BUILDINGENERGY NYC

REVIVE 2024:
A Streamlined Retrofit Design Framework

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Curated by Gwen McLaughlin and Kossivi Maglo

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REVIVE 2024: A Streamlined Retrofit Design Framework

BE NYC 2024

Al Mitchell

Welcome

Architects, designers

(Re)developers

Remodelers, Builders

Raters, Verifiers, Cx

Finance, Insurance, R.E.

Incentives, Policies

Everyone else

REVIVE 2024

A retrofit standard for all kinds of existing buildings

Overview

Introduction

- Goals / value proposition
  - Decarbonization, resilience, health
  - Individual retrofit plans
- Quality Process
  - Role of the CxP

Requirements walkthrough

- “What do I have to do”

Multifamily example (modeling focus)

Vision

Every building supports the health of **people** and the **planet**.

Outcome Goals

Properties the building should have

Resilience | Air sealing, insulation, seismic, PV, batteries…

+

Health | Radon, Carbon monoxide, mold…

+

Decarbonization | Electrification, community solar, low-carbon choices…

Resilience Focus

Building / campus / block scale

- Resilience from the grid
- Outage conditions

Utility scale

- Resilience for the grid
- Normal operation

Resilience Performance Protocol & Criteria

- Simulate seven-day outages, in extreme weather.
- Whole building remains habitable, not just a protected zone.
- On-site PV and batteries provide limited power.
- Assume full design occupancy for residential.
- Reduced ventilation rate 5 cfm/person.

Winter Resilience Criteria

- Zero hours below 35°F
- Limited degree-hours
  ≤ 216 SET-hours*, below 54°F
  (*similar to LEED pilot credit)
- Critical electrical loads covered

Summer Resilience Criteria

- Zero hours of Heat Index in Danger
- Zero “deadly days”
- Critical electrical loads covered

Health and Hazards

EPA

1. Asbestos
2. Belowground contaminants (except radon)
3. Building products/material emissions
4. Carbon monoxide and other combustion appliance emissions (nitrogen oxides, VOCs and particulates)
5. Environmental tobacco smoke
6. Garage air pollutants (CO, benzene and other VOCs)
7. Lead
8. Moisture (mold and other biologicals)
9. Pests
10. Polychlorinated biphenyls
11. Radon
12. Wood smoke and other solid fuel emissions
13. Heating, ventilating and air conditioning (HVAC) equipment
14. Combustion safety, vented combustion appliances
15. Combustion safety, unvented combustion appliances
16. Source or local exhaust ventilation
17. Whole-dwelling ventilation for distributed contaminant sources
18. Home safety
19. Protecting IAQ during construction
20. Jobsite safety

Infectious aerosols

FEMA, IBHS

SEISMIC

FLOOD, TSUNAMI

HAIL

WIND

ICE DAMS, SNOW LOAD

WILDFIRE / smoke

Decarbonization

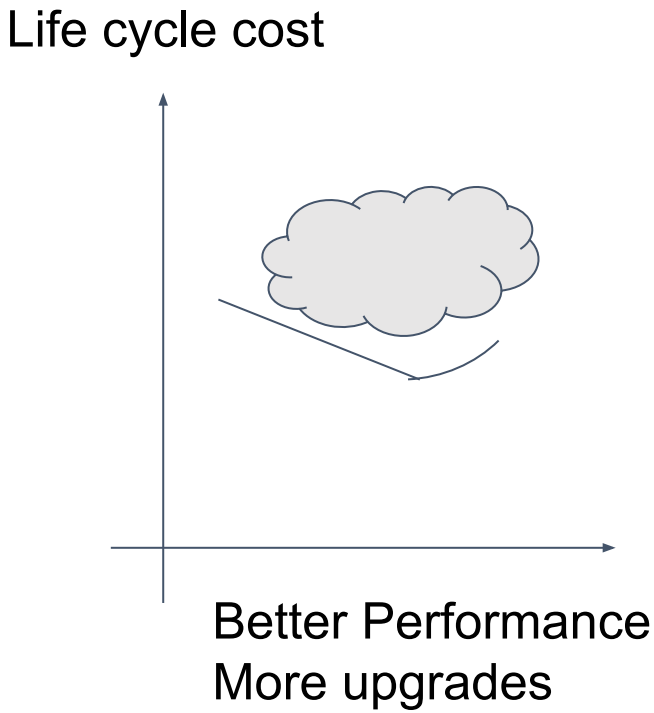
Ideally: **Absolute Zero** - no emissions ever happen in the supply chain or building life.

- That can’t yet be done so, what now?
- Operational decarb could be put on the energy supplier, but that does nothing for the building.
- What about operational vs. embodied carbon?

Decarbonization

An Idea Retrofit planning framed as an optimization

- Design as if there's a cost of carbon
  - There's value to carbon savings that isn't captured by conventional accounting.
- Minimize total life cycle cost
  - Subject to the constraints of providing resilience and fixing health risks.



Decarbonization

Cost Metric = Sum of these annualized costs:

- Direct energy cost. E.g. site kWh * $/kWh = $
- Direct building retrofit measures cost (material & labor)
  including building-level electrification cost. E.g. ft3 of stuff * $/ft3 = $
- Cost of carbon -- upfront/embodied. CO2e kg * $0.25/kg = $
- Cost of carbon – operating. CO2e kg * $0.25/kg = $
- Energy system transition cost. E.g. new solar + storage. $/W * W = $

"FULL COST ACCOUNTING"

Criterion – no greater than Baseline (existing)

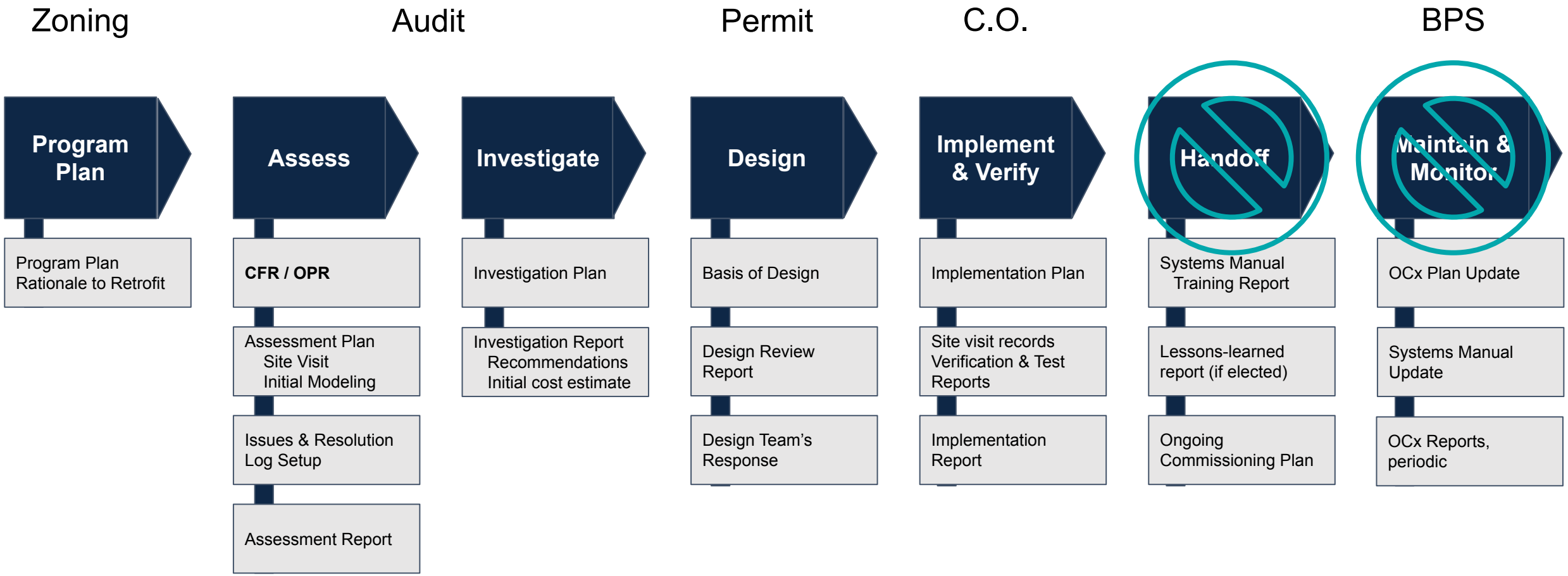
Plus additional decarbonization effort

- Electrification, renewable sources
- Embodied carbon

IN EFFECT, IT BECOMES A TIEBREAKER AMONG PACKAGES THAT MEET RESILIENCE.

Process Goal – Quality Assurance

Compliance is documented



Process goal – Openness for Scalability

The Standard Document

- Written in code-mandatory language.
- All calculation protocol spelled out, for the requirements on modeled performance.

Roles:

- Owner
- Authority
- Commissioning Provider
- Verification & Testing Providers

The Certification Program

- Our certification to the standard.
- Maintain open-source calculation engine.

Corresponding Roles for our certification to the standard:

- Owner
- Phius
- CPHC®
- Phius Raters & Verifiers

Owner is responsible for Review & Approval of reports on Elective Requirements

Requirements Walkthrough

Q: “What do I have to do?”

