REVIVE 2024

Good for the planet
Good for your buildings
Quality assured results

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 ~30 slides

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

Requirements walkthrough

- Outcome req's ~ 54 slides
- Process req's ~ 45 slides

Single family example - Assessment & Investigation focus

Multifamily example Modeling focus

Vision

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

From Vision to Action – Things to do

for existing buildings

Every building supports the health of:

People

- Shelter ➡ Robust, Resilient – Weatherization & Fortification versus site hazards
- Health ➡ Removing-unhealthy-stuff-ification

Planet

- Climate / GHG / CO_2 / Carbon ➡ Decarbonization

Motivation

Pls take REVIVE 2024 and go into this business

- Electrification / HVAC 2.0 apparently does not have enough value on its own
- Exterior remodeling companies may be well positioned…

Outcome goals

- Resilience
- Health
- Decarbonization

Process goals

- Quality assurance
- Openness

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…

Takes on Resilience

It's always fair to ask: resilient to what?

Building / campus / block scale

- Resilience from the grid
- Outage conditions

MAINLY THIS KIND FOR NOW

THERMAL & ELECTRICAL

A lot of other prep could be layered on

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

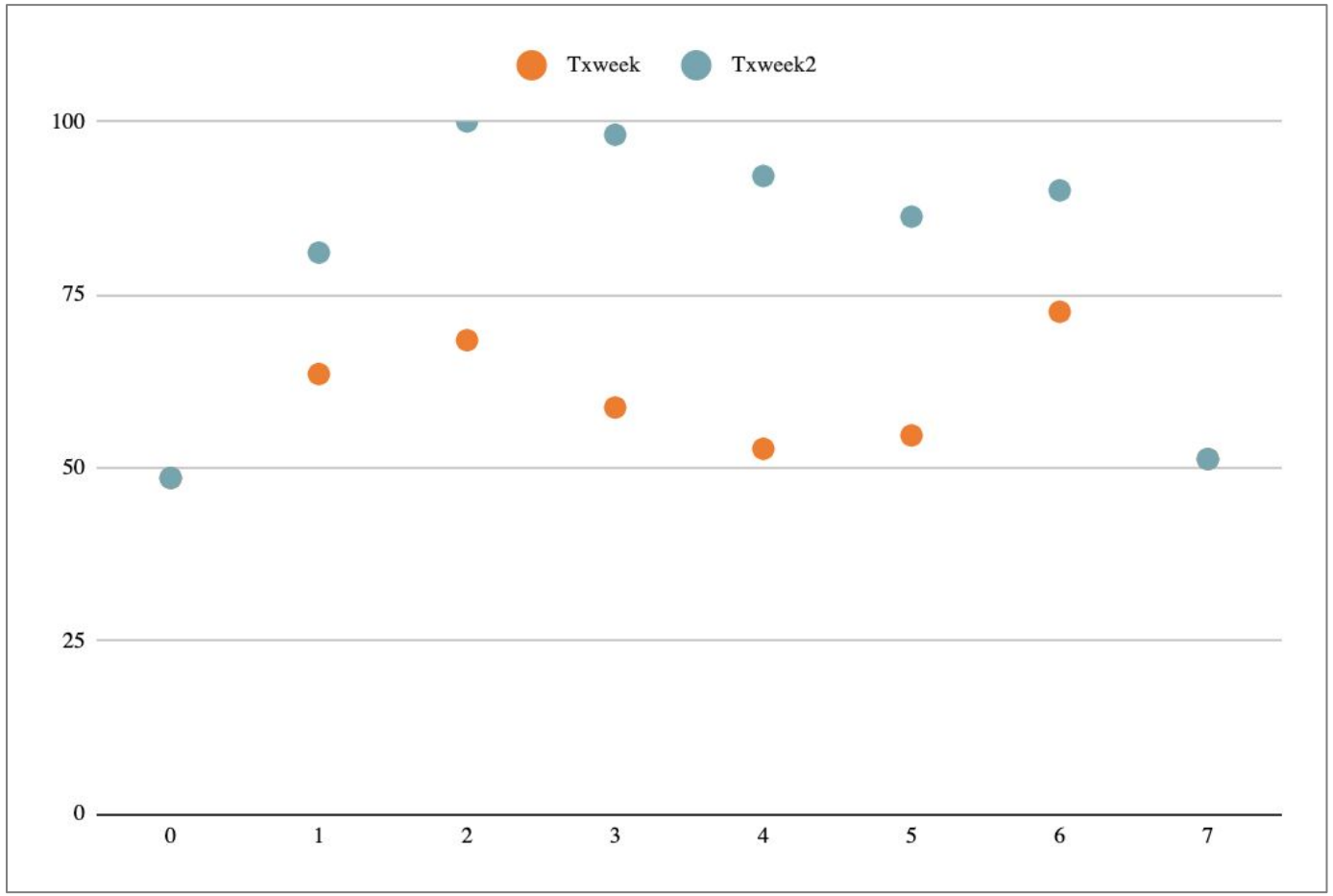
6.1.2 | Stress Weather for Resilience Tests

Take extreme week from TMY STAT file.

Morph to hit ASHRAE n-year return temperature extremes

Dry bulb & wet bulb

10-year winter
20-year summer



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

Motivation

Extreme weather is set to strengthen rapidly over the next 20 years, a new study has warned.

Scientists from the CICERO Center for International Climate Research in Norway say nearly three-quarters of the world's population will see dramatic changes in weather conditions unless greenhouse gas emissions are cut rapidly.

The tiny state of Vermont has a reputation for being a place that's relatively safe from the worst impacts of human-driven climate change. But as Vermont Public's Abagael Giles reports, a recent series of climate-fueled flooding disasters has some residents worried.

JULY 20, 2024 | 8 MIN READ

How Heat Combined with Hurricane Beryl to Cause Misery in Houston

Hurricane Beryl exposed the dangers of what happens when a storm cuts off power and a heat wave follows in its wake

BY CHELSEA HARVEY & E&E NEWS

Severe hail hit Calgary. A big hailstorm rolled across Calgary, Alberta , Canada on Tuesday evening. **Golf to baseball-size hail was reported from an intense storm that rolled across the city's northwest suburbs and out onto the high Plains of central Canada.** Aug 6, 2024

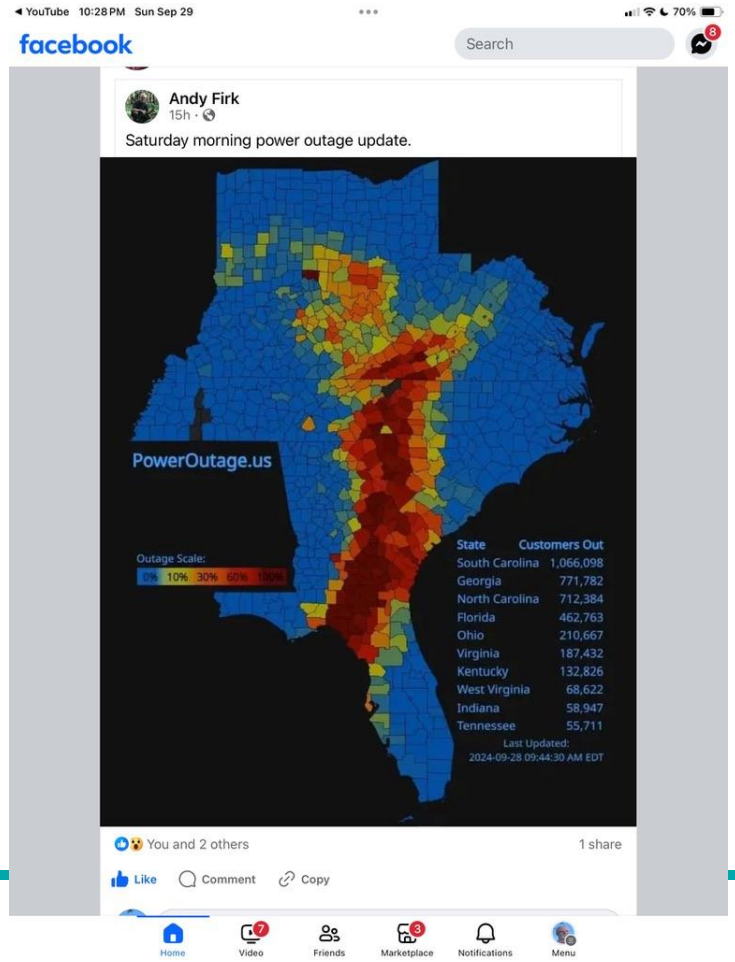
Minnesota town hit one of the highest dew points on record, 120-degree heat index

The heat index in the small town was 120 degrees!

JOE NELSON • AUG 26, 2024

Motivation

Helene caused outages as far inland as Ohio



Decarbonization

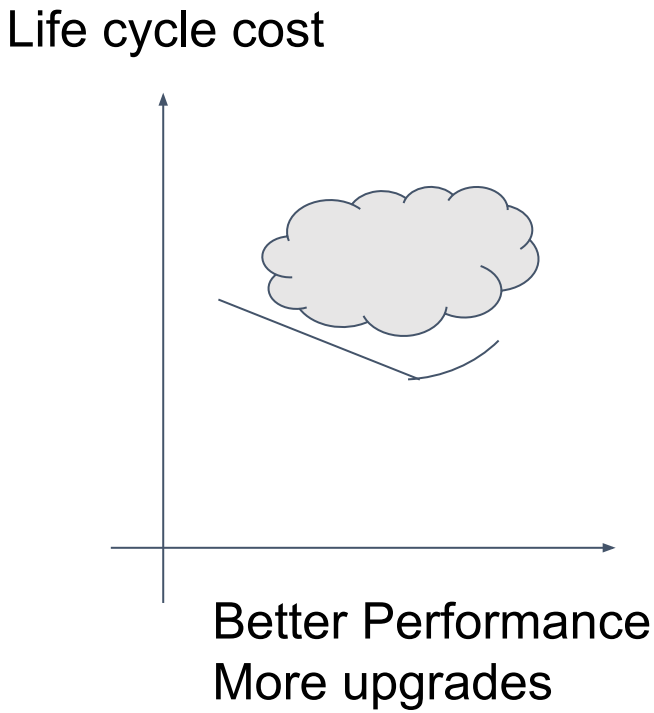
Ideally: **Absolute Zero** - no emissions ever happen in the supply chain or building life.

- 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)

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

Plus additional decarbonization effort

- Electrification, renewable sources
- Embodied carbon

ADORB

ADORB cost - **A**nnualized **D**ecarbonization **O**f **R**etrofitted **B**uildings cost

More about these later maybe

Default pattern for time-of-use electricity rates

Carbon price $250 per ton

Lifetime 70 years

Transition Cost $2.82 per W

Database of upgrade costs

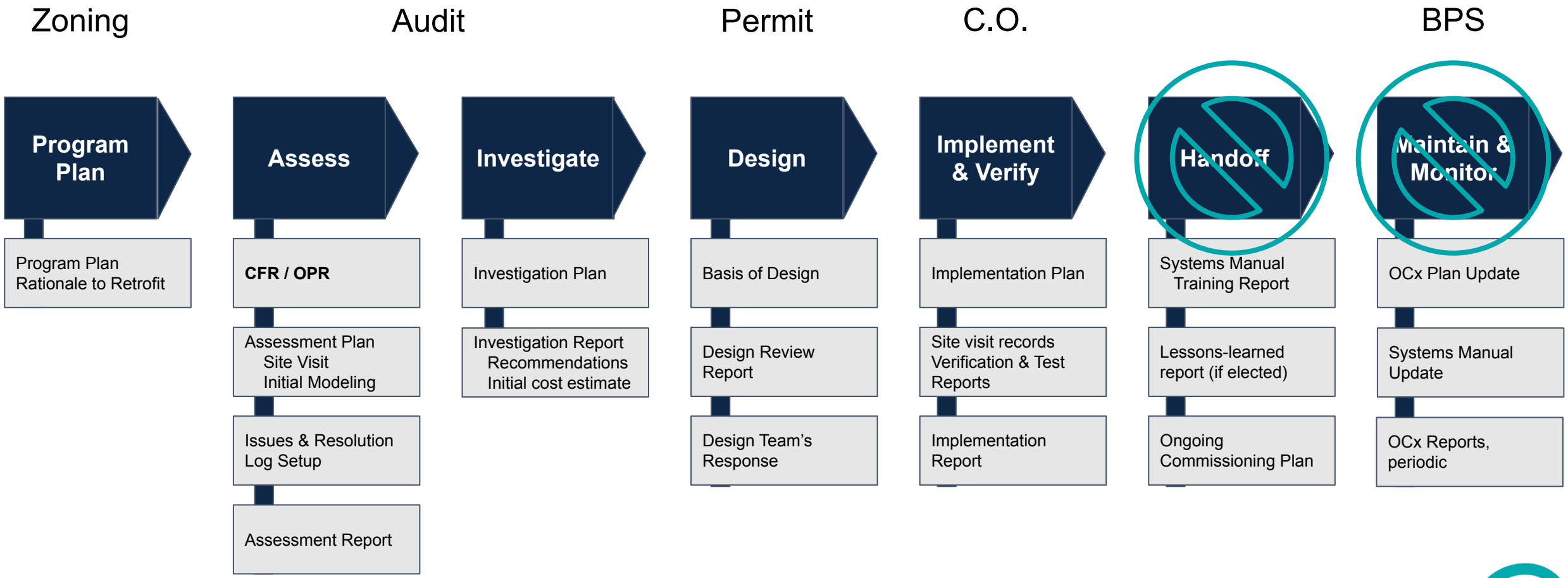
Long run marginal emissions rates for electricity

Embodied carbon calc
Level 1 approx
Level 2 approx

Discount rate 2% for direct costs, else 0

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

Use of Commissioning for Certification / Enforcement

ASHRAE Cx standards are written for the benefit of the Owner, to fulfill Owner's Project Requirements (OPR).

Adaptations for use in Certification / Enforcement:

- Most of the requirements in the CFR / OPR are those of this standard.
- Documentation deliverables go to both Owner and Authority.
- Gates for Acceptance & decision-to-proceed require concurrence of Owner and Authority.*

Acceptance Gates

REVIVE 2024 Acceptance Gates	clause	Owner	Authority
Programming	4.5.4	√	√
Assessment	8.6.10	√	√
Investigation Plan	8.7.5.7	√	
Investigation	8.7.10	√	√
Basis of Design	8.8.2	√	
Design Review	8.8.3	√	√
Implementation Plan	8.9.2.2	√	
Commissioning submittal review	8.9.3.1	√	
Implementation	8.9.7	√	√
Systems manual	8.10.3.3	√	
Train facility personnel	8.10.4.3	√	
Provide project documents to Owner	8.10.8	√	
Hand-Off	8.10.10	√	√
Ongoing Commissioning	8.11.11	√	√

Phius REVIVE 2024 - Project Team Roles

CxP - “Commissioning Provider”

- Per the Phius REVIVE Standard document:
  - An entity who manages the Commissioning Team to implement building commissioning

=

CPHC

- Per the Phius Certification Guidebook v24:
  - Works with project team throughout the process to ensure the project will meet all certification requirements

For all intents and purposes, these roles are equivalent during the Phius Certification Process. Both are expected to compile certification documents, facilitate and consult on design decisions, complete required energy modeling, and act as the liaison between Phius and the project team

Providing Commissioning

"A quality-focused process for enhancing the delivery of a project. The process focuses on verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet specified requirements."

Per ASHRAE Cx training it is in large part a communications job.

The CxP's influence derives from the Owner's authority.

- Might be stronger in REVIVE, due to Owner-directed elective requirements.

There might be more specialization by region and building type.

V&T Providers / Rater & Verifier Expectations

V&T Provider - Verification & Testing Providers

- Per the Phius REVIVE Standard document:
  - An entity who completes the building functional performance testing (FPT) activities or verify that elements of the building project meet stated requirements

=

Phius Rater & Verifiers

- Per the Phius Certification Guidebook v24:
  - Works with project team throughout the process to ensure the project will meet all certification requirements

These roles are equivalent during the Phius Certification Process. Both are expected to complete all required field testing and verification activities, and compile documentation demonstrating as-built compliance with standard requirements.

Phius REVIVE 2024 - CxP Expectations

On-Site Expectations (A&I Phase)

- The REVIVE standard requires on-site assessment and investigation of the existing conditions prior to any energy modeling or design
- We understand that the current CPHC workflow doesn't typically require in-person visits
- CxPs should communicate and work with a local project team to conduct all preliminary assessments if they are unable to be onsite themselves

Certification Expectations

- Facilitate assessment & investigation
  - Complete associated Workbook
  - Perform REVIVEcalc analysis
- Facilitate the design process
  - Ensure all deliverables established during assessment & investigation are addressed
  - Consult on proposed assemblies to confirm compliance with envelope durability & resiliency requirements (e.x. Appendix B)

New Construction		Retrofit
		Existing condition investigation
H/C performance	———	Resilience performance
S/E performance	———	Life cycle cost performance
IAQ, moisture mgmt	———	IAQ, moisture mgmt
		Site hazard fortification
EPA/DOE QA process	———	ASHRAE Cx process
		Monitoring / OCx

NC vs Retrofit

New construction

Guidebook
- Phius process requirements
- Outcome requirements
- Calc protocol (user)

Standard-setting document
- Informative

Workbooks for on-site QA

REVIVE 2024

Guidebook
- Phius practices, as Authority

REVIVEcalc handbook (user)

Standard document
- Outcome requirements
- Calc protocol (dev & user)
- Process vis-a-vis Authority
- Process vis-as-vis Owner

Workbooks for most Cx documentation

1 | Purpose

1.1

To establish:

Requirements for retrofit improvement work on existing buildings.

Criteria for the selection of buildings for retrofit (as opposed to razing or replacement with new buildings.)

1 | Purpose

1.2

The purposes of the improvements are to:

Eliminate direct and indirect greenhouse gas emissions, in normal operation.

Provide resilience to winter and summer power outages.

Fix defects of concern to the US EPA, that pose risks to indoor air quality.

Where appropriate, fortify the building against certain site hazards of concern to US FEMA, and insurers.

Meet elective requirements described in this standard, as selected by the Owner.

1 | Purpose

1.3

And in addition:

To employ a commissioning / quality assurance process.

To calculate the climate impact of the retrofit work and make efforts to reduce it.

To collect data on project costs, post-retrofit performance, and lessons learned.

2 | Scope

2.1

This standard provides requirements for:

The assessment and investigation of existing buildings.

The planning of retrofit phases.

The design, installation, and testing of retrofit improvements.

The operation, monitoring, and maintenance of the buildings after each retrofit phase.

2.2

This standard applies to all kinds of existing buildings.

2.3

Its provisions also apply to additions having an interior conditioned floor area no greater than 20% of: the existing building including (prior-to) any planned demolitions.

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 Operational decarbonization 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

Kinds of Requirements

Outcome

- Performance
- Prescriptive
- Minimum
- Owner-directed
  - Electives
  - ZERO or CORE Tier

- Single-family residential
- Multifamily residential
- Nonresidential
- Additions

Process & Documentation

- Roles & Responsibilities
- For Authority Approval
- For Owner Approval
- Performance Calculation Protocol

- Desk work
- Meetings
- On-site

Enforcement modalities

- Some requirements are enforced by the Authority.

  Withholding of permits, certificates, incentives

- Others are a matter of contractual obligation among the Owner and Project Team members.

