Occupant Controls	CC_Vacancy Controls	CC_Shades_Manual	CC_Shades_Automatic
Yes	Yes	Yes	Yes	Yes

BPA-HVAC Systems
System Type
1 - Package Terminal Air Conditioner

BPA-PLUMBING																				
WATER CLOSET			URINAL			SHOWER			LAVATORY			SINK			RESIDENTIAL LAVATORY			RESIDENTIAL SINK		
CC_PLBG_WC(max)_Required(Prescriptive)	CC_PLBG_WC(max)_Baseline(performance)	CC_PLBG_WC_Provided(gpf)	CC_PLBG_Urinal(max)_Required(Prescriptive)	CC_PLBG_Urinal(max)_Baseline(performance)	CC_PLBG_Urinal_Provided(gpf)	CC_PLBG_Shower(max)_Required(Prescriptive)	CC_PLBG_Shower(max)_Baseline(Performance)	CC_PLBG_Shower_Provided(gpm)	CC_PLBG_Lavatory(max)_Required(Prescriptive)	CC_PLBG_Lavatory(max)_Baseline(performance)	CC_PLBG_Lavatory_Provided(gpm)	CC_PLBG_Sink(max)_Required(Prescriptive)	CC_PLBG_Sink(max)_Baseline(performance)	CC_PLBG_Sink_Provided(gpm)	CC_PLBG_ResLavatory(max)_Required(Prescriptive)	CC_PLBG_ResLavatory(max)_Baseline(Performance)	CC_PLBG_ResLavatory_Provided(gpm)	CC_PLBG_ResSink(max)_Required(Prescriptive)	CC_PLBG_ResSink(max)_Baseline(Performance)	CC_PLBG_ResSink_Provided(gpm)

PROJECT INFORMATION

OPERATIONS

ENERGY CODE INFORMATION

AIA 2030 CHALLENGE

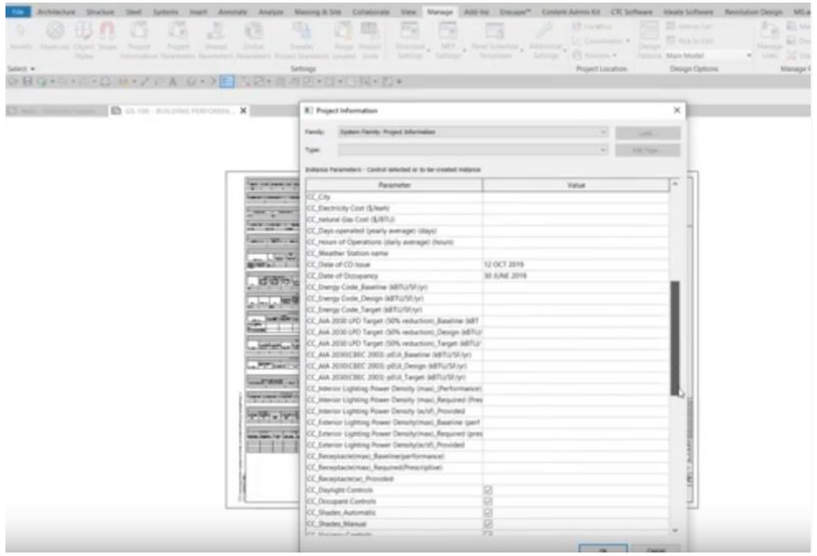
BUILDING PERFORMANCE RESULTS

ELECTRICAL

CONTROLS & HVAC

PLUMBING

Project Information



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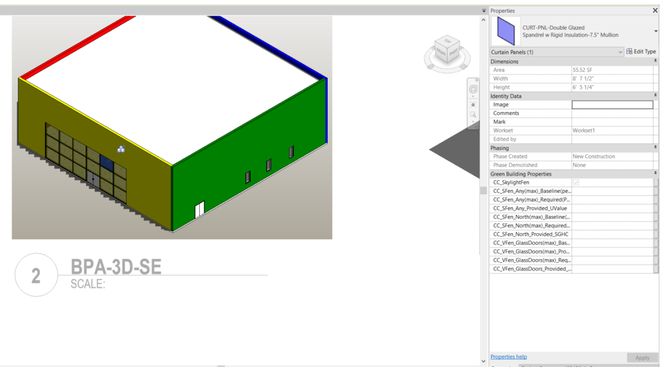
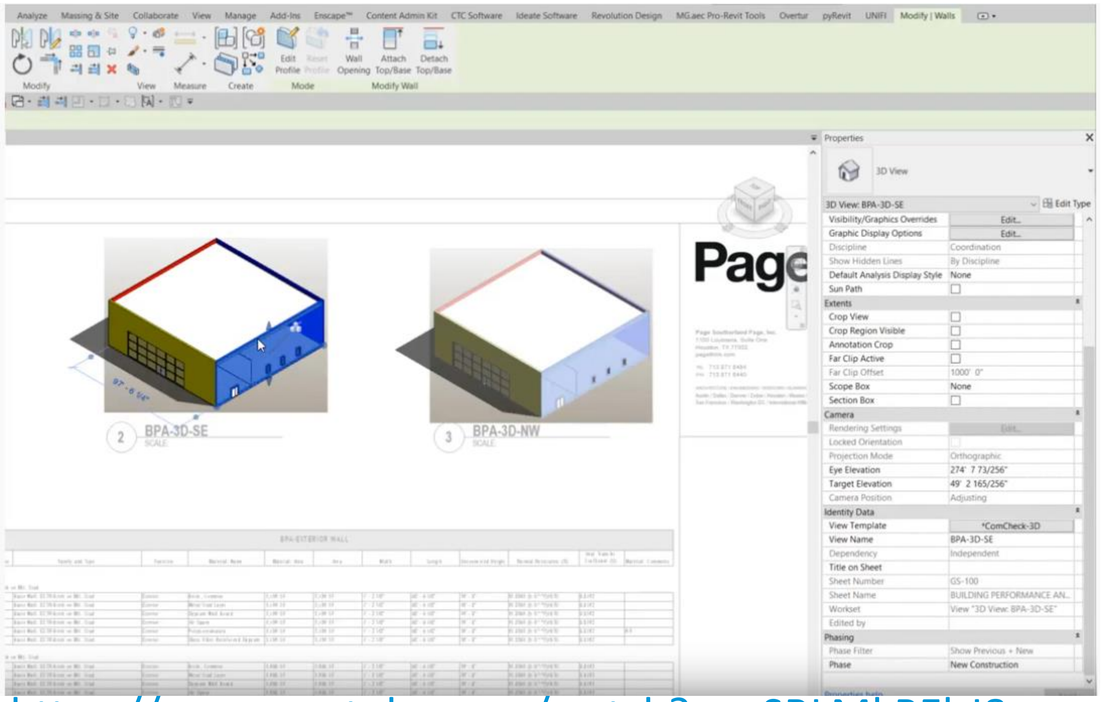


BPA Parameters tied to objects



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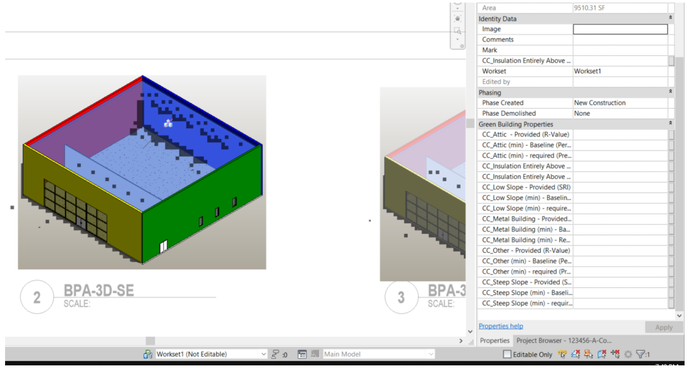
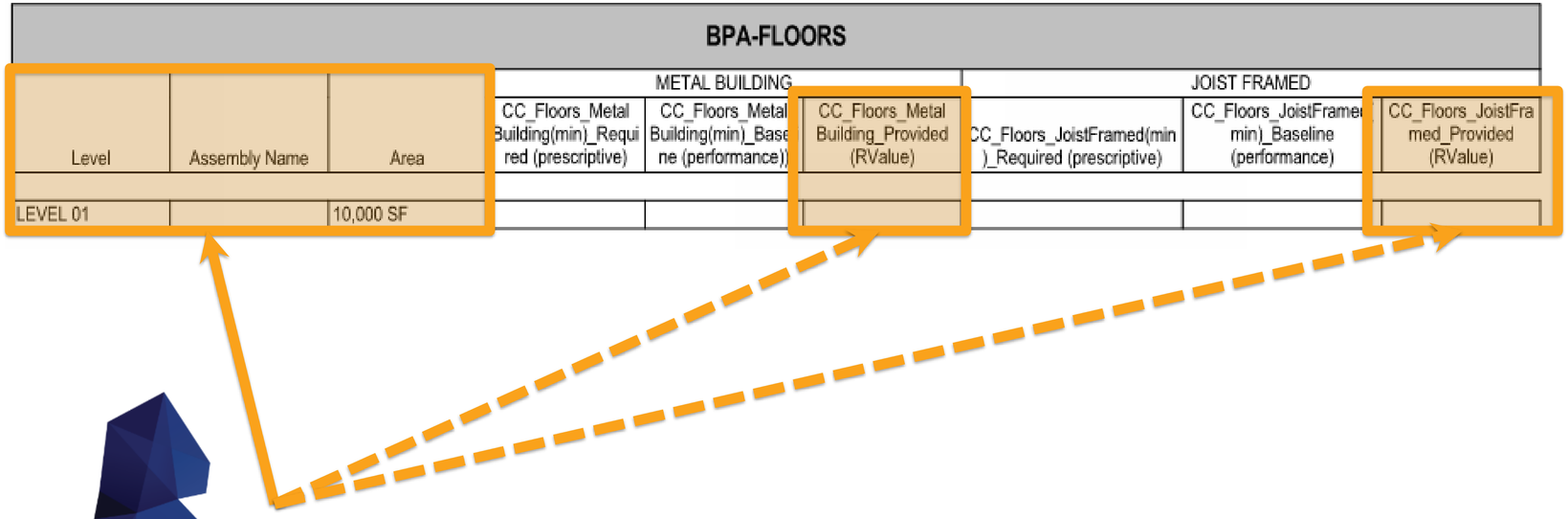