A: Well that depends, on:

- Who “you” are (your role)
- Some Owner’s choices
- Building category (Resid., Nonresid., Addition)
- Other things, e.g. where is it

Summary of Minimum Outcome Req's

5.1.1 IAQ - EPA Energy Savings Plus Health, Minimum Actions

5.1.2.1 Moisture Risk Mitigation (Guidebook Appendix B) or ASHRAE 227 section 7.5.5

5.1.2.2 Window Condensation Resistance (Guidebook 1.3.3.3, except comfort)

5.2 Hazard Mitigation pertinent to location
(Earthquake, Flood, Hail, High Wind, Snow Load and Ice Dams, Wildfire)
For all projects:

- 5.2.2 Electrical / Mechanical Flood Protection
- 5.2.3, 5.2.6 PV modules resistant to Hail, Fire
- 5.2.4 FORTIFIED Roof, no dry stack foundations
- 5.2.5 Fix any ice damming

6.2.1 Enclosure Air-Sealing per IECC 2021

6.2.2 Islanding of on-site generation

6.2.3 Battery Readiness

6.2.4 PV Readiness per ZERH

6.3 Winter Resilience (thermal & electrical)

6.4 Summer Resilience (thermal & electrical)

6.5.1 ADORB cost no greater than baseline

6.5.2.1 Tier b. Electrified in normal operation

6.5.2.2 Embodied decarbonization (in addition to reusing the building)

And for Additions:

- EPA Energy Star
- EPA Indoor airPLUS

Each Building: Rationale for Retrofit

Rationale for Retrofit	4.5.1.1 Intended Building Life:		Indefinite / Permanent	
	4.5.1.2 Building Functionality:		Existing function will be maintained	
	Existing Function	Residential:	Multifamily	
		Non-Residential:	N/A	
	New Function	Residential:	[Select Dropdown]	
		Non-Residential:	[Select Dropdown]	
	4.5.1.3 Site and Land Use:		*Climate migration risk values will automatically populate based on the Climate Migration Map published by PROPUBLICA based on the County defined in the 'Program Plan' tab below.*	Cx Team Notes
	4.5.1.3.1 Climate Migration	Project County:	Centre County	
		Heat Risk:	3	
		WB Risk:	4	WET BULB
		Farm Crop Risk:	3	
		Sea Level Rise Risk:	1	
		Wildfire Risk:	2	
		Economic Risk	**4**	
	4.5.1.3.2 Zoning	Typical Zoning Designation:	Residential	
		Specific Zoning Code:	[Enter Zoning Code (i.e. R-1)]	
		Variance Needed?	No	
Final Considerations & Cx Team Acceptance:			*This building may be an ideal candidate for retrofit. Please confirm acceptance of this determination by typing "X" in the box to the right.*	

4.5 Programming / Triage

4.5.2 Multiple-Facility Planning

Establish rank ordering

? least risk

? greatest opportunity

Plan for benchmarking

Sampling

Explore incentives

Deliverables

4.5.3.1 Multiple buildings: Program Plan

a. Facility identification
b. Ranking metrics
c. Prioritized list of facilities
d. Phase plan or execution schedule
e. Program Planning Team (names, affiliation, and title)

Also supported in the Phius REVIVE 2024 Assessment & Investigation Workbook

Multiple-Facility Planning

Phius REVIVE 2024 Programming Worksheet						EBCx Program Scope & Objectives			
Building Triage and Ranking	General		Owner Name:	Super Cool Owner		Program Mission Statement:	[Purpose for Retrofitting]		
			Submitter Name:	Super Cool Submitter					
			CPHC CxP Name:	Really Good CxP		Additional Notes:			
			CPHC CxP #:	12345					
			City:	Boalsburg					
			State:	Pennsylvania					
			County:	Centre County					
			Facility Quantity:	1					
	Facility Identification					Ranking Metrics			
	Facility Rank	Building Name	Existing Function	Approximate iCFA (sf)	Intended Function	Intended Building Life	Building Function	Climate Migration Score	Maintenance Needs
	1	Building 1	Residential	10,000	Residential	>30 yrs	No change	4	Moderate
	2	Building 5	Residential	15,000	Mixed-Use	>30 yrs	Moderate change	4	Minimal
	3	Builidng 3	Mixed-Use	15,000	Mixed-Use	>30 yrs	Slight change	4	Moderate
	4	Builidng 4	Vacant / None	10,000	Residential	>30 yrs	Complete change	4	Considerable
	5	Building 2	Industrial	13,000	Commercial	>30 yrs	Complete change	4	Considerable

Assessment

8.6.1 Owner provides facility information to Cxp

8.6.2 Occupant Survey

8.6.3 Assemble CxP Team

8.6.4 CxP & Owner develop CFR (Round 1)

8.6.5 Pre-Assessment Cx Plan

8.6.6 Outline the Systems Manual

8.6.7 Perform Assessment

8.6.8 Assessment Report

8.6.9 Deliverables

- Post-Assessment CFR
- Post-Assessment Cx Plan
- Systems Manual Outline
- Assessment Report
- Issues and Resolution Log

Updated Program Plan

8.6.10 Acceptance

Proceed if Owner and Authority approves

UPDATED WITH IAQ AND FORTIFICATION ELECTIVES

UPDATED WITH INVESTIGATION PLAN ITEMS

Packages and Summer Modes

Retrofit Packages:

0. Baseline House
1. Electrification
2. DOE ‘Market Ready Envelope’
3. IECC 2021

3b. IECC 2021 @ 0.06cfm50

4. Phius CORE Prescriptive

Summer Modes:

NV - natural vent., temp control

SNV - scheduled nat. vent., temp ctrl.

SNV+Shd - add exterior blinds

HP - heat pump

HP+Shd - heat pump + ext. blinds

EC - evaporative cooler (B zones)

EC+Shd - evap cooler + ext. blinds

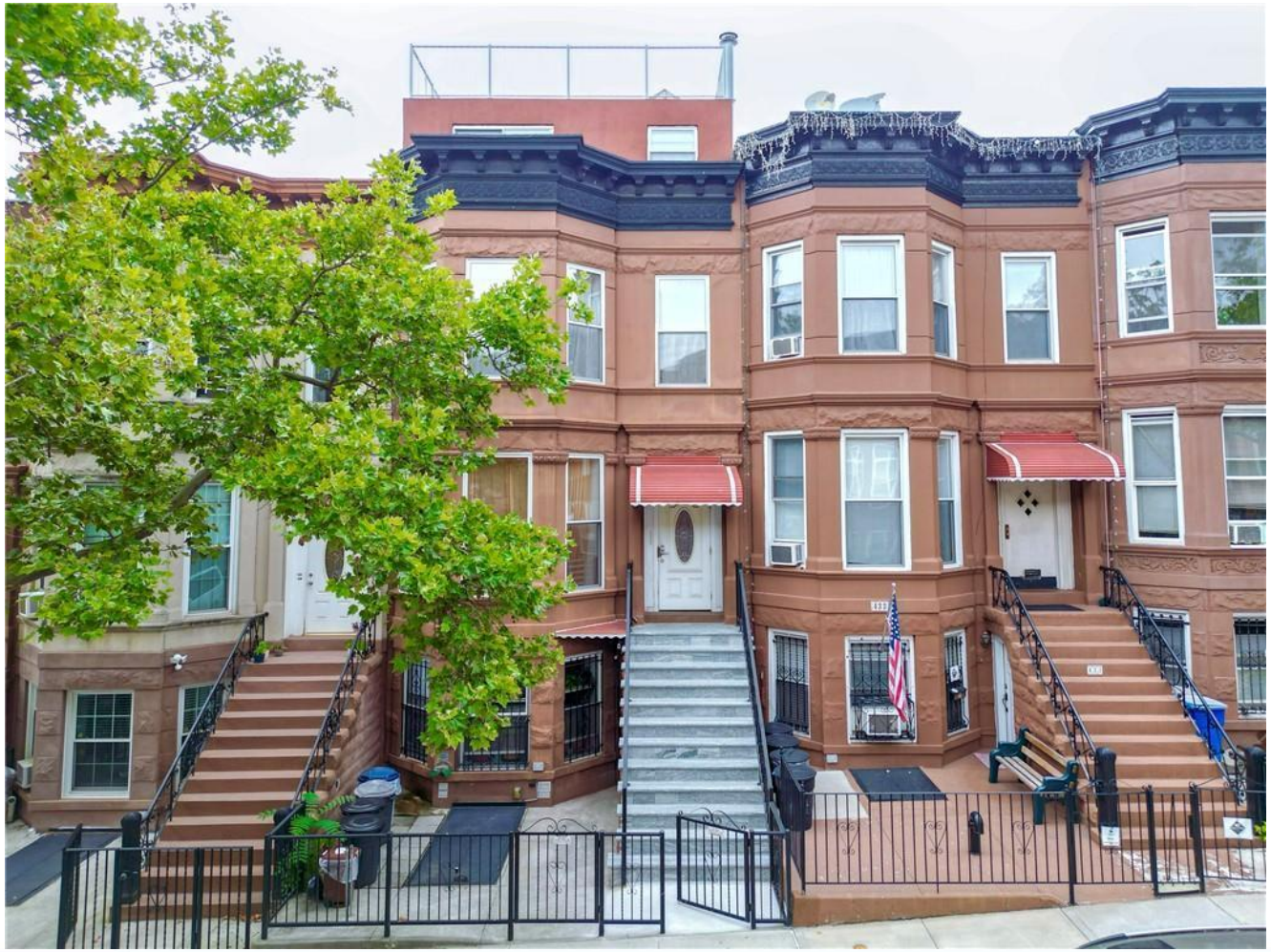
Multifamily Modeling Example

Brooklyn Apartment

Example Building

429 43rd St

Brooklyn, NY



Example Building

429 43rd St

Brooklyn, NY

- 11 Bed
- 8.5 Bath
- 4 units

Example Building

Phius REVIVE 2024 Workbook			CxP Required Information	Cx Team Notes
	General	Building/Facility Name:	Al's Apartments	
		Owner Name:	John Doe	
		Submitter Name:	Al Mitchell	
		CPHC CxP Name:	Al Mitchell	
		CPHC CxP #:	12345	
		Project Address:	429 43rd St	
		City:	Brooklyn	
		State:	New York	
		Zip Code:	11232	
Rationale for Retrofit	4.5.1.1 Intended Building Life:		70-100 years	
	4.5.1.2 Building Functionality:		Existing function will be maintained	
	Existing Function	Residential:	Multifamily	
		Non-Residential:	N/A	
	New Function	[illegible]	[illegible]	
		[illegible]	[illegible]	
	4.5.1.3 Site and Land Use:		***Climate migration risk values will automatically populate based on the Climate Migration Map published by PROPUBLICA based on the County defined in the 'Program***	**Cx Team Notes**
	4.5.1.3.1 Climate Migration	Project County:	Kings County	
		Heat Risk:	9	
		Wet Bulb Risk:	2	
		Farm Crop Risk:	8	
		Sea Level Rise Risk:	1	
		Wildfire Risk:	1	
		Economic Risk	**5**	
	4.5.1.3.2 Zoning	Typical Zoning	Residential	
		Specific Zoning Code:	R6B	
		Variance Needed?	No	
			This building may be an ideal candidate for retrofit. Please confirm acceptance of this	