  Payments, liens, hours worked

- Professional ethics

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

*Contaminants are listed **alphabetically** and are not in order of importance or prioritized in any way.*

1 Asbestos

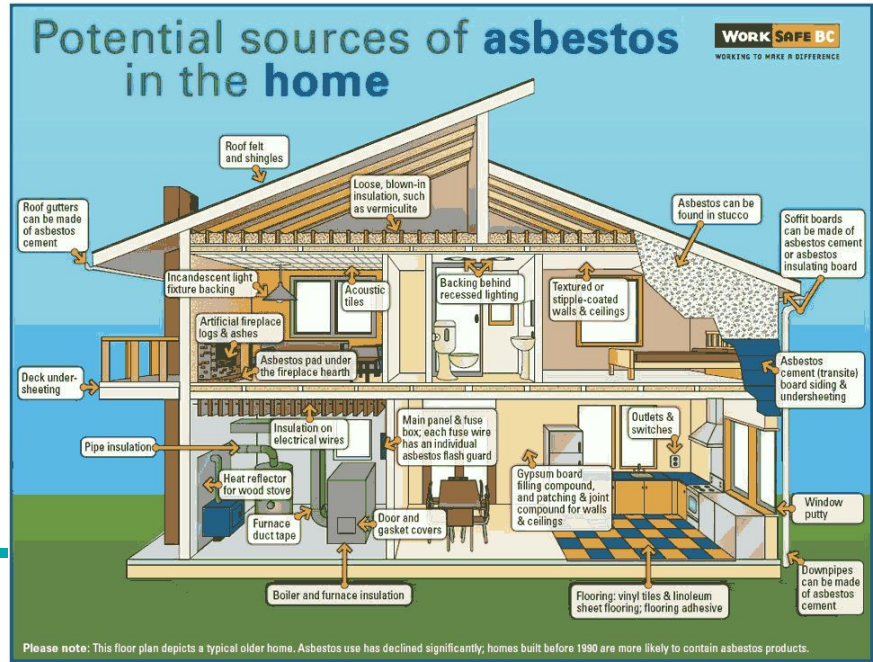
Built between 1930s and 1970s more likely

MA 1.1 Do not disturb <u>undamaged</u> Asbestos Containing Material

MA 1.2 Immediately isolate <u>damaged</u> ACM

MA 1.3 Work practices

- Do not sweep, vacuum, saw, sand, scrape, strip, drill…
- Any asbestos abatement/repair should be completed before blower door testing…



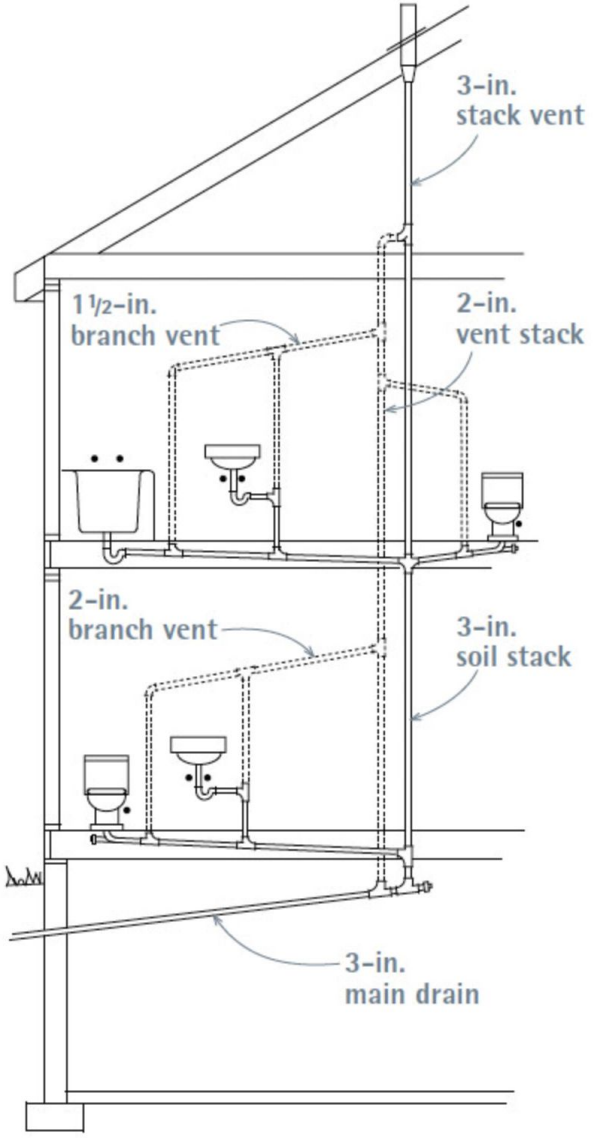
5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

2 Below ground contaminants (other than radon)

MA 2.1 Correct sewer vent problems

MA 2.2 Address drain traps prone to drying out

MA 2.3 Mitigate soil gas vapor intrusion



5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

3 Building products / materials emissions

MA 3.1 Minimize occupant and worker exposure to VOCs or other airborne contaminants

MA 3.2 Remove contaminated (moldy) building materials

MA 3.3 Select Least Toxic new materials for

Paint, flooring, carpet, adhesives, composite wood

MA 3.4 Post construction flush-out with outdoor air

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

4 Environmental tobacco smoke

MA 4.1 Adopt smoke-free policy or

MA 4.2 Source control, ventilation and air pressure control, compartmentalization air-sealing (see also Issue 16) and

MA 4.3 Additional compartmentalization if there is a history of complaints.

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

5 Garage air pollutants (CO, benzene, VOCs)

MA 5.1 Eliminate or Minimize Unwanted Air Transfer to Dwelling Units via Mechanical Equipment and Ductwork

MA 5.2 Compartmentalize Garage From Occupied Spaces (see also Issue 16)

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

6 Lead

MA 6.1 Comply With EPA's Lead-Based Paint RRP Program Rule. The rule's key instructions are to –

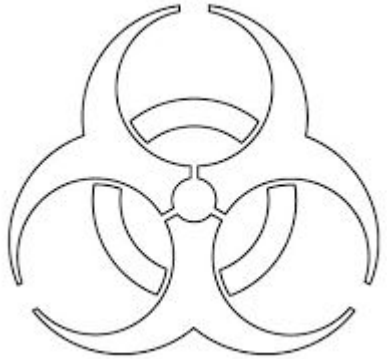
- Use a certified firm.
- Follow lead-safe work practices if disturbing more than 6 ft2 per room of interior or 20 ft2 of exterior painted surfaces. These minimum surface areas do not apply to window replacement, use of prohibited practices or demolition.
- Contain the work area to avoid resident exposure.
- Minimize lead dust and leave no dust or debris behind.
- Achieve visual post-cleaning criteria.

MA 6.2 Comply With State and Local Lead-Related Regulations

MA 6.3 Inform Maintenance Staff on Requirements for Lead-Safe Work Practices

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

7 Moisture control and mold



MA 7.1 Repair Moisture Problems

MA 7.2 Conduct Mold Remediation

MA 7.3 Ensure Proper HVAC Condensate Drainage for New and Existing Equipment

MA 7.4 Prevent Condensation in the Building Enclosure

MA 7.5 Use Nonporous Materials in Moisture-Prone Areas

MA 7.6 Control Moisture During Roofing Modifications

MA 7.7 Protect On-Site Materials from Moisture

MA 7.8 Ensure Proper Operation of HVAC Dehumidifiers

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

8 Outdoor Air Sources and Conditions

No minimum actions

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

9 Pests

MA 9.1 Mitigate Pest Infestations

MA 9.2 Reduce Potential for Pest Entry

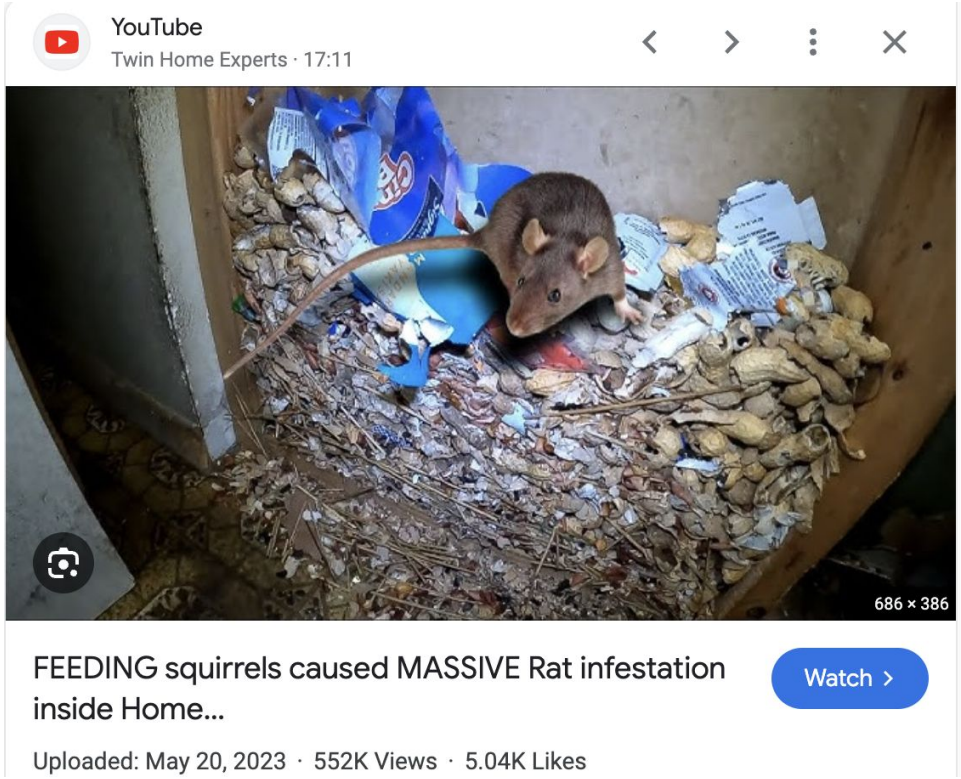
MA 9.3 Patch Openings to Eliminate Rodent Pathways

MA 9.4 Block Pest Movement Through Building

MA 9.5 Protect Outdoor Air Intakes and Exhausts

MA 9.6 Do Not Disturb Existing Pest Protections

MA 9.7 Keep Vegetation and Clutter Away from Building & Mechanicals



5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

10 Polychlorinated Biphenyls (PCBs)

MA 10.1 Replace PCB-Containing Fluorescent Light Ballasts

MA 10.2 Address Caulk Potentially Containing PCBs when it will be Disturbed During Building Upgrades

MA 10.3 Properly Dispose of PCB-Containing Light Ballasts, Caulk, and Other Materials

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

11 Radon

MA 11.1 Take Precautionary Measures Before Completing Energy Efficiency Upgrade Activities

MA 11.2 If ≥ 4 pCi/L pre-upgrade, recommend to the owner both mitigation and EA 5.1: Remove Air-Handling Equipment From Garages.

MA 11.3 If ≥ 4 pCi/L after renovation, install mitigation

MA 11.4 Correct Poorly Operating Mitigation System

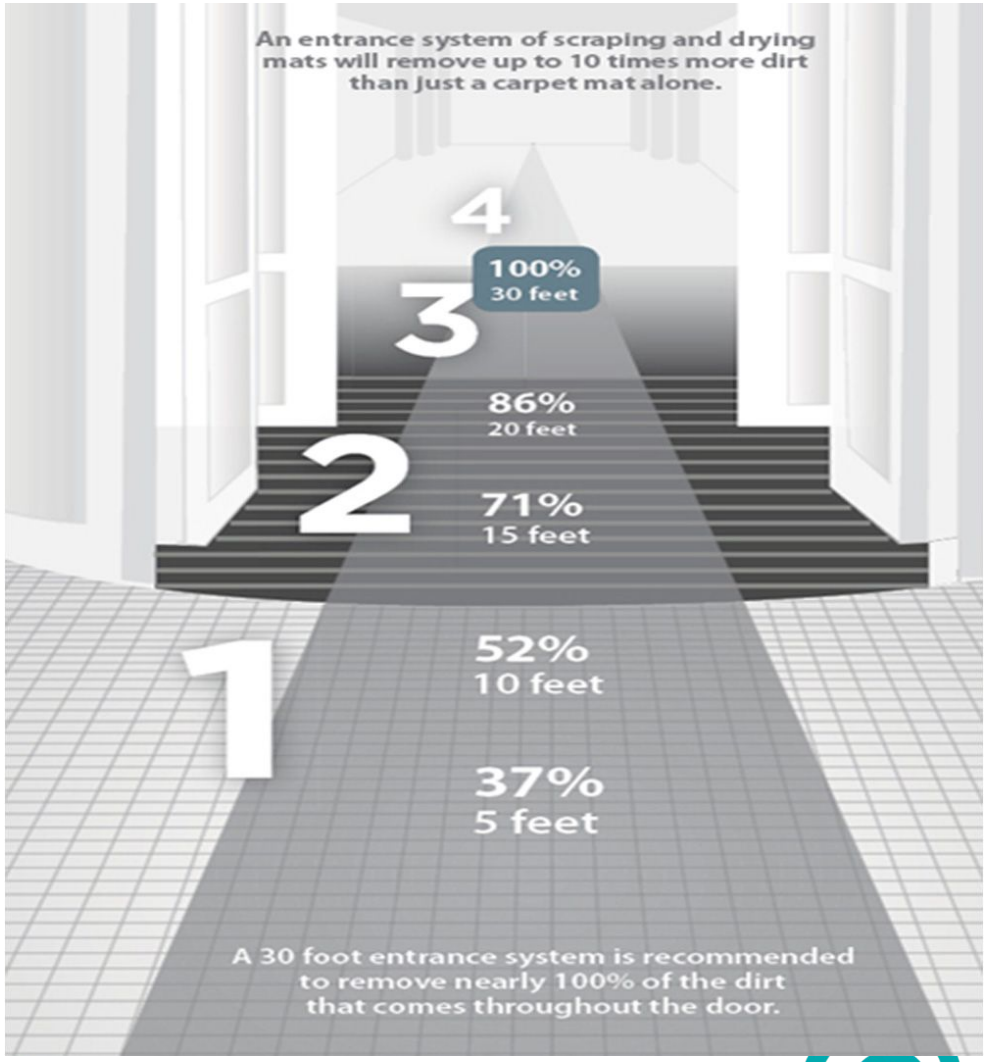
MA 11.5 Notify Owner/Manager About Radon-Reduction Measures

MA 11.6 If ≥ 2 pCi/L Prior to work, Add Precautionary Measures

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

12 Tracked-in Pollutants

MA 12.1 Provide Walk-Off Mats



5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

13 Unvented Combustion Appliances

MA 13.1 Ensure Adequate Exhaust and Ventilation in Kitchens Equipped With Gas Cooking Appliances (ASHRAE 62.2, see also Issue 21 Local Exhaust Ventilation)

MA 13.2 Remove Unvented Combustion Space Heaters

MA 13.3 Advise Occupants on Proper Operation and Maintenance

MA 13.4 Ensure that CO Detection and Warning Equipment is Installed and Working

ELECTRIFICATION MAKES THIS MOOT IN THE END, BUT THESE COULD APPLY TO INTERIM PHASES.

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

14 Vented Combustion Appliances

MA 14.1 Correct Deficiencies and Ensure Proper Operation of Combustion Equipment

MA 14.2 Ensure Proper Exhaust Locations

MA 14.3 Ensure Adequate Make-Up Air

MA 14.4 Ensure Proper Boiler Operation

MA 14.5 Ensure CO Detection and Warning Equipment Is Installed and Working Properly

ELECTRIFICATION MAKES THIS MOOT IN THE END, BUT THESE COULD APPLY TO INTERIM PHASES.

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

15 Wood Smoke and Other Solid Fuel Emissions

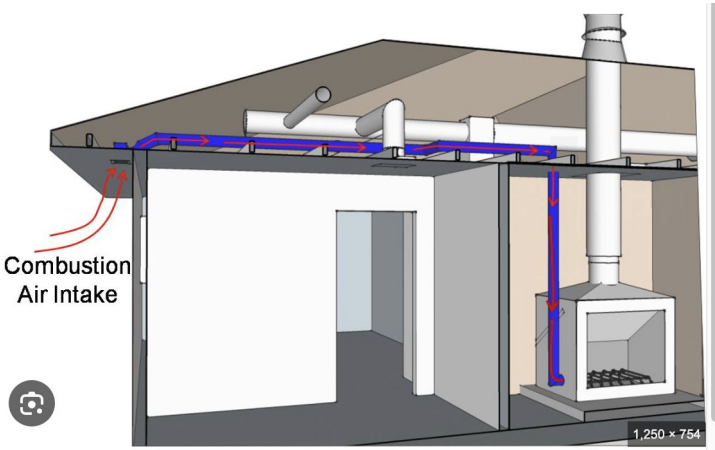
MA 15.1 Ensure Proper Operation of Wood- or Coal-Burning Appliances

MA 15.2 Install Properly Sized New Appliances

MA 15.3 Recommend Periodic Inspection and Maintenance of the Chimney and Appliance

MA 15.4 Share EPA Burn Wise Tips

MA 15.5 Also Refer to Priority Issue 14.0: Vented Combustion Appliances to Ensure That the Equipment Is Venting Properly and Working Correctly



Fireplaces and Wood Stoves Have Proper Ventilation | Building America Solution Center

Visit ›

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

16 Compartmentalization to Prevent Odor or Unwanted Air Transfer

MA 16.1 Minimize Pollutant Transfer Between Spaces

Follow the guidance in the order listed below for the most effective strategy: (1) source control and (2) ventilation and air pressure control.

1. Source Control

    If pollutant sources and odors were identified and can be readily addressed see the relevant PIs in this Guide e.g. 2, 3, 4, 5, 13, 14, 15, 21

2. Ventilation and Air Pressure Control

    Follow the Minimum Actions in Priority Issues 18.0, 19.0, 20.0 and 21.0, as applicable to the type of ventilation system.

For more information on compartmentalization by both ventilation and air pressure control, as well as air sealing, refer to Appendix A: Compartmentalization—Additional Information

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

17 HVAC Equipment

MA 17.1 Repair Improperly Operating HVAC Equipment

MA 17.2 Properly Size and Install New HVAC Equipment

MA 17.3 Ensure That There Is Adequate Air Filtration

MA 17.4 Control Mold and Bacterial Growth in HVAC Systems and Mechanical Equipment

MA 17.5 Train Building Staff on HVAC Operations and Maintenance

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

18 Mechanical Ventilation for Individual Dwelling Units

MA 18.1 Repair and Upgrade Dwelling Unit Mechanical Ventilation Systems as Needed

MA 18.2 Repair, Adjust and Upgrade Ventilation Systems in Common Corridors and Nonresidential Spaces as Needed

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

19 Mechanical Ventilation for Multiple Dwelling Units Using Central Exhaust

MA 19.1 Repair and Upgrade Central Mechanical Exhaust Ventilation Systems as Needed

MA 19.2 Repair, Adjust and Upgrade Ventilation Systems in Common Corridors and Nonresidential Spaces as Needed

450 × 525

A Standout Example of Duct Design...Or Lack Thereof - Energy Vanguard

Visit ›

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

20 Natural (not fan-powered) Ventilation

MA 20.1 Repair and Upgrade Natural Ventilation Systems as Needed

If the dwelling unit is served by natural ventilation and does not meet the exceptions to the whole-building mechanical ventilation requirement in ASHRAE Standard 62.2-2019, Section 4.1.1, or does not perform as intended, **convert the natural ventilation system to a fan-powered system**

MA 20.2 Repair, Adjust and Upgrade Ventilation Systems in Common Corridors and Nonresidential Spaces as Needed

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

21 Source Ventilation / Local Exhaust Ventilation

MA 21.1 Install, Repair or Replace Local Exhaust Ventilation in Dwelling Units

MA 21.2 Ensure Proper Venting of Clothes Dryers

MA 21.3 Meet Exhaust Requirements for Spaces Outside Dwelling Units

> Install, repair or replace exhaust ventilation in spaces outside dwelling units to meet the minimum exhaust rates specified in ASHRAE Standard 62.1-2019, Table 6.5. This may include, for example, janitor closets, trash storage areas, laundry facilities and parking garages.

MA 21.4 Implement Minimum Actions for Compartmentalization to Supplement Exhaust Ventilation

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

22 Building Safety for Occupants

MA 22.1 Correct Safety Hazards Identified During Assessments

Immediately correct urgent and life-threatening safety risks.

MA 22.2 Correct Deficiencies in Smoke and CO Alarms

MA 22.3 Recommend Appropriate Storage of Hazardous Chemicals

MA 22.4 Provide Adequate Fire Extinguishers

MA 22.5 Adjust Water Heater Temperatures ≤ 140 F

MA 22.6 Follow Precautions When Knob-and-Tube Electrical Wiring Is Present

5.1.1 IAQ – EPA Energy Savings Plus Health, Minimum Actions

23 Protecting Indoor Air Quality during Construction

MA 23.1 Minimize Occupant and Worker Exposures During Construction

MA 23.2 Protect HVAC Systems

MA 23.3 Handle Mercury Properly

MA 23.4 Protect Highly Absorptive Materials

Protect any existing absorptive materials (e.g., fabrics, furnishings, carpets) by fully covering them with plastic sheeting.

MA 23.5 Safely Install Spray Foam Insulation

Additions

EPA Energy Star

- National Program Requirements
- MFNC Rater Design Review Checklist
- MFNC Rater Field Checklist
- MFNC HVAC Functional Testing Checklist
- MFNC Water Management
- MFNC HVAC Design Report

EPA Indoor airPLUS Version 1

- Moisture Control
- Radon Control
- Pest Barriers
- HVAC Systems
- Combustion Pollutant Control
- Low Emission Materials
- Home Commissioning

Exceptions:

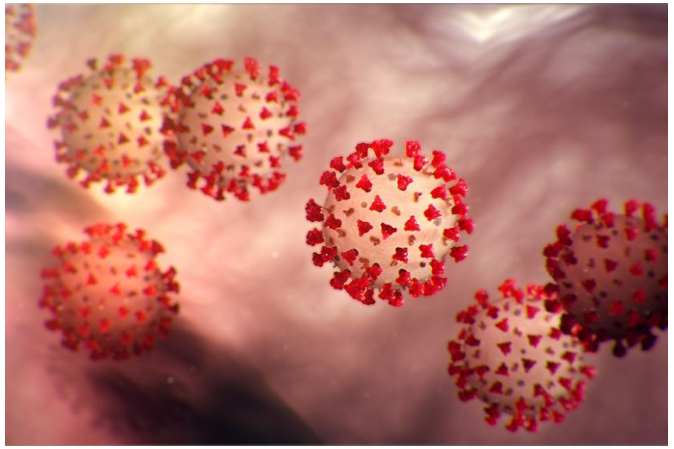
a. The eligibility limitations do not apply.
b. The verification, partnership, training, and credentialing requirements do not apply; they are superseded by the commissioning requirements of this standard (section 4.2).
c. Conversions that create new conditioned space but do not entail the construction of new enclosure elements.

5.1.1.1 Indoor Air Quality Electives

Consider complying with ASHRAE Standard 241 - Control of Infectious Aerosols.

Informative: Recirculating air filtration and upper room UV are the preferred approaches.

Informative: See also section 5.2.6.2 Wildfire Smoke.