BPA-FLOORS								
			METAL BUILDING			JOIST FRAMED		
Level	Assembly Name	Area	CC_Floors_Metal Building(min)_Required (prescriptive)	CC_Floors_Metal Building(min)_Baseline (performance)	CC_Floors_Metal Building_Provided (RValue)	CC_Floors_JoistFramed(min)_Required (prescriptive)	CC_Floors_JoistFramed(min)_Baseline (performance)	CC_Floors_JoistFramed_Provided (RValue)
LEVEL 01		10,000 SF						

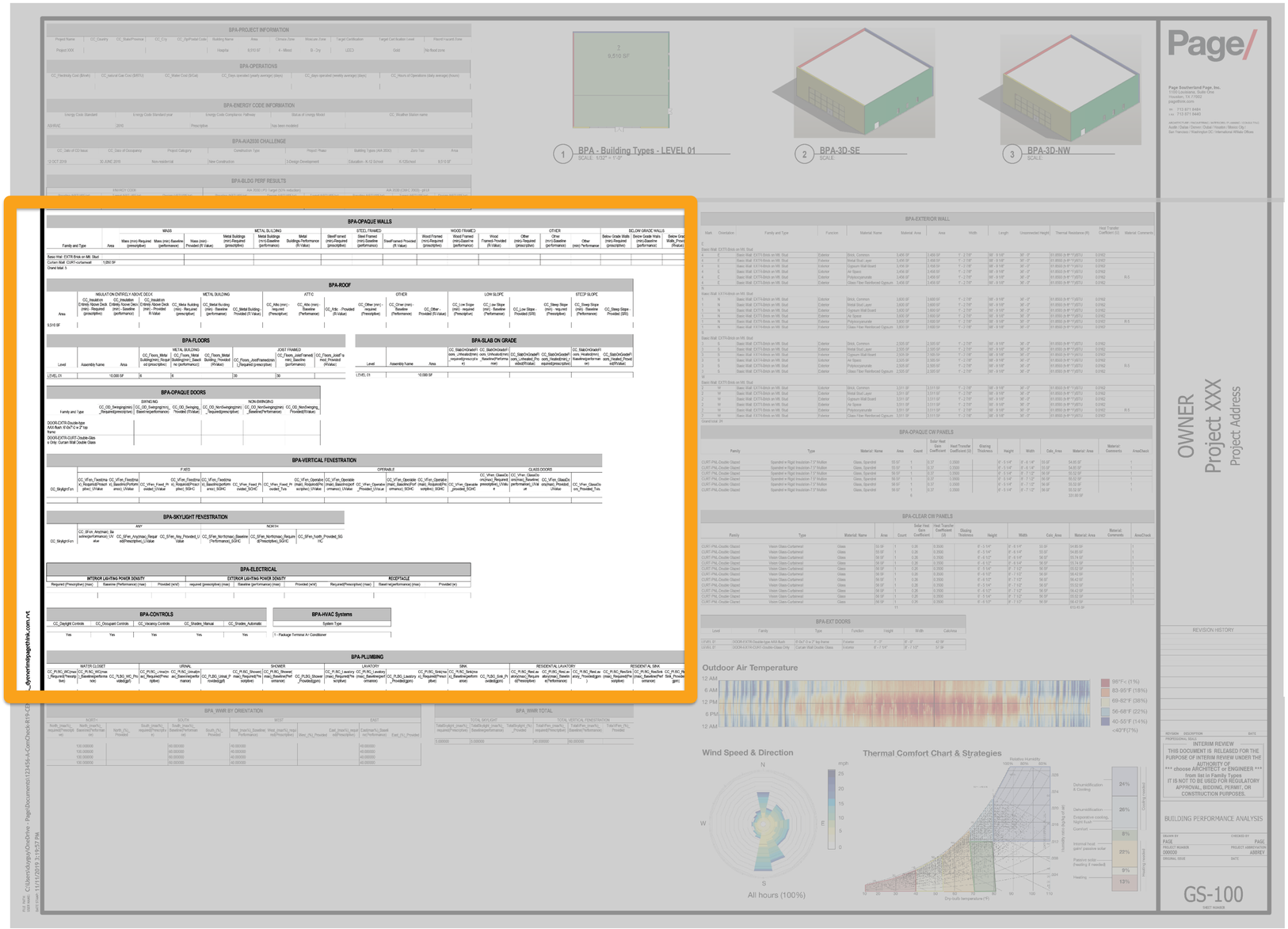
AUTODESK

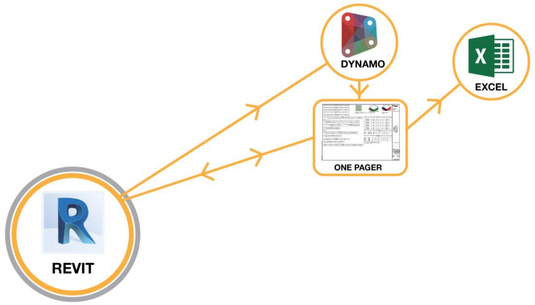
REVIT

Future Work:

Update Material Library with R-Values

Item 3 information outside of Revit that is pushed into Revit





PROJECT INFORMATION

BPA-BLDG PERF RESULTS

ENERGY CODE			AIA 2030 LPD Target (50% reduction)			AIA 2030 ICBEC 2003 - pSUI		
Baseline (kBTU/SF/yr)	Target (kBTU/SF/yr)	Design (kBTU/SF/yr)	Baseline (kBTU/SF/yr)	Design (kBTU/SF/yr)	Target (kBTU/SF/yr)	Baseline (kBTU/SF/yr)	Target (kBTU/SF/yr)	Design (kBTU/SF/yr)

OPAQUE WALLS

BPA-OPAQUE WALLS

		MASS			METAL BUILDING			STEEL FRAMED			WOOD FRAMED			OTHER			BELOW GRADE WALLS		
Family and Type	Area	Mass (min)-Required (prescriptive)	Mass (min)-Baseline (performance)	Mass (min) - Provided (R-Value)	Metal Buildings (min)-Required (prescriptive)	Metal Buildings (min)-Baseline (performance)	Metal Buildings-Performance (R-Value)	Steel Framed (min)-Required (prescriptive)	Steel Framed (min)-Baseline (performance)	Steel Framed-Provided (R-Value)	Wood Framed (min)-Required (prescriptive)	Wood Framed (min)-Baseline (performance)	Wood Framed-Provided (R-Value)	Other (min)-Required (prescriptive)	Other (min)-Baseline (performance)	Other (min)-Performance	Below Grade Walls (min)-Required (prescriptive)	Below Grade Walls (min)-Baseline (performance)	Below Grade Walls_Provided (Rvalue)
Basic Wall: EXTR-Brick on Mtl. Stud																			
Curtain Wall: CURT-cutsinwall	1,093 SF																		
Grand total: 5																			

ROOF

BPA-ROOF

	INSULATION ENTIRELY ABOVE DECK			METAL BUILDING			ATTIC			OTHER			LOW SLOPE			STEEP SLOPE		
Area	CC_Insulation Entirely Above Deck (min) - Required (prescriptive)	CC_Insulation Entirely Above Deck (min) - Baseline (performance)	CC_Insulation Entirely Above Deck (min) - Provided R-Value	CC_Metal Building (min) - Required (prescriptive)	CC_Metal Building (min) - Baseline (performance)	CC_Metal Building - Provided (R Value)	CC_Attic (min) - required (Prescriptive)	CC_Attic (min) - Baseline (Performance)	CC_Attic - Provided (R-Value)	CC_Other (min) - required (Prescriptive)	CC_Other (min) - Baseline (Performance)	CC_Other - Provided (R-Value)	CC_Low Slope (min) - required (Prescriptive)	CC_Low Slope (min) - Baseline (Performance)	CC_Low Slope - Provided (SRI)	CC_Steep Slope (min) - required (Prescriptive)	CC_Steep Slope (min) - Baseline (Performance)	CC_Steep Slope - Provided (SRI)
9,510 SF																		

FLOORS & SLAB ON GRADE

BPA-FLOORS

			METAL BUILDING			JOIST FRAMED		
Level	Assembly Name	Area	CC_Floors_Metal Building(min)_Required (prescriptive)	CC_Floors_Metal Building(min)_Baseline (performance)	CC_Floors_Metal Building_Provided (RValue)	CC_Floors_JoistFramed(min) - Required (prescriptive)	CC_Floors_JoistFramed(min) - Baseline (performance)	CC_Floors_JoistFramed_Provided (RValue)
LEVEL 01		10,000 SF						

BPA-SLAB ON GRADE

Level	Assembly Name	Area	CC_SlabOnGradeFloors_Unheated(min)_required(prescriptive)	CC_SlabOnGradeFloors_Unheated(min)_Baseline(Performance)	CC_SlabOnGradeFloors_Unheated_Provided(RValue)	CC_SlabOnGradeFloors_Heated(min) - required(prescriptive)	CC_SlabOnGradeFloors_Heated(min)_Baseline(performance)	CC_SlabOnGradeFloors_Heated_Provided(RValue)
LEVEL 01		10,000 SF						