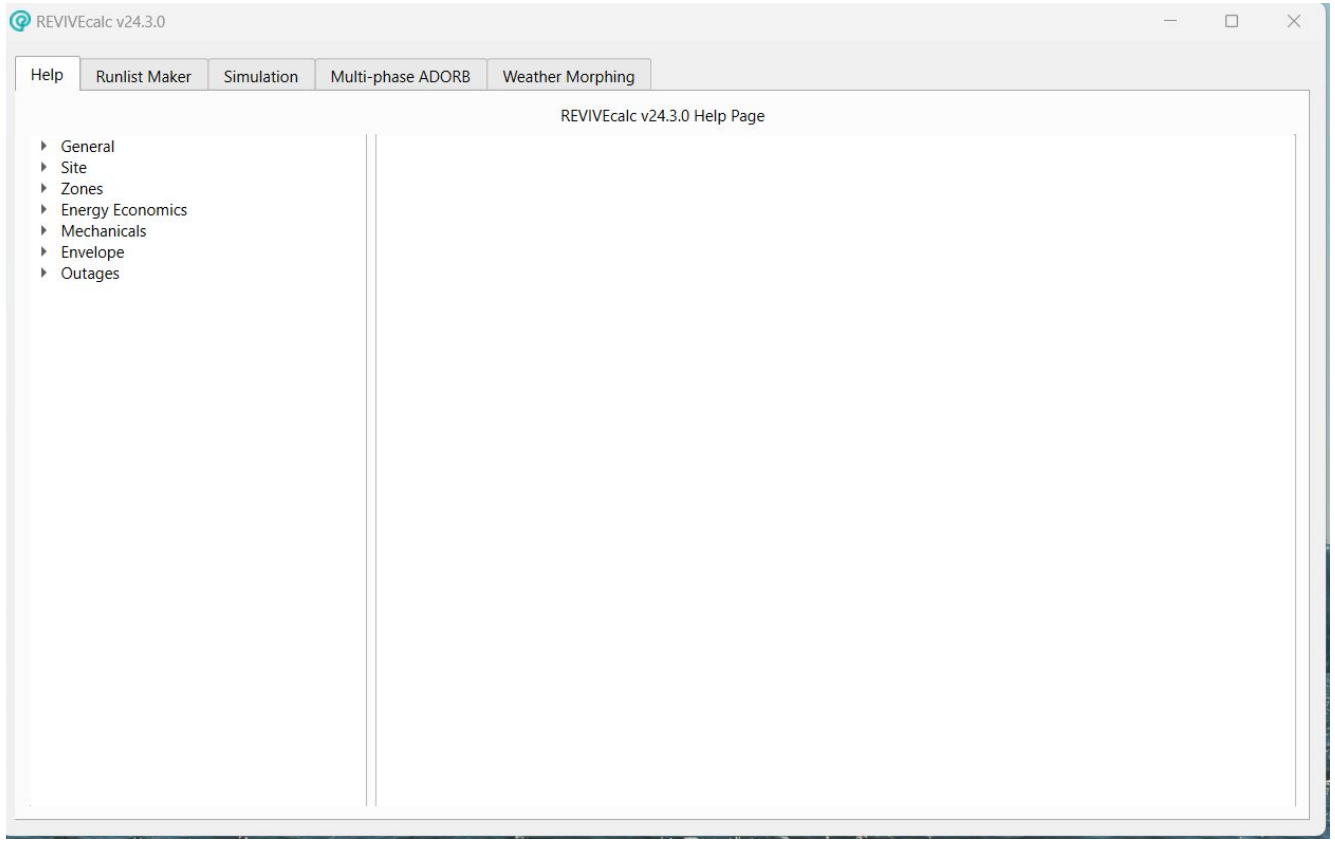
Phius REVIVE 2024 Workbook: Assessment

Priority Issue 11: Radon		CxP Assessment Planning Notes *Complete pre-assessment*	Assess or Defer	CxP Assessment Reporting Notes *Complete post-assessment*	Status?
Radon	**AP11.1 Determine whether the building has an active Radon Mitigation System**	No existing radon mitigation system - check on radon zone	No concern	No existing radon mitigation system needed. Project is located in radon zone 2	No further investigation required
	AP11.2 Select a radon-testing professions for building w/o an active radon system	Defer to investigation / testing	Defer to investigation	Deferred	Needs further investigation
	AP11.3 Determine whether radon testing will be completed either (1) pre- and post-upgrades or (2) post-upgrades only	Discuss with owner.	Walkthrough assessment	Owner has elected to do pre- and post testing.	Needs further investigation
Priority Issue 12: Tracked-In Pollutants		**CxP Assessment Planning Notes** *Complete pre-assessment*	**Assess or Defer**	**CxP Assessment Reporting Notes** *Complete post-assessment*	**Status?**
Tracked-In Pollutants	**AP12.1 Insptect floor surfaces at building common entrances**	Note and document accumulation of dirt or moisture on interior floors at shared entrance.	Walkthrough assessment	Vestibule for shared access does not currently contain a walk-off mat. Mild dirt accumulation, but could definitely be improved.	Remediation required
Priority Issue 13: Unvented Combustion Appliances		**CxP Assessment Planning Notes** *Complete pre-assessment*	**Assess or Defer**	**CxP Assessment Reporting Notes** *Complete post-assessment*	**Status?**
	AP13.1 Identify unvented combustion appliances and applicable regulations	Identify gas/kerosene space heters or unvented combustion appliances	Walkthrough assessment	Gas range is not currently vented	Remediation required
	AP13.2 Conduct a safety inspection	Defer to investigation, follow ANSI BPI-1200-S-2017	Defer to investigation	Defer to investigation, follow ANSI BPI-1200-S-2017	Needs further investigation

Example Building - Modeling

New, Free, Open source modeling tool: REVIVEcalc

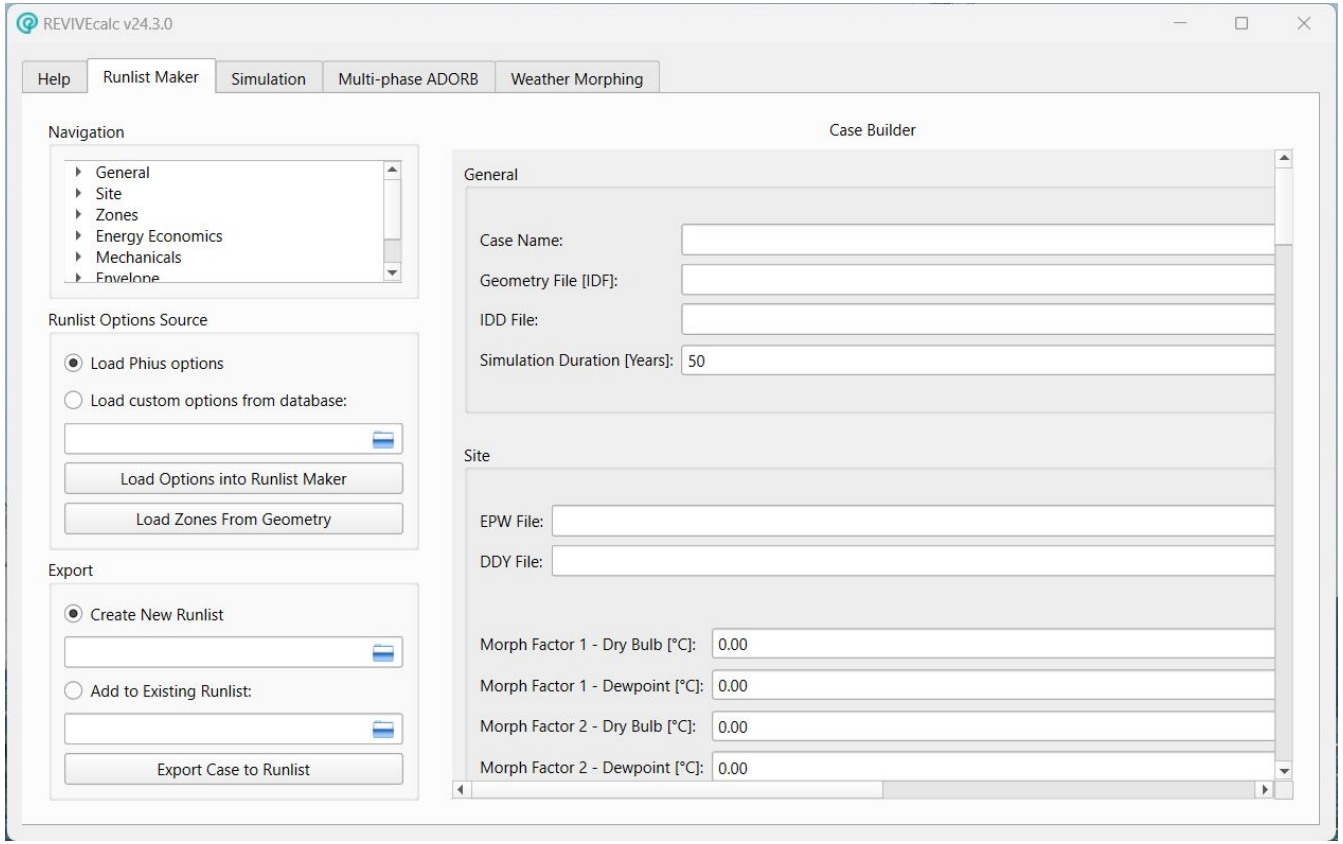
- Runs on EnergyPlus
- Automates resilience and annual simulation -> Lifecycle cost analysis
- Supports parametric iterations



