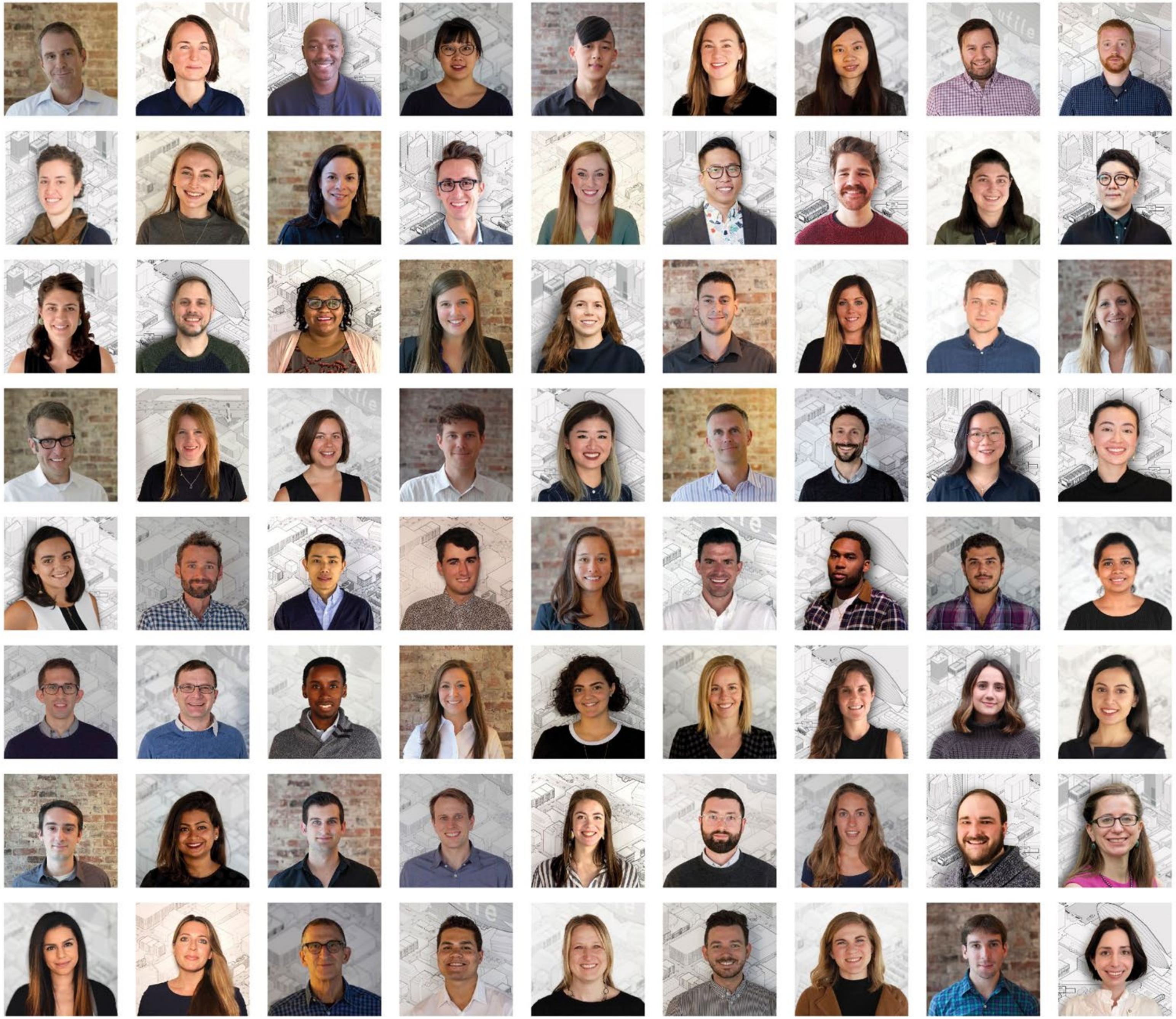
Passive In-House:
Advantages and Challenges of Embedding Performance Modeling Within an Architecture Firm

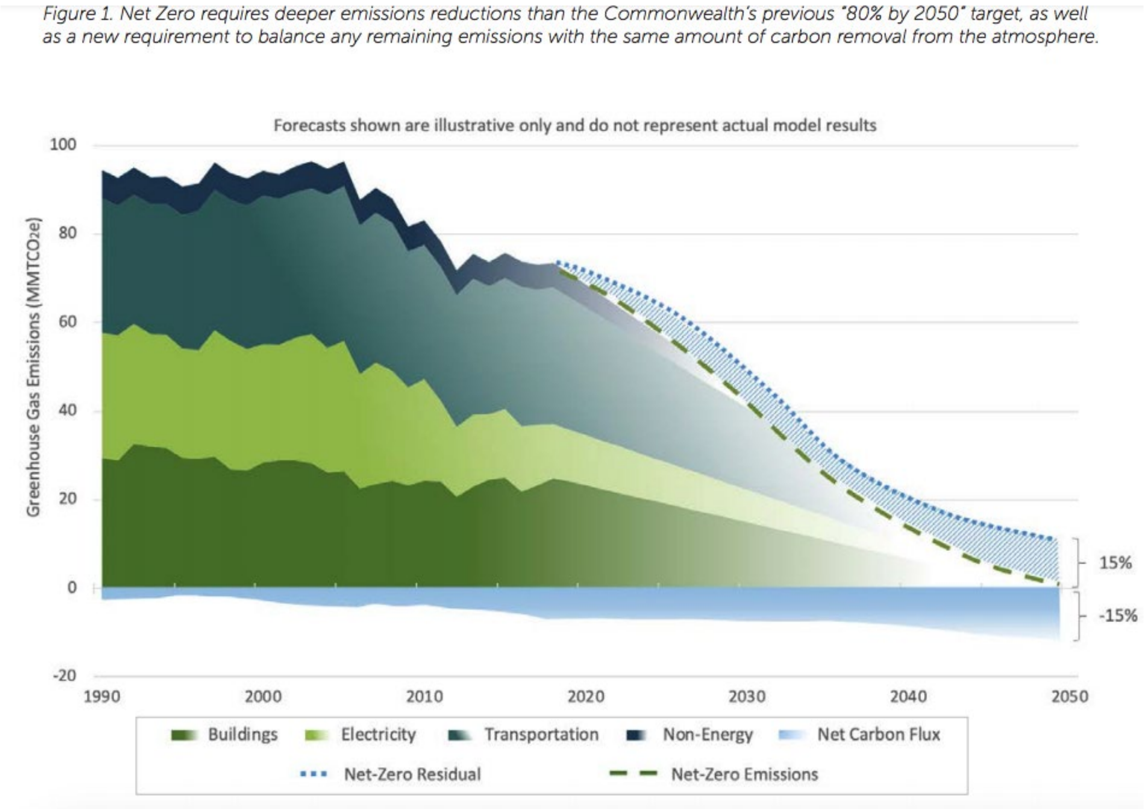
Jeff Geisinger, AIA, CPHC
Director of Sustainable Design
Utile

- Introduction
- In-house Energy Modeling and Passive House
- PH Toolkit: Feasibility and Detailed Stages
- Case Studies: Design Guidance, Documentation
- Lessons Learned and Next Steps