ASHRAE Planning Framework for Protecting Commercial Building Occupants from Smoke During Wildfire Event

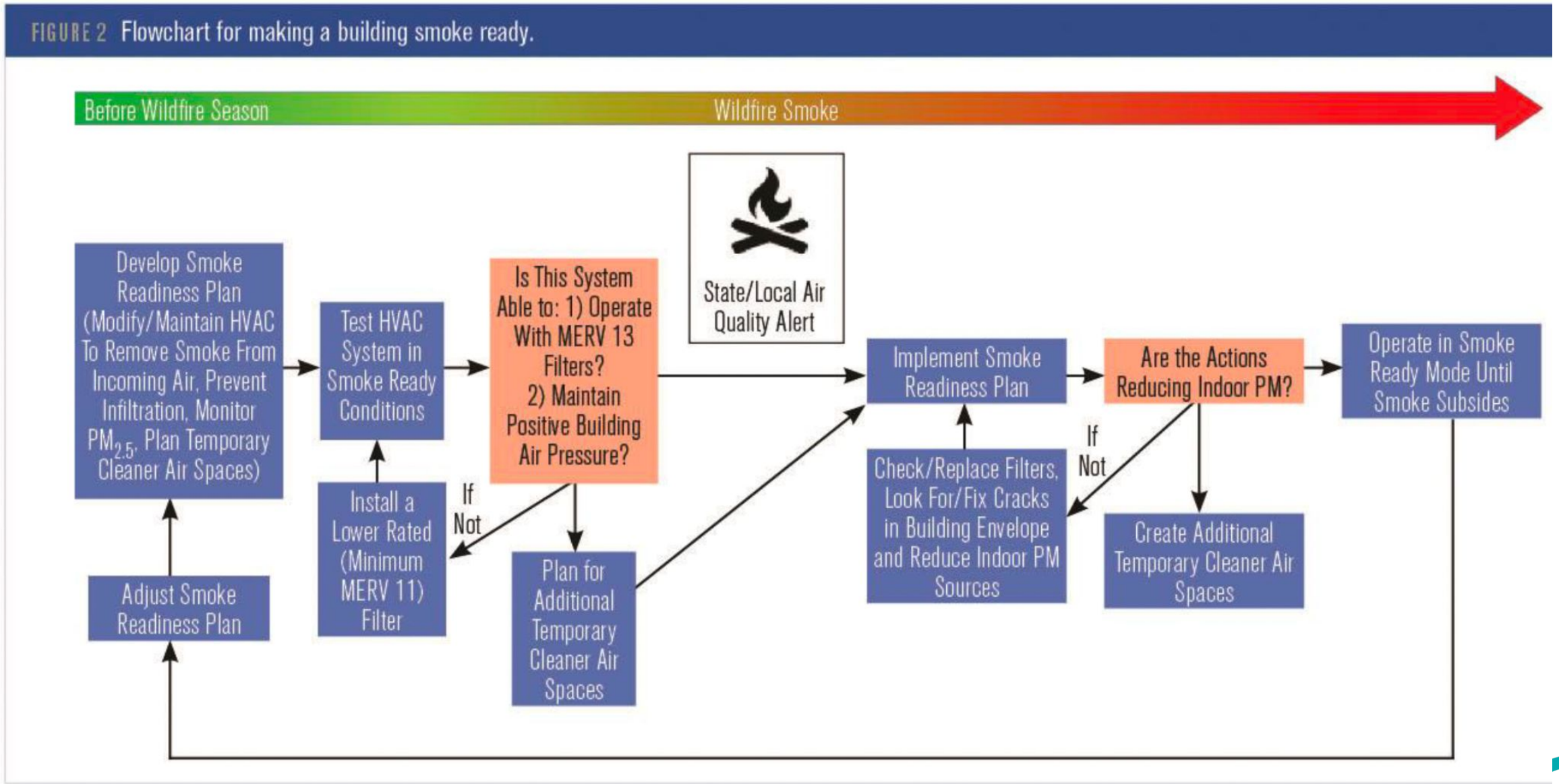


Figure 2. Flow Chart for making a building Smoke Ready.

5.1.2.1 Moisture Risk Mitigation

(Guidebook Appendix B) or ASHRAE 227 section 7.5.5

Opaque Assembly Moisture Control

Compliance Paths

1. Prescriptive
2. Performance (WUFI)
3. Qualified licensed PE design

B-2.1 Above Grade Walls

a) cavity insulation only
b) cavity + exterior cont. insul.
c) exterior insulation only
d) SIPS

B-2.2 Below grade walls

B-2.3 Interior retrofit of masonry

B-3 Roofs

a) vented, cavity insulation only
b) unvented, cavity + foam
c) unvented, exterior insulation only
d) SIPS

B-4.1 Floors with vapor permeable insulation

B-4.2 Below grade floors

5.1.2.2 Condensation Resistance

Interior Moisture Management at Construction Details

When calculated according to ISO 13788, the interior surface temperature of thermally bridged construction details must avoid mold growth…See Guidebook Appendix N-2.

Fenestration (window) Condensation Risk

When calculated according to ISO 13788…the interior surface temperature of both the glass and the frame must remain above the interior dew point temperature.

See Guidebook section 1.4.2.5.

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

5.2 Hazard Mitigation Flood

Base flood elevations are represented on FEMA maps as EL plus a number. This number represents the expected height rounded to the nearest foot.

5.2.2 Electrical / Mechanical Flood protection

Equipment & Conx necessary for Critical systems

- Elevated above 500-year flood level / 3 ft above 100-year OR
- Permanent dry flood protection to such elevation.

Conx for Backup Power

In FEMA designated flood zones V, A, B, D, and X-shaded, electrical connections shall be installed with a transfer switch…

- Likewise applies to critical systems, and shall be elevated.

5.2 Hazard Mitigation Hail

Roof-mounted PV systems

5.2.3 Hail

Flexible modules - FM Approval 4476 rated for Severe Hail

Rigid modules - FM Approval 4478 Class 4

5.2.6 Fire

Rigid modules - meet UL 1703 standards

5.2 Hazard Mitigation High Wind

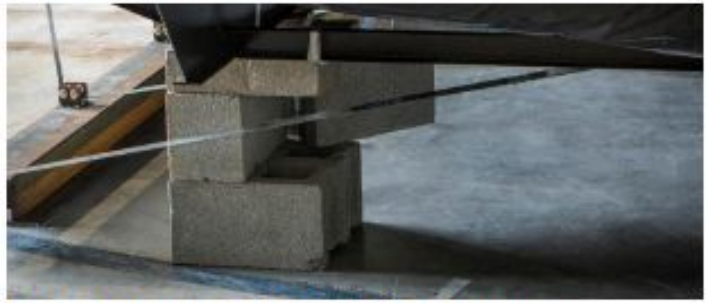


Figure 2.3. Ineligible dry-stack foundation

5.2.4 Structural / High Wind

a. No dry-stack foundations
b. FORTIFIED Home Standard Section 3 - Existing Roof OR

   FEMA P-804 section 4.1 - Basic Mitigation (Residential) OR

   FORTIFIED Commercial Section 3.1 - FORTIFIED Roof
c. Applicable local structural codes

SEE APPENDIX W *– WIND RETROFIT STRUCTURAL CODE COMPLIANCE CHECKS*

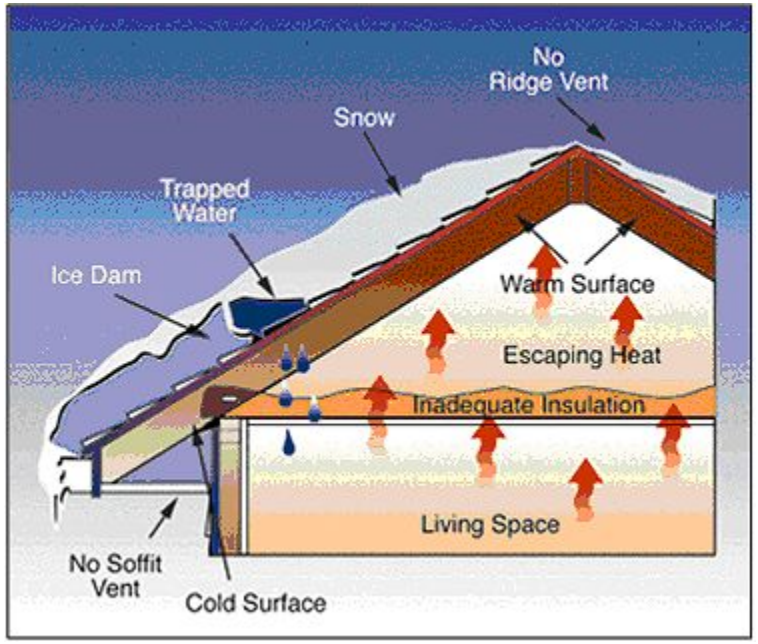
3.1 roof sheathing thickness
3.2 sealing and strengthening under roof deck
3.3 attic vents and covers (hurricane only)
3.4 engineered attachments for roof PV

5.2 Hazard Mitigation Ice Dams

5.2.5 Snow Load and Ice Dams

If ice dams have been a regular occurrence, diagnose and mitigate them.

Informative: See Lstiburek (2018).



5.2 Hazard Mitigation Earthquake

According to FEMA P-50, The International Building Code (IBC) provides engineered design guidance that can be applied to any retrofit.

5.2.1 Earthquake

Single-family Residential

Buildings in locations with a Seismic Design Category (SDC) of C through E (as specified in the International Residential Code), and within the scope of FEMA P-50, shall be improved to a Seismic Performance Grade of **B-minus** or higher.

Use FEMA P-50-1 Seismic Retrofit Guidelines for Detached, Single-Family, Wood-Frame Dwellings and the resources cited therein to develop the seismic part of the Cx Plan.

Multifamily Residential and Nonresidential

For buildings in locations with an SDC C through E, but outside the scope of FEMA P-50, the design of improvements requires the involvement of a licensed structural engineer.

5.2 Hazard Mitigation Wildfire

WILDFIRE SMOKE ELECTIVE: SEE ASHRAE GUIDELINE 44P interim planning framework.

In areas where the FEMA designated wildfire risk is "Relatively Moderate" or higher:

- Fire truck access
- Address visible from street
- 4 ft clearance to power lines
- 10 ft clear beside roadways
- Spark arrestors on chimney / BBQ

Defensible space

- Remove vegetation waste
- Cut grass, understory
- Remove combustible decks, stairs, overhangs
- Relocate outdoor furniture
- Trim trees 10 ft back from chimney, limb up 10 ft

Phius REVIVE Workshop Slides

part 1 of 2

6.2.1 Enclosure Air-Sealing

The post-retrofit whole-building air-tightness shall meet the requirements of IECC 2021

- 0.28 cfm50/ft2 for residential (per section R402.4.1.2)
- 0.4 cfm75/ft2 for commercial (per section C402.5.3) as defined in the IECC.

  Exception: See section 8.9.4.1 Air-tightness testing, for allowed methods.

Informative: Air-sealing for compartmentalization is also required by the ASHRAE 62.2 standard referenced in the EPA Energy Savings Plus Health protocol…See also section 8.7.6.1 Indoor Air Quality Investigation.

6.2.2 Islanding of on-site generation

On-site ~~renewable~~ electrical energy generation systems shall have the capability to disconnect from the grid and to operate without a grid connection.

Where subject to IEEE 1547, disconnection must be automatic and within 2 seconds.

A Primer on the Unintentional Islanding Protection Requirement in IEEE Std 1547-2018
David Narang,1 Sigifredo Gonzalez,2 and Michael Ingram1
1 National Renewable Energy Laboratory
2 Sandia National Laboratories

6.2.3 Battery Readiness

The electrical system shall have attached battery storage or space reserved for the same.

6.2.4 PV Readiness per ZERH

The provisions of the applicable U.S. DOE Zero Energy Ready Home PV-Ready Checklist Version 2 shall be met, unless one or more of the exceptions…applies.

Single Family

The U.S. DOE Zero Energy Ready Home Single Family Homes PV-Ready Checklist Version 2 (Rev. 1) applies.

Multifamily and Nonresidential

The U.S. DOE Zero Energy Ready Home Multifamily PV-Ready Checklist Version 2 applies.

U.S. DOE Zero Energy Ready Home Program Multifamily PV-Ready Checklist Version 2

1. A solar ready zone (SRZ) is designated and reserved on the roof
2. SRZ ≥ 40% of roof area

   less some deductions
3. Sub-zone widths ≥ 5 ft.
4. SRZ free of obstructions, e.g.
   - pipes, vents, ducts
   - skylights
   - roof-mounted equipment

5. Collateral dead load of ≥ 5 psf included in design.
6. Conduit pathways indicated on construction drawings.
7. Reserved space in electrical service panel (opposite end from panel supply)
8. Posted certificate indicating SRZ and this checklist.

Where SRZs are located on roof slopes of 4:12 or greater, SRZ is oriented in between 110 degrees to 270 degrees of true north.

6.3, 6.4 Winter / Summer Resilience (Thermal)

Residential evaluation protocol

No active space heating systems or equipment that use energy or fuel imported from off-site operate during the outage. Energy for space heating comes only from sources that are on-site (internal gains and passive or active solar thermal).

The energy for space cooling comes only from sources that are on-site (natural ventilation cooling, forced ventilation cooling, or other active systems operated with on-site electrical power)

Nonresidential evaluation protocol

The energy for space heating / cooling comes only from sources that are either

a. On-site, or
b. Provided by a local electrical microgrid or thermal energy network having primary energy sources that are all renewable.

16 PERMUTATIONS

Thermal	Electrical
Winter	Summer
Residential	Nonresidential
CORE	ZERO

6.3, 6.4 Winter / Summer Resilience (Electrical)

Tier A (Phius ZERO)

capable of covering critical electrical and process loads, using energy only from on-site sources that are renewable, without resorting to combustion (or fuel cells) directly or indirectly.

Informative: This effectively requires non-fuel-based and electrically-interacting energy storage such as electrochemical or gravity batteries, flywheels, ice storage, compressed air, pumped hydroelectric.

Tier B (Phius CORE)

capable of covering critical electrical and process loads using energy from on-site sources, but the means of covering said loads are not otherwise restricted.

If an active solar thermal system or evaporative cooler or heat pump is used to meet thermal resilience criteria, those are also critical electrical loads.

6.5.1 ADORB cost ≤ baseline

The ADORB cost of the proposed retrofit is to be no greater than that of a baseline case, in which the building is operated and maintained as-is.

Exception: If the project involves changes to the number of dwelling units, number of bedrooms, or conditioned floor area, then the ADORB cost shall not exceed that of the baseline on one of the following bases (whichever is least stringent):

a. Cost per unit of conditioned floor area
b. Cost per bedroom
c. Cost per dwelling unit

6.5, Appendix A | ADORB

Direct cost categories, for planning & reporting

Performance related

- Envelope
  - Air leakage / sealing / tightness
  - Ceilings, Roofs
  - Walls
  - Foundation, Floors
- HVAC
  - Mechanical ventilation
  - Space Conditioning
- Hot Water (DHW, SHW)
- Major appliances
- Lighting
- PV / Battery / Generation
- Other performance-related

Not performance related

- Indoor air quality related
- Hazard mitigation related
- Other in-scope
- Other out-of-scope
- Incentives
- Tax credits

6.5.2.1 Operational decarbonization

In normal operation (not outage)

Tier A (Phius ZERO)

Electrify by the final phase **and**

- Meet Phius ZERO per Guidebook, **or**
- Community solar

FOSSIL COMBUSTION FREE

Tier B (Phius CORE)

Electrify by the final phase.

Exceptions:

- Stored fuel for backup electricity generation
- Stored fuel for outdoor cooking

Embodied carbon

Level 1 embodied carbon calculation

Spending money implies emissions :(
ergo, saving money saves carbon :)

Economic input-output based.

- Cost of materials and labor, including soft costs
- Country of origin for materials

For a $1,000 Import from Canada:

$1,000 × 0.344 kg/$ = **344 kg** CO_2e

344 kg × $0.25/kg

= $86 embodied carbon cost

6% consulting fees on a $1,000,000 project:

$60,000 × 0.234 × 0.25 = **$3,510**

Country	US Trading Rank	GDP [USD MM]	CO_2 [MT]	EF [kg/$]
USA	-	20,936,600.00	4,900.0	0.234
China	1	14,722,730.70	9,500.0	0.645
Canada	**3**	**1,643,407.98**	**565.2**	**0.344**
Germany	5	3,806,060.14	696.1	0.183
India	10	2,622,983.73	2,300.0	0.877
France	15	2,603,004.40	303.5	0.117

6.5.2.2 Embodied decarbonization
(in addition to reusing the building)

Include at least one Level 2 embodied carbon measure.

A **correction** to Level 1 rather than a replacement of it.

Credits for carbon reductions available from 3 kinds of measures:

- Material choices
- Business practices
- Personal choices
    - Apply in the years worked on the project, adjusted based on % of income from project.

Reductions are relative to measure-specific baselines.

6.5.2.2 Embodied decarbonization

Level 2 embodied carbon credits worksheet

Category	CO2 emission savings measures	BAU reference emissions intensity [e.g. kgCO2e/kg]	Emissions intensity Unit	Reference quantity or scale	Project practice emissions intensity	Project quantity or scale	Savings credit [kg]	Savings credit [$]
Material	Substitute mass timber for steel structure	1.46	kgCO2e/kg	1000	0.2	3000	860	$215
Business Process	Domestic window supplier, avoid ocean shipping	0.003	kg/ton.km	6300	0	0	18.9	$5
Material							0	$0
Choose one							0	$0
Personal, use ->	https://coolclimate.berkeley.edu/calculator							
	Name or Initials	Fraction of annual income from this project, %	tons CO2-eq/year from CC calculator	% better than average, from CC calculator				
Personal	GSW	20%	20	36%			2250	$563
Personal							0	$0

7.1 Monitoring

Residential – No requirement.

Nonresidential

Register the building with Energy Star Portfolio Manager and track its energy and water utility meters.

Share with CxP and the Authority.

Continue monitoring for the period of time directed by the Authority.

ZERO FOR PHIUS

ENERGY STAR® Portfolio Manager®

Monitoring Electives
7.2 Indoor Environment
7.3 Energy End-Use
7.4 Water Quality
7.5 Waste/Materials

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

And for Additions:

- EPA Energy Star
- EPA Indoor airPLUS

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 Operational decarbonization Tier b. Electrified in normal operation

6.5.2.2 Embodied decarbonization (in addition to reusing the building)

7.1 Energy Star Portfolio Manager (Nonresid.)

That concludes the outcome requirements walkthrough :)

Let’s talk process now.

And documentation

Standard document

Foreword
1 Purpose
2 Scope
3 Definitions
4 Process, Part One
- **4.3 Owner's Participation**
- **4.5 Programming Phase – Building Triage and Ranking**

5 Mitigate Existing Deficiencies
- **5.1 Indoor Air Quality and Moisture Risk Mitigation**
- **5.2 Hazard Mitigation**

6 Performance Requirements
- **6.1 Simulation Requirements**
- **6.2 General Resilience**
- **6.3 Winter Resilience**
- **6.4 Summer Resilience**
- **6.5 Life Cycle Cost and Impact Control**

7 Monitoring Requirements, Measurement & Verification
8 Process, Part Two
- **8.6 Assessment Phase**
- **8.7 Investigation Phase**
- **8.8 Design Phase**
- **8.9 Implementation Phase**
- **8.10 Hand-off Phase**
- **8.11 Ongoing Commissioning Phase**

PROCESS

OUTCOME

PROCESS

Normative Appendix A – ADORB Cost Calculation Method
Normative Appendix SC – Schedules
Normative Appendix T-0 – Program Plan Outline
Normative Appendix T-1 – CFR Outline
Normative Appendix T-2 – Cx Plan Outline
Normative Appendix T-4 – Systems Manual Outline
Normative Appendix T-6 – Cx Report Outline

DOCUMENTATION.
Being superseded by Workbooks

Informative Appendix E – EPA Indoor Air Quality
Informative Appendix P – Retrofit Package Tiers
Informative Appendix S – Seismic Assessment & Evaluation Resources
Informative Appendix T-2.1 – Cx Plan Outline ideas
Informative Appendix T-3 – Basis of Design Outline
Informative Appendix T-5 – Facility Guide Outline
Informative Appendix U – Calculation Engine User Manual
Informative Appendix V – V&T Provider Credentials
Informative Appendix W – Wind retrofit structural code compliance checks

Guidebook

3.1 Process
- **3.1.1 Phase 0: Programming (Recommended)**
- **3.1.2 Phase 1: Paperwork**
- **3.1.3 Milestone 1: Project Registered**
- **3.1.4 Phase 2: Assessment, Investigation & Review**
- **3.1.5 Milestone 2: Assessment & Investigation Approval**
- **3.1.6 Phase 3: Design Review**
- **3.1.7 Milestone 3: Design Certification**
- **3.1.8 Phase 4: Implementation, Observation & Testing**
- **3.1.9 Milestone 4: Final Certification**
- **3.1.10 Phase 5: Monitoring & Ongoing Commissioning**
- **3.1.11 The Phius REVIVE 2024 Workbooks**
- **3.1.12 Review Timeline**

3.2 Fee Schedule

3.3 Requirements
- **3.3.2 Co-requisite Requirements**
- **3.3.3 Hazard Mitigation**
- **3.3.4 Performance Requirements**
- **3.3.5 Monitoring Requirements**
- **3.3.6 Ongoing Commissioning (OCx) & Monitoring Electives (Optional)**

3.4 Assessment and Investigation
- **3.4.1 Required Documentation**
- **3.4.3 Phius REVIVEcalc Modeling Tool**
- **3.4.4 Phius REVIVEcalc Modeling Protocol**

3.5 Design
- **3.5.1 Required Documentation**

3.6 On-Site
- **3.6.1 Required Documentation**
- **3.6.2 Corequisite Programs**

PROCESS

OUTCOME

DOCUMENTATION

- The REVIVE Program is covered in Section 3 of the Phius Certification Guidebook v24
- The intent of the *Guidebook* is to support the requirements outlined in the *Standard*
- The Guidebook addresses:
  - Phius' Certification Process
  - Certification requirements (per the Standard)
  - Modeling protocol (per the Standard)
  - Documentation requirements for each phase (for Phius Certification)

Main points of correspondence

Guidebook	Standard
3.1.1 Phase 0: Programming	4.5 Programming Phase - Building Triage and Ranking
3.1.2, 3.1.3 Paperwork and Project Registration	–
	4.5.4 Programming - Acceptance & Decision to Proceed
	8.6.10 Assessment - Acceptance & Decision to Proceed
3.1.5 Milestone 2: Assessment & Investigation Approval	8.7.10 Investigation - Acceptance & Decision to Proceed
3.1.7 Milestone 3: Design Certification	8.8.3 Design Review - Acceptance
	8.9.7 Implementation - Acceptance & Decision to Proceed
3.1.9 Milestone 4: Final Certification	8.9.7 Implementation - Acceptance & Decision to Proceed
–	8.10.10 Hand-Off - Acceptance & Decision to Proceed
3.1.10 Phase 5: Monitoring	8.11.11 Ongoing Commissioning - Acceptance

Phius Certification Process – REVIVE 2024

AIA Project Phases	Phius Benchmarks	Phase Summary
LOGICALLY, IF DECISION IS NOT TO RETROFIT, NO NEED TO REGISTER. BUT THE RATIONALE FOR RETROFIT DOES GET REVIEWED IN PHASE 2	**Phase 0** Programming	**3.1.1 Rationale for Retrofit** -A free online tool used to conduct a preliminary assessment for retrofit buildings **Multi-Facility Planning** -Project team creates initial Program Plan and establishes general scope of work to be completed
Pre-Design (PD)	**Phase 1** Paperwork	**3.1.2 Inquiry** -Project team requests a contract.
	Milestone 1 Project Registered	**3.1.3 Registration** -Invoice paid, contract signed, project number created. -The project is now publicly visible on Phius' Certified Project Database. -A project Dropbox folder is shared by Phius with the project team.