Example Building - Modeling

Runlist Maker

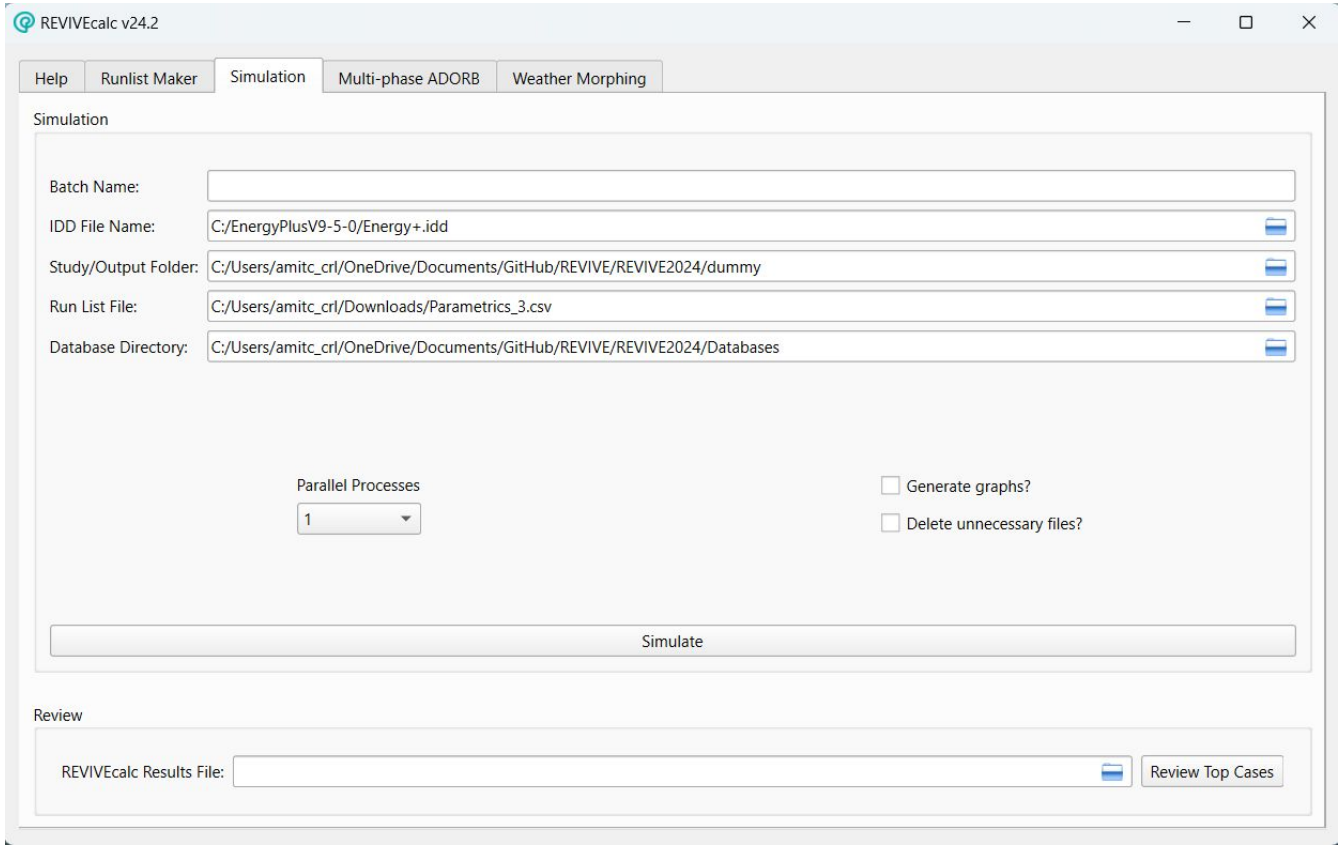
- Builds out a runlist of all cases to be considered
- Loads options from databases for easy reuse
- Editable in graphic interface or CSV format



Example Building - Modeling

Simulate Tab

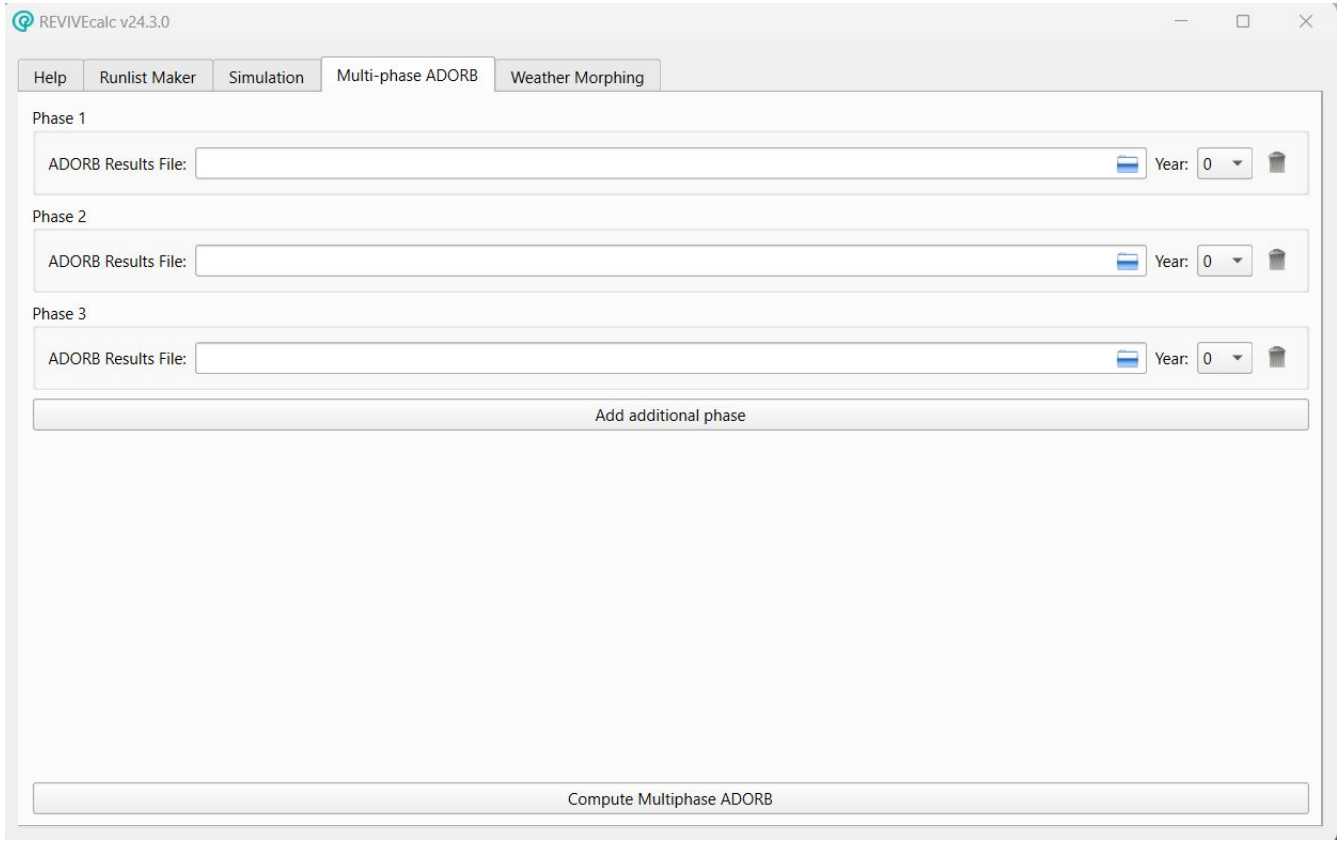
- Runs simulations in parallel
- Compiles results
- Quick results processing at the bottom to get top 5 cases



Example Building - Modeling

Multi-phase ADORB Tab

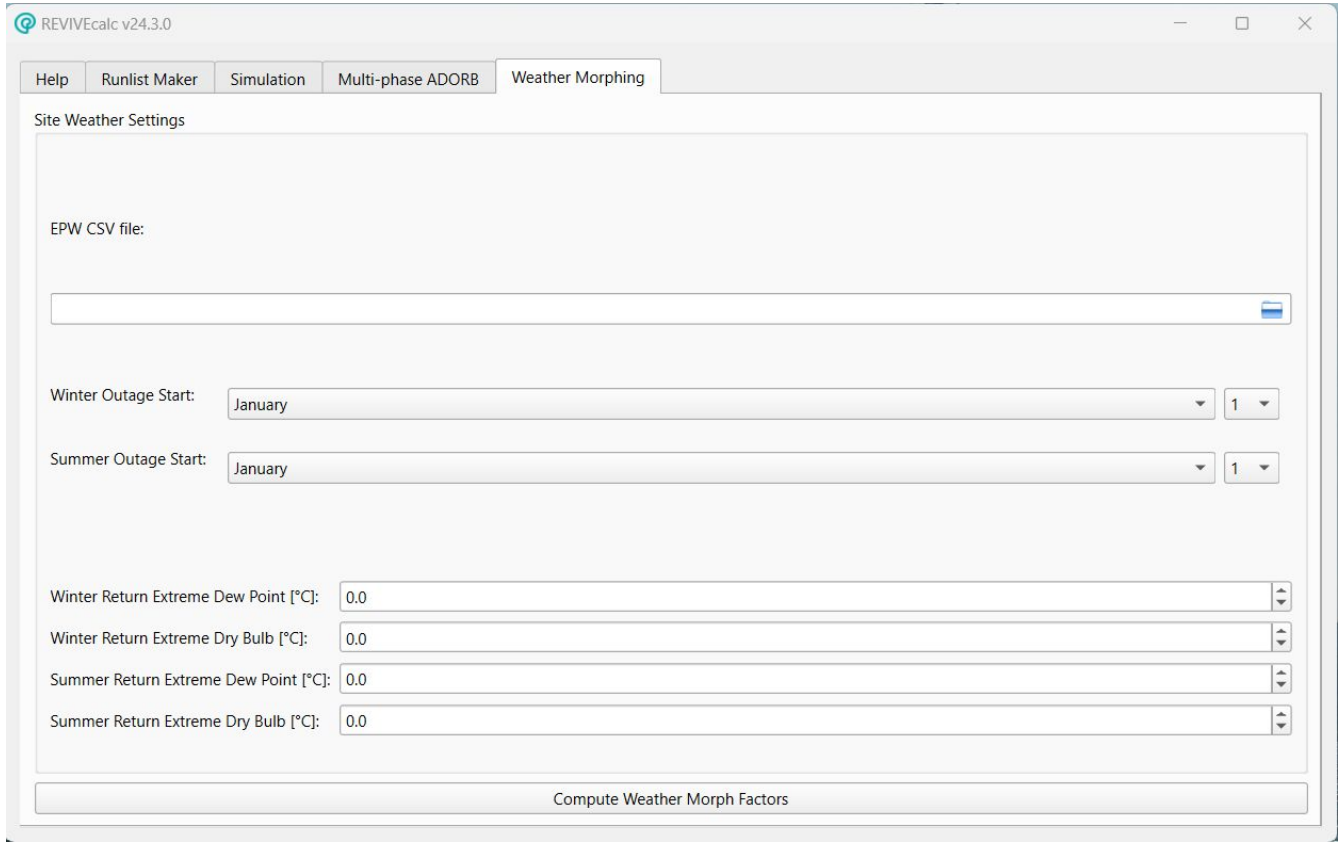
- Supports multiphase modeling
- Stitches together multiple cases into one LCCA
- Each case represents one phase of the project