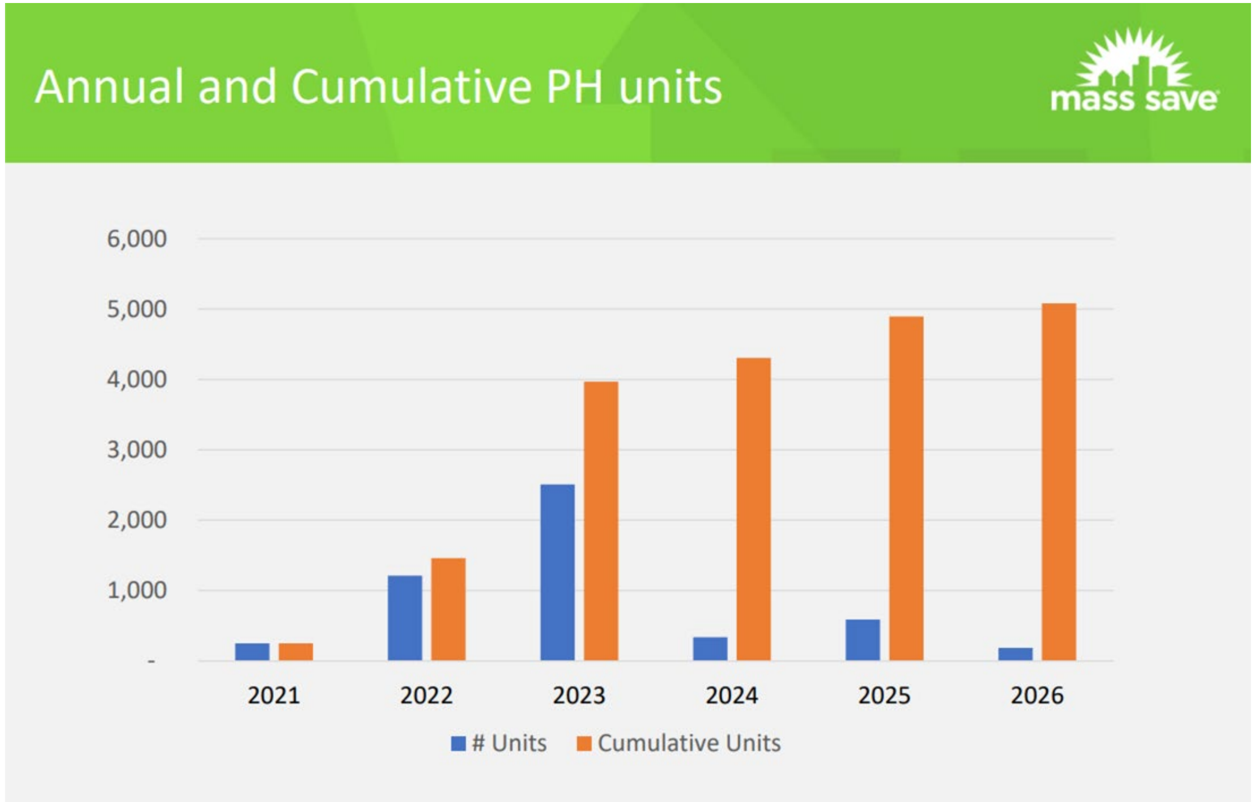
Utile Team



Massachusetts Context



MA Decarbonization Roadmap



Mass Save

Utile Projects Pursuing Phius Certification

152-158 Broadway
Somerville, MA | 45 Units

1599 Columbus Ave.
Boston, MA | 65 Units

1005 Broadway
Chelsea, MA | 38 Units

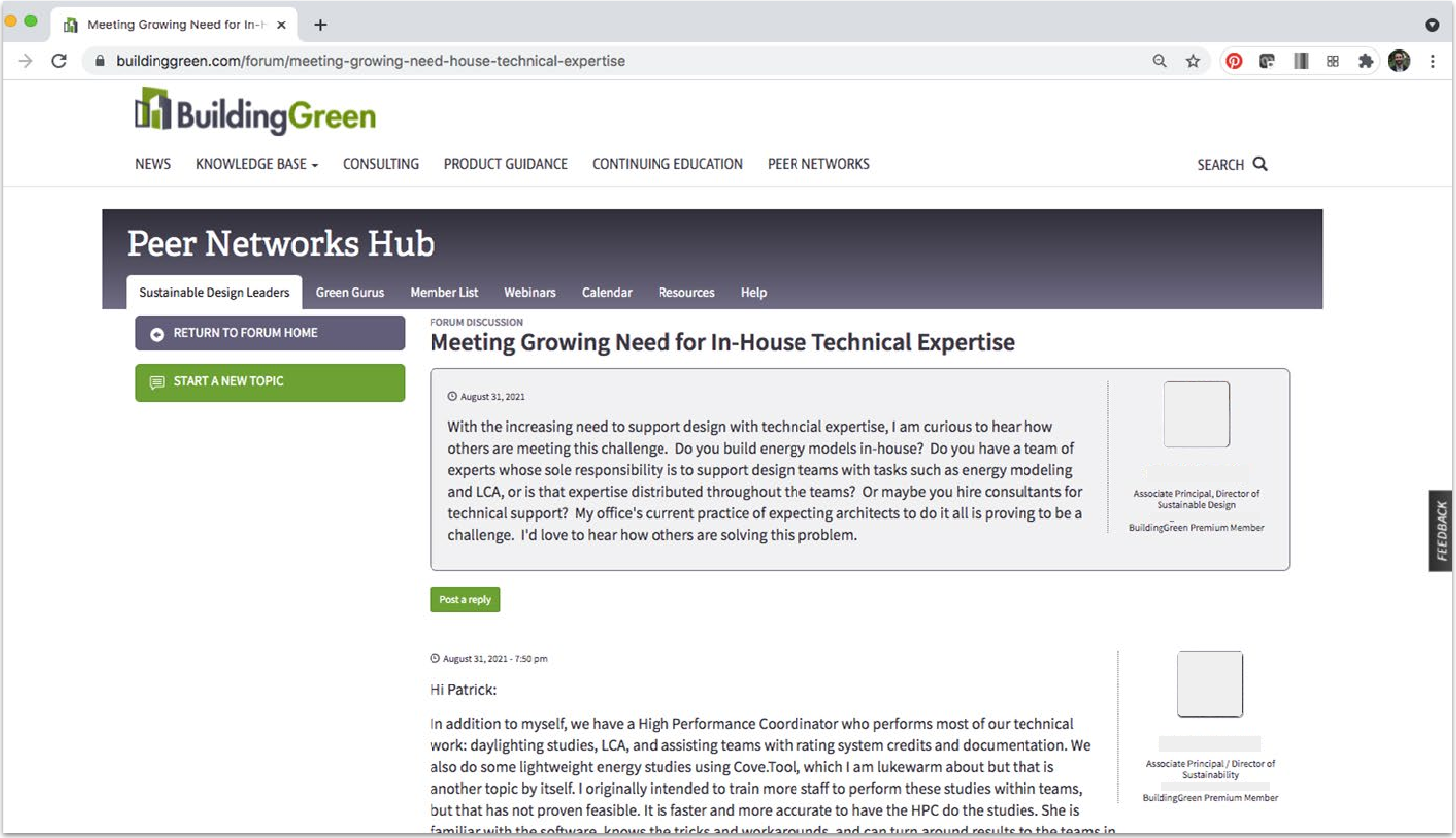
1200 Montello
Brockton, MA | 94 Units

25 Sixth St.
Chelsea, MA | 62 Units

Front St. Building 2
Portland, ME | 13 Units

Front St. Building 5
Portland, ME | 45 Units

3371 Washington St.
Boston, MA | 39 Units

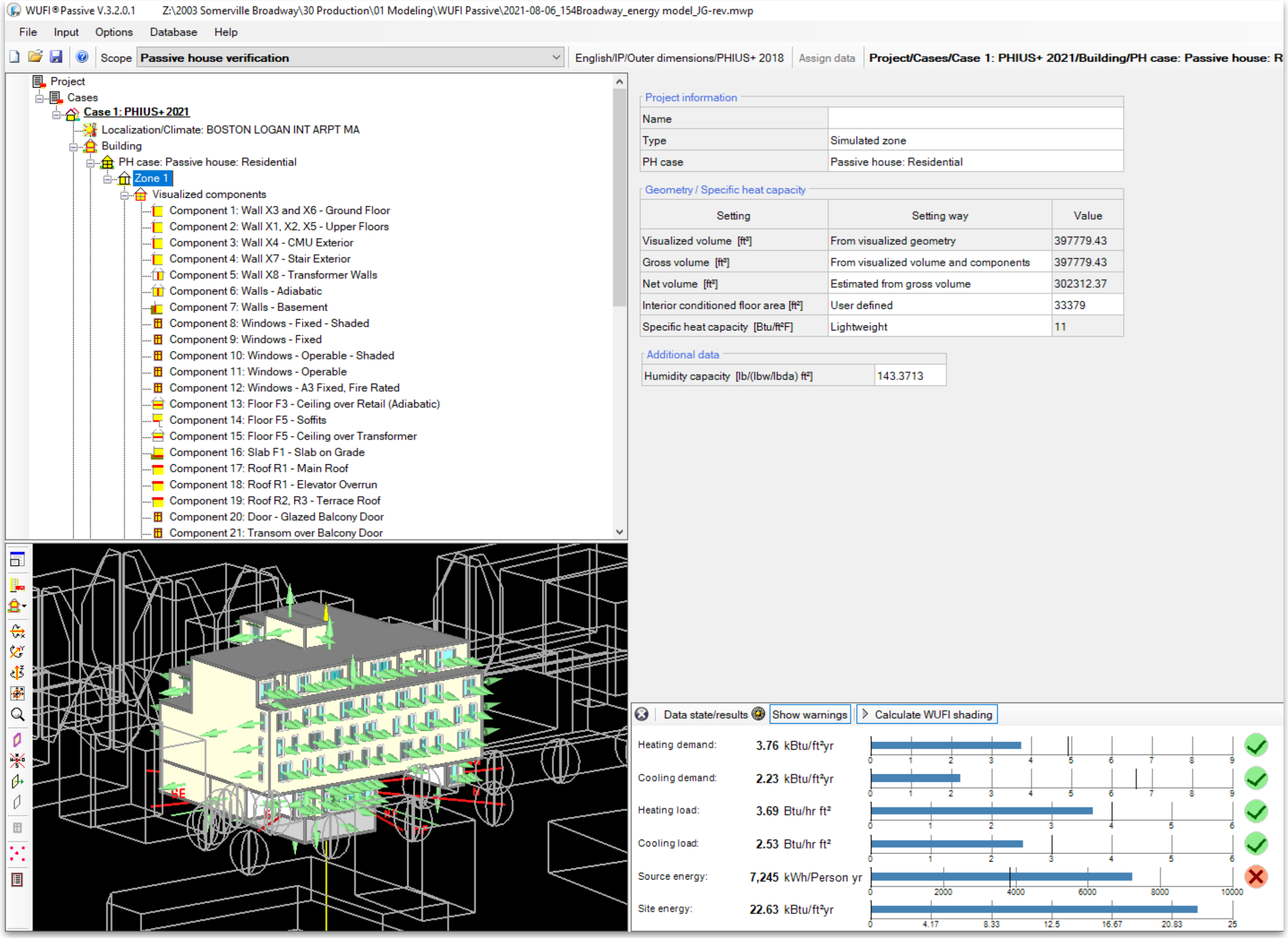

Meeting Growing Need for In-H
buildinggreen.com/forum/meeting-growing-need-house-technical-expertise
BuildingGreen
NEWS
KNOWLEDGE BASE
CONSULTING
PRODUCT GUIDANCE
CONTINUING EDUCATION
PEER NETWORKS
SEARCH
Peer Networks Hub
Sustainable Design Leaders
Green Gurus
Member List
Webinars
Calendar
Resources
Help
RETURN TO FORUM HOME
START A NEW TOPIC
FORUM DISCUSSION
Meeting Growing Need for In-House Technical Expertise
August 31, 2021
With the increasing need to support design with techncial expertise, I am curious to hear how others are meeting this challenge. Do you build energy models in-house? Do you have a team of experts whose sole responsibility is to support design teams with tasks such as energy modeling and LCA, or is that expertise distributed throughout the teams? Or maybe you hire consultants for technical support? My office's current practice of expecting architects to do it all is proving to be a challenge. I'd love to hear how others are solving this problem.
Associate Principal, Director of Sustainable Design
BuildingGreen Premium Member
Post a reply
August 31, 2021 - 7:50 pm
Hi Patrick:
In addition to myself, we have a High Performance Coordinator who performs most of our technical work: daylighting studies, LCA, and assisting teams with rating system credits and documentation. We also do some lightweight energy studies using Cove.Tool, which I am lukewarm about but that is another topic by itself. I originally intended to train more staff to perform these studies within teams, but that has not proven feasible. It is faster and more accurate to have the HPC do the studies. She is familiar with the software, knows the tricks and workarounds, and can turn around results to the teams in
Associate Principal / Director of Sustainability
BuildingGreen Premium Member
FEEDBACK

Energy Modeling Within Architecture Firms

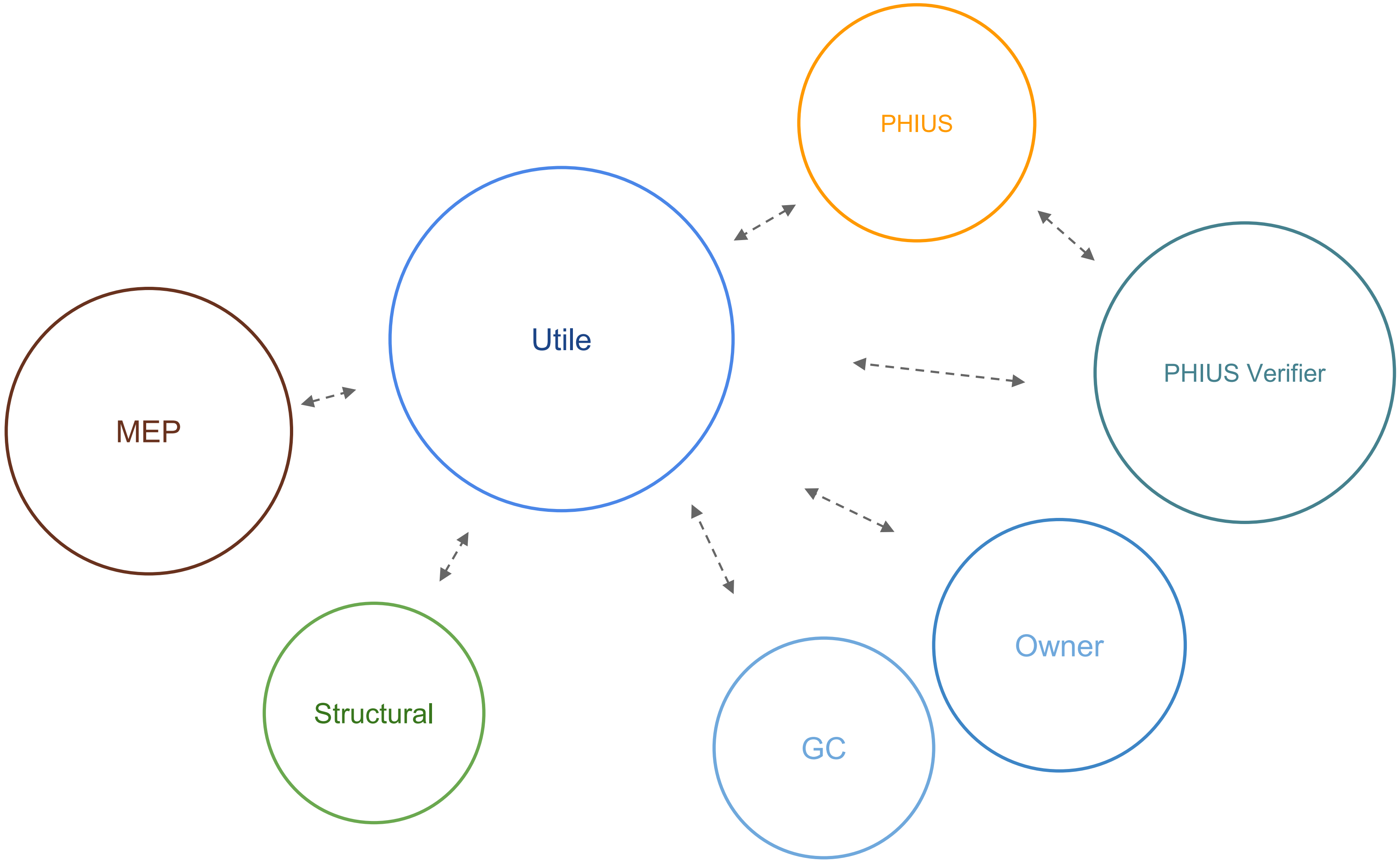
Energy Modeling Paradigm	Pros and Cons	Responsible Parties					
		Internal Design Staff		Internal Building Performance Specialist		External Consultant	
		Early	Detailed	Early	Detailed	Early	Detailed
“Outsource”	- Often happens too late to affect design decisions - Little transfer of knowledge to design team						●
“Some in-house”	- Disconnect/inconsistencies between early studies and detailed model Requires intermediate-level capacity within architecture firm	●		●			●
“Integrated”	- Requires advanced capacity within architecture firm + Deep transfer of knowledge to design team	●		●	●		

Opportunities for In-House Modeling

- More integrated design outcomes and documentation
- De-mystify the PHIUS process for the design and owner team
- Get to pre-certification faster (can use pre-cert letter for energy code compliance in MA at building permit stage)
- Increase staff literacy about energy performance, passive design, and building science