4.5 Programming / Triage

4.5.1 Buildings excused from retrofit

Considerations:

- Intended life ?
- Functional floor plan ?
- Site and Land Use
  - Zoning
  - Climate migration risk
    - County-by-county

<u>Deliverables</u>

4.5.3.2 Each building: Rationale to Retrofit

A Rationale for Retrofit tool is built-in to the Phius REVIVE 2024 Assessment & Investigation Workbook

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	
		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.*	

WET BULB

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

Phius Certification Process – REVIVE 2024

Schematic Design (SD)	**Phase 2** Assessment, Investigation & Review	**3.1.4 Assessment & Investigation** -Commissioning Provider (CxP) conducts existing building assessment and investigation, including creating and running the performance model **3.1.4 Assessment & Investigation Review** -CxP submits Assessment & Investigation deliverables to Phius -Phius Review & Feedback -CxP Revisions & Response -Repeat (as needed)
	Milestone 2 Assessment & Investigation Approval	**3.1.5 Assessment & Investigation Approval** -Phius approves the Assessment & Investigation deliverables. An official letter of approval is sent to the design team.

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

SUPPORTED IN THE WORKBOOK

8.6.9 Deliverables

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

Updated Program Plan

UPDATED WITH IAQ AND FORTIFICATION ELECTIVES

UPDATED WITH INVESTIGATION PLAN ITEMS

8.6.10 Acceptance

Proceed if Owner and Authority approves

8.6.4 Current Facility Requirements - Round 1

8.6.4.1 Facility Requirements

a. Regulatory and jurisdictional requirements (any violations of codes that need to be addressed).
b. Financial requirements.
c. Functional uses, functional activities/tasks performed in the building and associated requirements to facilitate efficient execution of occupant mission.
d. Space needs.
e. Occupancy requirements and occupancy schedules in normal operation.
f. Indoor environmental requirements (temperature, humidity, air quality, ventilation, lighting).
g. Level of systems control.
h. Preferred vendors / contractors.

8.6.4.1.1 Nonresidential - Outage-critical loads

8.6.4.2 Monitoring Electives

8.6.5 Pre-Assessment Cx Plan

8.6.5.1 Site Visit Planning

MORE ABOUT THIS 3 SLIDES AHEAD

8.6.5.2 Initial Modeling to Meet Performance Requirements

- Try package levels (Std doc Appendix P) OR
- Start max'd out and back things off OR
- Start baseline and add things

8.6.5.3 Retrofit Phase Plan for Performance-Related Measures

8.6.5.4 M&V Plan

8.6.5.5 Approach to Maintenance and Persistence of Benefits

8.6.5.6 Process Elective: Lessons-Learned Workshop

8.6.7 Perform Assessment

8.6.7.1 Site-Hazard Risk Assessments

Desk work

Look at maps for seismic, flood/tsunami, hail, wildfire

Determine design wind speed

- ATC web site or local code

At site

Is snow loading an issue?

8.6.7 Perform Assessment

8.6.7.2 Indoor Air Quality Risk Assessments **At site**

- Visit the site and perform all the Assessment Protocols of the US EPA Energy Savings Plus Health Indoor Air Quality Guidelines that can be done in a walkthrough.
- Capture assessments into the Assessment Report part of the Cx Report.
- Capture items that need further attention in the Investigation Phase, into the Investigation Plan section of the Cx Plan.

8.6.7.3 There is **no** 8.6.7.3

STRUCTURAL ISSUES
(SEISMIC AND HIGH WIND)
ARE ASSIGNED TO THE
INVESTIGATION PHASE

8.6.5.1 IAQ assessment site visit plan

2 Below ground contaminants (except radon)

AP 2.1 Evaluate Sources

-Take note of any odors on site/indoors

-Visually inspect any drain/waste/vent piping if easily accessible

3 Building products

AP 3.2-3.3 - Building Products/Material Emissions

-Discuss importance of safe product choices and avoiding VOCs

-Identify carpet prone to moisture/wetting problems

-Assess existing ventilation strategies

4 Carbon Monoxide

AP 4.1 Assessment of CO Sources

-Document all existing combustion equipment

5 Environmental tobacco smoke

AP 5.1 Look for Signs of Smoking Indoors

6 Garage air pollutants

AP 6.1-6.5 Garage Air Pollutants

-Assess existing garage configuration and characteristics

SUGGESTION FOR SINGLE-FAMILY

8.6.5.1 IAQ assessment site visit plan

7 Lead

AP 7.1 Assess Paint Conditions

-Document peeling, bubbled, or worn paint that may contain lead

8 Moisture / mold

AP 8.1-8.4 - Mold/Moisture Assessment

-Document all areas where moisture/mold issues are currently present or suspected

-Discuss containment of mold and remediation plan/strategies

9 Pests

AP 9.1-9.2 Pests

-Check for evidence of pests/rodents

10 PCBs

AP 10.1 Assess Light Ballasts

-Document any fluorescent light fixtures

11 Radon

AP 11.3 Determine if Active or Passive Radon Mitigation System

-Document current mitigation system, if applicable

INTRUSIVE INSPECTIONS DEFER TO INVESTIGATION PHASE

8.6.5.1 IAQ assessment site visit plan

13 HVAC equipment

AP 13.1-13.2 HVAC Equipment

-Document existing equipment functionality
-Document existing equipment information (make, model #, etc.) if easily accessible
-Note specific areas of occupant discomfort/concern

16 Local exhaust ventilation

AP 16.1-16.2 Source/Local Exhaust Ventilation

-Document existing ventilation strategies for kitchen/baths
-Document existing dryer exhaust

18 Safety

AP 18.1 Assess Conditions

-Check if existing wood stove vent is sealed
-Replace batteries/supply CO and smoke alarms
-Identify harmful chemicals on-site
-Inspect existing fire extinguisher, if any
-Check DHW temp. Adjust to align with state/local code if needed
-Document any and all additional hazards/occupant concerns

8.6.7 Perform Assessment

8.6.7.4 Set up Issues and Resolution Log.

SUPPORTED IN THE WORKBOOK

8.6.7.5 Update the CFR with Electives.

Review the Expanded Actions in the EPA Energy Savings Plus Health Guidelines referenced in section 5.1, and make an initial determination of which ones to include in the CFR.

Review the hazard mitigation electives listed in section 5.2 and make an initial determination of which ones to include in the CFR.

8.6.7.6 Document immediate improvements made.

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

SUPPORTED IN THE WORKBOOK

UPDATED WITH IAQ AND FORTIFICATION ELECTIVES

8.6.9 Deliverables

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

UPDATED WITH INVESTIGATION PLAN ITEMS

Updated Program Plan

8.6.10 Acceptance

Proceed if Owner and Authority approves

Investigation

8.7.1 Roles & Responsibilities

8.7.2 Update the Cx Team

8.7.3 Update the CFR

8.7.4 Review Facility Docu

8.7.5 Update Cx Plan

8.7.6 Perform Site Inv & Tests

8.7.7 Issues Analysis & Recom

8.7.8 Investigation Report

8.7.9 Deliverables

- Updated Cx Plan
- Updated Cx Report
  - add Investigation Report

8.7.10 Acceptance

Proceed if/when Owner and Authority approve

8.7.1 Roles and Responsibilities

Owner

a. Review the initial test procedures in the Investigation Plan with regard to changes in operating conditions and risks to Owner's property or production means.

b. **Provide access** to areas required to perform Cx Activities. If the CxP is required to be accompanied by the Owner's staff, that staff shall be dedicated to the CxP Team during the duration of Cx Activities.

c. Review field reports and Issues and Resolution Log, and **attend meetings with the CxP** to resolve conditions impeding the execution of the Cx Plan.

d. Review the Investigation Report and provide comments as appropriate.

CxP Team

a. Execute the investigation as defined in the Investigation Plan.

b. Develop project-specific test procedures.

c. Provide field and test reports on a weekly basis with the Issues and Resolution Log.

d. Provide **regular progress reports** as the Investigation Plan is executed, and identify conditions impeding the execution of the Plan.

8.7.5 Update Cx Plan

8.7.5.2 Pre-Site-Visit Tests

    8.7.5.2.1 Potential Disruptions

8.7.5.3 Stakeholder Interviews

8.7.5.6 Develop Test Procedures

8.7.5.7 Acceptance of the Investigation Plan (Owner)

8.7.6 Perform Site Investigation & Testing

8.7.6.1 Indoor Air Quality Investigation

Perform all the Assessment Protocols of the US EPA Energy Savings Plus Health Indoor Air Quality Guidelines that require **more than** a walkthrough and were omitted from the Assessment Phase.

8.7.6.2 Structural and Seismic Investigation

8.7.6.2.1 Earthquake Hazard Investigation **For locations with an SDC of C through E**

Perform a simplified seismic assessment as described in FEMA P-50 Simplified Seismic Assessment of Detached, Single-Family, Wood-Frame Dwellings, and determine the **Seismic Performance Grade**, for building types within its scope.

For other buildings
ASCE/SEI 41-13 Seismic Evaluation and Retrofit of Existing Buildings
FEMA P-58-1 FEMA P-58-1, Seismic Performance Assessment of Buildings, Volume 1
FEMA 547 Techniques for the Seismic Rehabilitation of Existing Buildings
FEMA P-807 Seismic Evaluation and Retrofit of Multi-Unit Wood-Frame Buildings with Weak First Stories

FEMA E-74 explains the sources of nonstructural earthquake damage in simple terms and provides methods for reducing potential risks.

8.7.6.2 Structural and Seismic Investigation

8.7.6.2.2 General Structural and High Wind

FORTIFIED Roof

For Single-family, Duplex, HUD manufactured, and Townhouses:

- Investigate to determine the alterations needed to comply with section 5.2.4.
- Do the code compliance checks listed in Table 5-1 of FEMA P-804, reproduced in Informative Appendix W.

For other buildings types follow a, b, or c below:

a. ASCE 11-99 - Guideline For Structural Condition Assessment Of Existing Buildings. A professional engineer must perform site inspections(s) to identify structural components that need retrofitting to meet minimum structural safety requirements.
b. FEMA P-424 - Design Guideline for Improving School Safety in Earthquakes, Floods, and High Winds, Section 6.6, Table 6-2, Checklist for Building Vulnerability of Schools Exposed to High Winds.
c. FEMA P-2062 - Guidelines for Wind Vulnerability Assessments of Existing Critical Facilities.

8.7.7 Issues Analysis and Recommendations

- Update Issues & Resolution Log.
- Develop initial cost estimates for Implementation.
- Make a list for the Owner focused on things requiring their review and decisions.

    Include ADORB cost breakdown.
- CxP assists the Owner in narrowing approaches to meeting CFR, and updating the retrofit phase plan.
- Update the M&V and Maintenance plans.

Investigation

8.7.1 Roles & Responsibilities

8.7.2 Update the Cx Team

8.7.3 Update the CFR

8.7.4 Review Facility Docu

8.7.5 Update Cx Plan

8.7.6 Perform Site Inv & Tests

8.7.7 Issues Analysis & Recom

8.7.8 Investigation Report

8.7.9 Deliverables

Updated Cx Plan

Updated Cx Report

add Investigation Report

8.7.10 Acceptance

Proceed if/when **Owner and Authority** approve

Phius Certification Process – REVIVE 2024

AIA Project Phases	Phius Benchmarks	Phase Summary
Design Development (DD) / Construction Drawings (CD)	**Phase 3** Design & Review	**3.1.6 Design** -Selection of design approach based on performance modeling completed during the investigation phase **3.1.6 Design Review** -CxP document upload -Phius Review & Feedback -CxP Revisions & Response -Repeat (as needed)
Bidding & Procurement	**Milestone 3** Design Certification	**3.1.7 Design Certification** -The design is certified by Phius. An official letter of design certification will be sent to the design team

Design

8.8.1 Select a Specific Approach

…select a specific approach to meeting the performance requirements of this standard and the other requirements of the CFR.

Deliverables

Design Review Report

Design Team's Response

SUPPORTED IN THE WORKBOOK

8.8.2 Basis of Design

If the services of design professionals are involved…

Documents the Designer's approach to meeting the CFR.

Reviewed by Owner and CxP.

Examples:

- *STRUCTURAL DESIGN*
- *COMPLEX MECHANICALS*
- *ADDITION ARCHITECTURE*
- *WINDOW DETAILS*
- *FLOOD BARRIERS*
- *ELECTRICAL PANEL*

8.8.3 Design Review

Review by Owner and Authority, Cx Team responds.

Phius Certification Process – REVIVE 2024

Construction Administration (CA) / Commissioning (Cx)	**Phase 4.1** Implementation, Observation & Testing	**3.1.8 Onsite Review** -Rater/Verifier performs site visits and communicates all changes to the Submitter/CxP -All changes should be recorded in the Phius REVIVE Workbook **Multi-Phase Projects** -When all phases are complete, the project will be eligible to submit documentation for final certification
Post-Construction (PC)	**Phase 4.2** Final Review	**3.1.8 Final Review** -Rater/Verifier Provider document upload -Phius Review & Feedback -Rater/Verifier Provider Response -Repeat (as needed)
	Milestone 4 Final Certification	**3.1.9 Final Certification** -The as-built project is Final Certified by Phius when all project phases are complete. A digital certificate and physical plaque will be sent to the project team. -Building resumes typical or new intended operation

Implementation

8.9.1 Update the Cx Team

8.9.1.1 Select Providers

8.9.2 Implementation Plan

8.9.3 Implement

8.9.3.1 Submittal Review

8.9.4 Observation & Testing

8.9.5 Update Documentation

8.9.6 Deliverables

- Updated Cx Plan
- Design Review Report and the Design Team's response
- Submittal Review Report
- Updated Cx Report, adding the Implementation Report
- Updated Systems Manual materials

8.9.7 Acceptance

Proceed if/when **Owner and Authority** approve

8.9.2 Implementation Plan

For each measure, the Implementation Plan includes the following:

a. Participants in the implementation and their roles and responsibilities
b. Schedule of implementation coordinated with occupants, security, housekeeping, utilities, etc., for schedule impacts, outages and shutdowns, etc.
c. Scope of work with details of the work, including
    1. method of implementation,
    2. work required for enhancing persistence (maintenance) in support of the *OCx*, and
    3. verification procedures and responsibilities

Informative note: Training is to take place in the Hand-Off Phase but, per Section 8.9.5.3.9 Training Documentation, there may be opportunities for training during implementation and verification and those should be documented if they occur.

8.9.2.2 The **Owner** shall review and accept the Implementation Plan prior to implementation.

8.9.3 Implement

Do it.

Update the Cx Report with the progress and results as they become available.

8.9.3.1 Submittal Review per ASHRAE 202 Section 11

11.1 For construction or renovation projects requiring contractor or supplier submittals, a submittal documents review for commissioned systems and assemblies shall be performed to evaluate compliance with the [CFR]. …

11.2 Requirements …

11.2.2 The Cx Provider **(CxP) shall** identify construction submittals to be provided by the contractor for the systems being commissioned.

11.2.3 The **CxP shall** review the construction submittals concurrently with the designers and provide comments to the designer.

11.2.4 The designer shall consider the CxP's comments and provide direction to the contractor in accordance with the designer's best professional judgment. A copy shall be **provided to the CxP**. …

11.3 Acceptance

11.3.1 The **CxP shall** maintain a record of all Cx submittal reviews and shall submit a written report to the Owner and design authority. If it is determined that any reviewed submittals do not comply with the [CFR], that submittal shall be provided to the Owner to determine whether the system or equipment shall be accepted or rejected.

8.9.4 Implementation Observation & Testing

8.9.4.1 Introduction. The proper installation, coordination, testing, and interaction among commissioned systems and assemblies shall be evaluated by the **V&T Provider**. …

8.9.4.2.2 Checklists and test procedures with necessary report forms shall be developed after submittal approval and used during equipment or assembly installation. All completed checklists and test reports shall be included in the final Cx Report. …

8.9.4.2.2.a Project-specific construction checklists and testing procedures shall be established for review by the Owner and appropriate team members.

8.9.4.2.2.c Whenever a test data result is required for a specific system or assembly, there shall be an item in the associated construction checklist for the test data to be **submitted to the Cx Provider (CxP)**. …

8.9.4 Implementation Observation & Testing

8.9.4.2.4 Implementation Kick-off Meeting. The **CxP shall** coordinate Cx Activities at the beginning of the construction process and at other times as necessary. After updating and creating the Cx Plan documents noted above, and prior to commencing actual implementation of the recommendations, the **Cx Team shall conduct a kick-off meeting** with the Owner's representative, V&T Provider, and any selected outside providers and/or contractors. The purpose of the meeting is to review the roles of each party, resolve any misunderstandings, finalize the schedule, and ensure the updated Cx Plan is as complete as needed by the Owner and the Authority.

During the meeting the following shall take place:

a. Review the updated Cx Plan.
b. Review the specific roles and responsibilities of contractors or consultants and the Owner's in-house staff to clarify who will implement.

8.9.4 Implementation Observation & Testing

8.9.4.2.5 “Receiving and Installing”

a. What was specified and submitted vs what was delivered.
b. Equipment condition at delivery and at installation.
c. Evaluate proper installation.

Informative: Conducting site visits for verification. Periodically, appropriate Cx Team *members should visit the job site to verify installation of the selected measures. These visits provide an opportunity to identify issues early in the implementation that may not be able to be resolved later or cost more to resolve later.*

8.9.4 Implementation Observation & Testing

8.9.4.2.6 Executing Test Procedures

a. Once construction checklists and test procedures are established, the responsible entities shall execute relevant test protocols and repeat testing as necessary until equipment, systems, or assemblies being tested pass all tests.
b. The **V&T Provider directs, witnesses, and documents the tests** conducted by the Project Team as required by the Cx Plan.
c. Completed test reports shall be submitted to the Project Team for review and **to the CxP** for evaluation. …

8.9.4 Implementation Observation & Testing

OOPS

~~8.9.4.1~~ 8.9.4.3 Enclosure Air-Tightness Testing

Verify by one of the following methods:

- ANSI 380
- ASTM E779
- ASTM E1827, two-point method.
- ASTM E3158
- ASTM E741
- CAN/CGSB-149.10-2019, as-operated, guarded.
- ZMPT

For the methods that involve testing the enclosure zone-by-zone, enough zones shall be tested to cover the entire enclosure.

The testing shall be done after any changes that affect the air barrier, such as fenestration changes and penetrations for pipes, ducts, and wiring, or the installation of sleeves for such penetrations.

Informative note: Only doing blower door compartmentalization tests might create an unsafe condition for occupants by disturbing asbestos-containing materials - whole-building test not as risky.