Example Building - Modeling

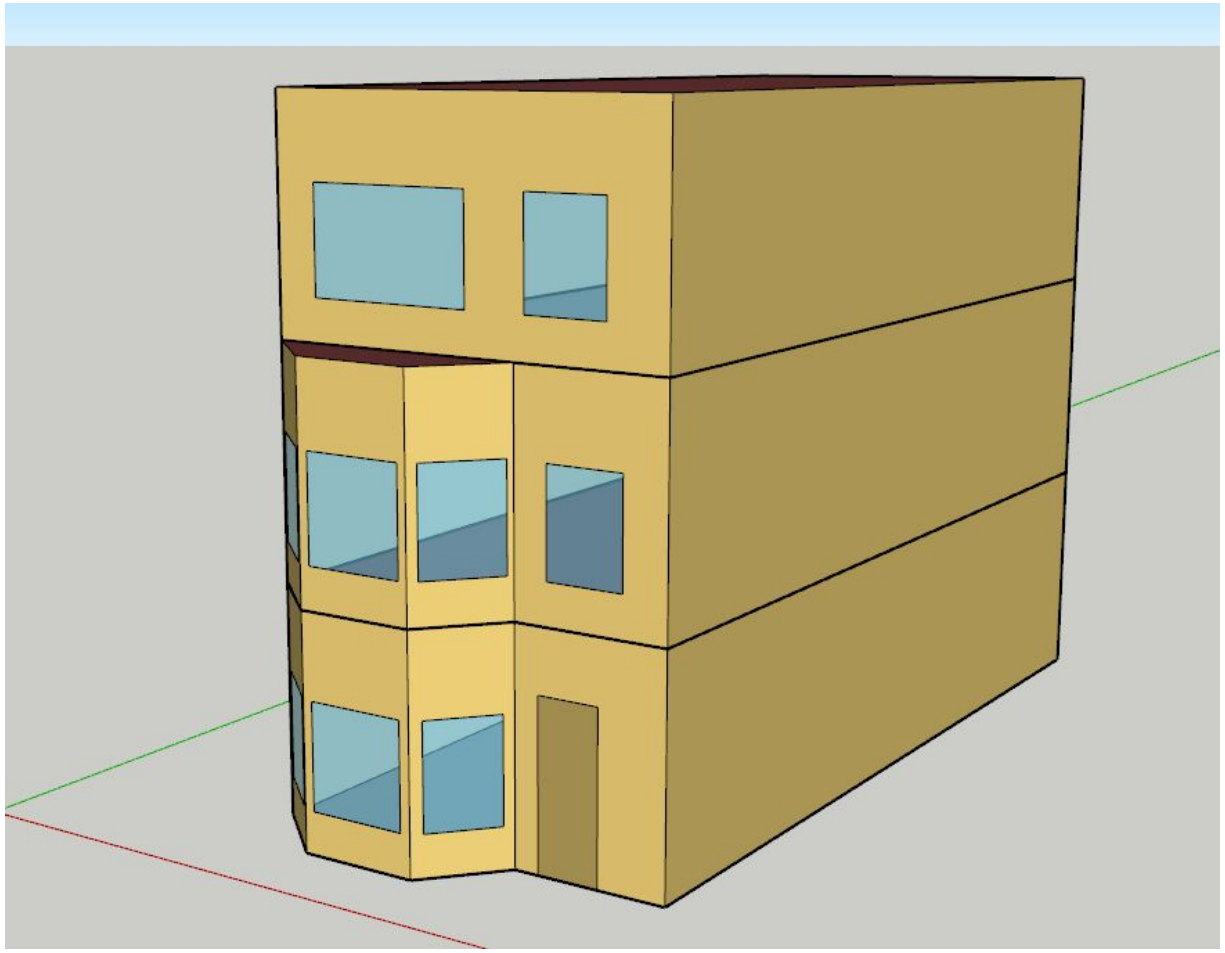
Weather Morphing Tab

- Morphs weather to statistical returns
- Factors apply to extreme week during resilience outage



Multifamily Modeling

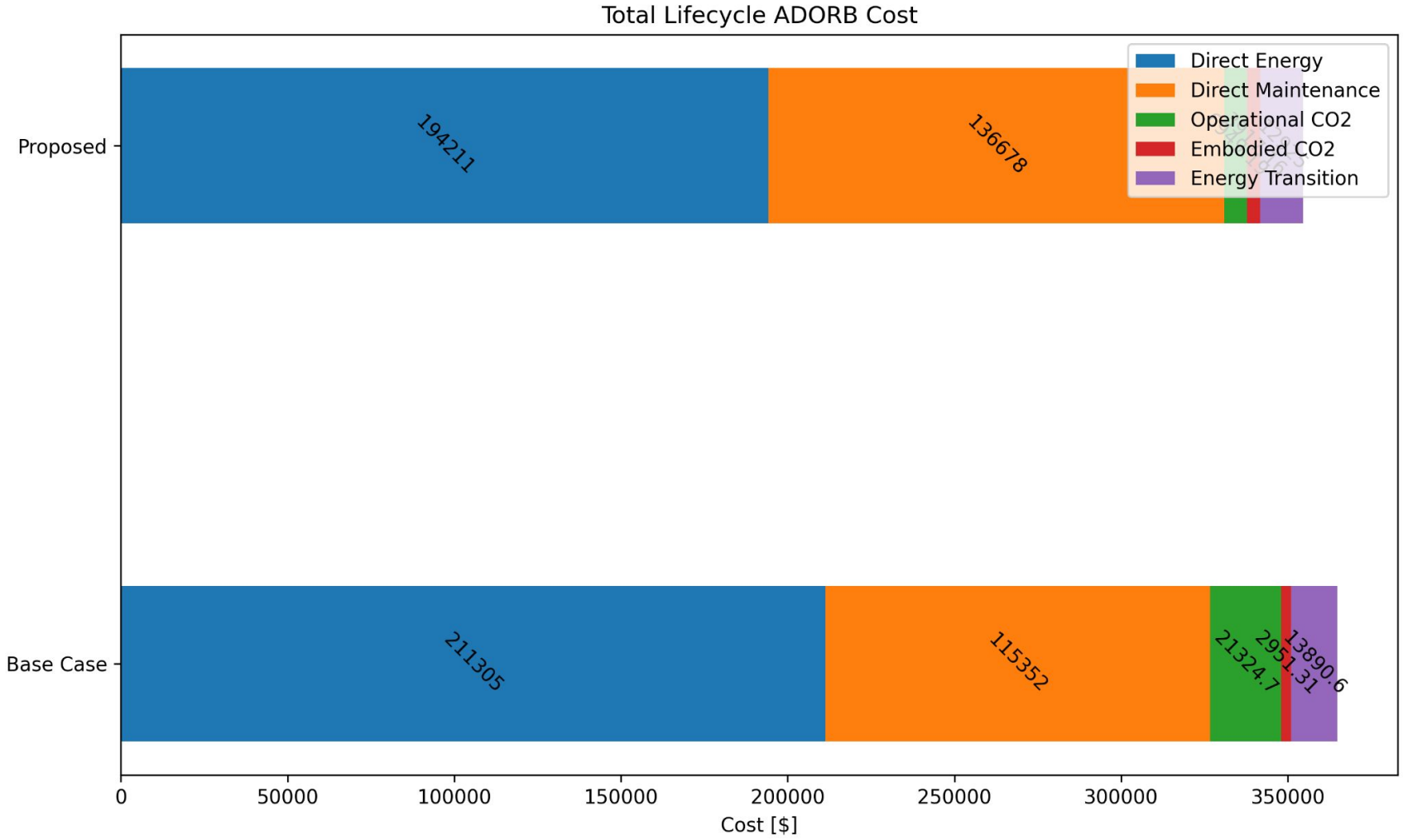
- Full multizonal modeling support
  -
- Can utilize multiple geometry editing tools
  - Output must be IDF
- Assemblies are tagged so they can be