Collaborators

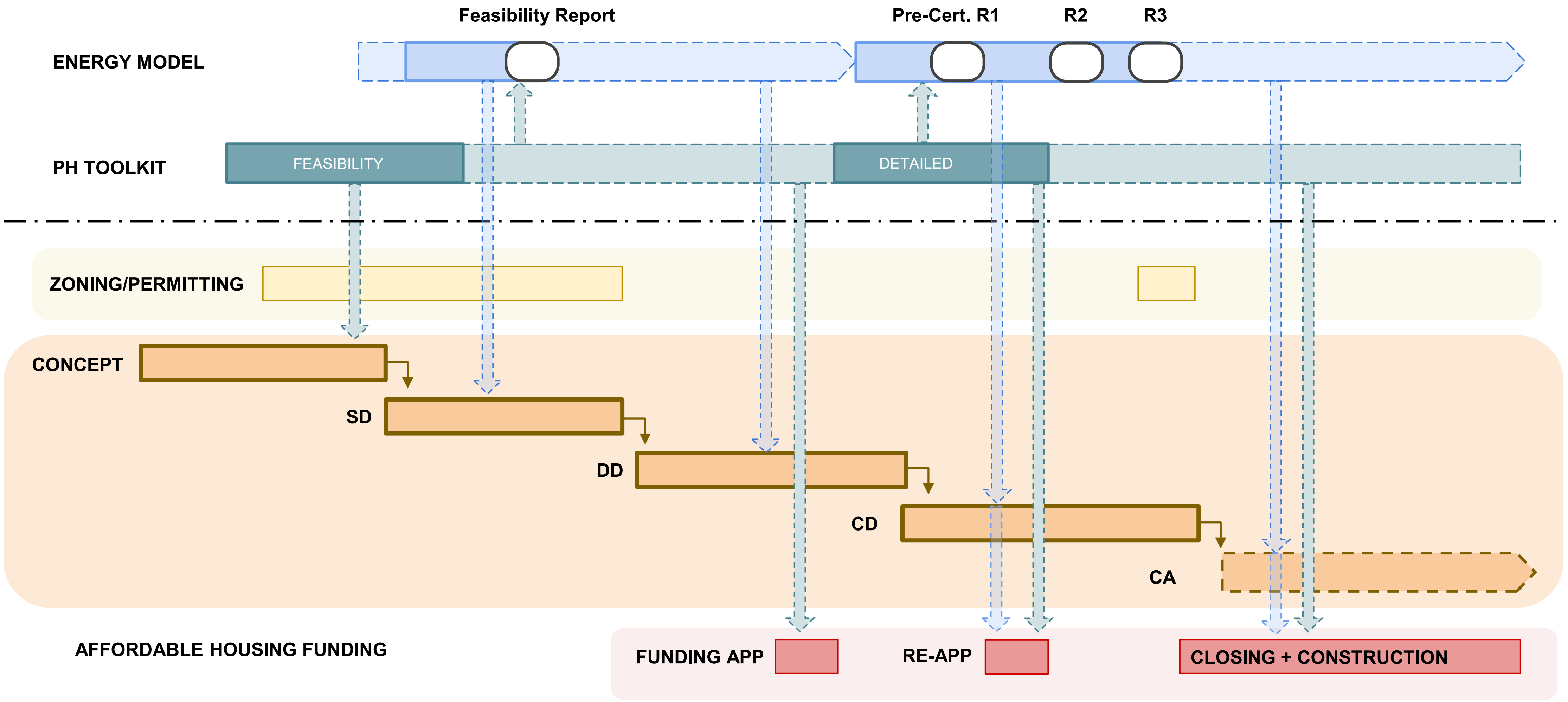


Passive House Energy Modeling Milestones

	Feasibility Stage	Detailed (Pre-Certification) Stage
Goal	Confirm viability, set targets, flag problem areas	Create documentation for official review
Phase	Concept Design / SD	Start early CD’s
Model Level of Detail	Rough / Lots of assumptions	Very Detailed
CPHC/Energy Modeler Involvement	● Build initial energy model and compile inputs from assumptions ● Create Feasibility Report for integrated team guidance	● Re-build energy model to current project ● Coordinate inputs with design team, MEP engineer ● Multiple QA/QC rounds (bluebeam drawing markup) before first PHIUS submission ● Multiple rounds of submissions to PHIUS addressing official feedback ● Thermal bridge modeling in THERM to coordinate with energy model, check for condensation risk

Developing a set of tools to guide Passive House decision making

Early energy modeling and feasibility assessment inform later design and budgeting decisions



In-House Structure

Lead CPHC / Modeler	Energy Model Support	PM + Project Designers	QA/QC Support
• Leads initial Feasibility Studies • "Owns" the WUFI model • Performs THERM analysis • Submits the project to Phius • Provides design guidance and drawing review • Coordinates inputs with mechanical engineer	• Builds and updates the WUFI geometry from Revit or Rhino • Runs supporting analyses, like Net Volume	• Implements PH requirements into the project design and documentation • Manages sheets such as iCFA, assemblies, etc. that directly correspond with WUFI	• Reviews details for continuity of control layers, constructability, moisture management

Working Groups

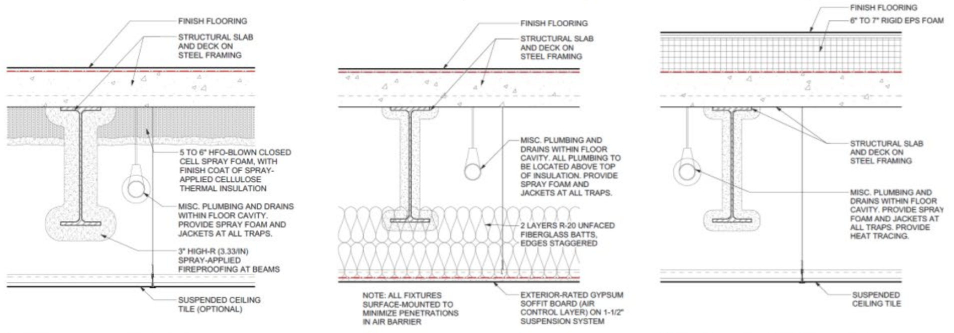
- Housing Cohort
- Revit Standards and Best Practices
- PH/Revit Working Group

Feasibility Stage

Passive House “Toolkit”

Floors

	Insulation at Underside of Deck	Insulation on Suspended Hard Ceiling	Insulation on Top of Deck



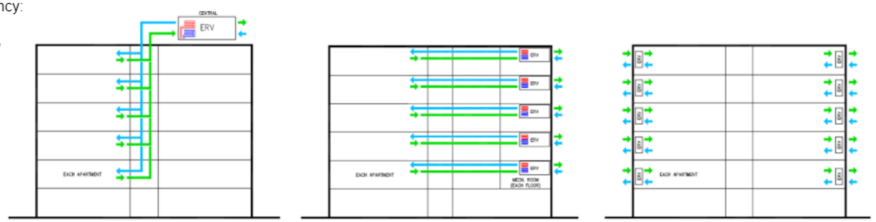
	Insulation at Underside of Deck	Insulation on Suspended Hard Ceiling	Insulation on Top of Deck
First Cost	- Requires heat tape and insulation at piping - Cost of large amounts of spray applied insulation should be studied relative to other options	+ Inexpensive insulation material + Eliminates heat tape - Hard ceiling assembly is an additional expense	- Requires heat tracing and insulation at piping
Constructability	- Some thermal bridging at beams Thermal bridging at beam/column intersection can be resolved with structural thermal break pad or via over-spraying onto the columns (high-R fireproofing, for example)	- Different from standard practice - Requires increased attention to detail for air sealing - Some thermal bridging at beams Thermal bridging at beam/column intersection can be resolved with structural thermal break pad	- Different from standard practice. Foam on top of slab adds complexity to interior framing, must be high compressive strength
Performance / Other Concerns	+ All insulation above deck, keeping moisture-sensitive sheathing warm and dry Additional energy use from heat tape must be accounted for in model - Closed cell spray foam has high embodied energy	+ All piping above insulation, avoiding freezing + Low embodied energy insulation approach - Access panels to P-traps interrupt continuous air and thermal control layers	- May be problematic for incidental leaks that may occur in 2nd floor living units - Foam has higher embodied carbon + Eliminates all thermal bridging through podium structure Additional energy use from heat tape must be accounted for in model

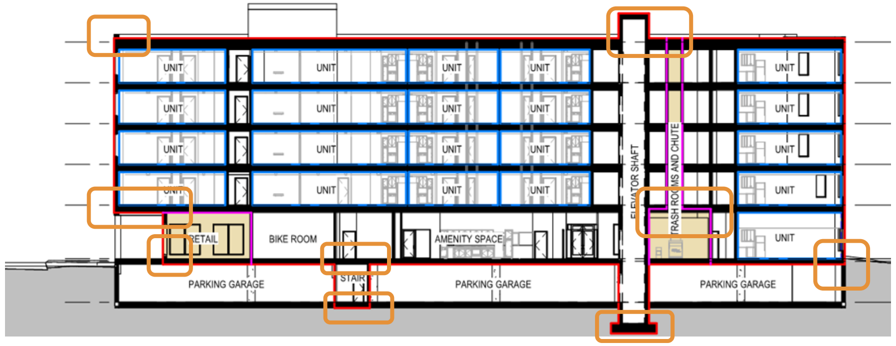
Energy Recovery Ventilation: Typologies

Central (Roof mount)	Semi-Central (Floor-by-floor)	Individual (Each Apartment)

General guidelines

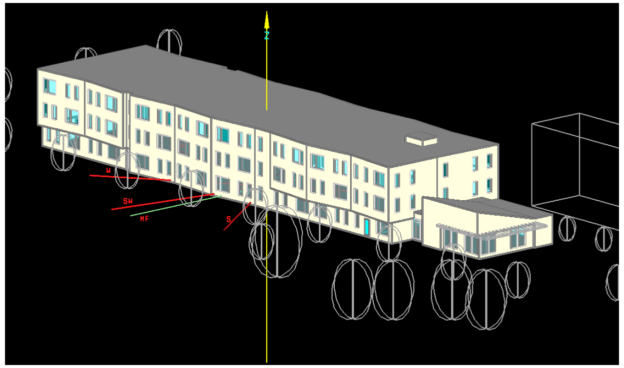
- 100% outside air
- Balanced, continuous ventilation
  - exhaust at kitchens and baths
  - fresh air to all living spaces
- High sensible recovery efficiency: >80%+
- High fan power efficiency (low W/cfm)