8.9.5 Update the Cx Documentation

8.9.5.1 CFR

8.9.5.2 Cx Plan

- Updated Phase Plan
- M&V Documentation
- Maintenance Strategies

8.9.5.4 Owner Electives

- *Supplements 8.9.5.3.8*

8.9.5.5 Systems Manual Materials

FOR USE IN THE HANDOFF PHASE

8.9.5.3 Cx Report

0. Executive summary
1. Update performance analysis
3. New discoveries
5. Test Documentation
6. Issues & Resolution Log
7. Site visit records
8. Verification documentation
9. Training documentation

Implementation

8.9.1 Update the Cx Team

8.9.1.1 Select Providers

8.9.2 Implementation Plan

8.9.3 Implement

8.9.3.1 Submittal Review

8.9.4 Observation & Testing

8.9.5 Update Documentation

8.9.6 Deliverables

- Updated Cx Plan
- Design Review Report and the Design Team's response
- Submittal Review Report
- Updated Cx Report, adding the Implementation Report
- Updated Systems Manual materials

8.9.7 Acceptance

Proceed if/when **Owner and Authority** approve

Handoff

8.10.1 Roles and Responsibilities

8.10.2 Develop OCx Plan

8.10.3 Assemble Systems Manual

8.10.4 Train Facility Personnel

8.10.6 Lessons-Learned Workshop (if elected)

8.10.7 Finalize Cx Report

8.10.8 Project Docs to Owner

8.10.9 Deliverables

- Cx Report
- Systems Manual
  - Facility Guide
- OCx Plan

Handoff

8.10.1.2 Cx Team Responsibilities

a. Deliver the Systems Manual, and conduct training. Training shall include avoiding operation mistakes, modifications implemented, and associated reasoning associated with the modifications.
b. Conduct lessons-learned workshop/meeting (per section 8.10.6, if elected per section 8.6.5.6.)

Handoff

8.10.2 Develop OCx Plan

The OCx Plan is the guiding document for

- how the facility's condition and performance will be monitored and evaluated,
- what systems or features will be included,
- what parameters will be tracked, and
- how deviations from the CFR will be corrected.

Informative: Guidance appropriate to single-family homes can be found in the Healthy Homes Maintenance Checklist from the National Center for Healthy Housing.

It has the following sections:

- *Yard and Exterior*
- *Garage*
- *Exterior Roof, Walls, and Windows*
- *Basement and Crawlspace*
- *Attic*
- *Interior Walls, Ceilings, Windows, and Doors*
- *HVAC Equipment filters*
- *Plumbing and Fixtures*
- *Appliances*
- *Electrical Equipment*

Phius Certification Process – REVIVE 2024

AIA Project Phases	Phius Benchmarks	Phase Summary
On-going Commissioning (OCx)	**Phase 5.1** Monitoring	**3.1.10 Monitoring** -Non-residential projects are required to register with and allow Phius access to the Energy Star Portfolio Manager
	Phase 5.2 Ongoing Commissioning (Optional)	**3.1.10 Ongoing Commissioning (OCx) & Monitoring Electives** -Additional monitoring and commissioning electives are encouraged for all projects, but not required

8.11 Ongoing Commissioning

8.11.1 Introduction

8.11.2 Assemble the OCx Team

8.11.3 Update the OCx Plan

8.11.4 Verify achievement of CFR

8.11.5 Investigate Unacceptable Outcome

8.11.6 Implement Recommendations

8.11.7 Update Systems Manual

8.11.8 Update Personnel Training

8.11.9 Write & Deliver OCx Report

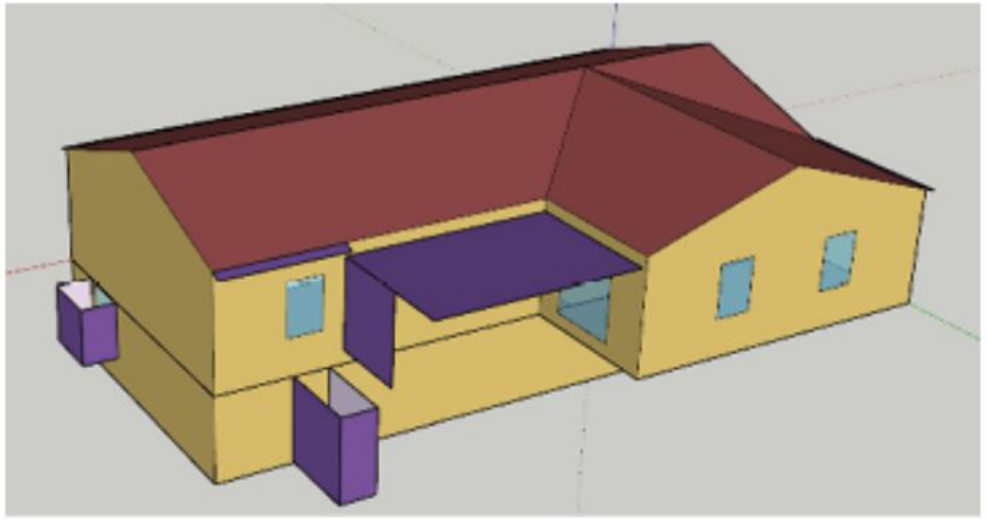
8.11.10 Deliverables

- Updated *OCx* Plan
- Updated *Systems Manual*
- *OCx* Report (made periodically)

8.11.11 Acceptance

Continue if Owner approves, and Authority if so required.

Single Family Deep Dive: KMR



Standard Sections: 4.5, 8.6-8.7
Guidebook Sections: 3.1.4 & 3.4

Agenda

- Group Exercise - What's your process?
- KMR Background
  - Existing conditions
  - Scope / Outcome goals
- Assessments
  - Site Hazards Assessments / Electives
  - EPA Assessments / Electives

A & I Workbook Walkthrough will be integrated throughout

- Next up: Modeling

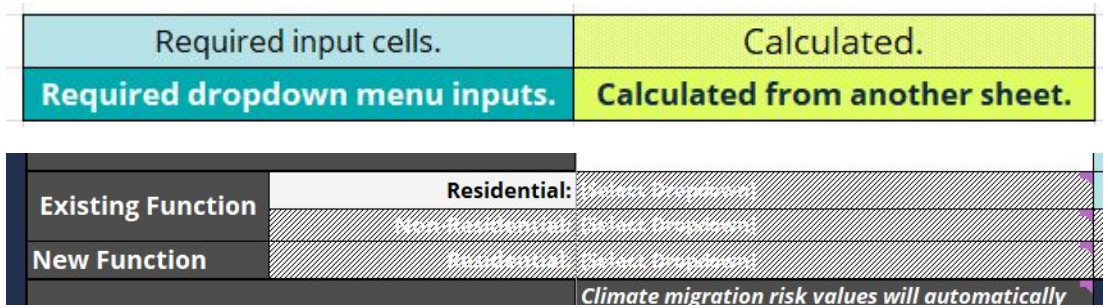
Group Exercise

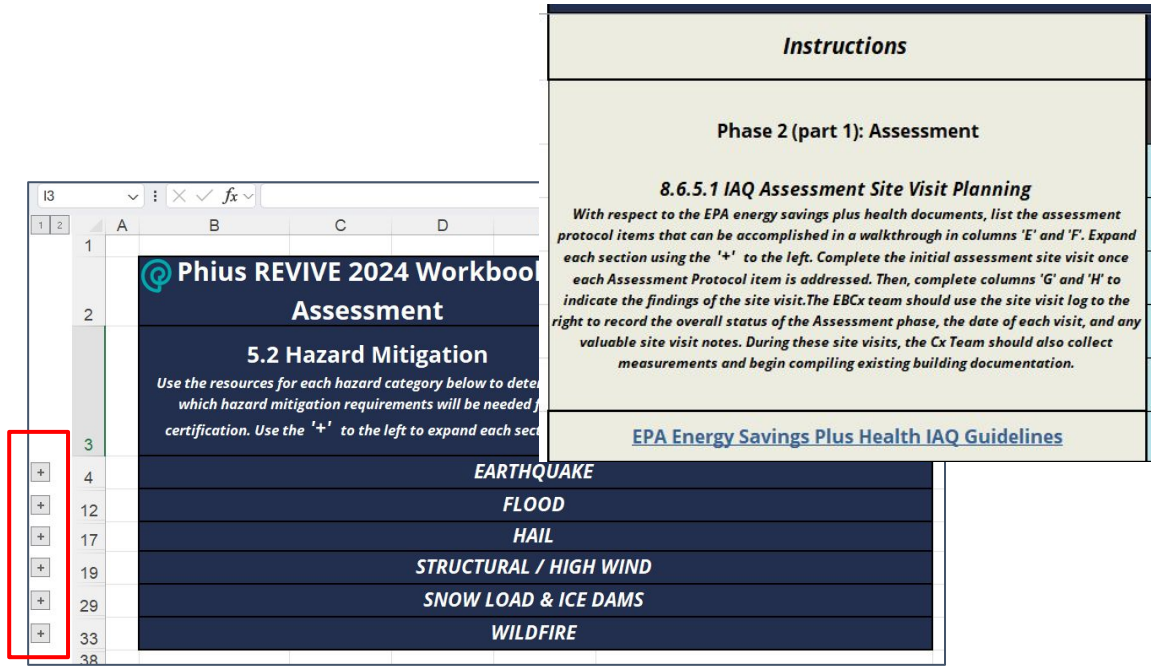
You've just been hired to retrofit a single family home. The client is interested in the trendy "deep energy retrofit". What's your process?

1. ...

Assessment & Investigation Workbook Overview

- Same color scheme used in typical Phius calculators
- Work through tabs and sections in order: top to bottom, left to right
- As information is filled out, sections of the workbook that are not applicable will automatically ‘gray out’
- Many instructions and resources are built into the calculator
- Use the ‘+’ on the to the left of the worksheets to expand and close sections as you work through





KMR Background

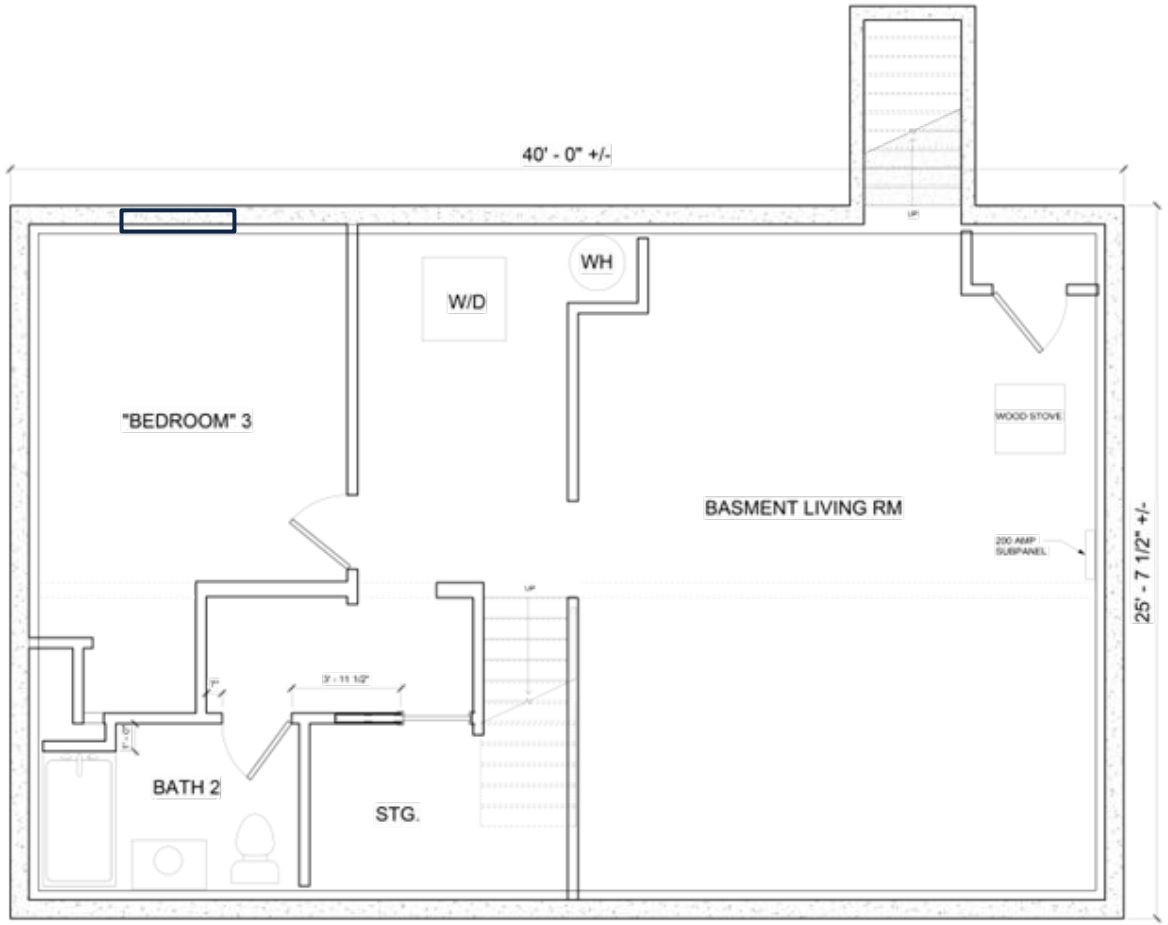
- ~2,100 sf single-family home
- Located in central Pennsylvania
- Project Details
  - 3 beds
  - 2 baths
    - 1 non-functional
    - 1 semi-functional
- Occupancy
  - 2 adults
  - 2 teenagers
  - 2 dogs
  - 1 elderly relative will need accommodations soon
- Existing Systems
  - Central AC is completely broken
    - Using 2 window AC units
  - Heating via electric baseboard
  - Fully electric (no combustion equipment)
  - Decommissioned wood stove in basement

KMR Existing Conditions - Exterior Photos

KMR Existing Conditions - Main Level

- Main house (1984)
  - Typical 2x6 wood-stud construction w/ FG
- Family room - addition
  - Crawlspace - insulation?
  - 2x4 walls w/ FG
- Garage - addition (?)
  - Uninsulated concrete slab on grade
  - AHU in ceiling above
  - 2x4 walls w/ FG
- Baseboard installed at red lines

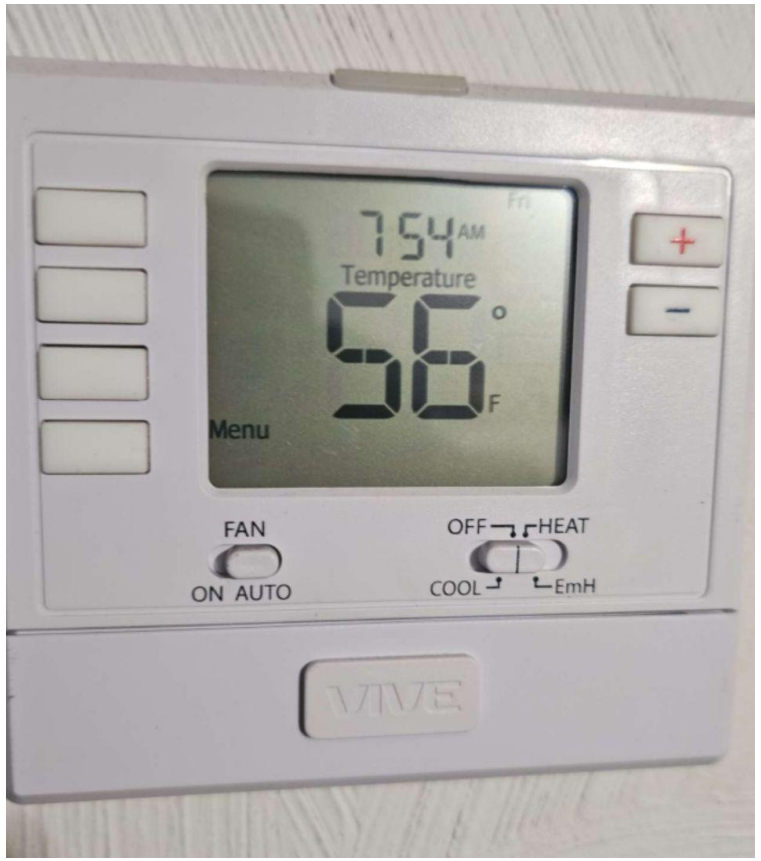
KMR Existing Conditions - Basement



- Typical 8” CMU foundation
- Framed wall to interior
  - Insulated?
  - Does not occur at laundry/equip room or former wood-storage closet
- Assuming uninsulated 4” concrete slab
- Egress via bilco doors
- Laundry (vented exhaust dryer) / HWH location
- Decommissioned wood stove
  - Existing flue - currently stuffed with fiberglass
- Decommissioned Bedroom 3
  - Infilled window
  - Likely done when family room was added
- Baseboard is not used in the basement

KMR Scope / Outcome Goals

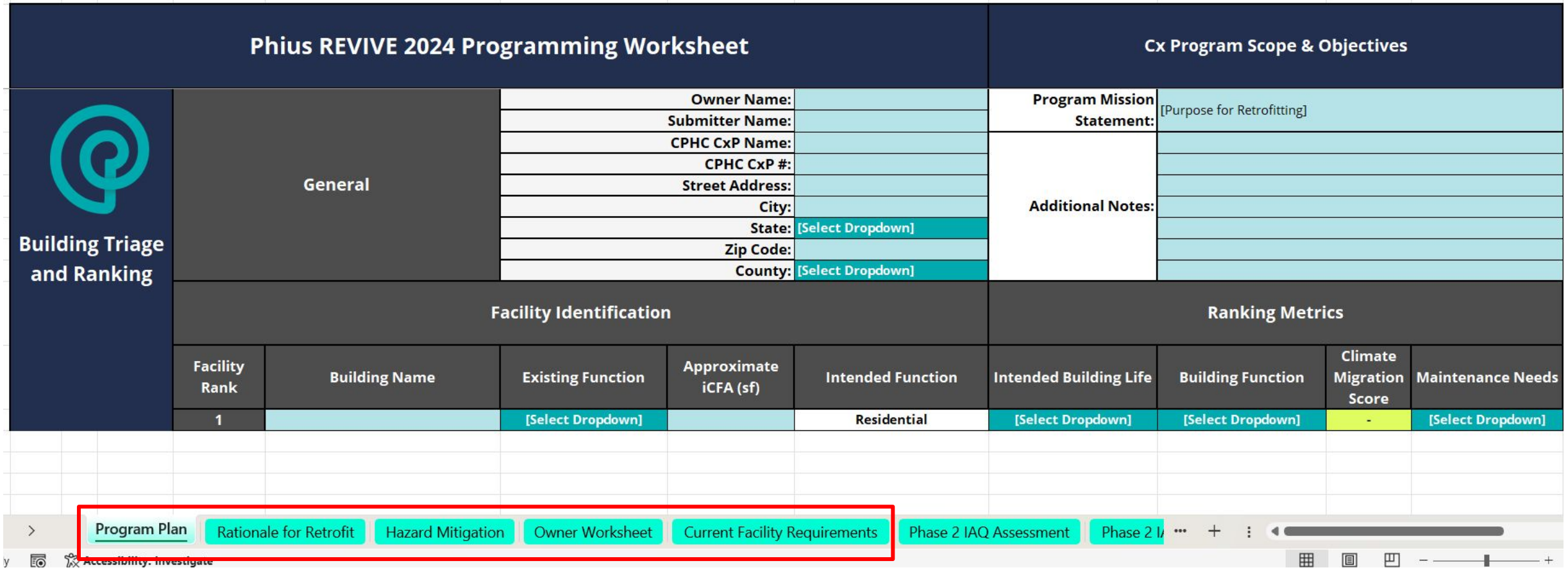
- Reduce energy bills
- Improve indoor comfort
- Improve durability / existing deficiencies
- Fix plumbing issues / leaks
- Replace broken mechanical systems
- Accommodate elderly relative via conversion of garage to ADA suite



Retrofit to Phius REVIVE ~~2021~~ 2024 Standard

REVIVE Process Checkpoint

Standard Sections: 4.5, 8.6 Guidebook Sections: 3.4.2.3 - 3.4.2.7



Phius REVIVE 2024 Programming Worksheet

Cx Program Scope & Objectives

Building Triage and Ranking

General

Owner Name:	
Submitter Name:	
CPHC CxP Name:	
CPHC CxP #:	
Street Address:	
City:	
State:	[Select Dropdown]
Zip Code:	
County:	[Select Dropdown]

Program Mission Statement:	[Purpose for Retrofitting]
Additional Notes:	

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		[Select Dropdown]		Residential	[Select Dropdown]	[Select Dropdown]	-	[Select Dropdown]

Program Plan | Rationale for Retrofit | Hazard Mitigation | Owner Worksheet | Current Facility Requirements | Phase 2 IAQ Assessment | Phase 2 I…

Program Plan

Phius REVIVE 2024 Programming Worksheet						Cx Program Scope & Objectives			
Building Triage and Ranking	General	Owner Name:	Haley Kalvin-Gold			Program Mission Statement:	[Purpose for Retrofitting]		
		Submitter Name:	Haley Kalvin-Gold						
		CPHC CxP Name:	Graham Wright			Additional Notes:			
		CPHC CxP #:	12345						
		Street Address:	123 Sweet Street						
		City:	Boalsburg						
		State:	Pennsylvania						
		Zip Code:	16827						
		County:	Centre County						
	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	KMR	Residential	2,140	Residential	>30 yrs	No change	17	Moderate