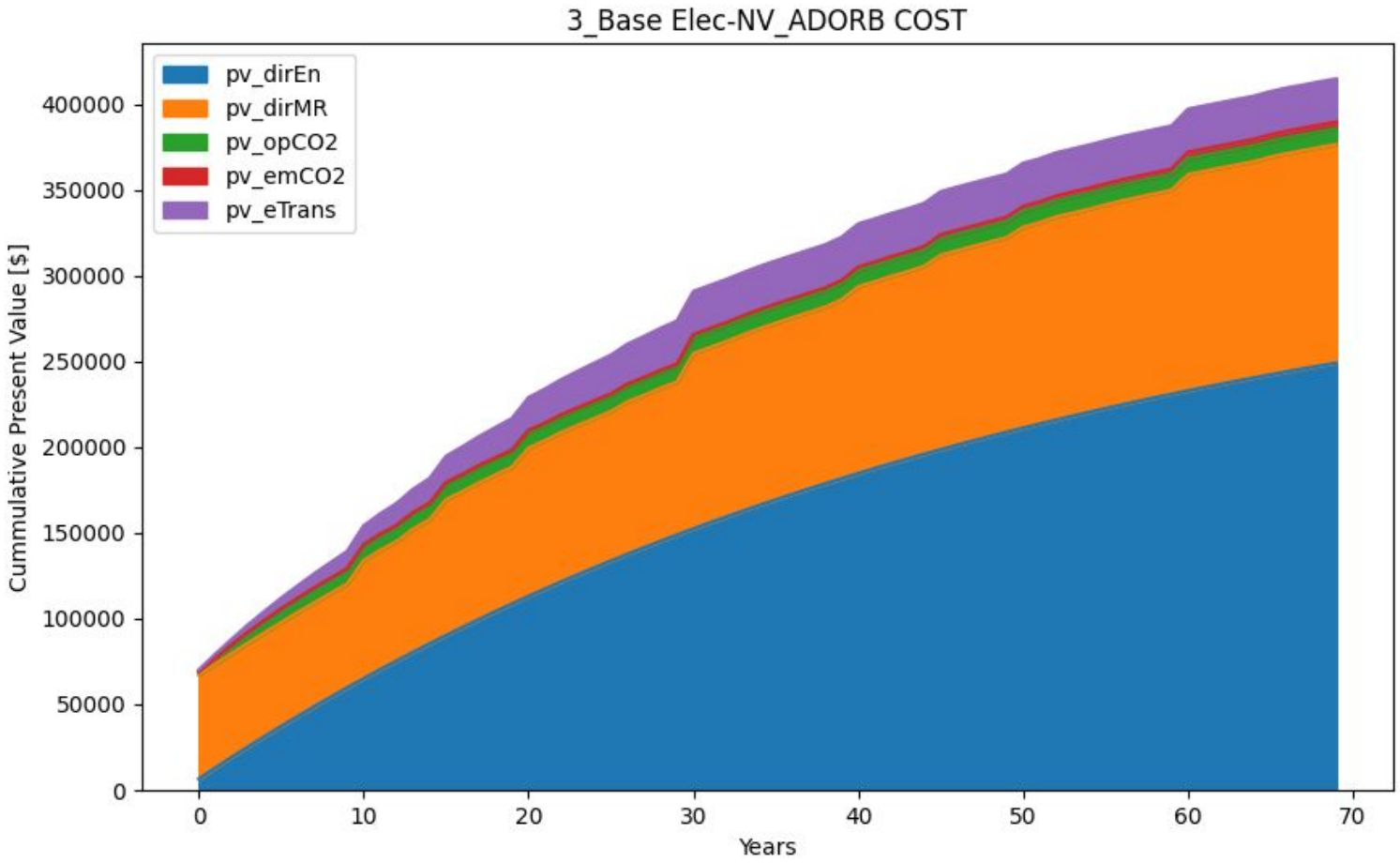
Multifamily Modeling

Run Name	EUI	Peak Electric Demand [W]	First Year Electric Cost [$]	First Year Gas Cost [$]	First Cost [$]	Total ADORB Cost [$]
BASE-NV	35.25	6615.64	$ 4,862.52	$ 772.48	$ -	$ 364,822.89
Base Elec-NV	31.26	11998.38	$ 6,645.58	$ -	$ 28,638.38	$ 414,992.87
DOE Envelope-NV	24.1	6155.74	$ 5,179.15	$ -	$ 32,195.18	$ 354,680.41
IECC-Elec-NV	24.91	7260.25	$ 5,344.30	$ -	$ 37,164.57	$ 379,679.93
IECC-004-Elec-NV	22.93	5119.03	$ 4,938.32	$ -	$ 42,650.39	$ 364,635.34
Phius Precriptive-NV	22.3	5024.45	$ 4,809.49	$ -	$ 51,464.87	$ 382,488.38