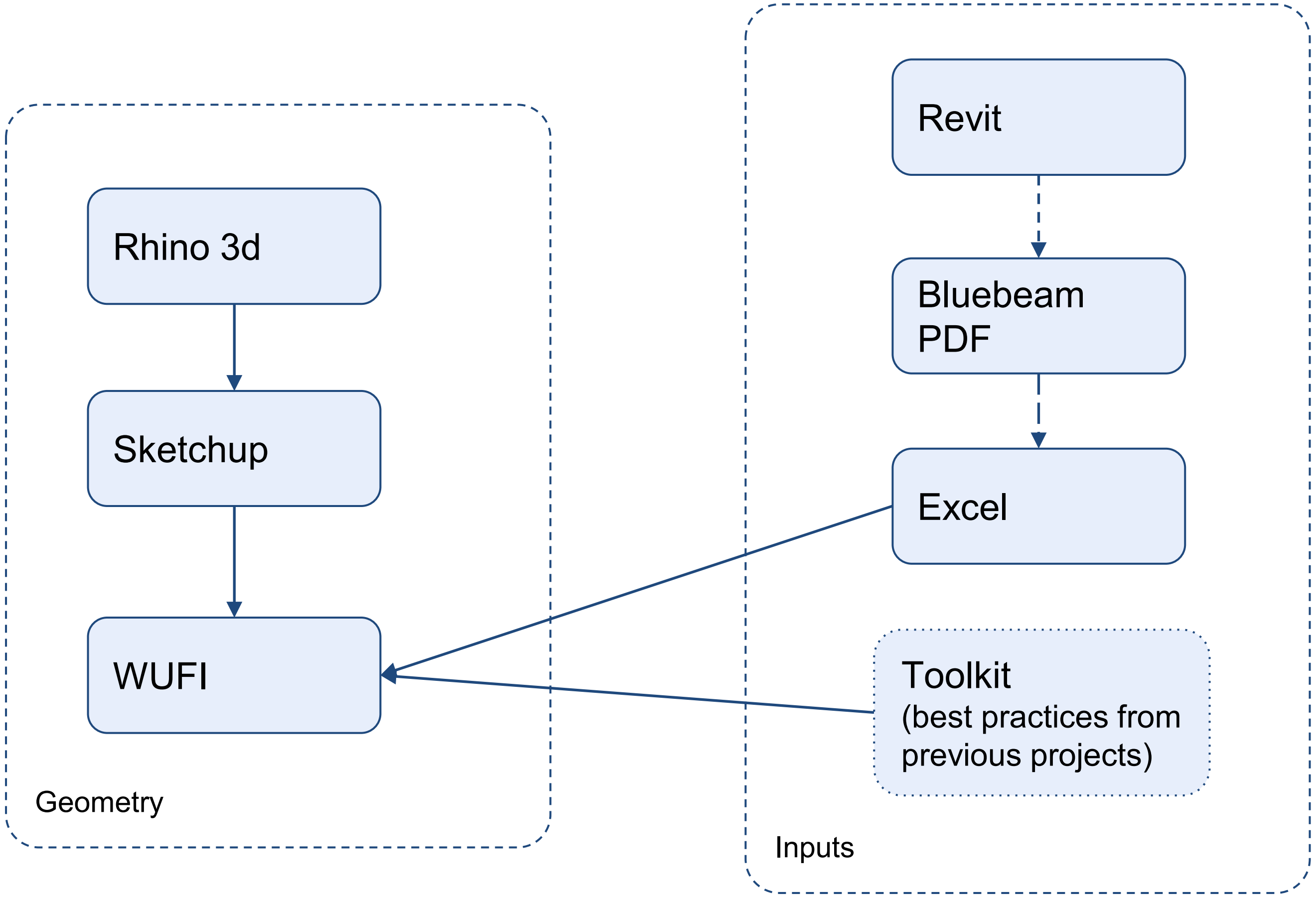




Feasibility Stage

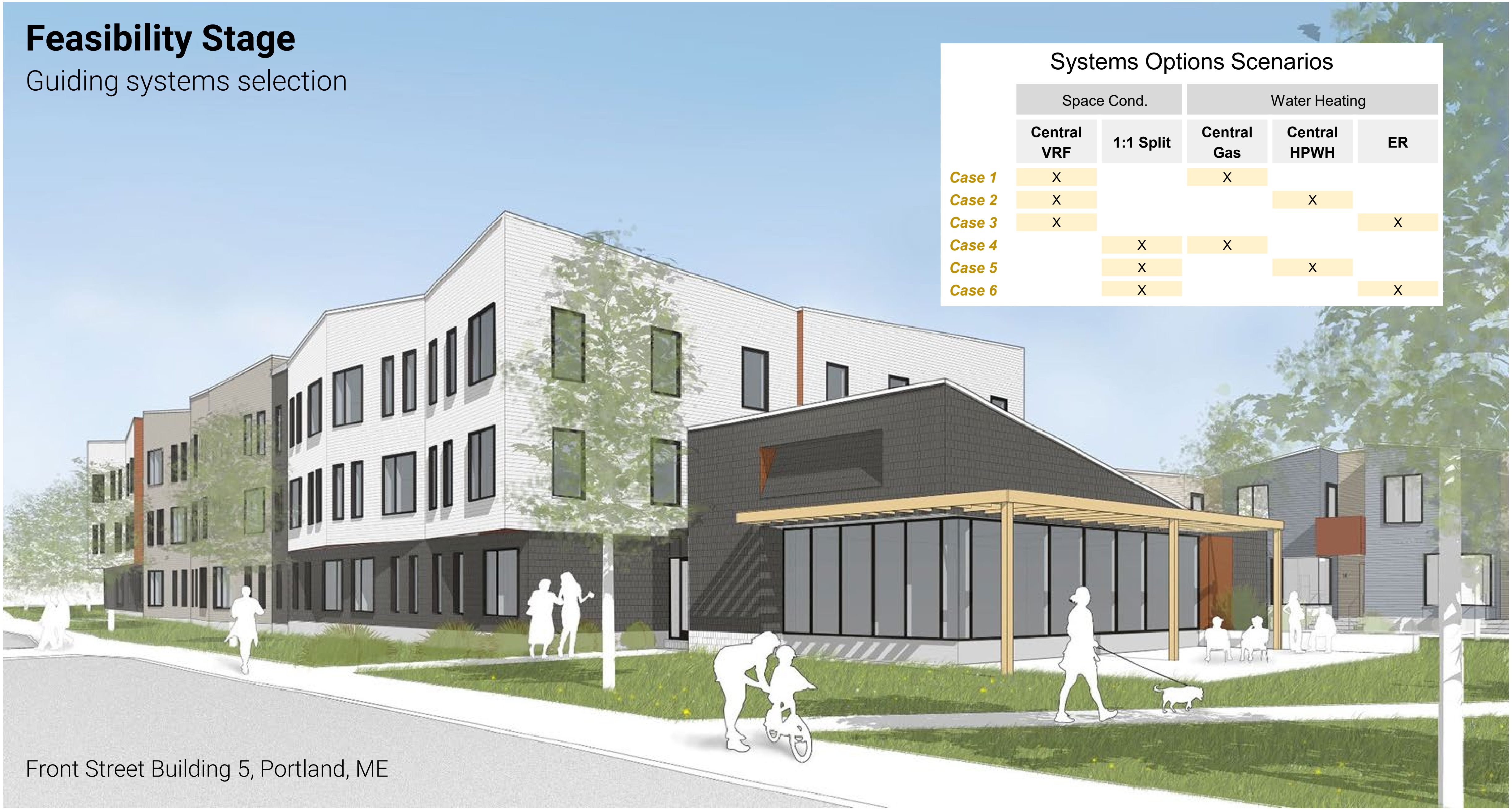
Energy Modeling Workflow





Feasibility Stage

Guiding systems selection



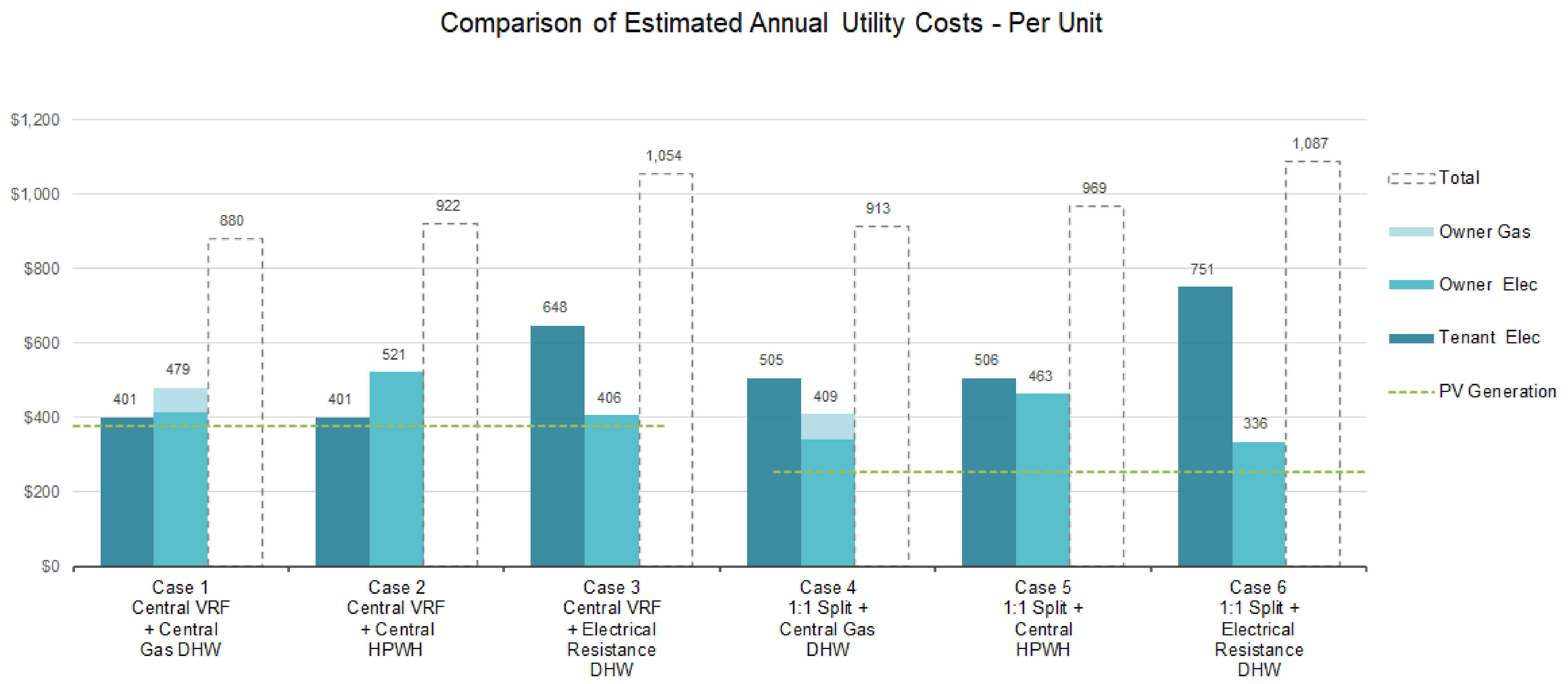
Front Street Building 5, Portland, ME

Systems Options Scenarios

	Space Cond.		Water Heating		
	Central VRF	**1:1 Split**	**Central Gas**	**Central HPWH**	**ER**
Case 1	X		X		
Case 2	X			X	
Case 3	X				X
Case 4		X	X		
Case 5		X		X	
Case 6		X			X