OPAQUE DOORS

BPA-OPAQUE DOORS

	SWINGING			NON-SWINGING		
Family and Type	CC_OD_Swinging(min)_Required(prescriptive)	CC_OD_Swinging(min)_Baseline(performance)	CC_OD_Swinging_Provided (RValue)	CC_OD_NonSwinging(min)_Required(prescriptive)	CC_OD_NonSwinging(min)_Baseline(Performance)	CC_OD_NonSwinging_Provided(RValue)
DOOR-EXTR:Double-Type AAA:Flush: 6'-0x7'-0 w 2" iso frame						
DOOR-EXTR:CURT-Double-Glass Only: Curtain Wall Double Glass						

VERTICAL FENESTRATION

BPA-VERTICAL FENESTRATION

	FIXED							OPERABLE						GLASS DOORS			
DC_SkylightFen	CC_VFen_Fixed(max)_Required(Prescriptive)_UValue	CC_VFen_Fixed(max)_Baseline(Performance)_UValue	CC_VFen_Fixed_Provided_UValue	CC_VFen_Fixed(max)_Required(Prescriptive)_SGHC	CC_VFen_Fixed(max)_Baseline(performance)_SGHC	CC_VFen_Fixed_Provided_SGHC	CC_VFen_Fixed_Provided_Tvis	CC_VFen_Operable(max)_Required(Prescriptive)_UValue	CC_VFen_Operable(max)_Baseline(performance)_UValue	CC_VFen_Operable_Provided_UValue	CC_VFen_Operable(max)_Baseline(Performance)_SGHC	CC_VFen_Operable(max)_Required(Prescriptive)_SGHC	CC_VFen_Operable_provided_SGHC	CC_VFen_GlassDoors(min)(max)_Required(prescriptive)_UValue	CC_VFen_GlassDoors(max)_Baseline(performance)_UValue	CC_VFen_GlassDoors(max)_Provided_UValue	CC_VFen_GlassDoors_Provided_Tvis

SKYLIGHT FENESTRATION

BPA-SKYLIGHT FENESTRATION

	ANY			NORTH		
DC_SkylightFen	CC_SFen_Any(max)_Baseline(performance)_UValue	CC_SFen_Any(max)_Required(Prescriptive)_UValue	CC_SFen_Any_Provided_UValue	CC_SFen_North(max)_Baseline (Performance)_SGHC	CC_SFen_North(max)_Required(Prescriptive)_SGHC	CC_SFen_North_Provided_SGHC

ELECTRICAL

BPA-ELECTRICAL

INTERIOR LIGHTING POWER DENSITY			EXTERIOR LIGHTING POWER DENSITY			RECEPTACLE		
Required (Prescriptive) (max)	Baseline (Performance) (max)	Provided (w/sf)	required (prescriptive) (max)	Baseline (performance) (max)	Provided (w/sf)	Required(Prescriptive) (max)	Baseline(performance) (max)	Provided (w)

CONTROLS & HAVC SYSTEMS

BPA-CONTROLS

CC_Daylight Controls	CC_Occupant Controls	CC_Vacancy Controls	CC_Shades_Manual	CC_Shades_Automatic
Yes	Yes	Yes	Yes	Yes

BPA-HVAC Systems

System Type
1 - Packaged Terminal Air Conditioner

PLUMBING

BPA-PLUMBING

WATER CLOSET			URINAL			SHOWER			LAVATORY			SINK			RESIDENTIAL LAVATORY			RESIDENTIAL SINK		
CC_PLBG_WC(max)_Required(Prescriptive)	CC_PLBG_WC(max)_Baseline(performance)	CC_PLBG_WC_Provided(gpf)	CC_PLBG_Urinal(max)_Required(Prescriptive)	CC_PLBG_Urinal(max)_Baseline(performance)	CC_PLBG_Urinal_Provided(gpf)	CC_PLBG_Shower(max)_Required(Prescriptive)	CC_PLBG_Shower(max)_Baseline(Performance)	CC_PLBG_Shower_Provided(gpm)	CC_PLBG_Lavatory(max)_Required(Prescriptive)	CC_PLBG_Lavatory(max)_Baseline(performance)	CC_PLBG_Lavatory_Provided(gpm)	CC_PLBG_Sink(max)_Required(Prescriptive)	CC_PLBG_Sink(max)_Baseline(performance)	CC_PLBG_Sink Provided(gpm)	CC_PLBG_ResLavatory(max)_Required(Prescriptive)	CC_PLBG_ResLavatory(max)_Baseline(Performance)	CC_PLBG_ResLavatory_Provided(gpm)	CC_PLBG_ResSink(max)_Required(Prescriptive)	CC_PLBG_ResSink(max)_Baseline(Performance)	CC_PLBG_ResSink_Provided(gpm)

BPA-FLOORS								
			METAL BUILDING			JOIST FRAMED		
Level	Assembly Name	Area	CC_Floors_Metal Building(min)_Required (prescriptive)	CC_Floors_Metal Building(min)_Baseline (performance)	CC_Floors_Metal Building_Provided (RValue)	CC_Floors_JoistFramed(min)_Required (prescriptive)	CC_Floors_JoistFramed(min)_Baseline (performance)	CC_Floors_JoistFramed_Provided (RValue)
LEVEL 01		10,000 SF						

AUTODESK

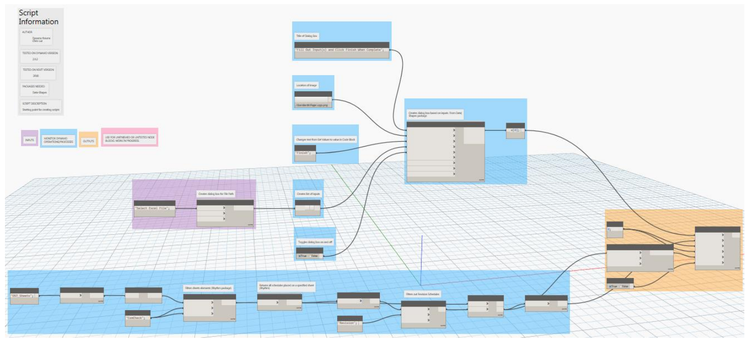
REVIT

Excel

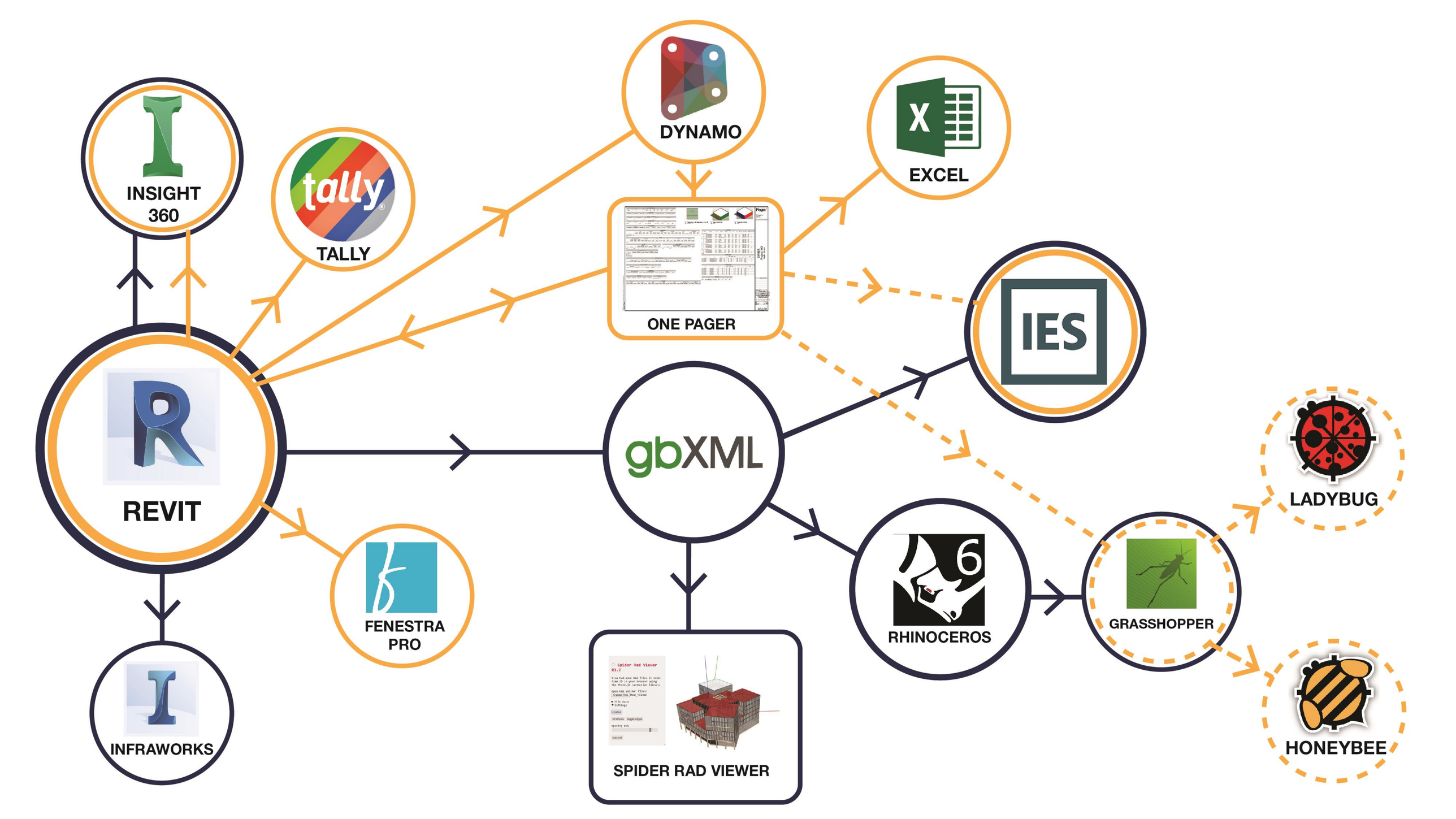
Prescriptive

Performance

Dynamo



Floors					
Mass	6.3	min c.i.	6.3	min c.i.	R-Value
Steel Joist	30	min	30	min	R-Value
Wood Framed and Other	30	min	30	min	R-Value
Slab-on-Grade Floors					
Unheated	NR	min	NR	min	R-Value
Heated	10	min for 24 in.	10	min for 24 in.	R-Value
Opaque Doors					
Swinging	0.7	min	0.7	min	U-Value
Non-Swinging	0.5	min	0.5	min	U-Value
Window to Wall Ratio					
Total Skylight	5%	max	5%	max	%
Total Vertical Fenestration	40%	max	60%	max	%
North			100%	max	%
South			60%	max	%
East			40%	max	%
West			40%	max	%