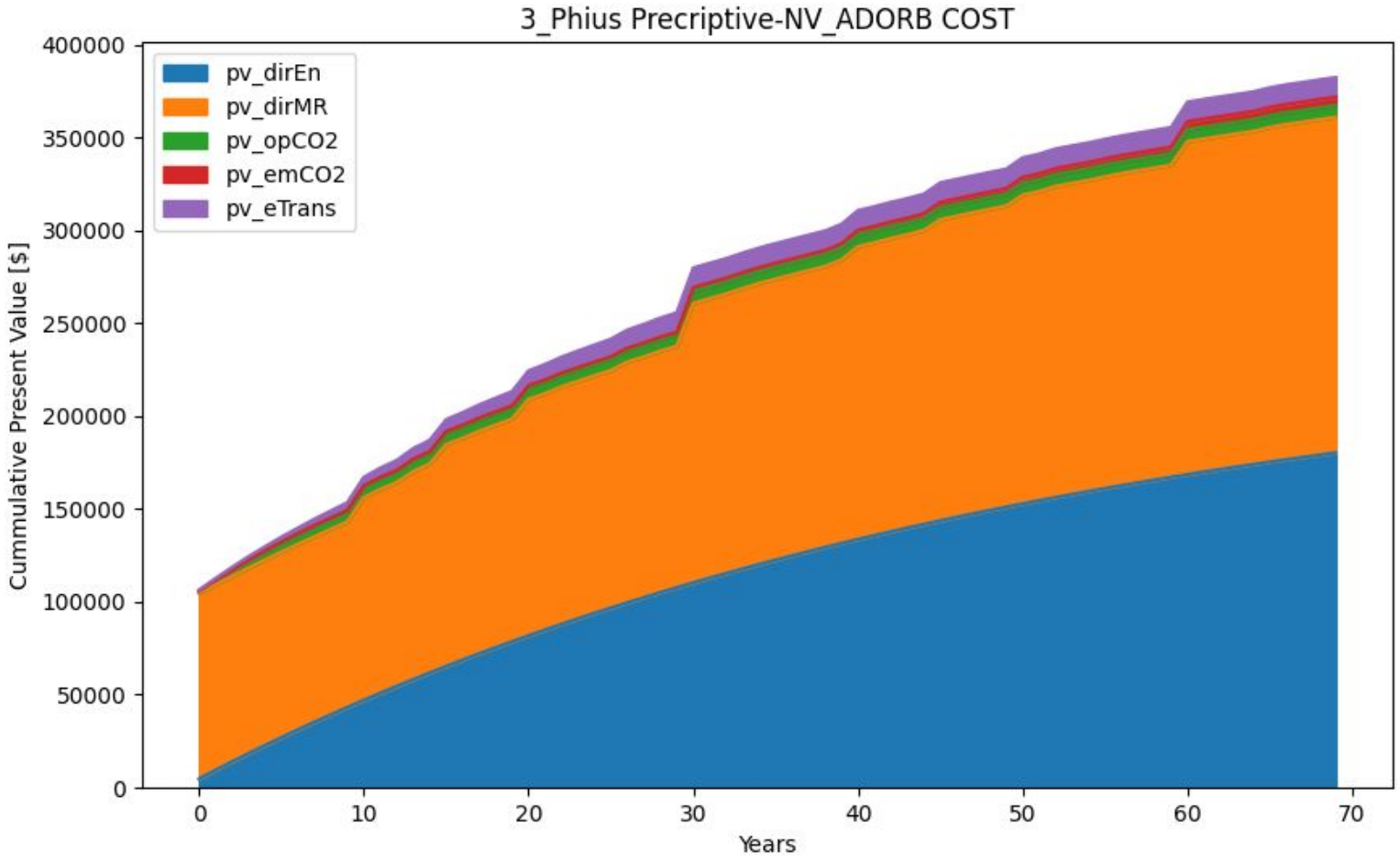
Multifamily Modeling - Outputs



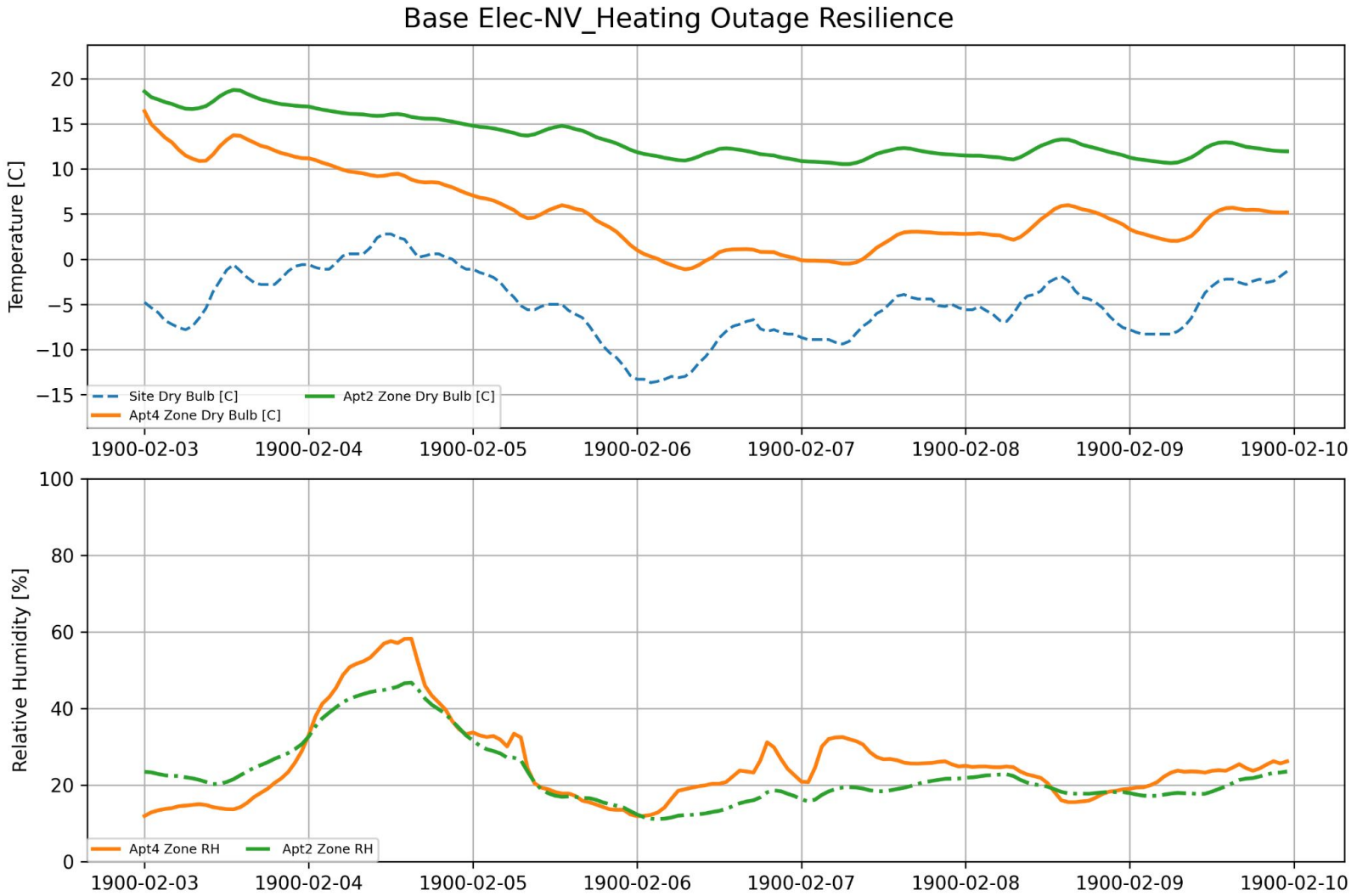
Multifamily Modeling - Outputs



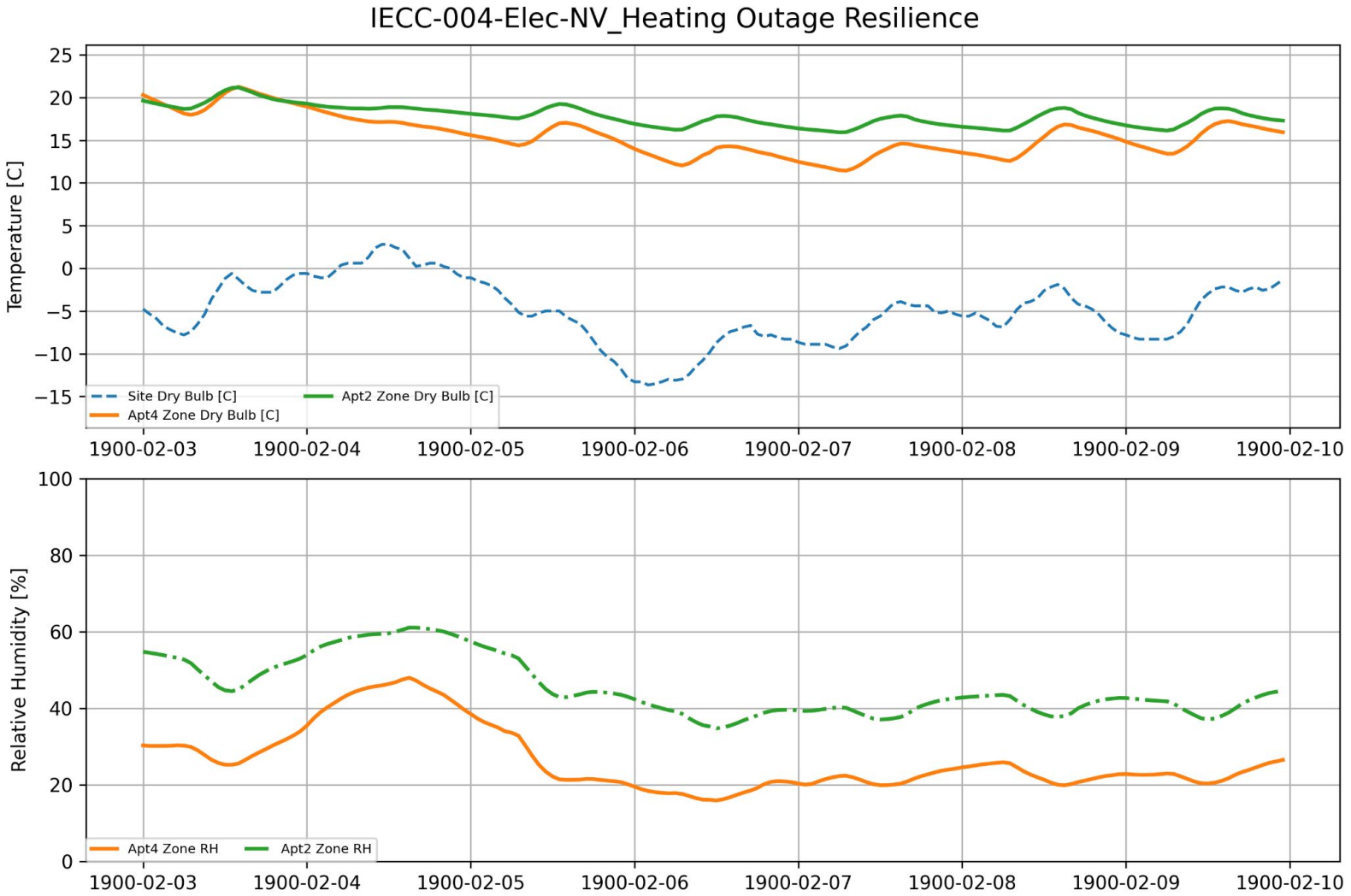
Multifamily Modeling - Outputs



Multifamily Modeling - Outputs



Multifamily Modeling - Outputs



Multifamily Modeling - Outputs

Base Case

Heating SET Hours

	SET ≤ 12.2°C Hours (F)	SET ≤ 12.2°C OccupantHours (F)	Longest SET ≤ 12.2°C Duration [hr]	Start Time of the Longest SET ≤ 12.2°C Duration
APT2	0.00	0.00	0.00	-
APT3	58.92	235.67	37.50	06-FEB-00:00
APT4	410.00	1230.00	118.50	05-FEB-01:30
Min	0.00	0.00	0.00	-
Max	410.00	1230.00	118.50	-
Average	156.31	488.56	52.00	-