Feasibility Stage

Guiding systems selection

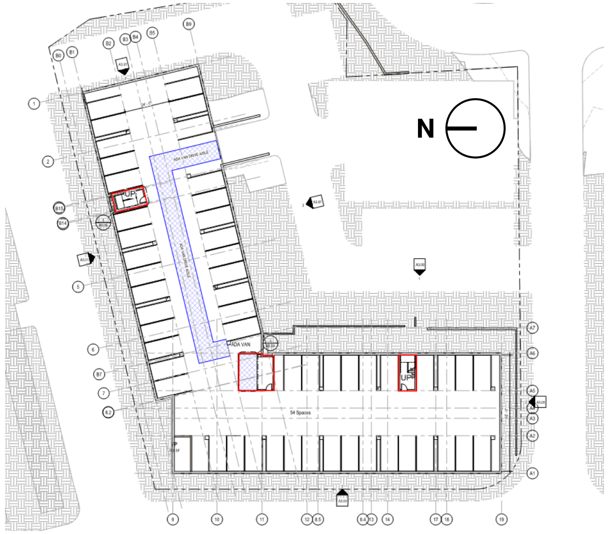


Feasibility Stage

Early THERM studies for vetting structural approaches

Montello St. Housing, Brockton, MA

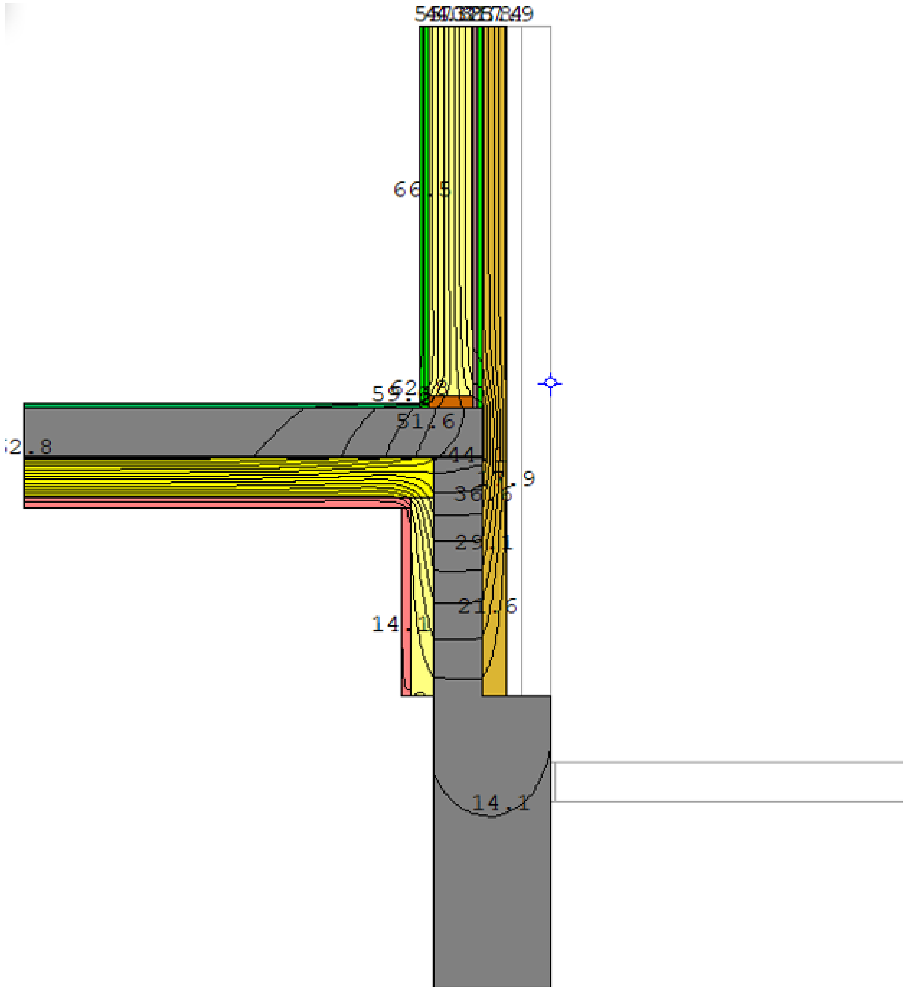
Ground Floor Plan



Basement Floor Plan

Feasibility Stage

Early THERM studies for vetting structural approaches



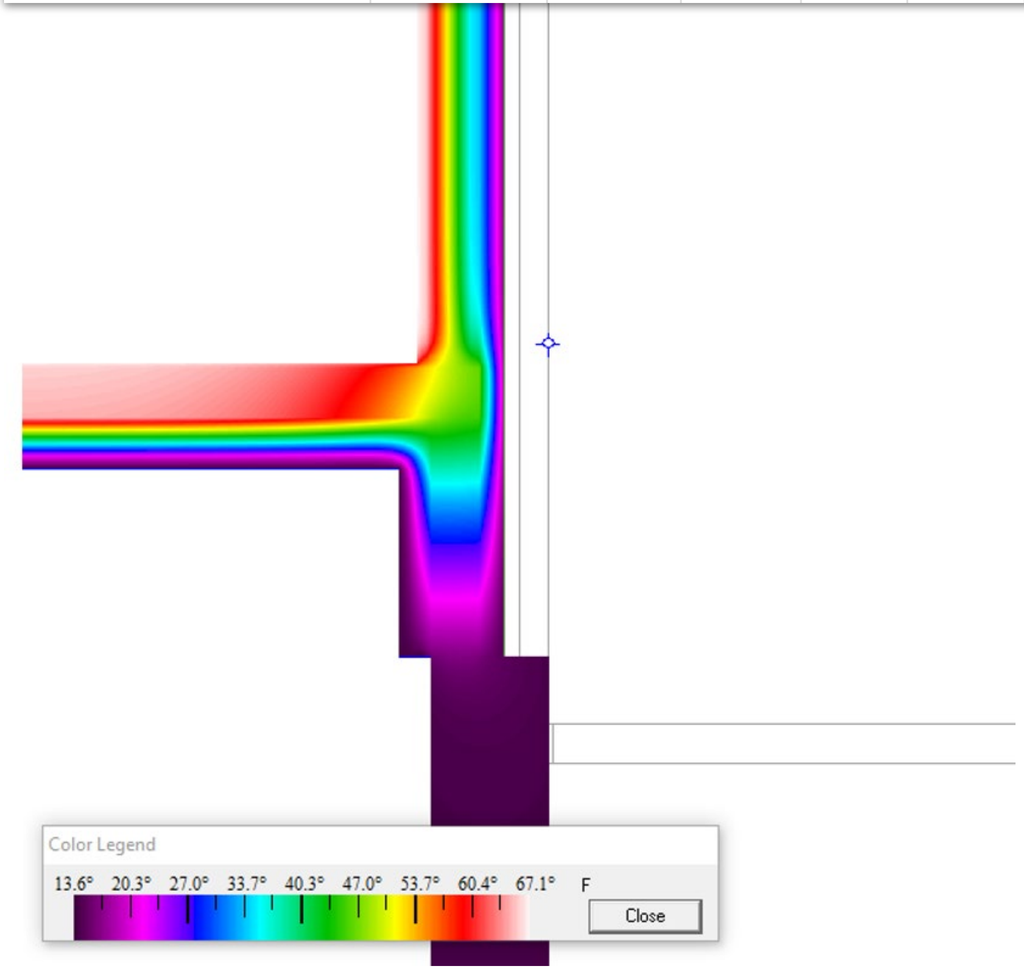
5 Enter values below:

θsi =	58.3
θe =	22.3
θi=	68

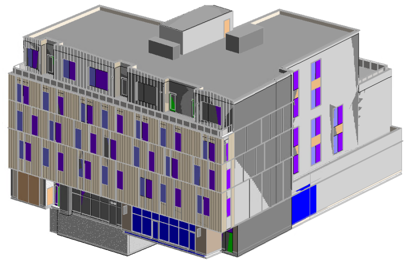
Calculated fRsi **79%** **Critical fRsi** **64%**

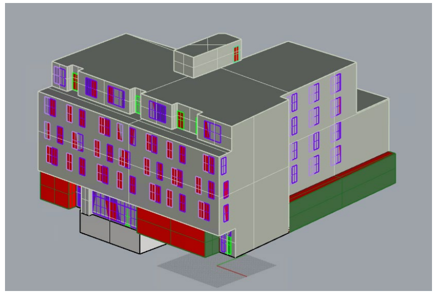
6 If the calculated fRsi is smaller than the critical fRsi, then there is a problem of condensation, otherwise there is not.

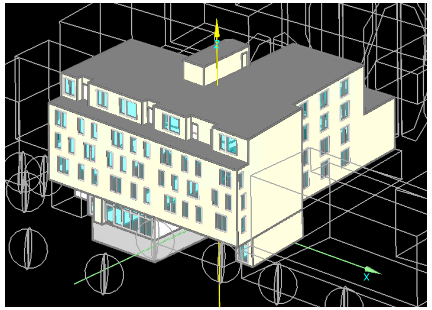
RISK OF MOLD GROWTH ON INTERIOR SURFACE? **NO**

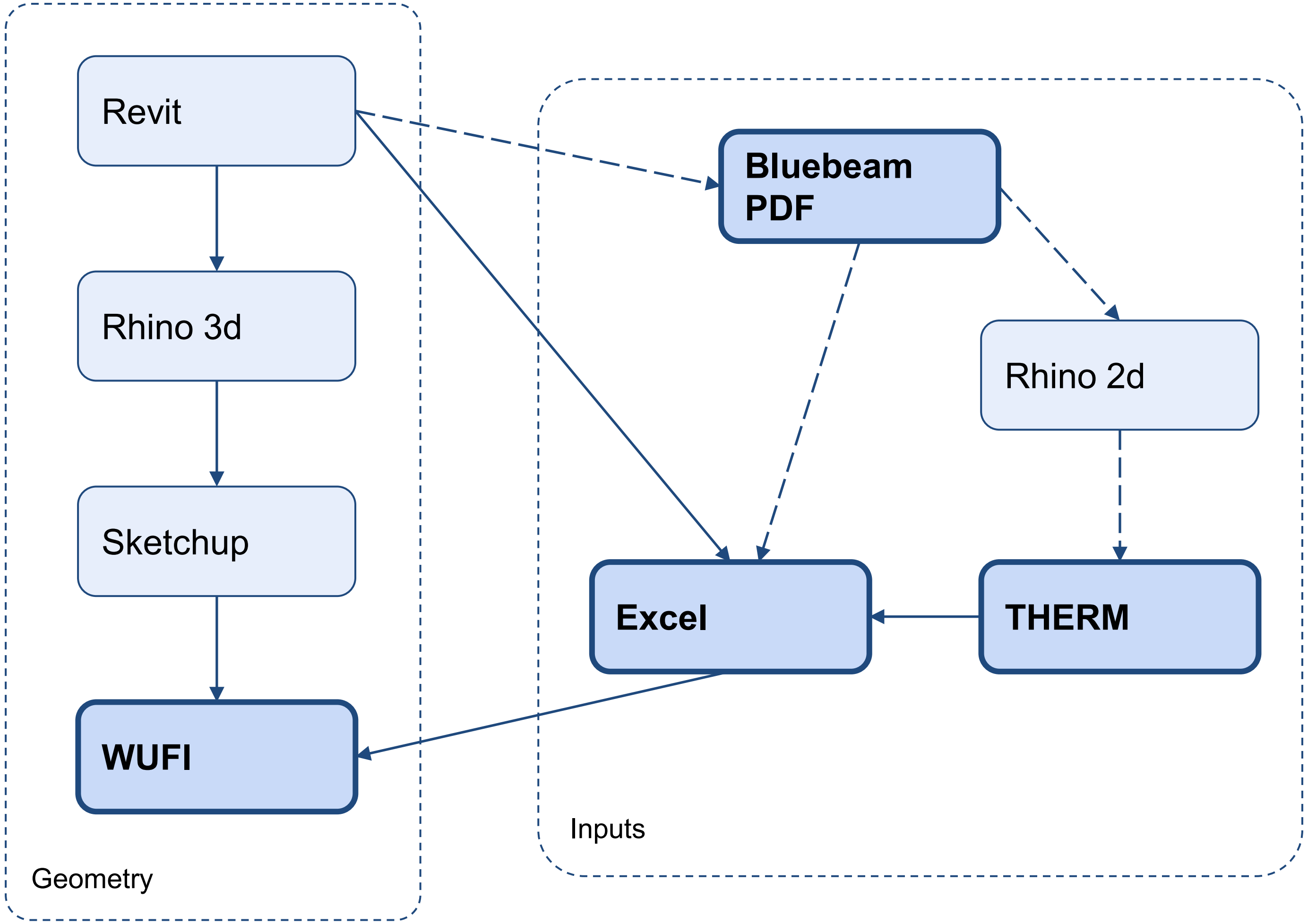


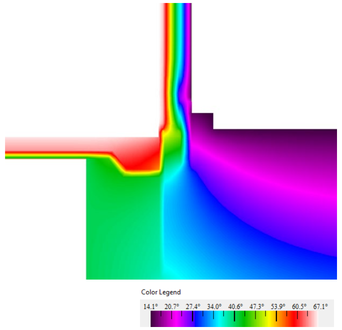
Detailed Energy Modeling Workflow





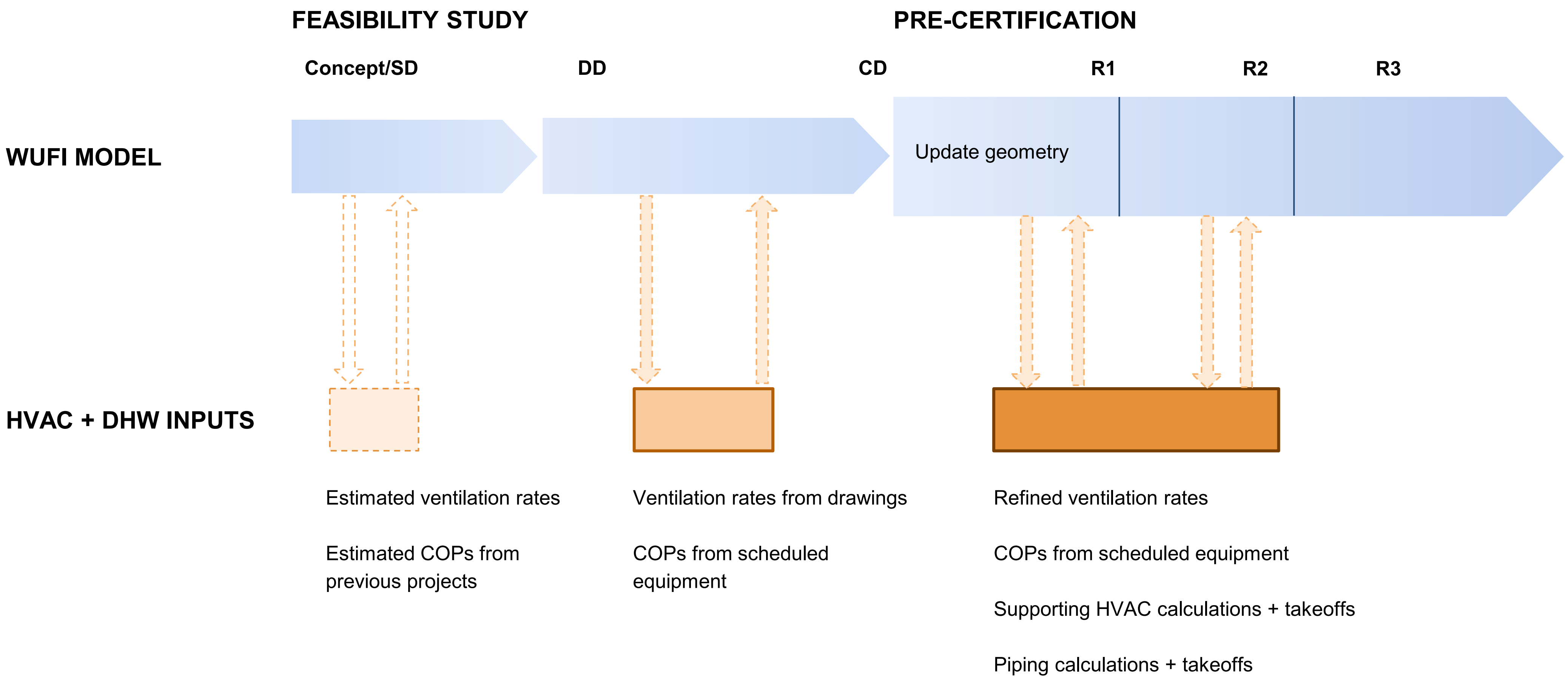






Bold = PHIUS will review

WUFI Model Coordination with MEP



Detailed (Pre-Cert) Stage

Ongoing WUFI Model "Cross-Checking"