Rationale for Retrofit

Phius REVIVE 2024 Workbook			CxP Required Information	Cx Team Notes
	General	Building/Facility Name:	KMR	
		Owner Name:	Haley Kalvin-Gold	
		Submitter Name:	Haley Kalvin-Gold	
		CPHC CxP Name:	Graham Wright	
		CPHC CxP #:	12345	
		Project Address:	123 Sweet Street	
		City:	Boalsburg	
		State:	Pennsylvania	
		Zip Code:	16827	
Rationale for Retrofit	4.5.1.1 Intended Building Life:		50-70 years	
	4.5.1.2 Building Functionality:		Existing function will be adjusted	Garage conversion
	Existing Function	Residential:	Select Dropdown	
		Non-Residential:	Select Dropdown	
	New Function	Residential:	Select Dropdown	

Inputs start here on this worksheet

Rationale for Retrofit	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	
		Wet Bulb Risk:	4	
		Farm Crop Risk:	3	
		Sea Level Rise Risk:	1	
		Wildfire Risk:	2	
		Economic Risk	4	
		Combined Risk:	**17**	
	4.5.1.3.2 Zoning	Typical Zoning Designation:	Residential	
		Specific Zoning Code:	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.*	X

A rationale for retrofit statement will generate based on all inputs up to this point

Hazard Mitigation

Phius REVIVE 2024 Workbook: Assessment	Site Hazard Mitigation Requirements
5.2 Hazard Mitigation *Use the resources for each hazard category below to determine which hazard mitigation requirements will be needed for certification. Use the '+' to the left to expand each section.*	Single Family Duplexes Townhomes
EARTHQUAKE	
5.2.1 Earthquake — Seismic Deisgn Category (SDC):	A
IRC 2021 R301.2.2	
w/i scope of FEMA P-50? (SF detached, wood frame)	[Select Dropdown]
Seismic Performance Grade:	[Select Dropdown]
Simplified Seismic Assessment Form	
Certification Requirement:	No requirement
Compliance Resources:	FEMA P-50-1
FLOOD	
HAIL	
STRUCTURAL / HIGH WIND	
SNOW LOAD & ICE DAMS	
WILDFIRE	

Resources on the left are used to determine your project's hazard zones

FLOOD		
5.2.2 Flood	FEMA Flood Zone (first letter only): How to Read a Flood Map (2022)	X-unshaded
	Certification Requirement:	No requirement
	Compliance Resources:	IBHS FORTIFIED Commercial (Sec 3.2.4 & 3.2.5)
HAIL		
5.2.3 Hail	Certification Requirement:	PV Modules must be FM Approved for hail. Refer to Section 3.3.2.2 of the Phius 2024 Certification Guidebook for alternate compliance paths for Flexible and Rigid PV Panels
STRUCTURAL / HIGH WIND		
5.2.4 Structural & High Wind	Dry stack foundation? IBHS FORTIFIED HOME Fig 2.1, 2.2, &2.3	No
	Ultimate design wind speed (Vult): IRC 2021 R301.2.1(1)	<115.0
	Certification Requirement (Foundation):	No requirement
	Certification Requirement (Roof):	IBHS FORTIFIED Roof (High Wind designation) or FEMA P-804 Sec. 4.1
	Compliance Resources:	HUD4930.3G IBHS FORTIFIED Home Sec 3 FEMA P-804 Sec 4.1

The project-specific certification requirement will generate based on the inputs above. The resource to reference for compliance with the certification requirement is linked below

Owner Worksheet

Phius REVIVE 2024 Workbook: Owner Worksheet			8.6.1 Facility Information	Additional Notes
	Facility Summary	Project Name:	KMR	
		Year Constructed:	1980-1990	
		Known Prior Renovations?	Yes	Family room & garage added after main house
		Existing iCFA (sf):	2,140	
		Number Bedrooms:	3	
		Number Bathrooms:	2	
		Existing Occupants:	4	
		Roof / Ceiling Insulation:	Unconditioned attic	
		Wall Construction:	Wood Stud	
		Foundation Type:	Heated Basement	Crawlspace, heated basement, & garage (SOG)
		Cooling System:	Window AC units	Central AC is broken
		Heating System:	Electric	Baseboard
		Hot Water System:	Electric	
		Ventilation System:	Direct exhaust (range hood, bath fan, etc)	Direct exhaust bathroom, recirc range hood
	Available Facility Documents	Construction Documents:	Not available	
		Sytems / Facility Manuals:	Not available	
		Existing consultant reports:	Not available	
		Utility rates / supplier info:	Provided to CxP	$0.19/kWh estimated
		Utility meter / submeter location:	Provided to CxP	
		Operations / maintenance report:	Not available	
		Annual maintence cost breakdown:	Not available	
		Onsite energy production:	Not available	
		Low-cost repair budget:	Not sure / need help	$100

Work with the owner to complete these sections. It's okay if they don't know information or don't have all of the facility documents.

Much of the 'facility summary' portion will become known once a site visit is completed, so skip if needed and come back to it later.

Budget to address things that can immediately be remediated during a walkthrough, like replacing smoke alarms or their batteries

All occupant survey items should be completed, along with any notes about specific complaints.

Could be presented as a survey, or work these things into a conversation about the general comfort and satisfaction within the home.

			8.6.2 Occupant Survey	Additional Notes
	General	Age Range of Occupants:	All ages	
	Noise	Acoustical Privacy:	Semi-private	
		Ambient noise negatively impacting concentration:	Distracting	Noisy highway behind house
	Thermal	Perception of Summer comfort:	Warm	AC units help in summer
		Perception of Winter comfort:	Cold	Drafty near doors and windows
	Visual	Adequate lighting for tasks / activities:	Adequate	
		Light quality:	Satisfied	
		Lighting color discrimination:	Neutral	
		Problematic light flicker:	Satisfied	
		Glare:	Satisfied	
		Difficulty seeing computer screen:	Satisfied	
		Adequacy of light levels:	Satisfied	
	Indoor air quality	Air Quality (general):	Stuffy / stale	
		Unpleasant odors:	None, n/a	

Current Facility Requirements (CFR)

General Requirement:			The retrofitted building shall meet the requirements of Phius REVIVE 2024. The retrofitted building shall also meet the owner-directed and owner-elected requirements listed below.		
Onwer-Elected Facility Requirements *Each owner-elected deliverable must be completed, proven, and accepted by Phius in order to become Final Certified. The Cx Team will be expected to address deliverables during Phase 2: Design*			**Requirement ID** *Work with the Owner to define specific facility requirements. Create a unique name for each owner-elected deliverable below*	**Description** *Briefly describe each owner-elected requirement*	**Date Added**
8.6.4.1 Facility Requirements	FR1 Regulatory	FR1.1	Basement Bedroom	Current basement bedroom is missing an egress window. Client would like to relocate bedroom to main living area of basement which will require the installation of a window in the basement.	10/21/2024
		FR1.2			
		FR1.3			
		FR1.4			
		FR1.5			
	FR2 Financial	FR2.1	Rebates / Assistance	Client wishes to prioritize keeping the out-of-pocket cost of retrofity low. Identify loccal / federal rebates or assistance programs for home upgrades	
		FR2.2			
		FR2.3			
		FR2.4			
		FR2.5			
		FR3.1	ADA Suite	Handicapped elderly relative moving in, client wishes to convert the garage to a private, accessible living space.	

Record any owner-elected requirements as they pertain to regulatory/code requirements, financial goals/budgets, functional requirements, or preferred vendors to complete the work

Then, summarize everything you know about the project so far including existing conditions and any known outcome goals defined in the sections below

Phius REVIVE 2024 Workbook: Current Facility Requirements (CFR)

Facility Summary *The Cx team should interpret and synthesize the information provided by the Owner up to this point. Create a comprehensive project narrative in the space to the right*	The Kalvin-Mulfinger Residence is an all-electric 3-bed, 2-bath, 2,140 sf single family home located in Boalsburg, Pennsylvania (CZ-5C). The home was constructed in 1987 as a 4-bed 2-bath house, and included the main level of the house, garage, and finished basement. A 290 sf bonus room and porch were added to the back side of the home between the time of construction and 2011, when the current owners moved in. The exact year of construction of the addition is unknown. The current full-time occupants include 2 adults and 2 dogs. 2 teenage boys also reside in the home ~10 days/month, and post renovation, 1 elderly adult will be moving in full-time. One adult works from home 2 days/week. The existing construction of above grade walls is 2x6 studs with fiberglass batt cavity insulation. The ceiling is also insulated with fiberglass batts between 2x6 truss chords, with an unconditioned attic space above. The foundation walls of the basement are constructed of CMU block, and are framed with 2x4 insulated studs to the interior in most areas, excluding the laundry room wall. The bonus room is constructed over a crawl space, and the garage is slab-on-grade, typical. The existing heating system is electric baseboard. The cooling system was central air, with a Lennox CU/AHU. The AHU has failed due to its location in the unconditioned attic space, and no longer provides cooling to the home. In the cooling season, 2 window AC units are used to cool the house, along with ceiling fans. There is an existing EStar rated electric water heater connected to uninsulated copper piping. There is an existing radon mitigation system in place, believed to be a passive system. If not passive, no fan can be heard, so the assumption would be that it will need to be replaced/serviced.

Current Facility Requirements (CFR)

Ongoing Comissioning / Measurement & Verification Non-residential project teams should confirm their intent to register with Energy Star Portfolio Manager using the Dropdown meny below (7.4.1). ALL other M&V items below are electives ONLY and will not impact certification.			M&V Electives	Additional Notes	Date Added
8.6.4.2 OCx / M&V Elevtives	7.1 Indoor Environment	Hazardous Gas 7.1.1	None		
		IEQ 7.1.2	RESET Air Standard		
	7.2 Energy End-Use	MELs 7.2.1	No		
		Dehumidification 7.2.2	No		
		Heating 7.2.3	No		
		Cooling 7.2.4	No		
		DHW 7.2.5	No		
		Lighting 7.2.6	No		
		Appliances 7.2.7	No		
		Humidification 7.2.8	No		
	7.3 Water Quality	RESET 7.3.1	No		
	*7.4 Waste / Materials	ES Portfolio Mgr. 7.4.1	Yes		
*Required for Nonresidential Projects only					

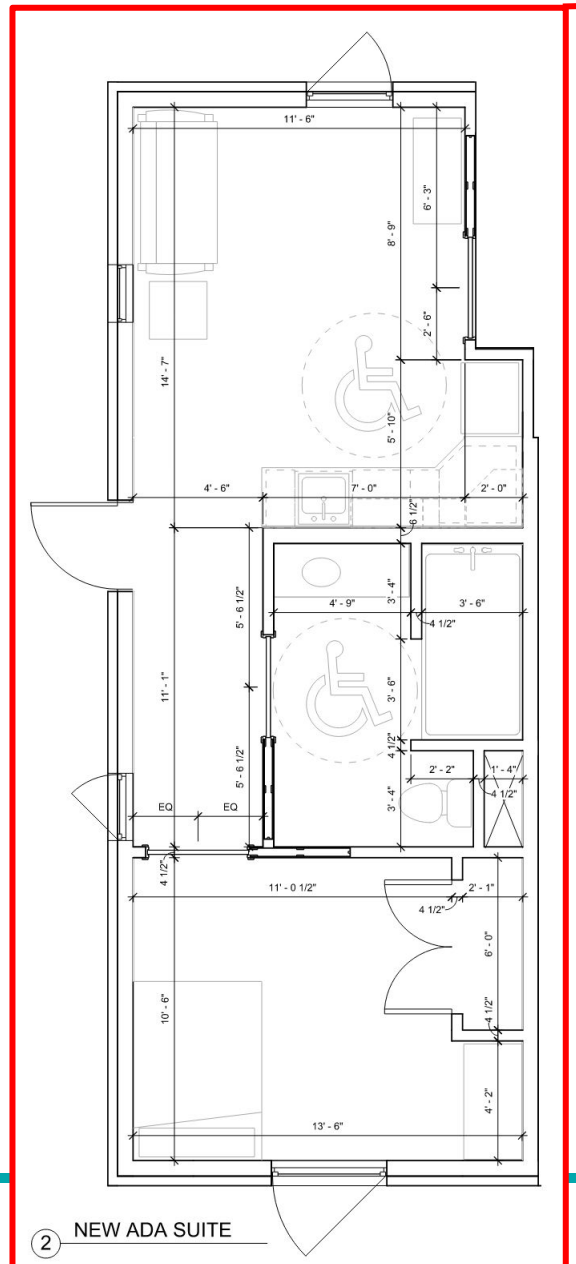
All OCx / M& V Electives are optional, but encouraged :)

KMR Scope / Outcome Goals

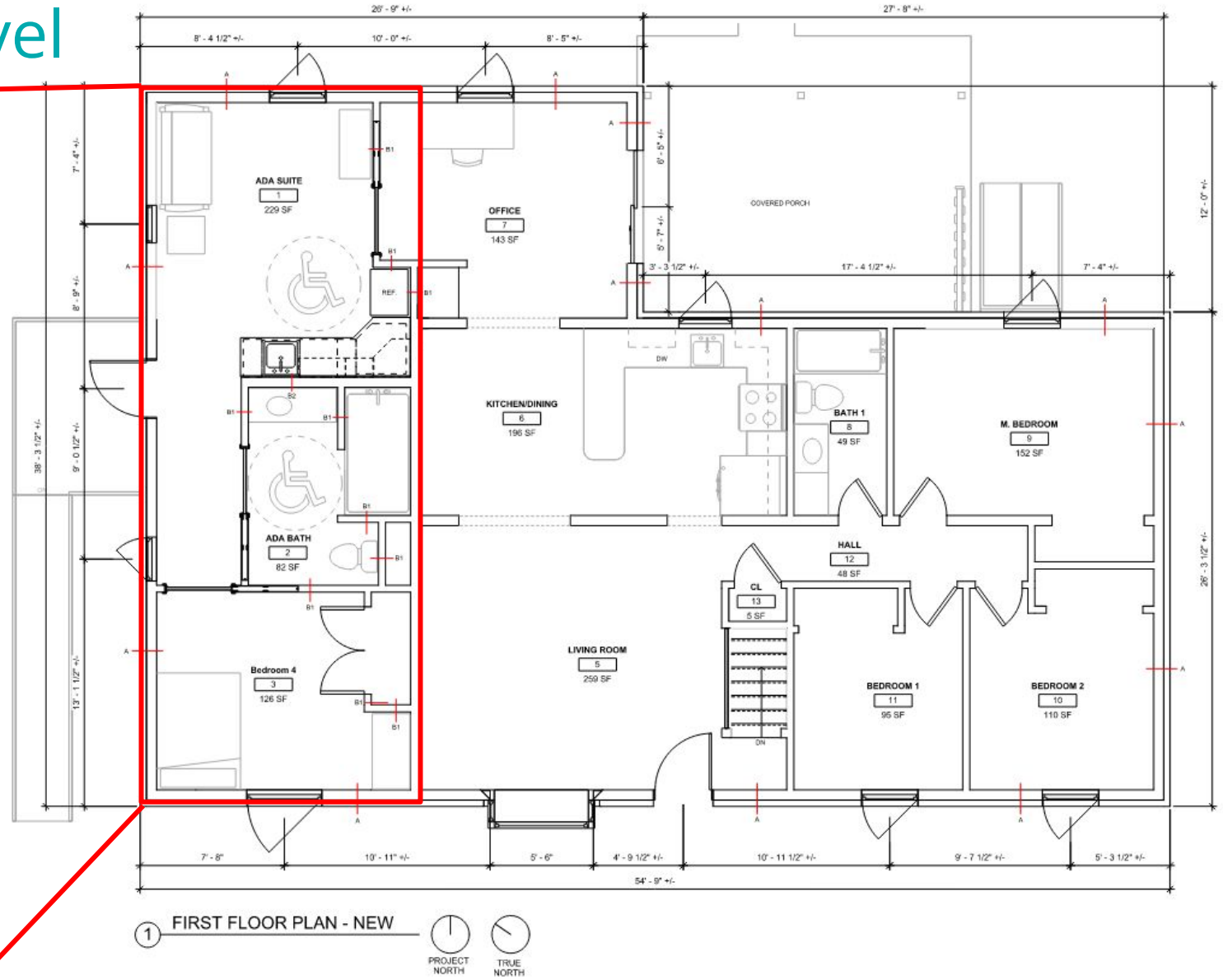
- Reduce energy bills
- Improve indoor comfort
- Improve durability / existing deficiencies
- Fix plumbing issues / leaks
- Replace broken mechanical systems
- Accommodate elderly relative via conversion of garage to ADA suite

Since I knew the envelope would grow, but not beyond the existing structure, I started by designing the new interior layout with the garage brought into the thermal envelope and the basement bedroom relocated *prior* to conducting the EPA Guideline Assessments. That way, I'd have the end goal in mind and could eliminate assessments for issues that I knew would already be remediated by the interior redesign, thereby saving me time on-site

KMR New Layout - Main Level



2 NEW ADA SUITE

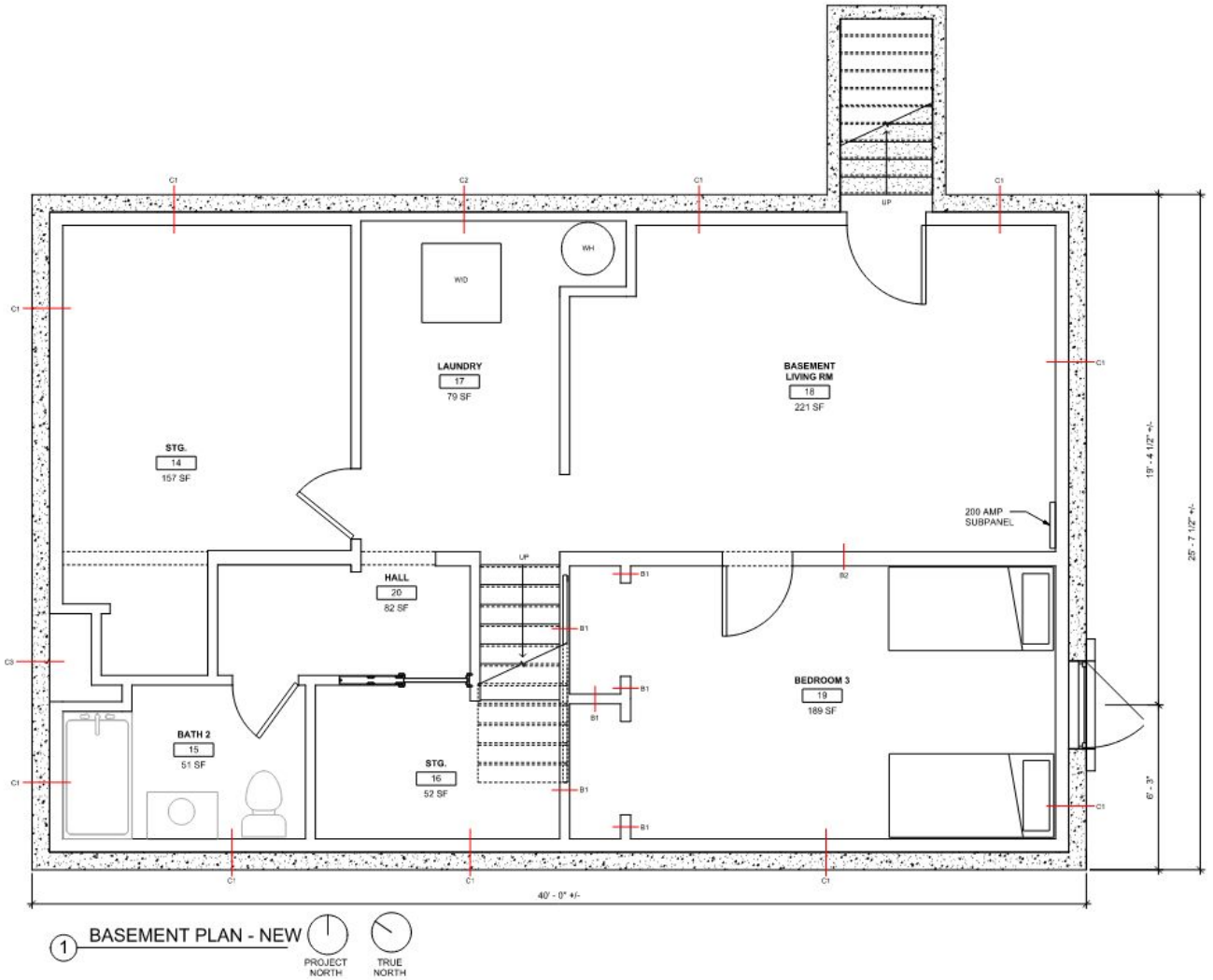


1 FIRST FLOOR PLAN - NEW

PROJECT NORTH

TRUE NORTH

KMR New Layout - Basement



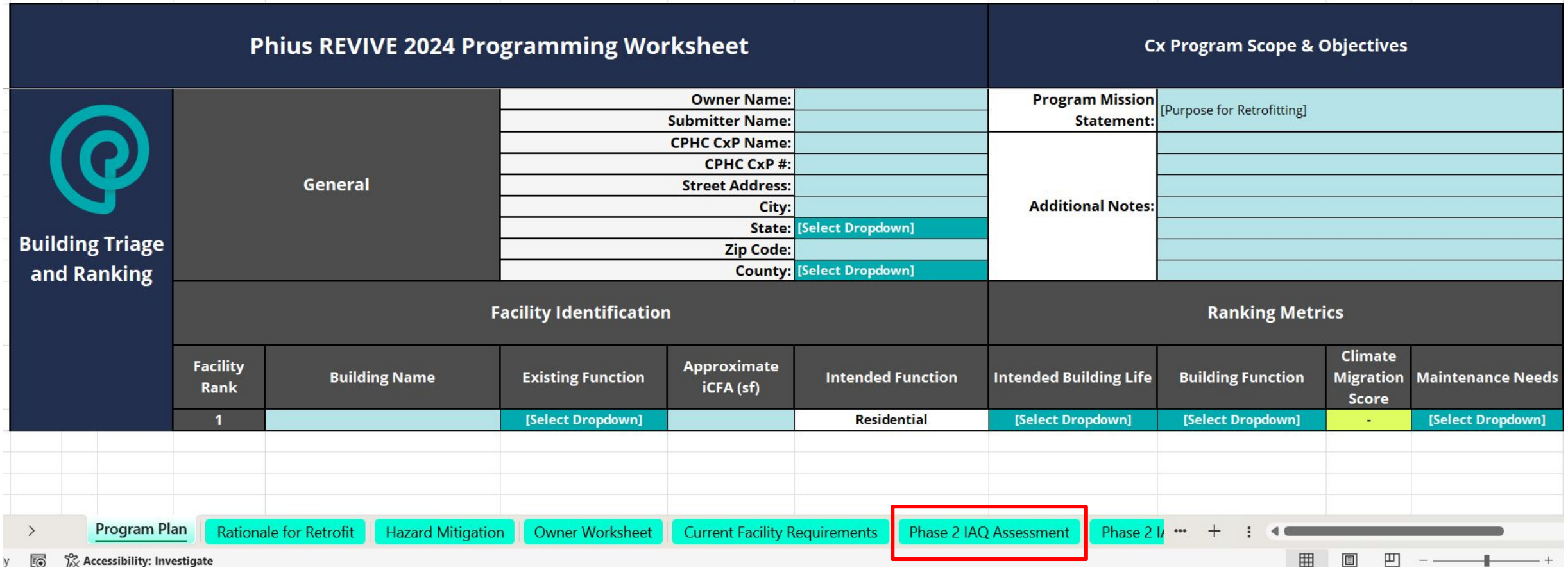
At this point, I had enough information about the physical characteristics of the project pre- and post-retrofit, I was able to begin the creation of the 3D geometry for both cases to use in **REVIVEcalc**