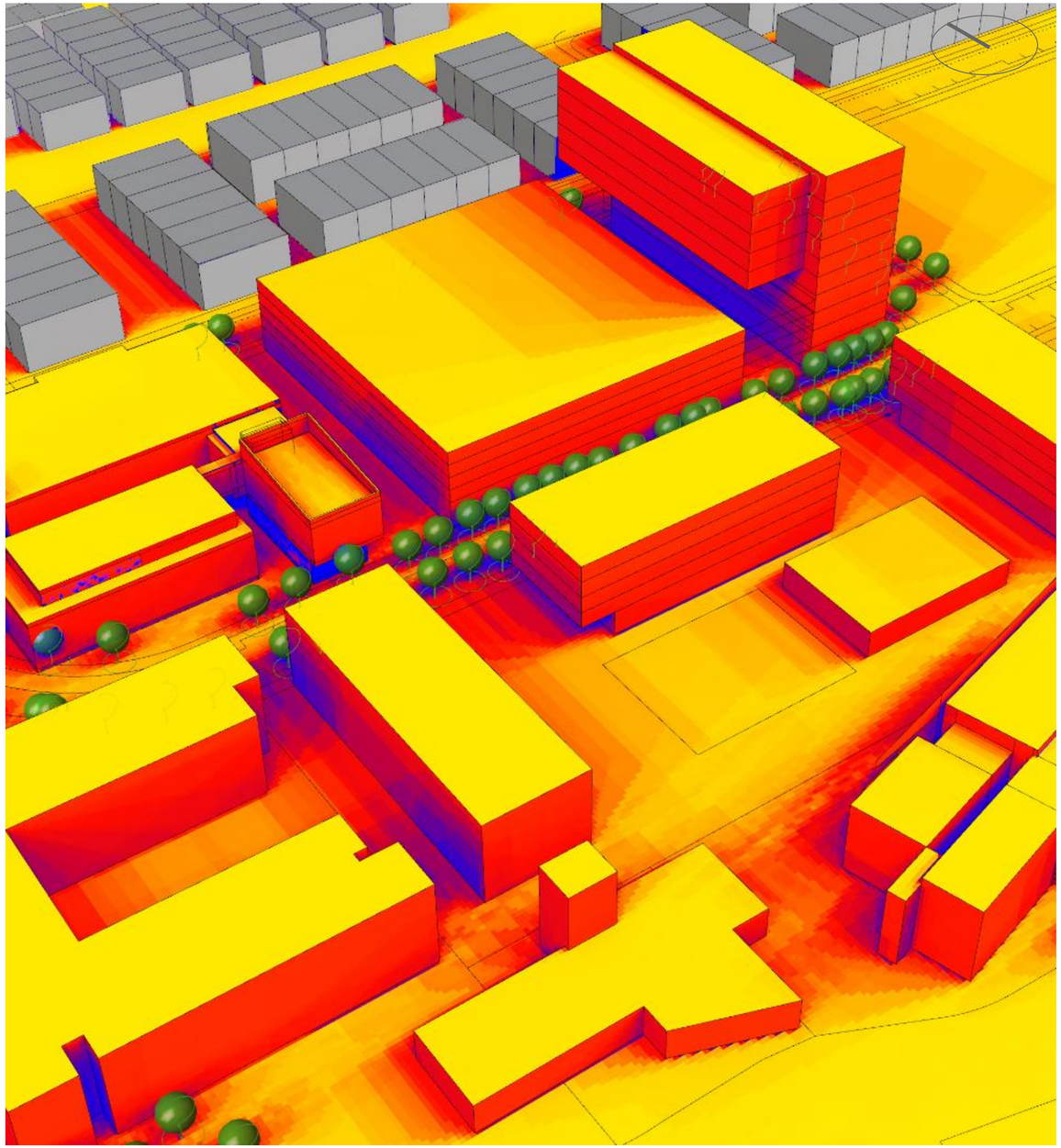

INSIGHT 360
TALLY
DYNAMO
EXCEL
ONE PAGER
IES
REVIT
gbXML
FENESTRA PRO
RHINOCEROS
GRASSHOPPER
LADYBUG
HONEYBEE
INFRAWORKS
SPIDER RAD VIEWER