Sixth Street Affordable Housing, Chelsea, MA

Detailed (Pre-Cert) Stage

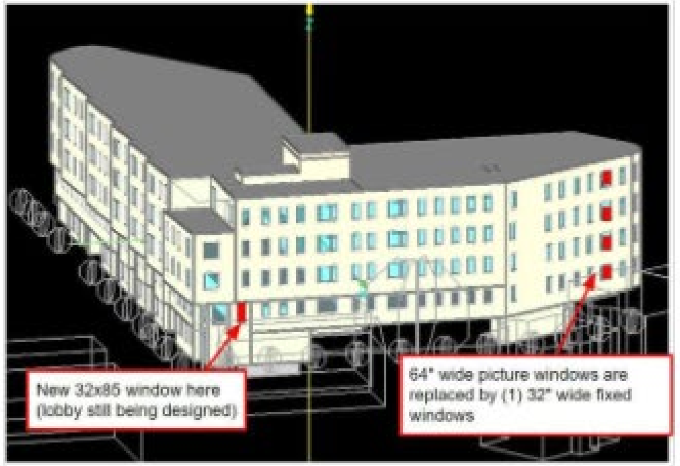
Ongoing WUFI Model “Cross-Checking”

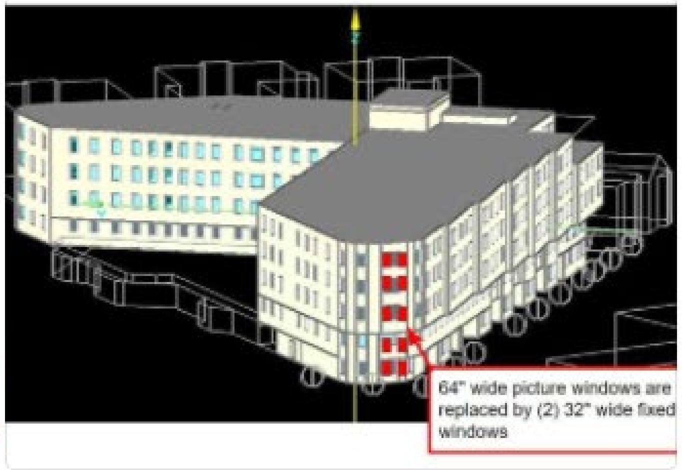
Monday, February 1st

Jessica Y 12:46 PM

Hi Jeff, we've been making a few window changes that I'm updating in WUFI. I switched some fixed and operable types, and deleted some windows we got rid of, but there's a few changes I didn't know how to make. Hope it's ok to show these here

2 files





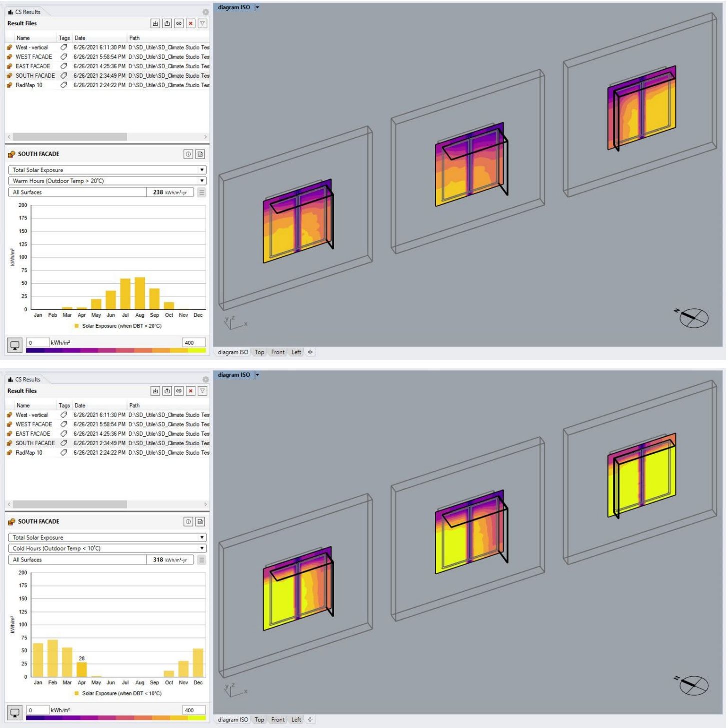
Design Guidance

Optimizing external window shading for seasonal performance

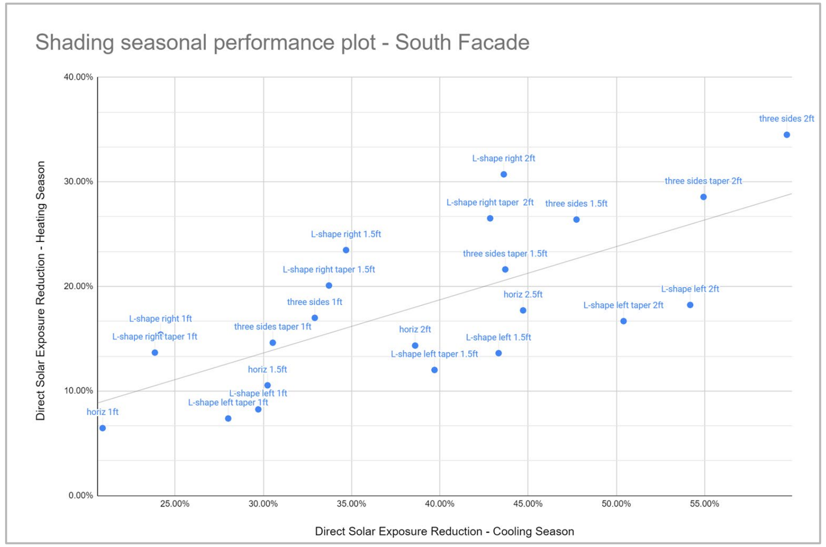
Broadway Housing, Somerville, MA

Design Guidance

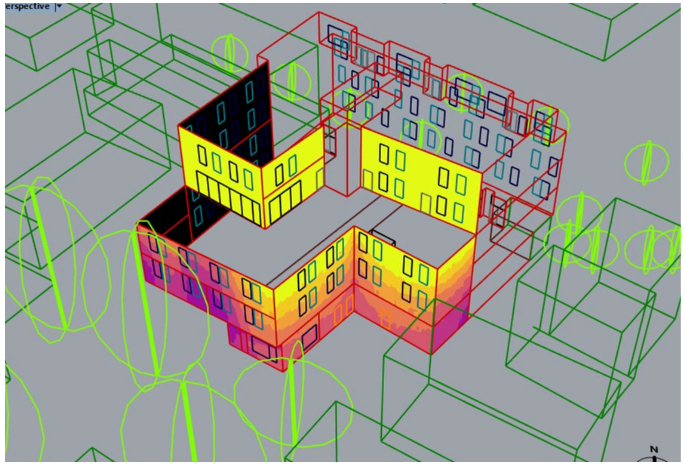
Optimizing external window shading for seasonal performance



1. ClimateStudio solar radiation analysis of 24 shading typologies /depths during heating and cooling seasons



2. Scatter plot for evaluating seasonal performance of shading typologies and depths



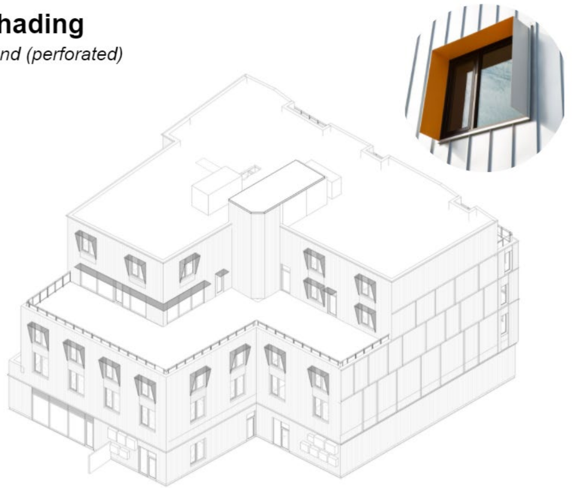
3. Facade overshadowing analysis for local guidance of shading placement

Rear Facade - Shading

Option 4 - 3-sided surround (perforated)

Criteria	Rating
Aesthetics	+
Solar heat gain, summer	+
Solar heat gain, winter	-
Daylighting	-
Views of city	-

Improves		Neutral	Detracts	
+	+	/	-	-



4. Options presentation with client based on analysis

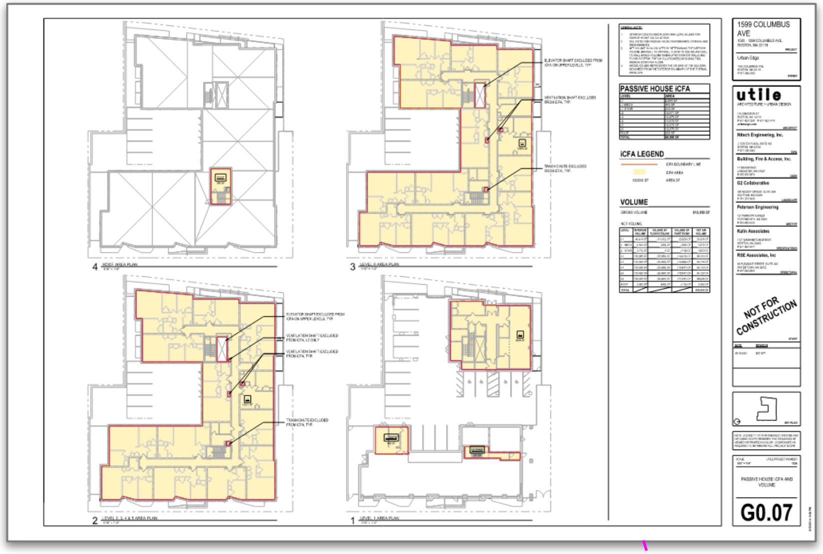
Revit and Passive House Documentation

	Feasibility Study	Pre-Certification		Comments
Contract Document G-Series		*R1 Submission*	*Round 2, 3…*	
iCFA	X	**X**		Understand the definition of iCFA. Constantly check iCFA **area plans** for coordination with updates to the floor plans.
Net Volume			**X**	This can usually wait until the second round of submission. Check with the Working Group for the most appropriate workflow for your project.
Thermal Envelope Diagram	X	**X**	**X**	Understand the location of the thermal and air control layers for your project. Coordinate with any changes to the design.
Exterior Assemblies		**X**	**X**	Make sure all types are covered and properly tagged on wall sections. The energy model will use these assemblies as named on the sheet.
Room Tagging for Int. Gain Calcs	X	**X**	**X**	These names and areas will be used both for model inputs and for PHIUS review. Schedules (.csv) can speed up CPHC coordination.
Contract Document A-Series				
Typical Exterior Details		**X**	**X**	Start with windows, foundation, parapet, floor edge. Clearly show the continuity of the thermal and air control layers, and make sure all materials are properly labeled
Window Schedule, Surround Dim's		**X**	**X**	Window surround dimensions will be directly input into the energy model. Refer to the PHIUS Guidebook for how to document window extensions
Thermal Bridge Details		X	**X**	Flag these early with the CPHC and coordinate with structural consultant if applicable
Unique Conditions Exterior Details		X	**X**	Call out unique air sealing conditions and make sure all materials properly labeled
Other				
Consultant drawings (MEP) to PHIUS/DOE/EPA standards		**X**	**X**	Coordinate with the MEP engineer early (e.g., ventilation flow rate schedule)