REVIVE Process Checkpoint: Assessment Planning

Think “walkthrough”

Standard Section: 8.6

Guidebook Section: 3.4.2.8



Phius REVIVE 2024 Programming Worksheet						Cx Program Scope & Objectives			
Building Triage and Ranking	General	Owner Name:				Program Mission Statement:	[Purpose for Retrofitting]		
		Submitter Name:							
		CPHC CxP Name:				Additional Notes:			
		CPHC CxP #:							
		Street Address:							
		City:							
		State:	[Select Dropdown]						
		Zip Code:							
		County:	[Select Dropdown]						
	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		[Select Dropdown]		Residential	[Select Dropdown]	[Select Dropdown]	-	[Select Dropdown]

Program Plan | Rationale for Retrofit | Hazard Mitigation | Owner Worksheet | Current Facility Requirements | Phase 2 IAQ Assessment | Phase 2 I

Accessibility: Investigate

Phase 2 IAQ Assessment Planning

Phius REVIVE 2024 Workbook: Assessment

Instructions	Site Visit Log			
	Team Members	Assessment Complete?	Date	Notes
Phase 2 (part 1): Assessment ***8.6.5.1 IAQ Assessment Site Visit Planning*** *With respect to the EPA energy savings plus health documents, list the assessment protocol items that can be accomplished in a walkthrough in columns 'E' and 'F'. Expand each section using the '+' to the left. Complete the initial assessment site visit once each Assessment Protocol item is addressed. Then, complete columns 'G' and 'H' to indicate the findings of the site visit.The EBCx team should use the site visit log to the right to record the overall status of the Assessment phase, the date of each visit, and any valuable site visit notes. During these site visits, the Cx Team should also collect measurements and begin compiling existing building documentation.*		[Select Dropdown]		
		[Select Dropdown]		
		[Select Dropdown]		
		[Select Dropdown]		
		[Select Dropdown]		
EPA Energy Savings Plus Health IAQ Guidelines		[Select Dropdown]		

Priority Issue 1: Asbestos		CxP Assessment Planning Notes *Complete pre-assessment*	Assess or Defer	CxP As
Asbestos	AP1.1 Determine Potential Asbestos Hazard	Year built 1984 - not concerned about asbestos	No concern	

No entries yet since we're in the planning phase and haven't yet completed the Assessment Site Visit

Phius REVIVE 2024 Workbook: Assessment

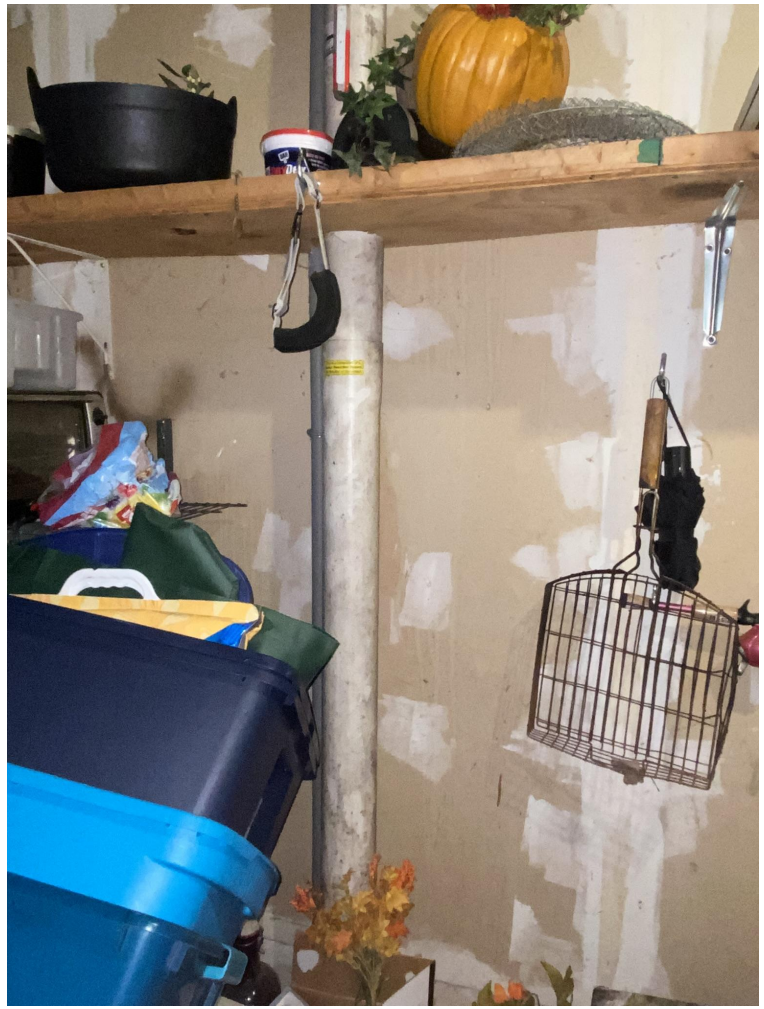
Priority Issue 1: Asbestos		CxP Assessment Planning Notes *Complete pre-assessment*	Assess or Defer	CxP Assessment Reporting Notes *Complete post-assessment*	Status?
Asbestos	AP1.1 Determine Potential Asbestos Hazard	Year built 1984 - not concerned about asbestos	No concern		[Select Dropdown]
Priority Issue 2: Below Ground Contaminants (Except Radon)		**CxP Assessment Planning Notes *Complete pre-assessment***	**Assess or Defer**	**CxP Assessment Reporting Notes *Complete post-assessment***	**Status?**
Below Ground Contaminants (except radon)	AP2.1 Evaluate Sources	All electric - no major concern about gasoline or fuel oil except possibly runoff from nearby highway, so probably no for gasoline or fuel. No current occupant complaints	No concern		[Select Dropdown]
	AP2.2 Evaluate Sewer Vent System	Defer to investigation phase	Defer to investigation		[Select Dropdown]
Priority Issue 3: Building Products & Material Emissions		**CxP Assessment Planning Notes *Complete pre-assessment***	**Assess or Defer**	**CxP Assessment Reporting Notes *Complete post-assessment***	**Status?**
Building Products / Material Emissions	AP3.1 Assess Product Choices	Defer to investigation phase	Defer to investigation		[Select Dropdown]
	AP3.2 Carpet	Existing carpet in the basement has been wetted by lumbing leaks from above. Assess carpet during walkthrough	Walkthrough assessment		[Select Dropdown]
	[illegible] Ventilation	Assess kitchen and bath exhaust during walkthrough	Walkthrough assessment		[Select Dropdown]
Priority Issue 4: CO & Other Combustion Appliance Emissions		**CxP Assessment Planning Notes *Complete pre-assessment***	**Assess or Defer**	**CxP Assessment Reporting Notes *Complete post-assessment***	**Status?**
CO & Other Combustion Appliance Emissions	AP4.1 Conduct Assessment of CO Sources	Document all existing combustion equipment during walkthrough. System to be removed	Walkthrough assessment		[Select Dropdown]

Use the first column to create a plan to address all of the assessment protocol items per EPA ES+H. Use the second column to indicate whether it can be accomplished during a walkthrough, should be deferred to the investigation phase (i.e. radon testing), or is of known concern.

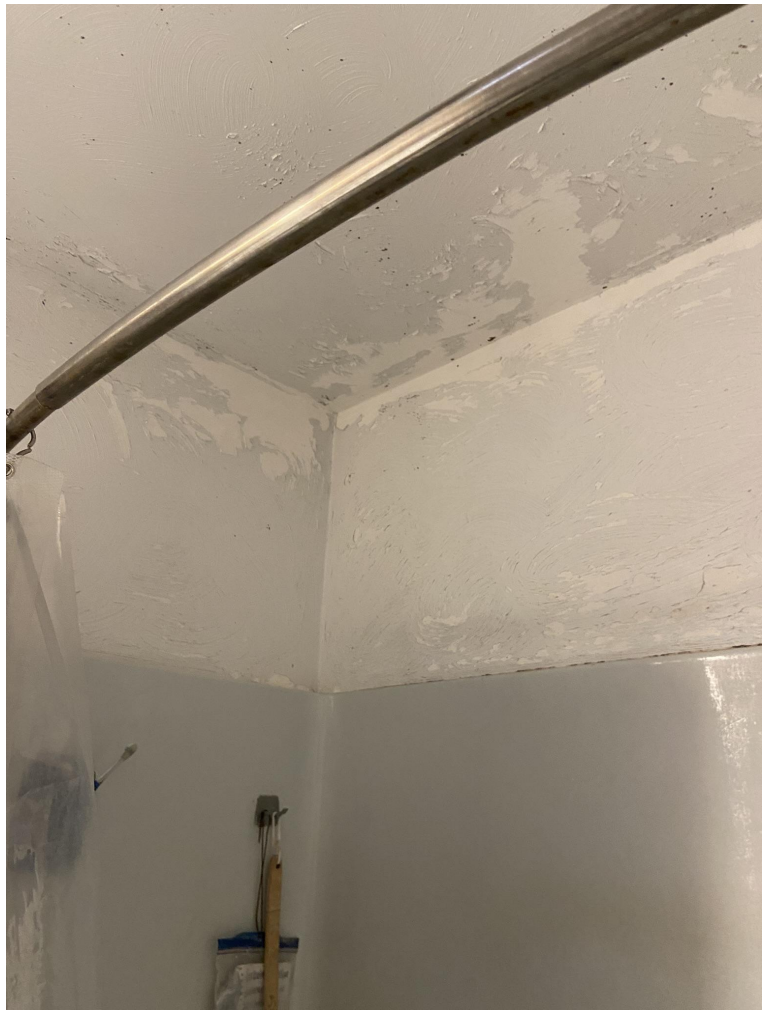
KMR Existing Conditions - Systems

KMR Existing Conditions - Systems

KMR Existing Conditions - Systems



KMR Existing Conditions - Mold / Moisture



Existing Conditions (not pictured)

- Main level plumbing leak into basement below
  - Recurring event, toilet has a tendency to continuously run
  - Clear water damage to basement wall/ceiling, possible mold issue
  - Basement carpet has definitely been wetted by these events
- Mouse droppings in attic
- Exhaust dryer vent disconnected
- Visible holes to outside around front and back doors

REVIVE Process Checkpoint: Assessment Reporting &...

What happened during the walkthrough? Standard Section: 8.6 Guidebook Section: 3.4.2.8

Phius REVIVE 2024 Programming Worksheet						Cx Program Scope & Objectives			
Building Triage and Ranking	General	Owner Name:				Program Mission Statement:	[Purpose for Retrofitting]		
		Submitter Name:							
		CPHC CxP Name:				Additional Notes:			
		CPHC CxP #:							
		Street Address:							
		City:							
		State:	[Select Dropdown]						
		Zip Code:							
		County:	[Select Dropdown]						
	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		[Select Dropdown]		Residential	[Select Dropdown]	[Select Dropdown]	-	[Select Dropdown]

Program Plan | Rationale for Retrofit | Hazard Mitigation | Owner Worksheet | Current Facility Requirements | Phase 2 IAQ Assessment | Phase 2 I...

Accessibility: Investigate

Phase 2 IAQ Assessment Reporting

Phius REVIVE 2024 Workbook: Assessment

Instructions	Site Visit Log			
	Team Members	Assessment Complete?	Date	Notes
Phase 2 (part 1): Assessment ***8.6.5.1 IAQ Assessment Site Visit Planning*** ***With respect to the EPA energy savings plus health documents, list the assessment protocol items that can be accomplished in a walkthrough in columns 'E' and 'F'. Expand each section using the '+' to the left. Complete the initial assessment site visit once each Assessment Protocol item is addressed. Then, complete columns 'G' and 'H' to indicate the findings of the site visit.The EBCx team should use the site visit log to the right to record the overall status of the Assessment phase, the date of each visit, and any valuable site visit notes. During these site visits, the Cx Team should also collect measurements and begin compiling existing building documentation.***	HKG / GW	No / Incomplete	3/1/2024	
	HKG / GW	All AP items addressed or deferred.	4/1/2024	
		[Select Dropdown]		
		[Select Dropdown]		
		[Select Dropdown]		
EPA Energy Savings Plus Health IAQ Guidelines		[Select Dropdown]		

Create a new entry for each site visit. Note whether or not all assessment items have been addressed, enter the date of the site visit, and any important notes about the visit (i.e. where you left off the last time, things that still need addressed, etc)

Phius REVIVE 2024 Workbook: Assessment

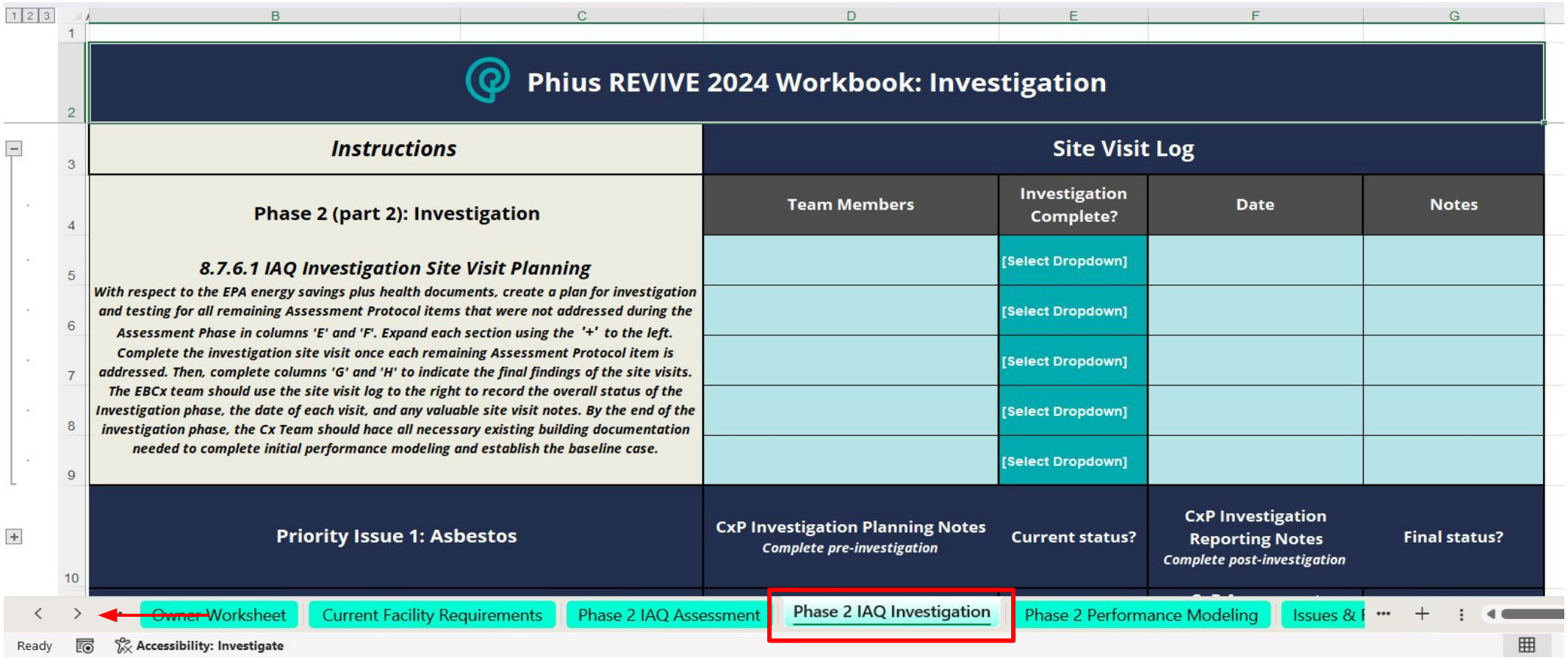
Priority Issue 1: Asbestos		CxP Assessment Planning Notes *Complete pre-assessment*	Assess or Defer	CxP Assessment Reporting Notes *Complete post-assessment*	Status?
Asbestos	AP1.1 Determine Potential Asbestos Hazard	Year built 1984 - not concerned about asbestos	No concern	Year built 1987 - not concerned about asbestos.	No further investigation required
Priority Issue 2: Below Ground Contaminants (Except Radon)		**CxP Assessment Planning Notes** *Complete pre-assessment*	**Assess or Defer**	**CxP Assessment Reporting Notes** *Complete post-assessment*	**Status?**
Below Ground Contaminants (except radon)	AP2.1 Evaluate Sources	All electric - no major concern about gasoline or fuel oil except possibly runoff from nearby highway, so probably no for gasoline or fuel. No current occupant complaints	No concern	No concern.	No further investigation required
	AP2.2 Evaluate Sewer Vent System	Defer to investigation phase	Defer to investigation	Deferred	Needs further investigatio
Priority Issue 3: Building Products & Material Emissions		**CxP Assessment Planning Notes** *Complete pre-assessment*	**Assess or Defer**	**CxP Assessment Reporting Notes** *Complete post-assessment*	**Status?**
Building Products / Material Emissions	AP3.1 Assess Product Choices	Defer to investigation phase	Defer to investigation	Deferred	Needs further investigatio
	AP3.2	Existing carpet in the basement has been wetted by lumbing leaks from above. Assess carpet during walkthrough	Walkthrough assessment	Possible mold in the carpet. Replace with hard surface flooring	Remediation required
	AP3.3 Ventilation	Assess kitchen and bath exhaust during walkthrough	Walkthrough assessment	Direct exhaust from bathroom. Existing vent appears clogged Recirculation range hood	Remediation required
Priority Issue 4: CO & Other Combustion Appliance Emissions		**CxP Assessment Planning Notes** *Complete pre-assessment*	**Assess or Defer**	**CxP Assessment Reporting Notes** *Complete post-assessment*	**Status?**
CO & Other Combustion Appliance	AP4.1 Conduct Assessment of CO Sources	Document all existing combustion equipment during walkthrough. System to be removed	Walkthrough assessment	No working CO alarms found, existing combustion equipment is decommissioned and to be removed.	Remediation required

Use the right two columns to complete all site visit reporting notes, and indicate whether or not further investigation is needed, if remediation is required, or if the issue was able to be resolved during the walkthrough

REVIVE Process Checkpoint: Investigation Planning

Think “testing” / slightly disruptive but necessary investigation

Standard Section: 8.7 Guidebook Section: 3.4.2.9



Phius REVIVE 2024 Workbook: Investigation

Instructions	**Site Visit Log**			
Phase 2 (part 2): Investigation	**Team Members**	**Investigation Complete?**	**Date**	**Notes**
8.7.6.1 IAQ Investigation Site Visit Planning		[Select Dropdown]		
With respect to the EPA energy savings plus health documents, create a plan for investigation and testing for all remaining Assessment Protocol items that were not addressed during the Assessment Phase in columns 'E' and 'F'. Expand each section using the '+' to the left. Complete the investigation site visit once each remaining Assessment Protocol item is addressed. Then, complete columns 'G' and 'H' to indicate the final findings of the site visits. The EBCx team should use the site visit log to the right to record the overall status of the Investigation phase, the date of each visit, and any valuable site visit notes. By the end of the investigation phase, the Cx Team should hace all necessary existing building documentation needed to complete initial performance modeling and establish the baseline case.		[Select Dropdown]		
		[Select Dropdown]		
		[Select Dropdown]		
		[Select Dropdown]		

Priority Issue 1: Asbestos	**CxP Investigation Planning Notes** *Complete pre-investigation*	**Current status?**	**CxP Investigation Reporting Notes** *Complete post-investigation*	**Final status?**