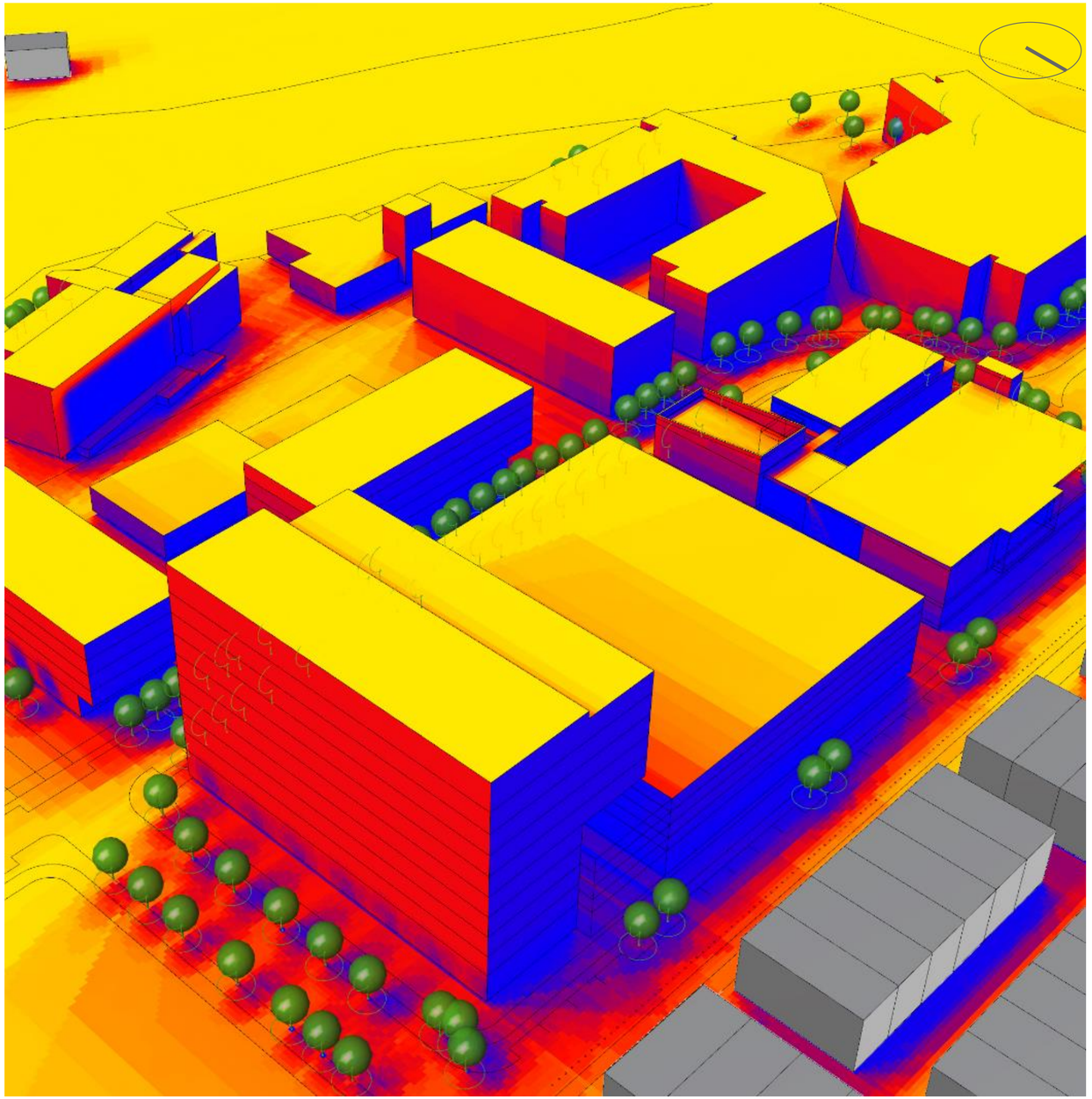
Context

Process

Implementation

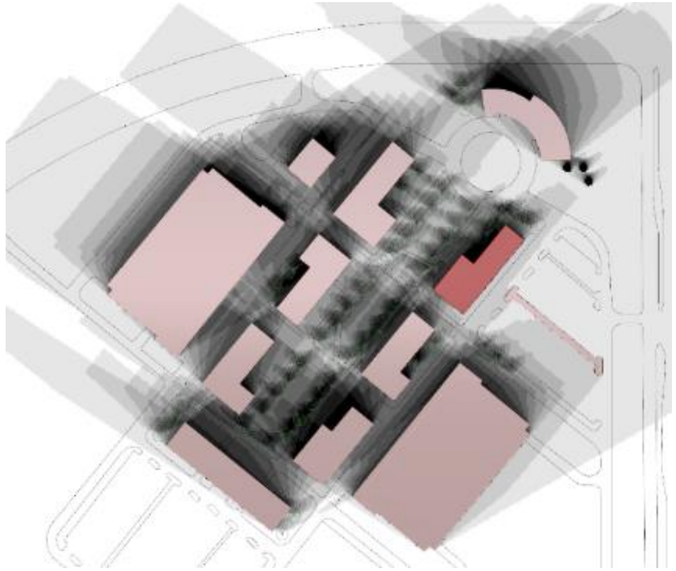
Next steps

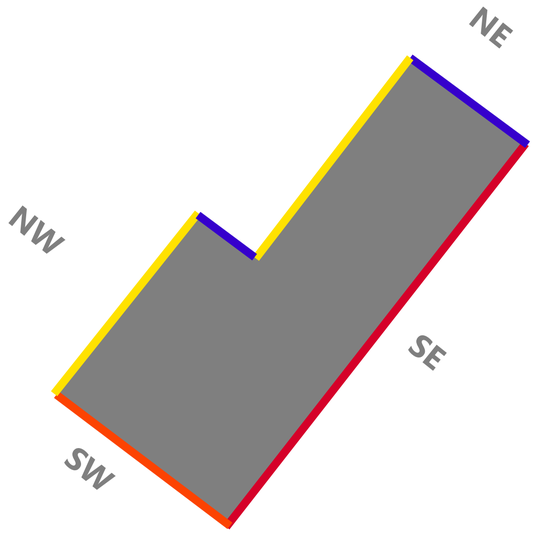


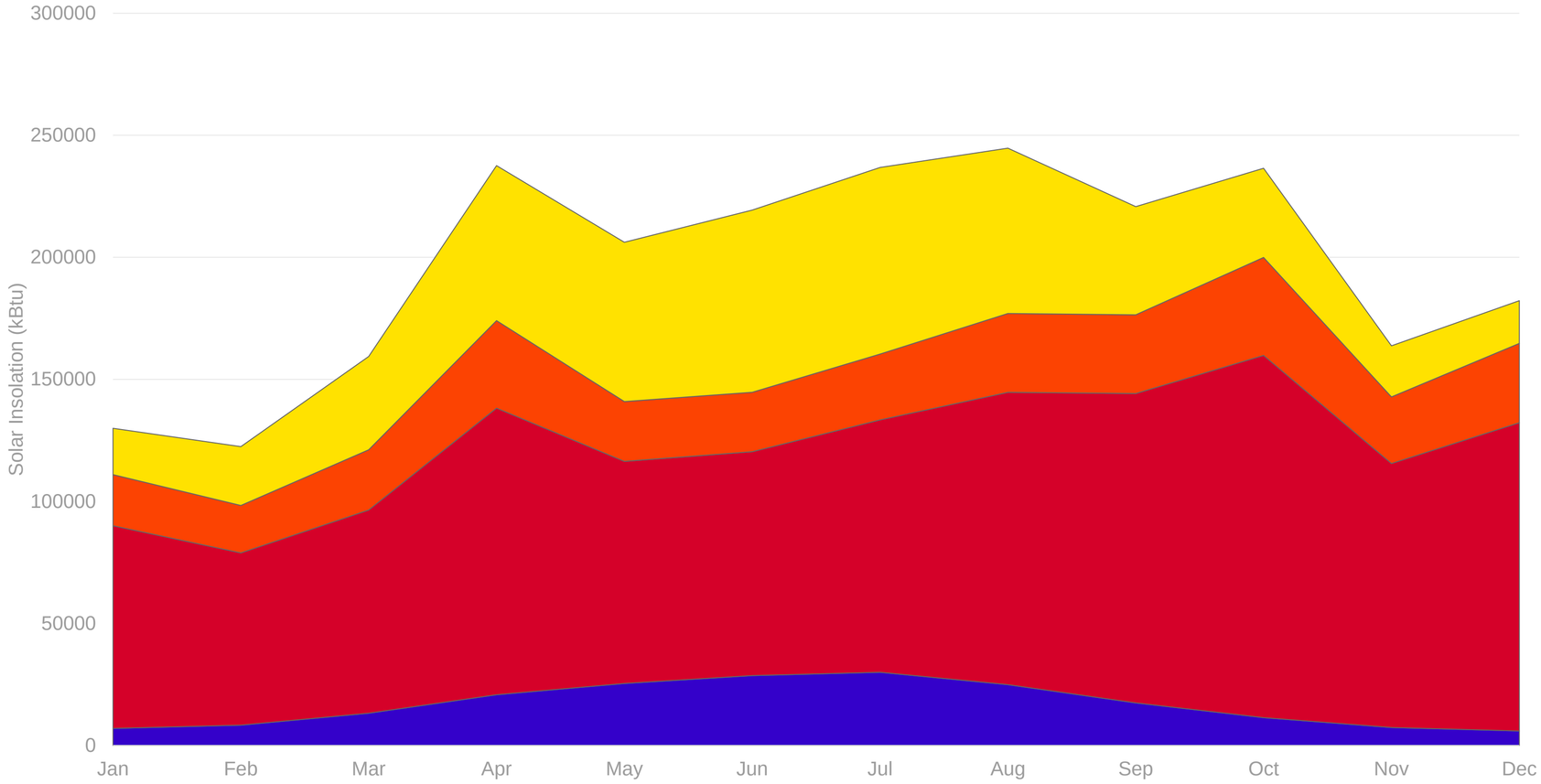


0 2 kBtu/ft^2

Shading Recommended

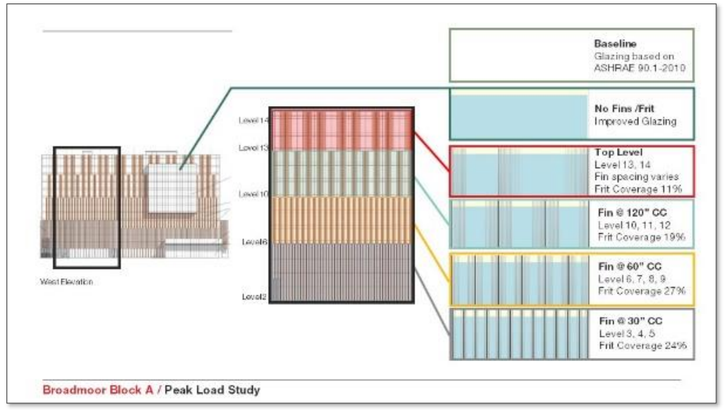


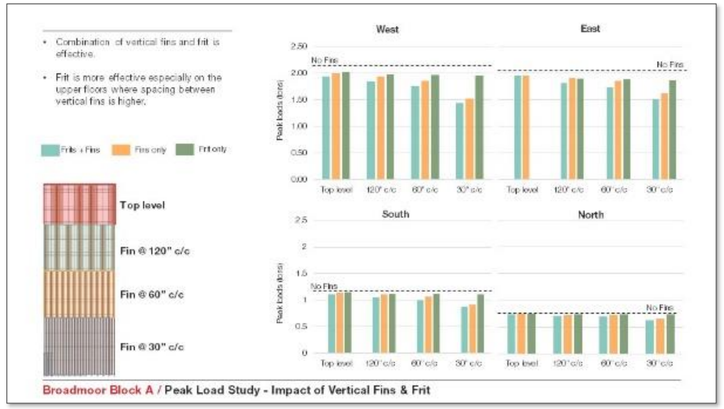


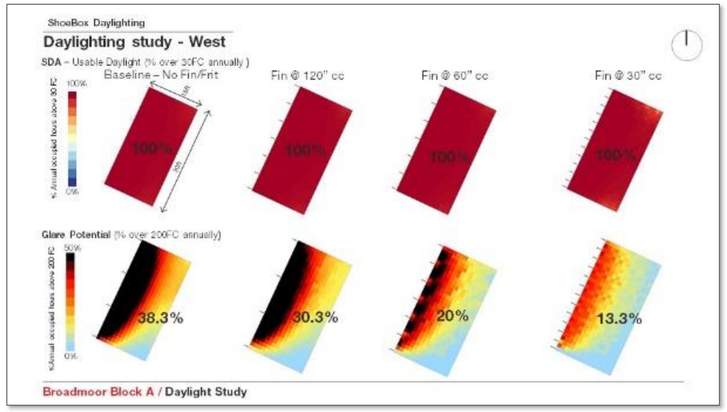


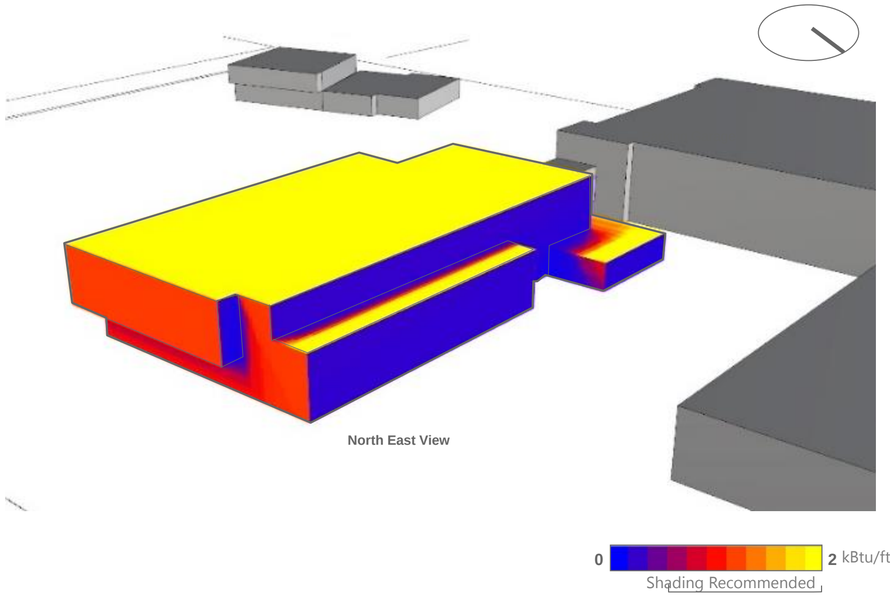
9% North East	54% South East	14% South West	23% North West