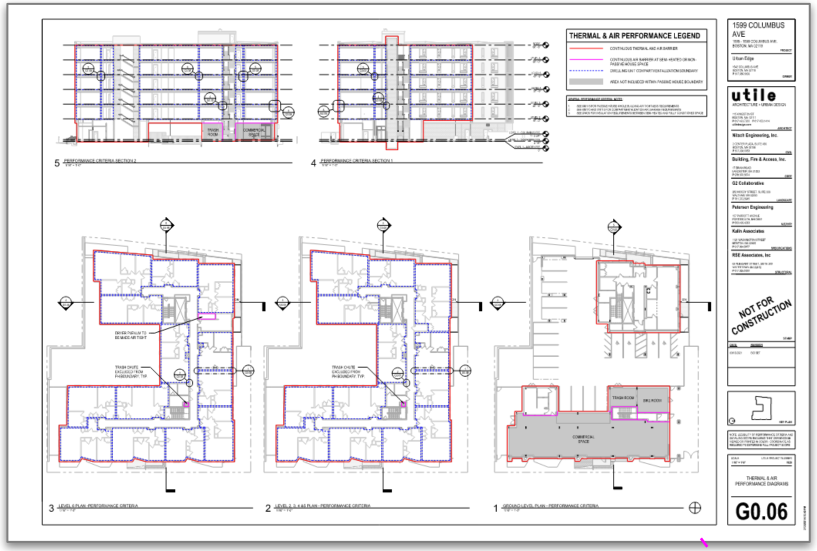
X	Required for CPHC inputs
X	Required for CPHC inputs + PHIUS Review

Revit and Passive House Documentation

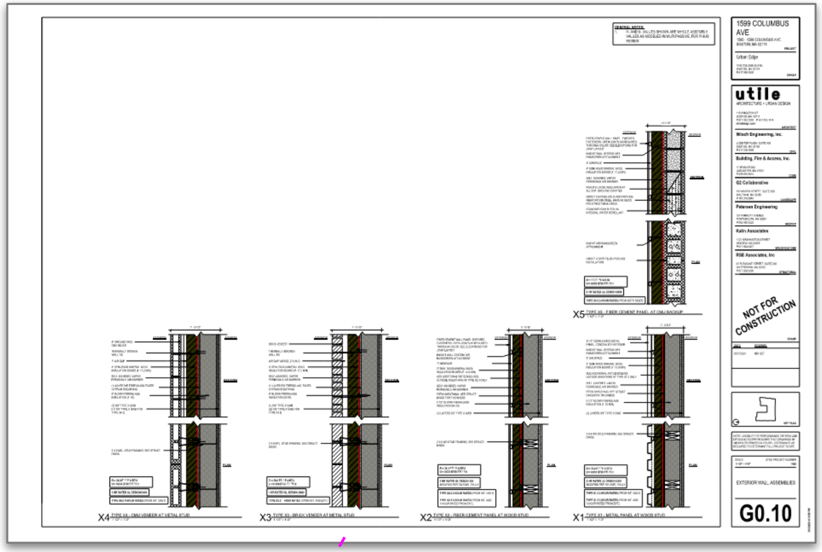
iCFA and Volume



Thermal and Air Performance Diagram Sheet/



Exterior Assembly Sheets



Inputs in WUFI

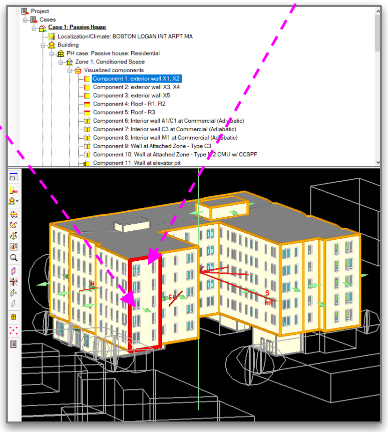
Geometry / Specific heat capacity

Setting	Setting way	Value
Visualized volume [ft³]	From visualized geometry	813185.56
Gross volume [ft³]	From visualized volume and components	813185.56
Net volume [ft³]	User defined	518414
Interior conditioned floor area [ft²]	User defined	66996
Specific heat capacity [Btu/ft²F]	Lightweight	11

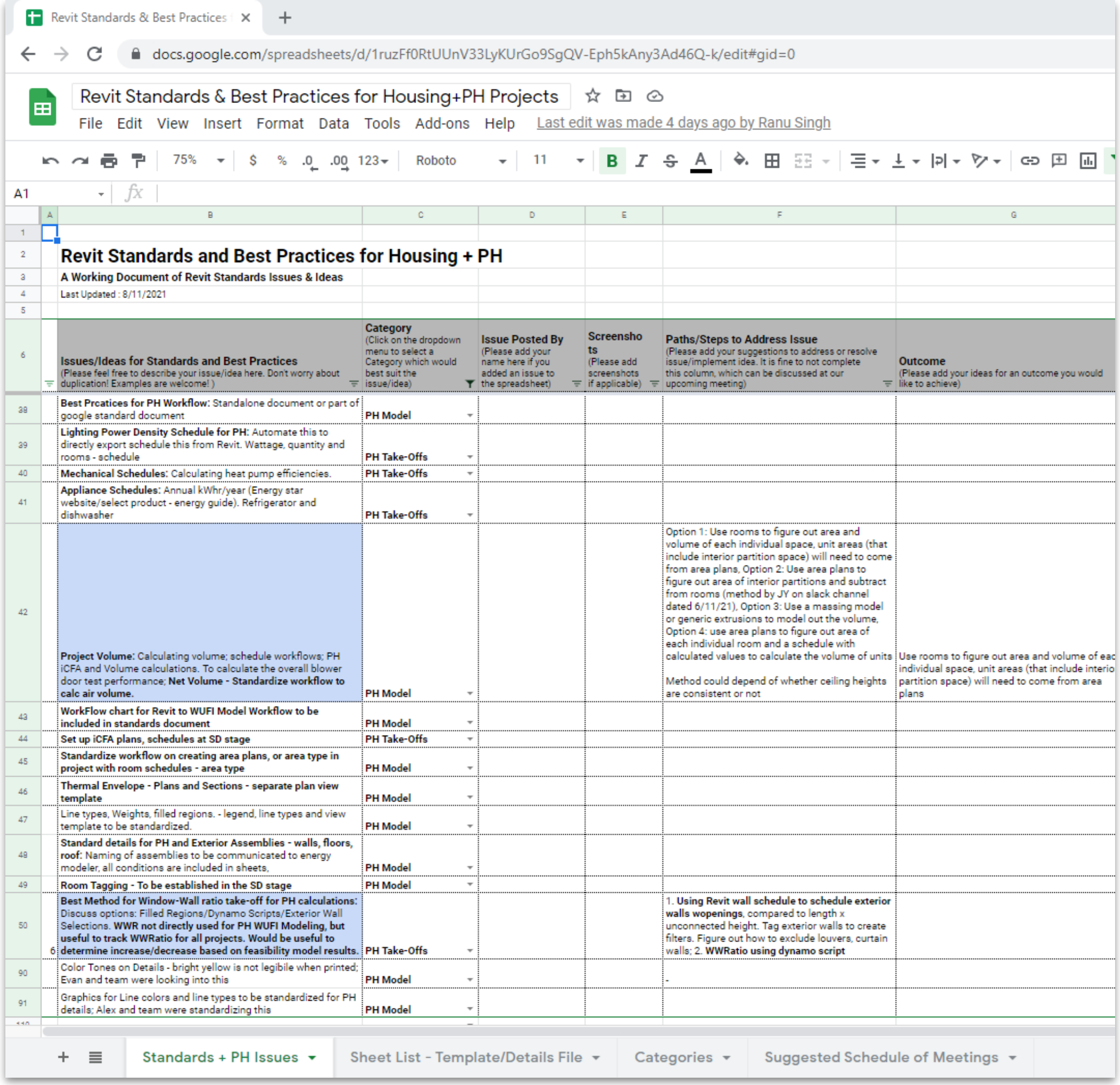
Additional data

Humidity capacity [lb/(lbw/lbda) ft²]	143.3713

Inputs in WUFI



Tracking Progress and Cataloging Data



Revit Standards & Best Practices for Housing+PH Projects

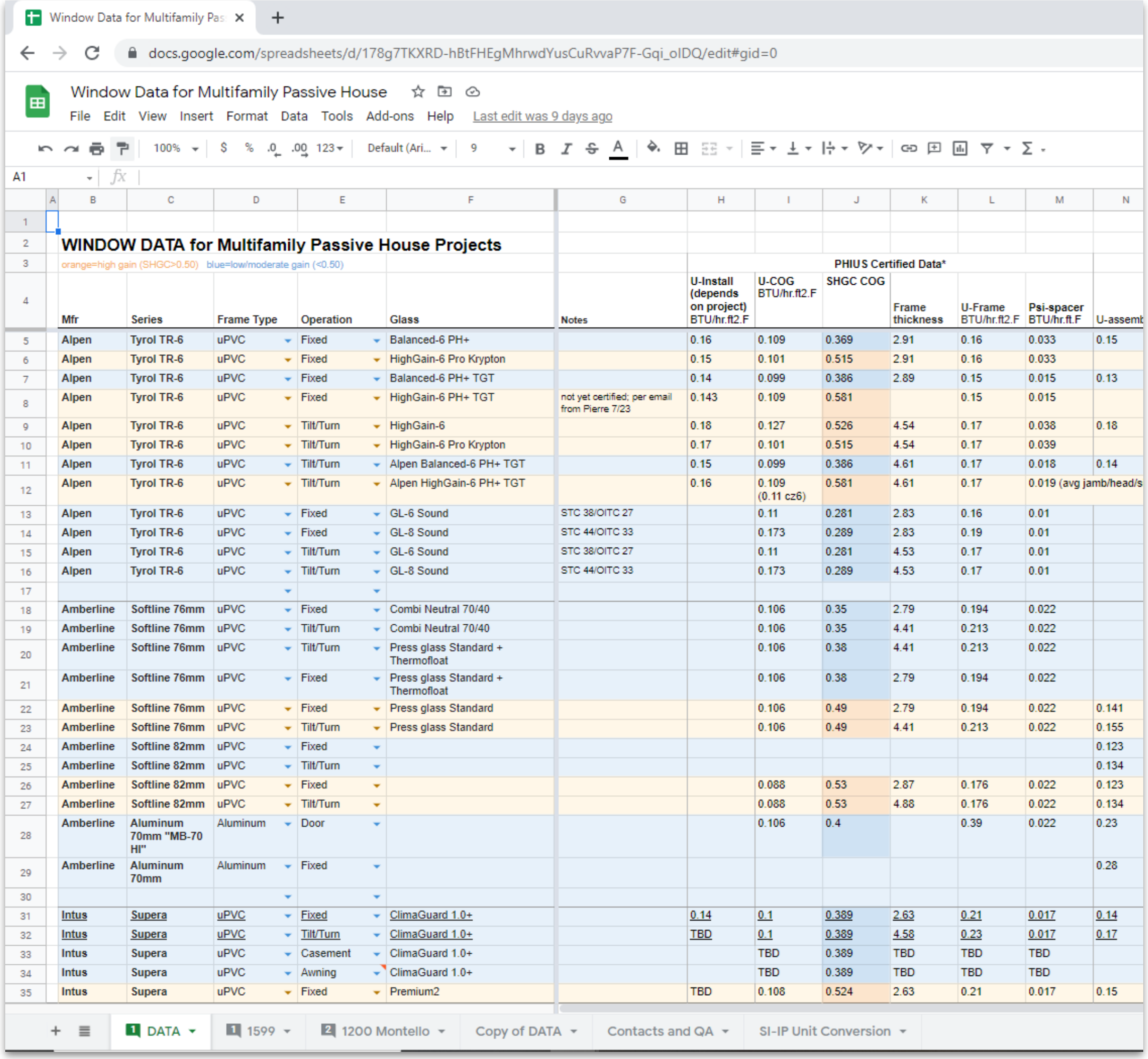
Revit Standards and Best Practices for Housing + PH