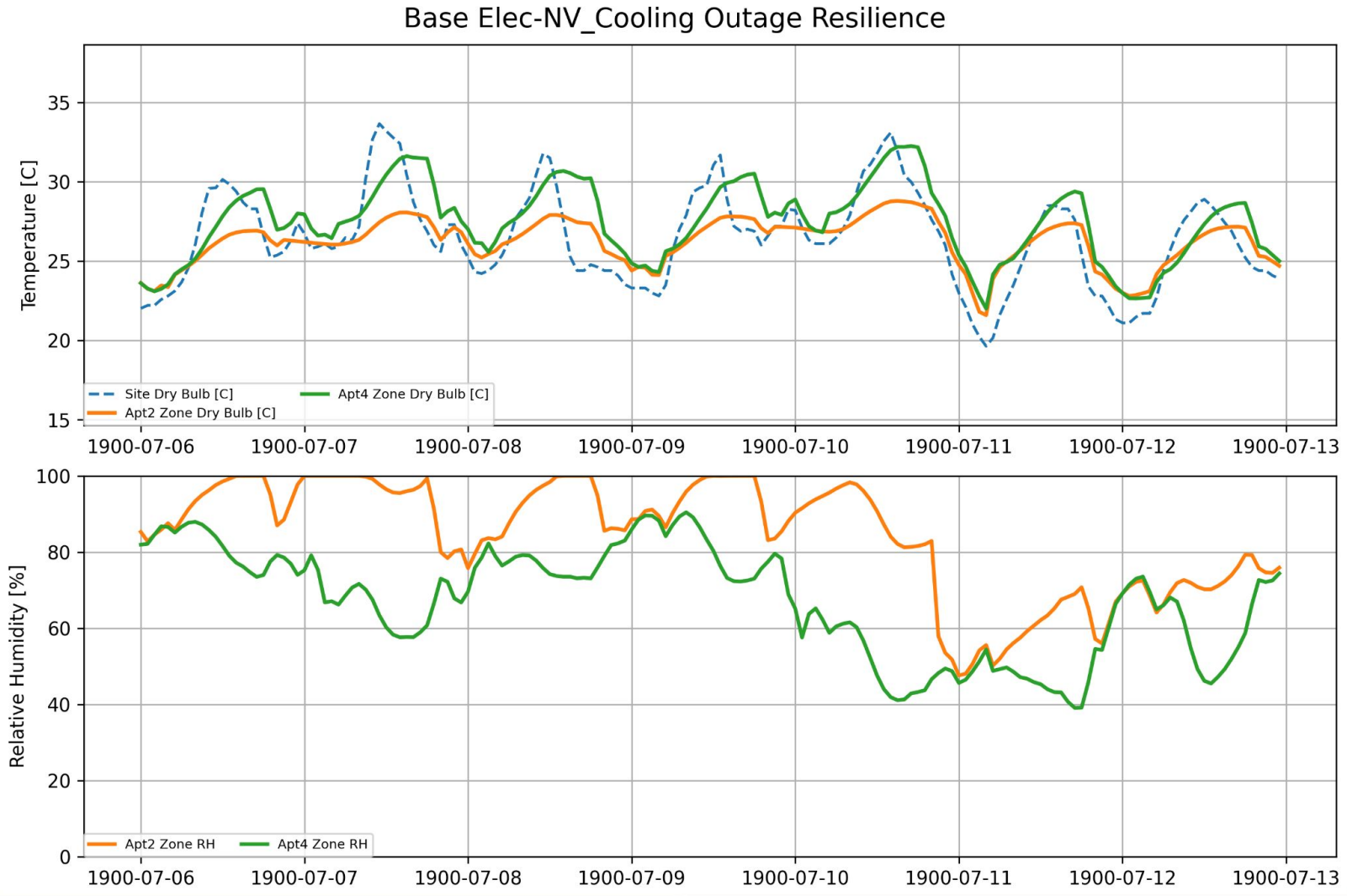
Multifamily Modeling - Outputs

IECC 2021 + Airsealing

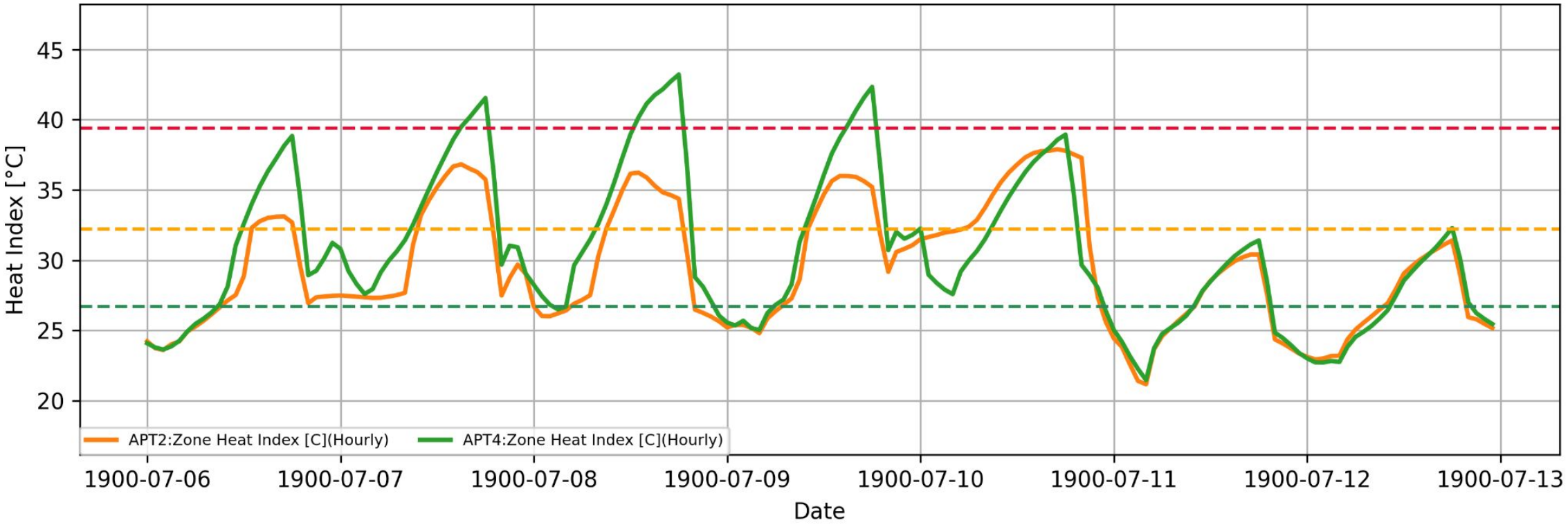
Heating SET Hours

	SET ≤ 12.2°C Hours (F)	SET ≤ 12.2°C OccupantHours (F)	Longest SET ≤ 12.2°C Duration [hr]	Start Time of the Longest SET ≤ 12.2°C Duration
APT2	0.00	0.00	0.00	-
APT3	0.00	0.00	0.00	-
APT4	0.00	0.00	0.00	-
Min	0.00	0.00	0.00	-
Max	0.00	0.00	0.00	-
Average	0.00	0.00	0.00	-

Multifamily Modeling - Outputs



Multifamily Modeling - Outputs



Multifamily Modeling - Outputs

Base Case

Heat Index Hours

	Safe (≤ 26.7°C) [hr]	Caution (> 26.7, ≤ 32.2°C) [hr]	Extreme Caution (> 32.2, ≤ 39.4°C) [hr]	Danger (> 39.4, ≤ 51.7°C) [hr]	Extreme Danger (> 51.7°C) [hr]
APT2	8649.00	64.00	47.00	0.00	0.00
APT3	8641.25	63.25	37.50	18.00	0.00
APT4	8643.00	70.25	46.75	0.00	0.00
Min	8641.25	63.25	37.50	0.00	0.00
Max	8649.00	70.25	47.00	18.00	0.00
Average	8644.42	65.83	43.75	6.00	0.00
Sum	25933.25	197.50	131.25	18.00	0.00

Multifamily Modeling - Outputs

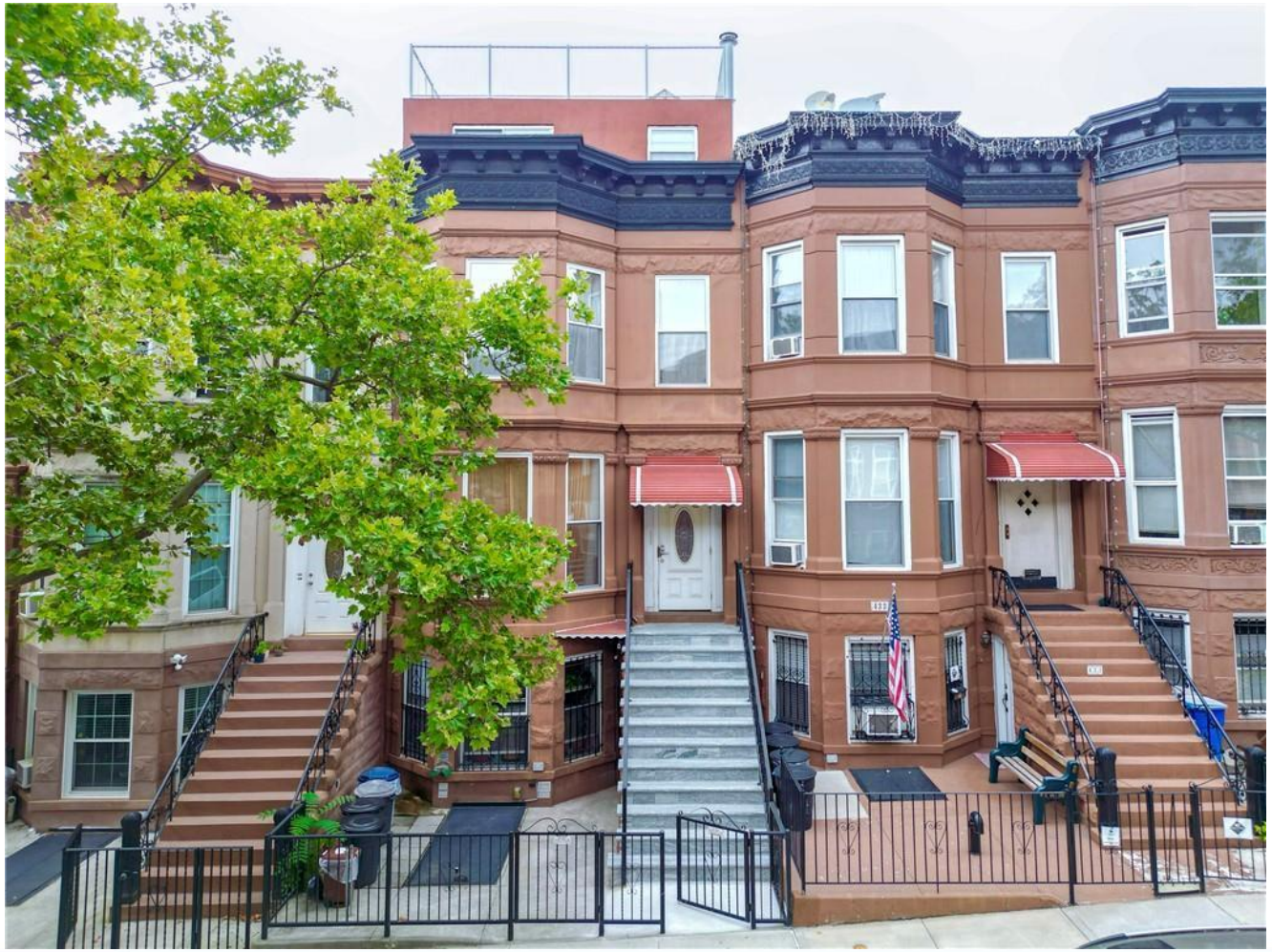
IECC 2021 + Airsealing

Heat Index Hours

	Safe (≤ 26.7°C) [hr]	Caution (> 26.7, ≤ 32.2°C) [hr]	Extreme Caution (> 32.2, ≤ 39.4°C) [hr]	Danger (> 39.4, ≤ 51.7°C) [hr]	Extreme Danger (> 51.7°C) [hr]
APT2	8647.50	62.25	50.25	0.00	0.00
APT3	8640.75	55.00	34.25	30.00	0.00
APT4	8642.00	64.00	38.75	15.25	0.00
Min	8640.75	55.00	34.25	0.00	0.00
Max	8647.50	64.00	50.25	30.00	0.00
Average	8643.42	60.42	41.08	15.08	0.00
Sum	25930.25	181.25	123.25	45.25	0.00

In Summary

- Base case is not efficient nor resilient
- For almost identical lifecycle cost:
  - 35% reduction in energy
  - 12% reduced energy cost
  - Thermal Resilience!
- IECC 2021 with additional air sealing seems to work well
- Can optimize further



The Future of REVIVE

As a brand-new standard…

- There's still a long way to go
- We need projects to test it out for real & help us learn where we can make improvements
- Questions are welcome so we understand where and how we can be more clear in our guidance

Current & Coming-soon Resources

- Current resources:
  - Phius REVIVE 2024
- Coming-soon…
  - REVIVEcalc User Handbook
  - Phius REVIVE 2024 Design Workbook
  - Phius REVIVE 2024 Implementation Workbook
  - Additional calculators & tools
  - Ongoing REVIVEcalc developments

Questions

Thank you!

Can always email: amitchell@phius.org

Github:
https://github.com/Phius-ResearchComittee/REVIVE

Standard Page:
https://www.phius.org/phius-revive-2024