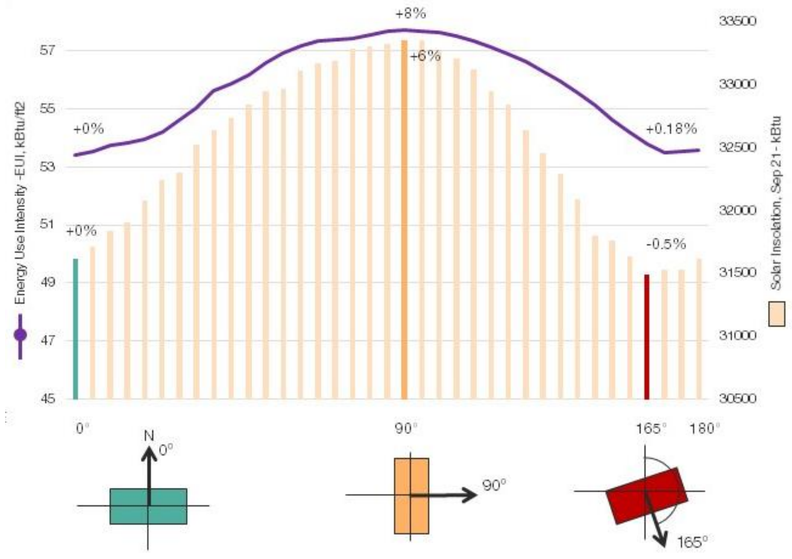
Broadmoor, Block A, Austin, TX

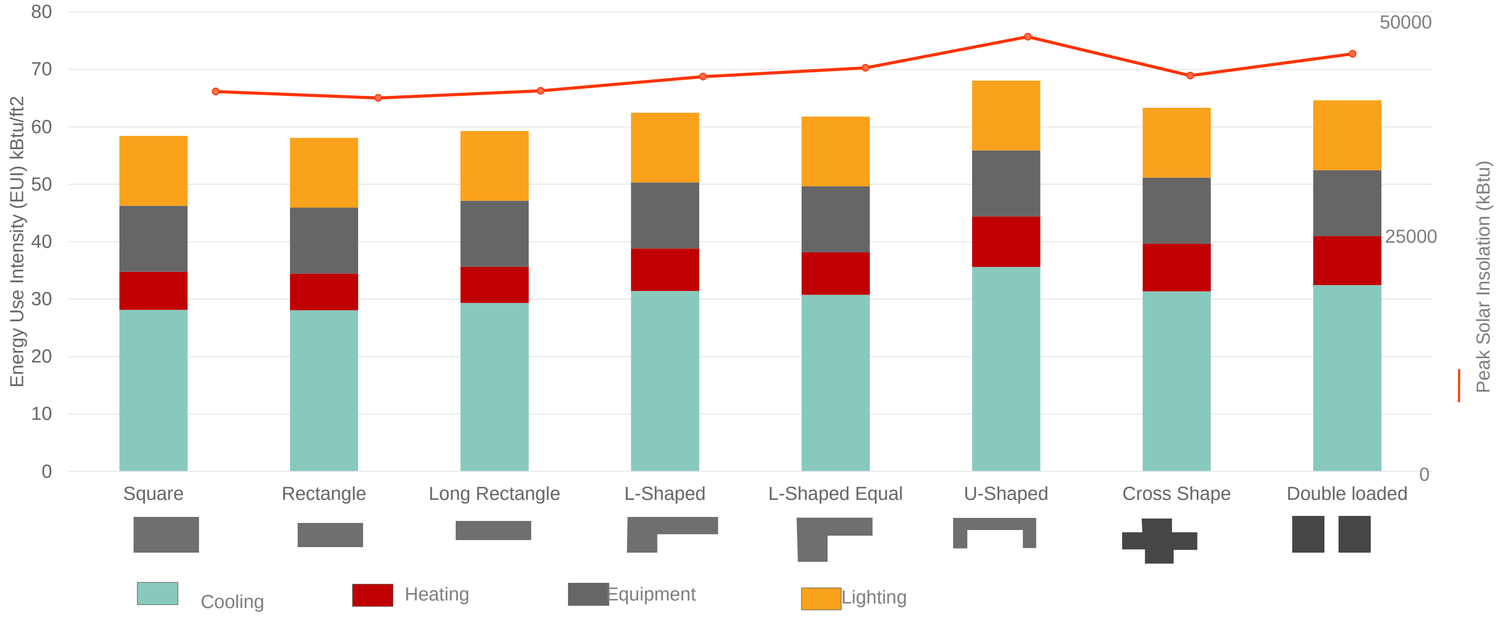


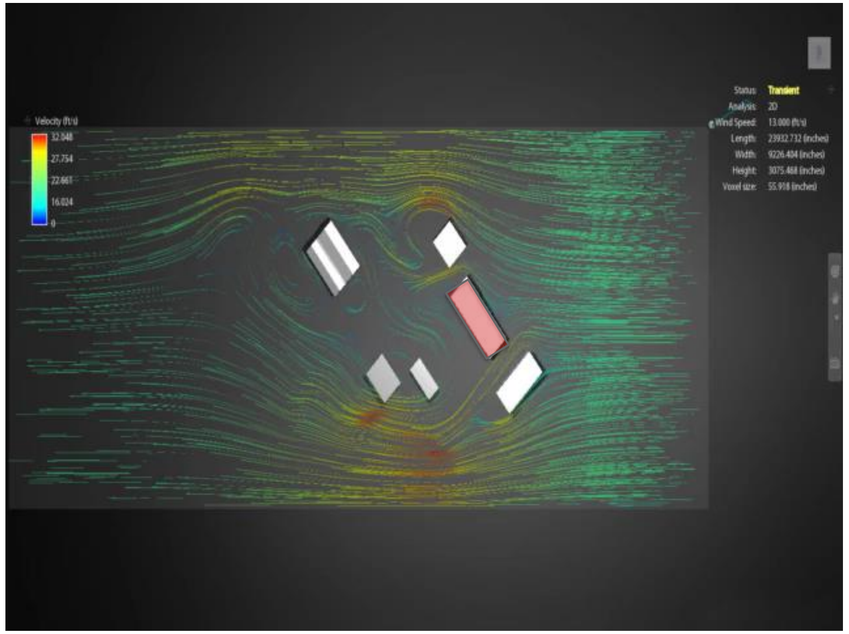


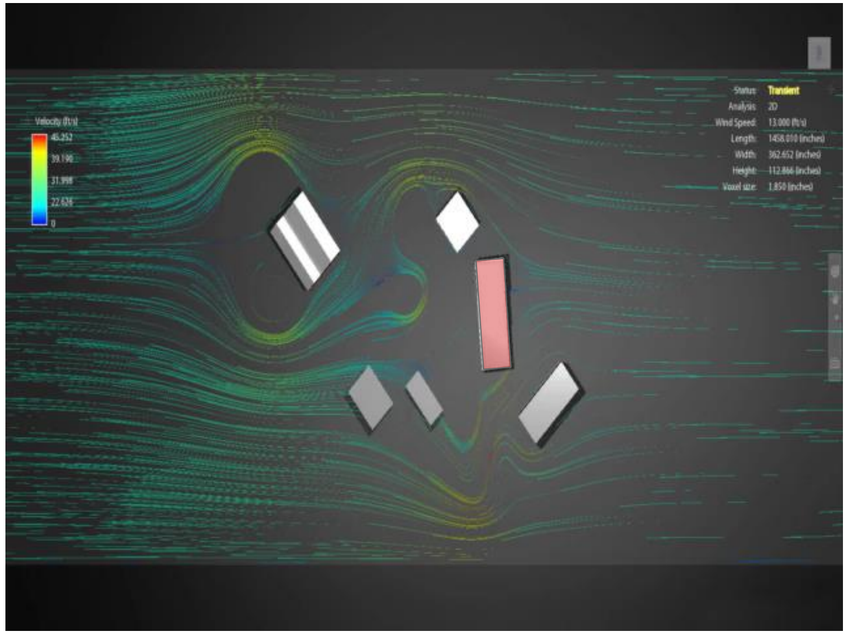


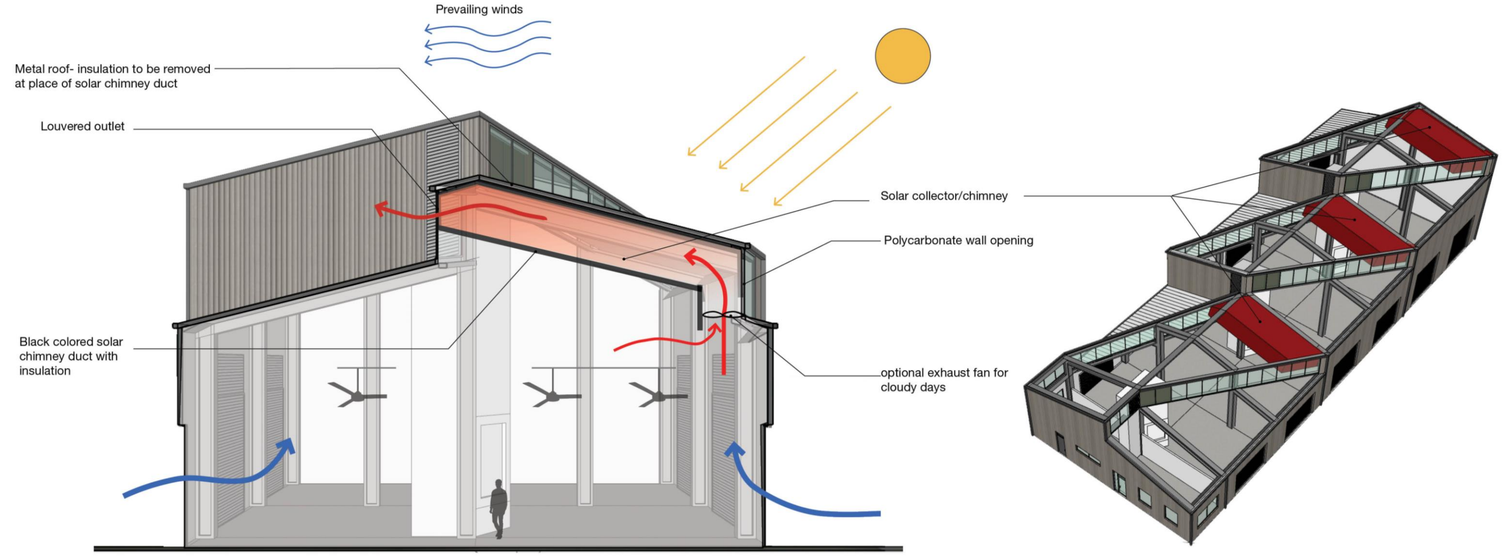

North East View
0
2 kBtu/ft²
Shading Recommended

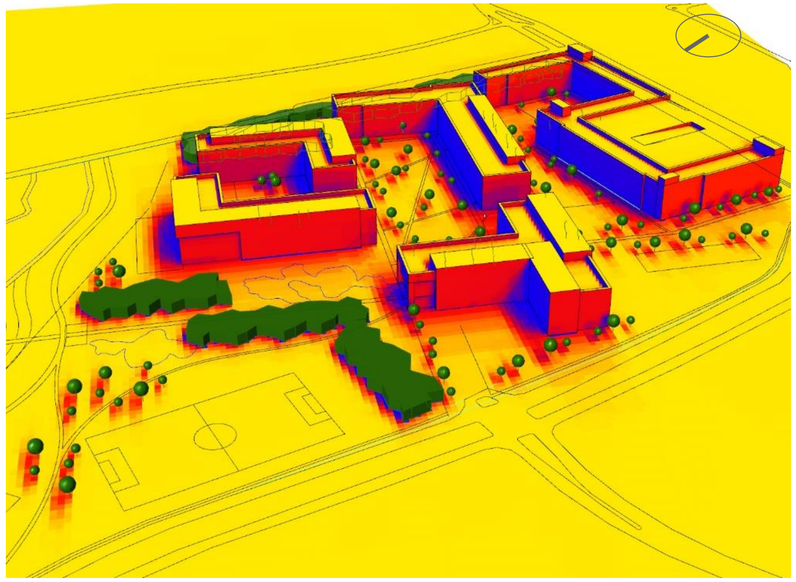

+8%
+6%
+0%
+0%
+0.18%
-0.5%
Energy Use Intensity -EUI, kBtu/ft2
Solar Insolation, Sep 21 - kBtu
57
55
53
51
49
47
45
33500
33000
32500
32000
31500
31000
30500
0°
90°
165°
180°
N
0°
90°
165°

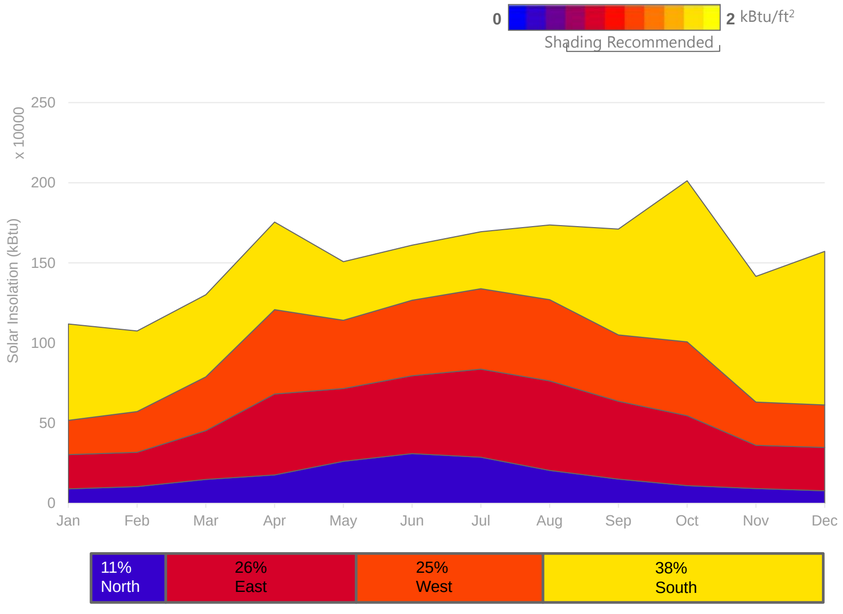

Energy Use Intensity (EUI) kBtu/ft2
Peak Solar Insolation (kBtu)
80
70
60
50
40
30
20
10
0
50000
25000
0
Square
Rectangle
Long Rectangle
L-Shaped
L-Shaped Equal
U-Shaped
Cross Shape
Double loaded
Cooling