A Working Document of Revit Standards Issues & Ideas

Last Updated : 8/11/2021

Row	Issues/Ideas for Standards and Best Practices (Please feel free to describe your issue/idea here. Don't worry about duplication! Examples are welcome!)	Category (Click on the dropdown menu to select a Category which would best suit the issue/idea)	Issue Posted By (Please add your name here if you added an issue to the spreadsheet)	Screenshots (Please add screenshots if applicable)	Paths/Steps to Address Issue (Please add your suggestions to address or resolve issue/implement idea. It is fine to not complete this column, which can be discussed at our upcoming meeting)	Outcome (Please add your ideas for an outcome you would like to achieve)
38	**Best Prcatices for PH Workflow:** Standalone document or part of google standard document	PH Model				
39	**Lighting Power Density Schedule for PH:** Automate this to directly export schedule this from Revit. Wattage, quantity and rooms - schedule	PH Take-Offs				
40	**Mechanical Schedules:** Calculating heat pump efficiencies.	PH Take-Offs				
41	**Appliance Schedules:** Annual kWhr/year (Energy star website/select product - energy guide). Refrigerator and dishwasher	PH Take-Offs				
42	**Project Volume:** Calculating volume; schedule workflows; PH iCFA and Volume calculations. To calculate the overall blower door test performance; **Net Volume - Standardize workflow to calc air volume.**	PH Model			Option 1: Use rooms to figure out area and volume of each individual space, unit areas (that include interior partition space) will need to come from area plans, Option 2: Use area plans to figure out area of interior partitions and subtract from rooms (method by JY on slack channel dated 6/11/21), Option 3: Use a massing model or generic extrusions to model out the volume, Option 4: use area plans to figure out area of each individual room and a schedule with calculated values to calculate the volume of units Method could depend of whether ceiling heights are consistent or not	Use rooms to figure out area and volume of eac individual space, unit areas (that include interio partition space) will need to come from area plans
43	**WorkFlow chart for Revit to WUFI Model Workflow to be included in standards document**	PH Model				
44	**Set up iCFA plans, schedules at SD stage**	PH Take-Offs				
45	**Standardize workflow on creating area plans, or area type in project with room schedules - area type**	PH Model				
46	**Thermal Envelope - Plans and Sections - separate plan view template**	PH Model				
47	Line types, Weights, filled regions. - legend, line types and view template to be standardized.	PH Model				
48	**Standard details for PH and Exterior Assemblies - walls, floors, roof:** Naming of assemblies to be communicated to energy modeler, all conditions are included in sheets,	PH Model				
49	**Room Tagging - To be established in the SD stage**	PH Model				
50	**Best Method for Window-Wall ratio take-off for PH calculations:** Discuss options: Filled Regions/Dynamo Scripts/Exterior Wall Selections. **WWR not directly used for PH WUFI Modeling, but useful to track WWRatio for all projects. Would be useful to determine increase/decrease based on feasibility model results.**	PH Take-Offs			1. **Using Revit wall schedule to schedule exterior walls wopenings**, compared to length x unconnected height. Tag exterior walls to create filters. Figure out how to exclude louvers, curtain walls; 2. **WWRatio using dynamo script**	
90	Color Tones on Details - bright yellow is not legibile when printed; Evan and team were looking into this	PH Model			-	
91	Graphics for Line colors and line types to be standardized for PH details; Alex and team were standardizing this	PH Model				

Standards + PH Issues | Sheet List - Template/Details File | Categories | Suggested Schedule of Meetings



Window Data for Multifamily Passive House

WINDOW DATA for Multifamily Passive House Projects

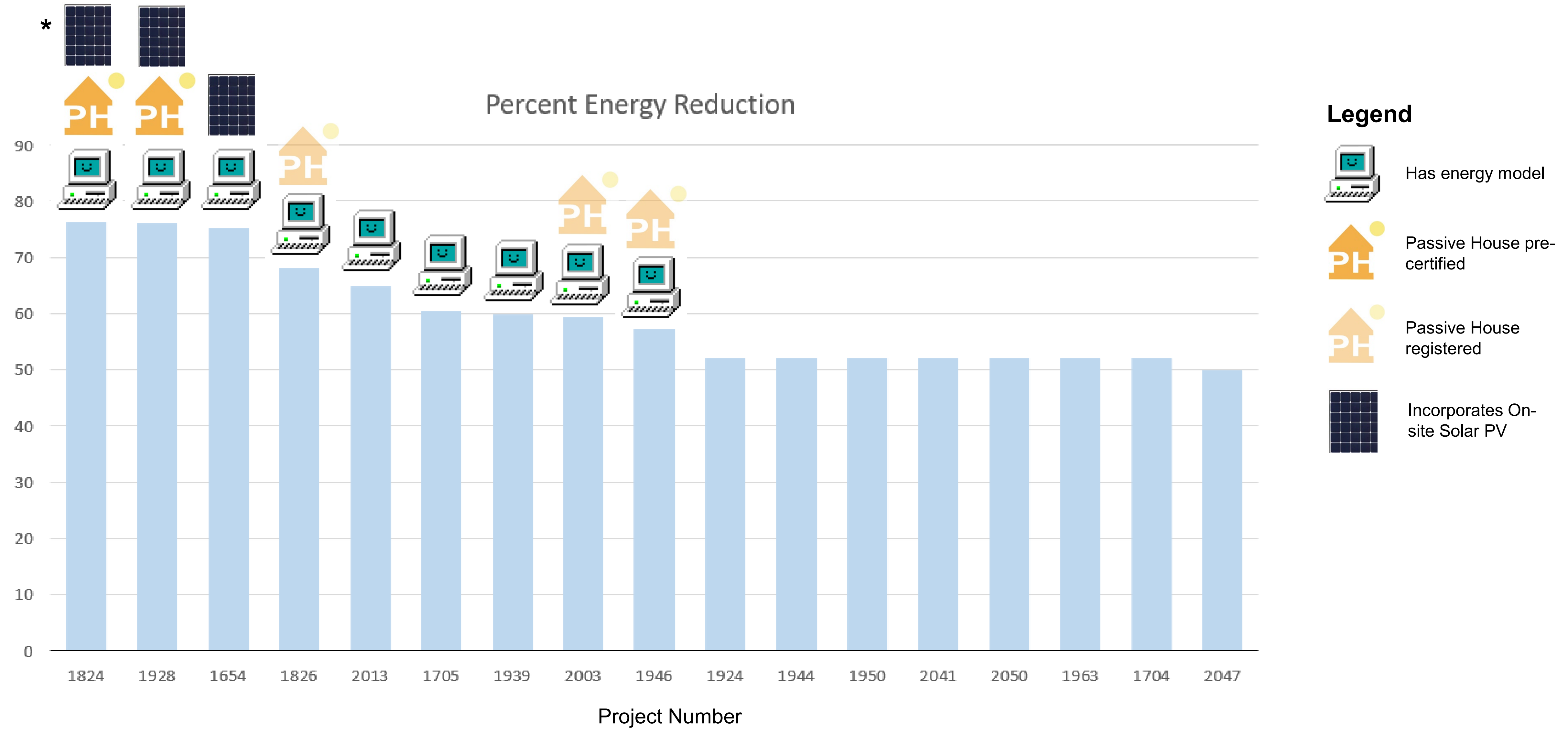
orange=high gain (SHGC>0.50) blue=low/moderate gain (<0.50)

PHIUS Certified Data*

Row	Mfr	Series	Frame Type	Operation	Glass	Notes	U-Install (depends on project) BTU/hr.ft2.F	U-COG BTU/hr.ft2.F	SHGC COG	Frame thickness	U-Frame BTU/hr.ft2.F	Psi-spacer BTU/hr.ft.F	U-assemb
5	Alpen	Tyrol TR-6	uPVC	Fixed	Balanced-6 PH+		0.16	0.109	0.369	2.91	0.16	0.033	0.15
6	Alpen	Tyrol TR-6	uPVC	Fixed	HighGain-6 Pro Krypton		0.15	0.101	0.515	2.91	0.16	0.033	
7	Alpen	Tyrol TR-6	uPVC	Fixed	Balanced-6 PH+ TGT		0.14	0.099	0.386	2.89	0.15	0.015	0.13
8	Alpen	Tyrol TR-6	uPVC	Fixed	HighGain-6 PH+ TGT	not yet certified; per email from Pierre 7/23	0.143	0.109	0.581		0.15	0.015	
9	Alpen	Tyrol TR-6	uPVC	Tilt/Turn	HighGain-6		0.18	0.127	0.526	4.54	0.17	0.038	0.18
10	Alpen	Tyrol TR-6	uPVC	Tilt/Turn	HighGain-6 Pro Krypton		0.17	0.101	0.515	4.54	0.17	0.039	
11	Alpen	Tyrol TR-6	uPVC	Tilt/Turn	Alpen Balanced-6 PH+ TGT		0.15	0.099	0.386	4.61	0.17	0.018	0.14
12	Alpen	Tyrol TR-6	uPVC	Tilt/Turn	Alpen HighGain-6 PH+ TGT		0.16	0.109 (0.11 cz6)	0.581	4.61	0.17	0.019 (avg jamb/head/s	
13	Alpen	Tyrol TR-6	uPVC	Fixed	GL-6 Sound	STC 38/OITC 27		0.11	0.281	2.83	0.16	0.01	
14	Alpen	Tyrol TR-6	uPVC	Fixed	GL-8 Sound	STC 44/OITC 33		0.173	0.289	2.83	0.19	0.01	
15	Alpen	Tyrol TR-6	uPVC	Tilt/Turn	GL-6 Sound	STC 38/OITC 27		0.11	0.281	4.53	0.17	0.01	
16	Alpen	Tyrol TR-6	uPVC	Tilt/Turn	GL-8 Sound	STC 44/OITC 33		0.173	0.289	4.53	0.17	0.01	
17													
18	Amberline	Softline 76mm	uPVC	Fixed	Combi Neutral 70/40			0.106	0.35	2.79	0.194	0.022	
19	Amberline	Softline 76mm	uPVC	Tilt/Turn	Combi Neutral 70/40			0.106	0.35	4.41	0.213	0.022	
20	Amberline	Softline 76mm	uPVC	Tilt/Turn	Press glass Standard + Thermofloat			0.106	0.38	4.41	0.213	0.022	
21	Amberline	Softline 76mm	uPVC	Fixed	Press glass Standard + Thermofloat			0.106	0.38	2.79	0.194	0.022	
22	Amberline	Softline 76mm	uPVC	Fixed	Press glass Standard			0.106	0.49	2.79	0.194	0.022	0.141
23	Amberline	Softline 76mm	uPVC	Tilt/Turn	Press glass Standard			0.106	0.49	4.41	0.213	0.022	0.155
24	Amberline	Softline 82mm	uPVC	Fixed									0.123
25	Amberline	Softline 82mm	uPVC	Tilt/Turn									0.134
26	Amberline	Softline 82mm	uPVC	Fixed				0.088	0.53	2.87	0.176	0.022	0.123
27	Amberline	Softline 82mm	uPVC	Tilt/Turn				0.088	0.53	4.88	0.176	0.022	0.134
28	Amberline	Aluminum 70mm "MB-70 HI"	Aluminum	Door				0.106	0.4		0.39	0.022	0.23
29	Amberline	Aluminum 70mm	Aluminum	Fixed									0.28
30													
31	Intus	Supera	uPVC	Fixed	ClimaGuard 1.0+		0.14	0.1	0.389	2.63	0.21	0.017	0.14
32	Intus	Supera	uPVC	Tilt/Turn	ClimaGuard 1.0+		TBD	0.1	0.389	4.58	0.23	0.017	0.17
33	Intus	Supera	uPVC	Casement	ClimaGuard 1.0+			TBD	0.389	TBD	TBD	TBD	
34	Intus	Supera	uPVC	Awning	ClimaGuard 1.0+			TBD	0.389	TBD	TBD	TBD	
35	Intus	Supera	uPVC	Fixed	Premium2		TBD	0.108	0.524	2.63	0.21	0.017	0.15

DATA | 1599 | 1200 Montello | Copy of DATA | Contacts and QA | SI-IP Unit Conversion

AIA 2030 Commitment - Reporting Year 2020



Lessons Learned and Next Steps

- Clear communication of model and results is key
- WUFI has challenges as an early design tool
- Know the right time to switch from the Feasibility model to the Pre-Cert model
- Modeling is complex and has a high learning curve. Invest in training
- Multiple tools and steps can lead to errors, so care needs to be taken
- Improve link between Revit / Contract Docs / PHIUS inputs

Thank you!

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