Heating
Equipment
Lighting

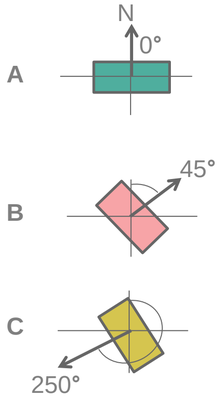

Velocity (ft/s)
32.948
27.754
22.661
16.024
0
Status: Transient
Analysis: 2D
Wind Speed: 13.000 (ft/s)
Length: 23932.732 (inches)
Width: 9226.404 (inches)
Height: 3075.468 (inches)
Voxel size: 55.916 (inches)


Velocity (ft/s)
46.252
39.196
31.998
22.624
0
Status: Transient
Analysis: 2D
Wind Speed: 13.000 (ft/s)
Length: 1458.010 (inches)
Width: 362.652 (inches)
Height: 112.866 (inches)
Voxel size: 1.850 (inches)

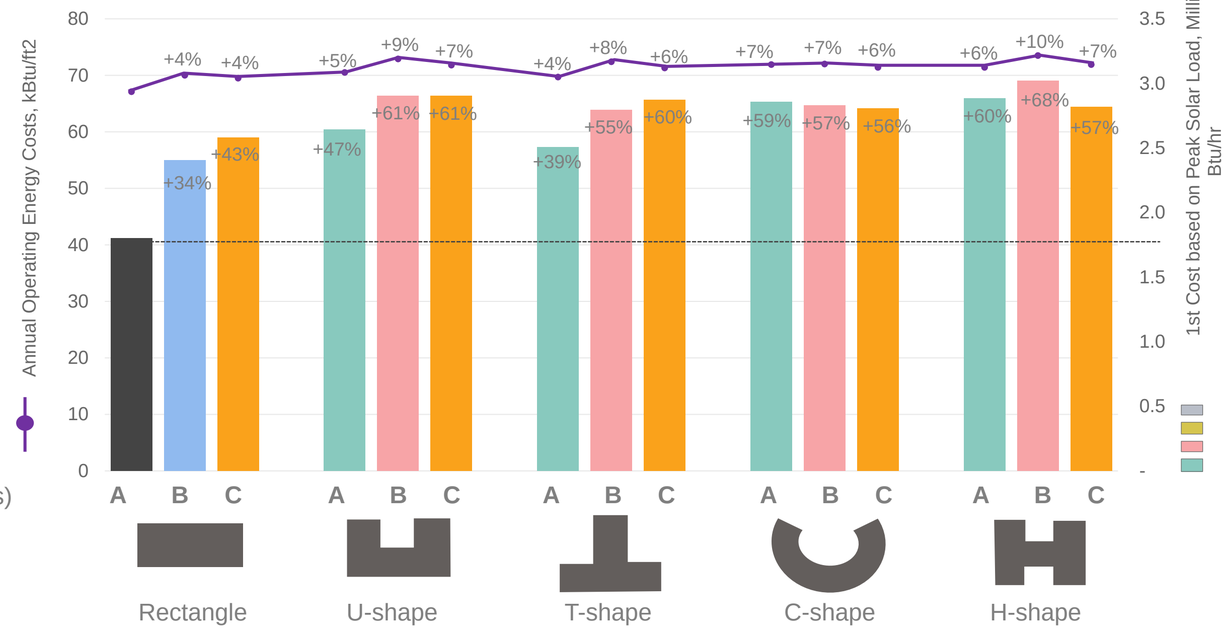

Prevailing winds
Metal roof- insulation to be removed at place of solar chimney duct
Louvered outlet
Solar collector/chimney
Polycarbonate wall opening
Black colored solar chimney duct with insulation
optional exhaust fan for cloudy days

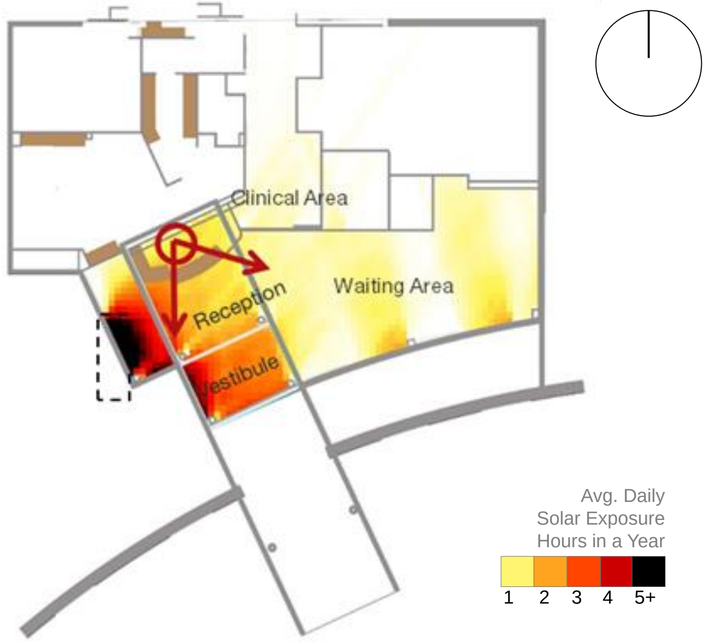


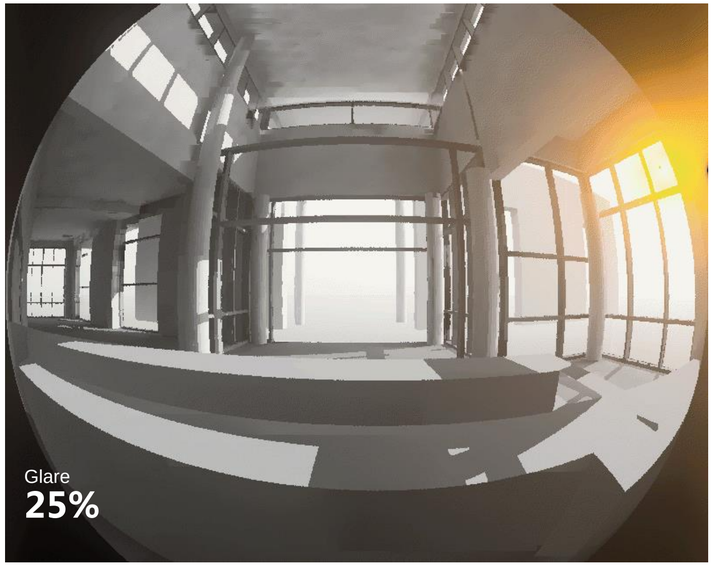


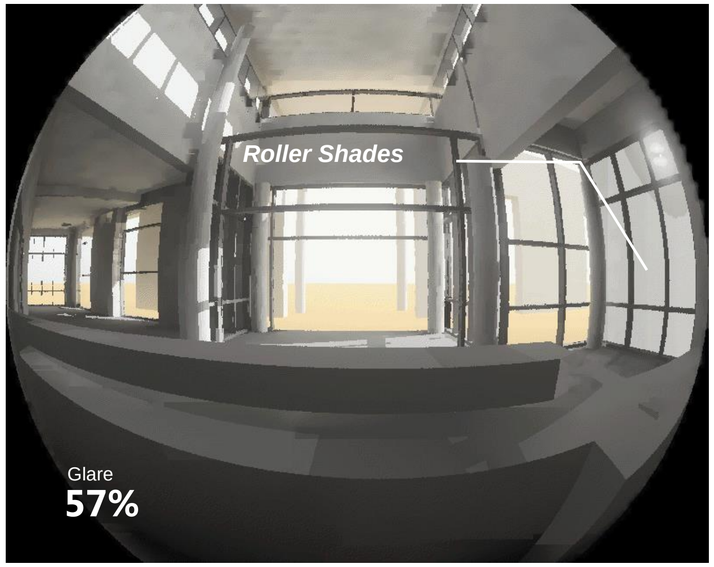


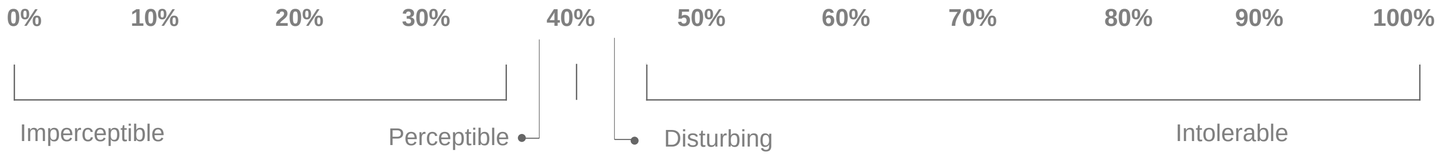
Assumptions:
Program: Classrooms
Area: 150,000 sf (4 floors)
Facades: ASHRAE 90.1-2010
Window wall ratio: 30%



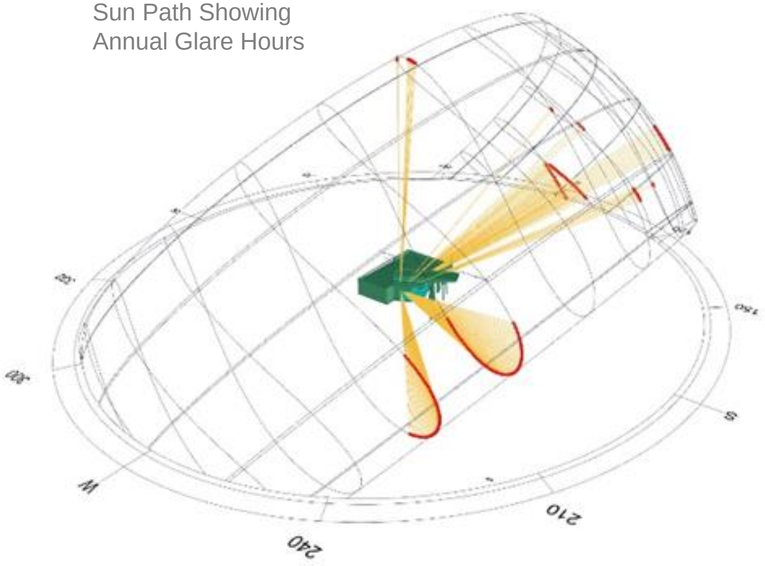


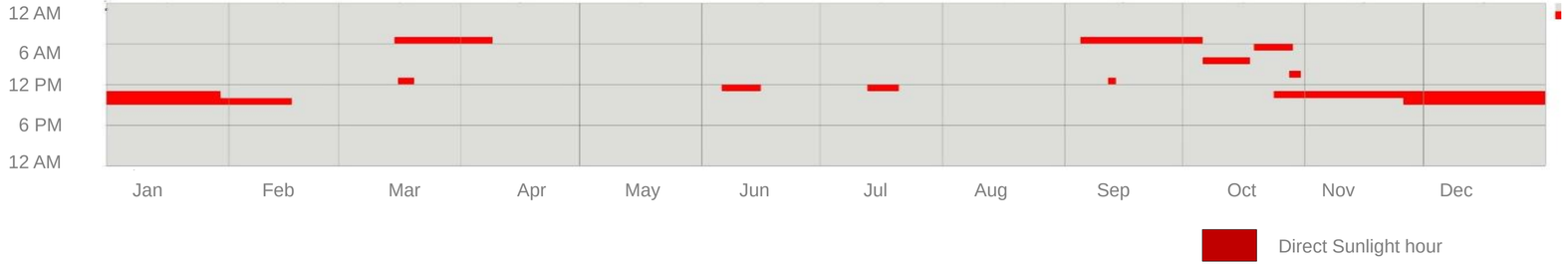






Sun Path Showing
Annual Glare Hours





Context

Process

Implementation

Next steps

Best Modeling Practices

Actual Model Concepts

Understand difference between rooms (Arch) and spaces (MEP)

Room separation lines for MEP team

Ceilings as NOT Room Bounding

Use correct families for interior vs exterior

Utilize BPA shared parameters for coordination

Have early discussion to decide “Prescriptive” versus “Performance” Energy Code path

Communication between team is critical

Shadow Model

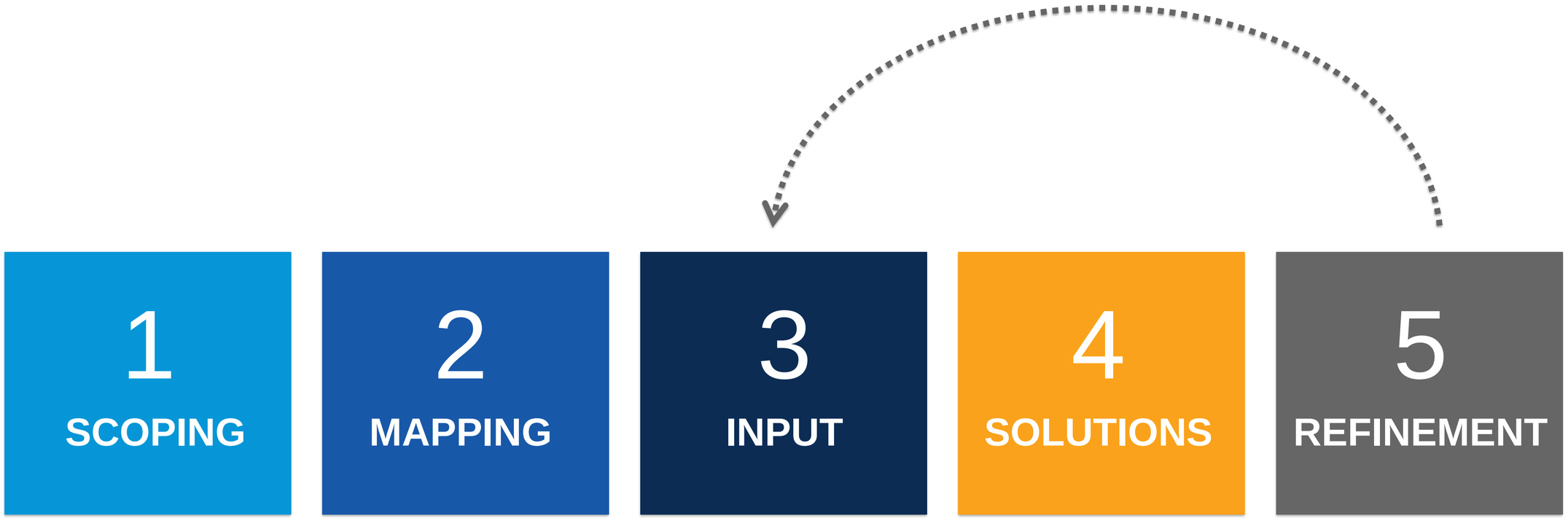
Create a Shadow Model for exporting GBXML

Link actual model to shadow model to track changes & update

Add Spaces

Simplify geometry to basic elements: floor, roof, walls

Use generic building component families



Define the issues & goals

Identify metrics & processes

Engage stakeholders

Create improved processes

Update standards & processes for improvement