Owner Worksheet | Current Facility Requirements | Phase 2 IAQ Assessment | Phase 2 IAQ Investigation | Phase 2 Performance Modeling | Issues & F

Ready Accessibility: Investigate

Phase 2 IAQ Investigation Planning

Phius REVIVE 2024 Workbook: Investigation

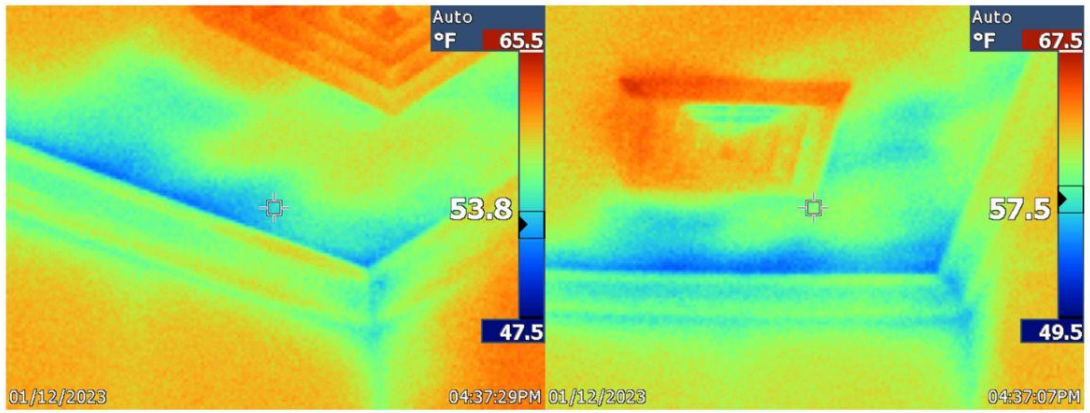
Instructions	Site Visit Log			
	Team Members	Investigation Complete?	Date	Notes
Phase 2 (part 2): Investigation		[Select Dropdown]		
		[Select Dropdown]		
8.7.6.1 IAQ Investigation Site Visit Planning		[Select Dropdown]		
With respect to the EPA energy savings plus health documents, create a plan for investigation and testing for all remaining Assessment Protocol items that were not addressed during the Assessment Phase in columns 'E' and 'F'. Expand each section using the '+' to the left. Complete the investigation site visit once each remaining Assessment Protocol item is addressed. Then, complete columns 'G' and 'H' to indicate the final findings of the site visits. The EBCx team should use the site visit log to the right to record the overall status of the Investigation phase, the date of each visit, and any valuable site visit notes. By the end of the investigation phase, the Cx Team should hace all necessary existing building documentation needed to complete initial performance modeling and establish the baseline case.		[Select Dropdown]		
		[Select Dropdown]		

Again, no entries yet since we're in the planning phase and haven't yet completed the Investigation Site Visit

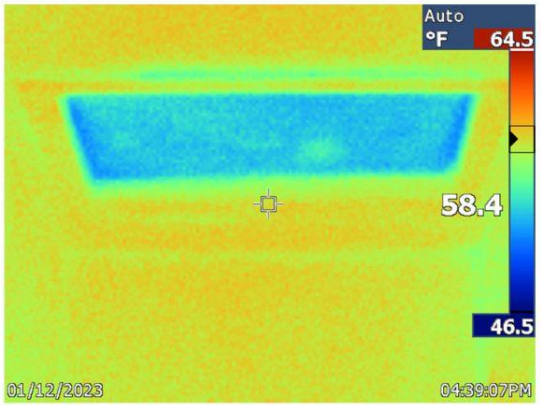
Priority Issue 1: Asbestos		**CxP Investigation Planning Notes** *Complete pre-investigation*	**Current status?**	**CxP Investigation Reporting Notes** *Complete post-investigation*	**Final status?**
Asbestos	AP1.1 Determine Potential Asbestos Hazard		No further investigation required		[Select Dropdown]
Priority Issue 2: Below Ground Contaminants (Except Radon)		**CxP Assessment Planning Notes** *Complete pre-assessment*	**Assess or Defer**	**CxP Assessment Reporting Notes** *Complete post-assessment*	**Status?**
Below Ground Contaminants (except radon)	AP2.1 Evaluate Sources		No further investigation required		[Select Dropdown]
	AP2.2 Evaluate Sewer Vent System	Evaluate sewer vent system per protocol	Needs further investigation		[Select Dropdown]
Priority Issue 3: Building Products & Material Emissions		**CxP Assessment Planning Notes** *Complete pre-assessment*	**Assess or Defer**	**CxP Assessment Reporting Notes** *Complete post-assessment*	**Status?**
Building Products / Material Emissions	AP3.1 Assess Product Choices	Defer to design / implementation planning. Refer to minimum actions	Needs further investigation		[Select Dropdown]
	AP3.2 Carpet	Carpet to be replaced, remediation required	Remediation required		[Select Dropdown]
	AP3.3 Ventilation	Ventilation system not sufficient, remediation required	Remediation required		[Select Dropdown]

Use the first column to create a plan to address all of the remaining assessment protocol items per EPA ES+H. Items marked 'no further investigation required' or 'resolved' during the assessment phase will be eliminated from the list, so they don't need readdressed. The second column will auto-full based on the final status of the investigation phase. Do not alter this column.

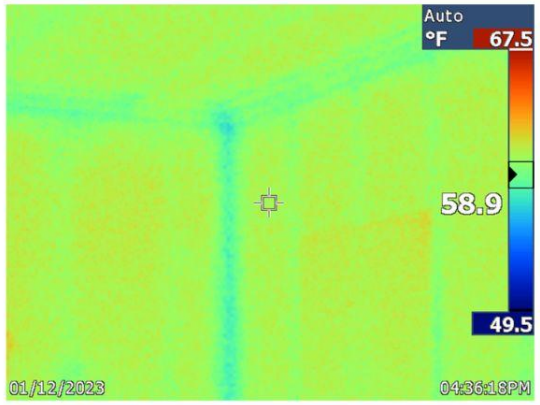
KMR Existing Conditions - Thermal Images



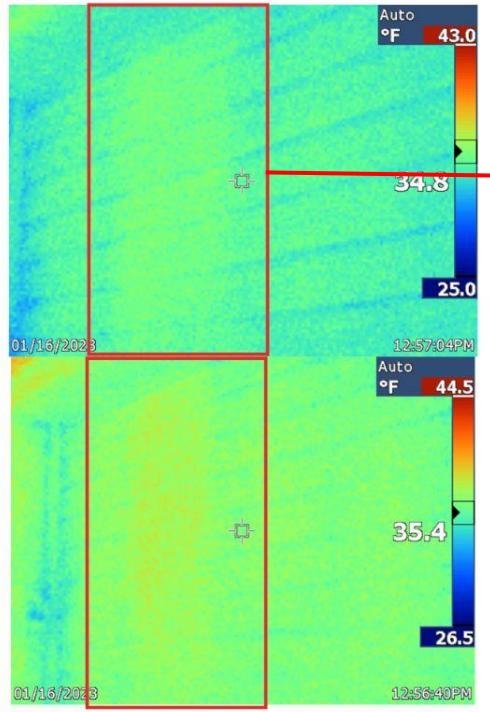
INSULATION ISSUE AROUND VENT - DINING ROOM

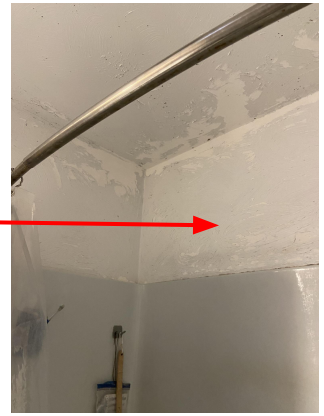


COLD AIR INFILTRATION AT ATTIC ACCESS PANEL



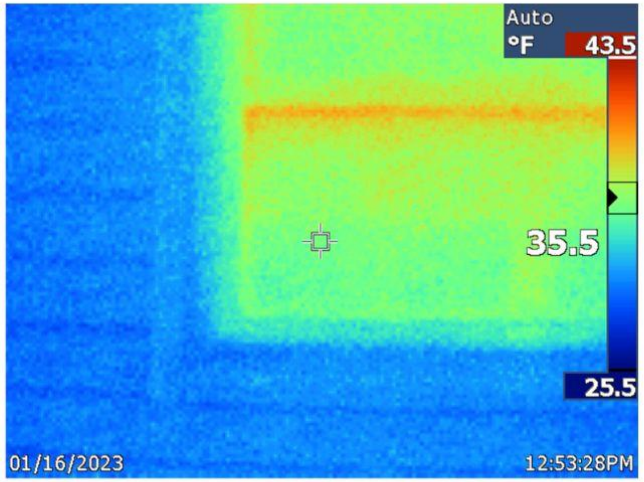
COLD AIR INFILTRATION AT CORNER, FAR BEDROOM.
STUD VISIBILITY



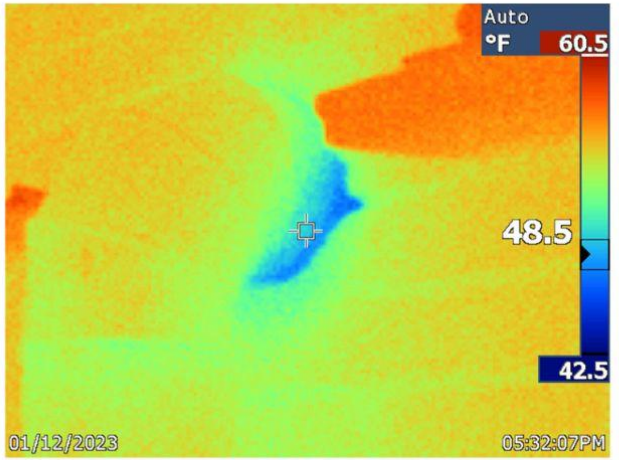


EXTERIOR - HEAT LOSS THROUGH WALL AT BATHROOM

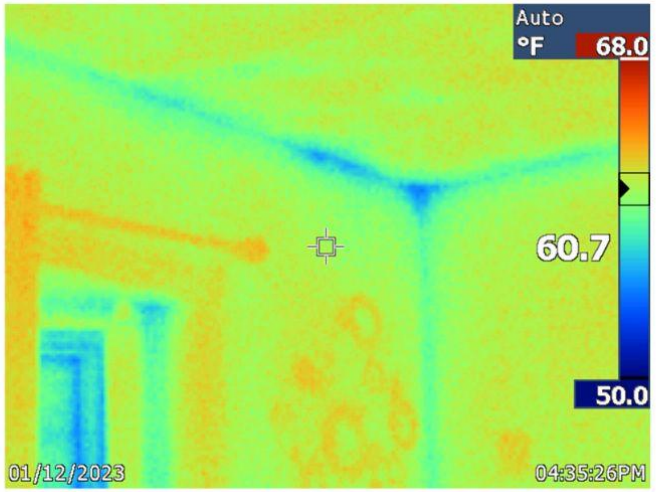
KMR Existing Conditions - Thermal Images



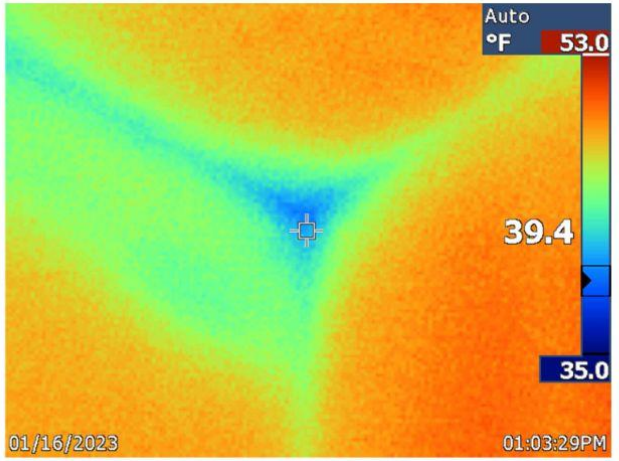
HEAT LOSS THROUGH DOUBLE HUNG WINDOW (TYPICAL)



INFILTRATION AT WALL PENETRATION FOR FLUE

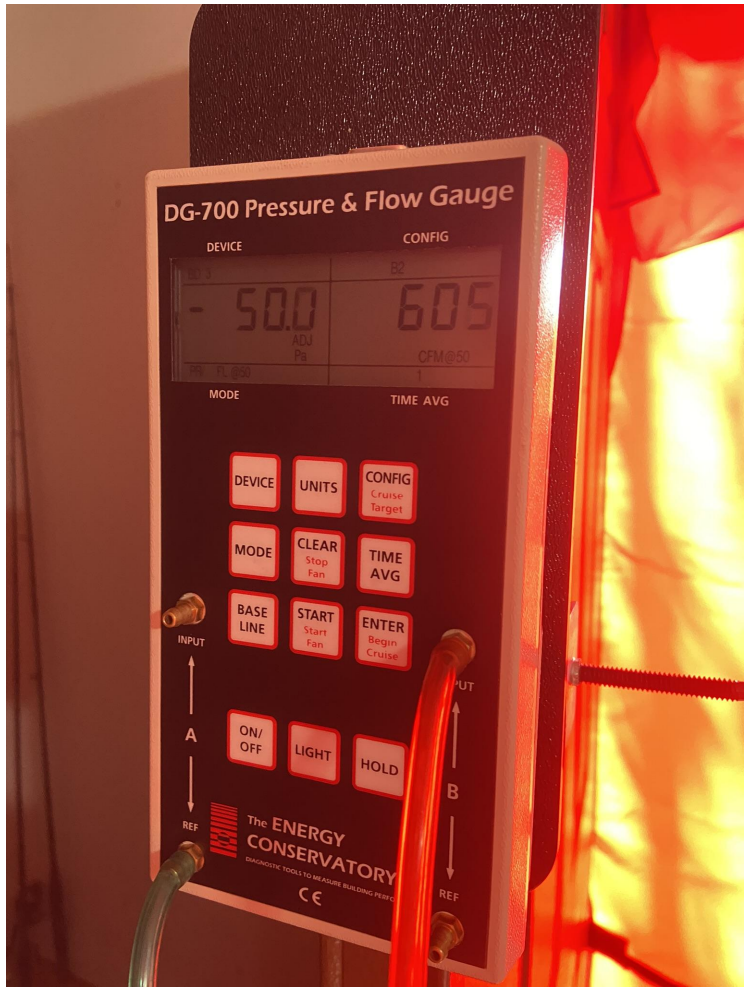


LIVING ROOM COLD AIR INFILTRATION



MISSING INSULATION AT CORNER (UNKNOWN LOCATION)

KMR Existing Conditions - Blower Door Test



The french doors to the covered porch flew open during the first test…

- 3659 cfm / 5460 ft^2 envelope =
  - 0.67 cfm/ft^2 @ 50 Pa

This may be a realistic baseline because the doors are often left open for the dogs

The door to the garage flew open during the second test…

- 1949 cfm / 5460 ft^2 envelope =
  - 0.36 cfm/ft^2 @ 50 Pa

Good to know since garage is to be converted!

Third time's the charm, and with all doors secured…

- 605 cfm / 5460 ft^2 envelope =
  - 0.11 cfm/ft^2 @ 50 Pa

Seems too good to be true…

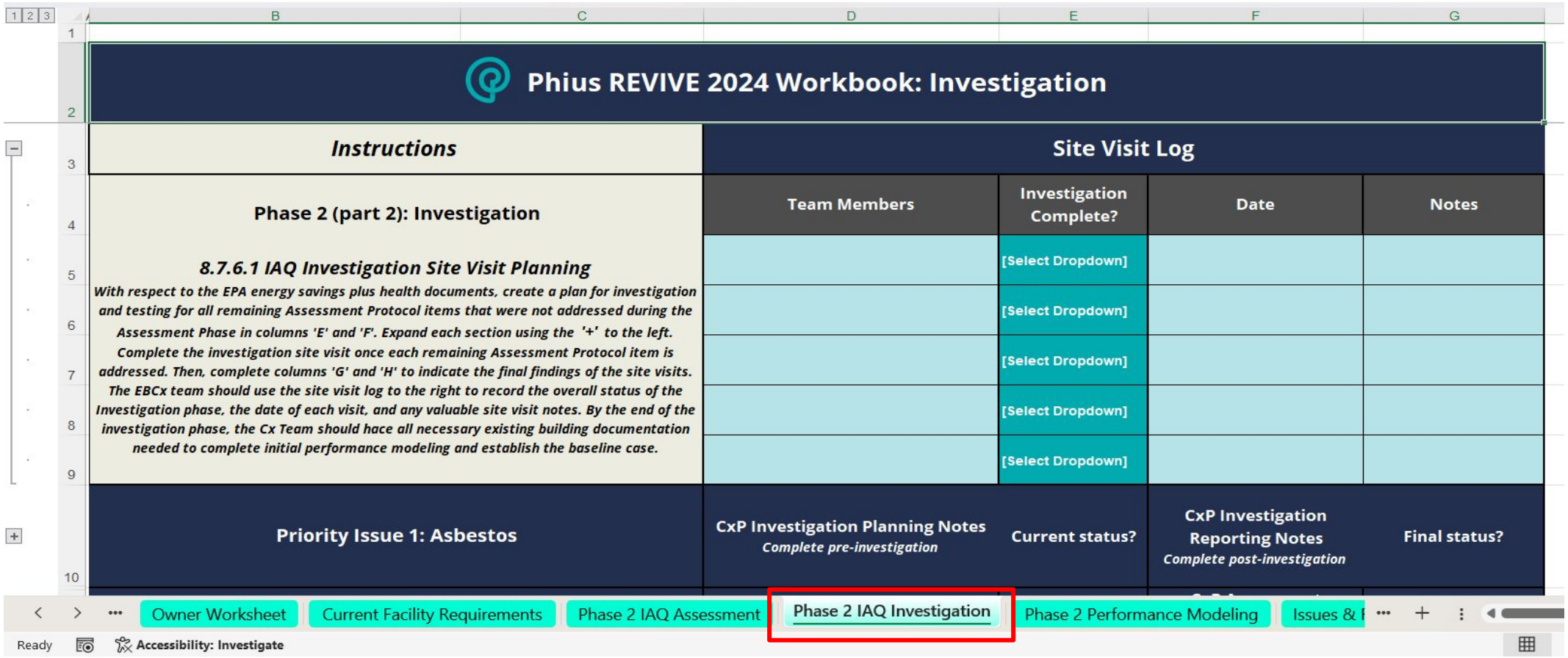
Results may be unreliable as blower door testing is not my area of expertise but at the end of the day it was a great learning experience and fun real-world application of the numbers I throw into WUFI!

REVIVE Process Checkpoint: Investigation Reporting

What were the test results?

Standard Section: 8.7

Guidebook Section: 3.4.2.9



Phius REVIVE 2024 Workbook: Investigation

Instructions	Site Visit Log			
	Team Members	Investigation Complete?	Date	Notes
Phase 2 (part 2): Investigation		[Select Dropdown]		
		[Select Dropdown]		
8.7.6.1 IAQ Investigation Site Visit Planning		[Select Dropdown]		
With respect to the EPA energy savings plus health documents, create a plan for investigation and testing for all remaining Assessment Protocol items that were not addressed during the Assessment Phase in columns 'E' and 'F'. Expand each section using the '+' to the left. Complete the investigation site visit once each remaining Assessment Protocol item is addressed. Then, complete columns 'G' and 'H' to indicate the final findings of the site visits. The EBCx team should use the site visit log to the right to record the overall status of the Investigation phase, the date of each visit, and any valuable site visit notes. By the end of the investigation phase, the Cx Team should hace all necessary existing building documentation needed to complete initial performance modeling and establish the baseline case.		[Select Dropdown]		
		[Select Dropdown]		

Priority Issue 1: Asbestos	CxP Investigation Planning Notes *Complete pre-investigation*	Current status?	CxP Investigation Reporting Notes *Complete post-investigation*	Final status?

Owner Worksheet | Current Facility Requirements | Phase 2 IAQ Assessment | Phase 2 IAQ Investigation | Phase 2 Performance Modeling | Issues & F

Ready | Accessibility: Investigate

Phase 2 IAQ Investigation Reporting

Phius REVIVE 2024 Workbook: Investigation

Instructions	Site Visit Log			
Phase 2 (part 2): Investigation	**Team Members**	**Investigation Complete?**	**Date**	**Notes**
8.7.6.1 IAQ Investigation Site Visit Planning	HKG	No / Incomplete	5/1/2024	
With respect to the EPA energy savings plus health documents, create a plan for investigation and testing for all remaining Assessment Protocol items that were not addressed during the Assessment Phase in columns 'E' and 'F'. Expand each section using the '+' to the left. Complete the investigation site visit once each remaining Assessment Protocol item is addressed. Then, complete columns 'G' and 'H' to indicate the final findings of the site visits. The EBCx team should use the site visit log to the right to record the overall status of the Investigation phase, the date of each visit, and any valuable site visit notes. By the end of the investigation phase, the Cx Team should hace all necessary existing building documentation needed to complete initial performance modeling and establish the baseline case.	HKG	All AP items addressed or deferred.	6/1/2024	Radon / CO testing
		[Select Dropdown]		
		[Select Dropdown]		
		[Select Dropdown]		

Create a new entry for each site visit. Note whether or not all remaining assessment items have been addressed, enter the date of the site visit, and any important notes about the visit (i.e. where you left off the last time, things that still need addressed, etc)

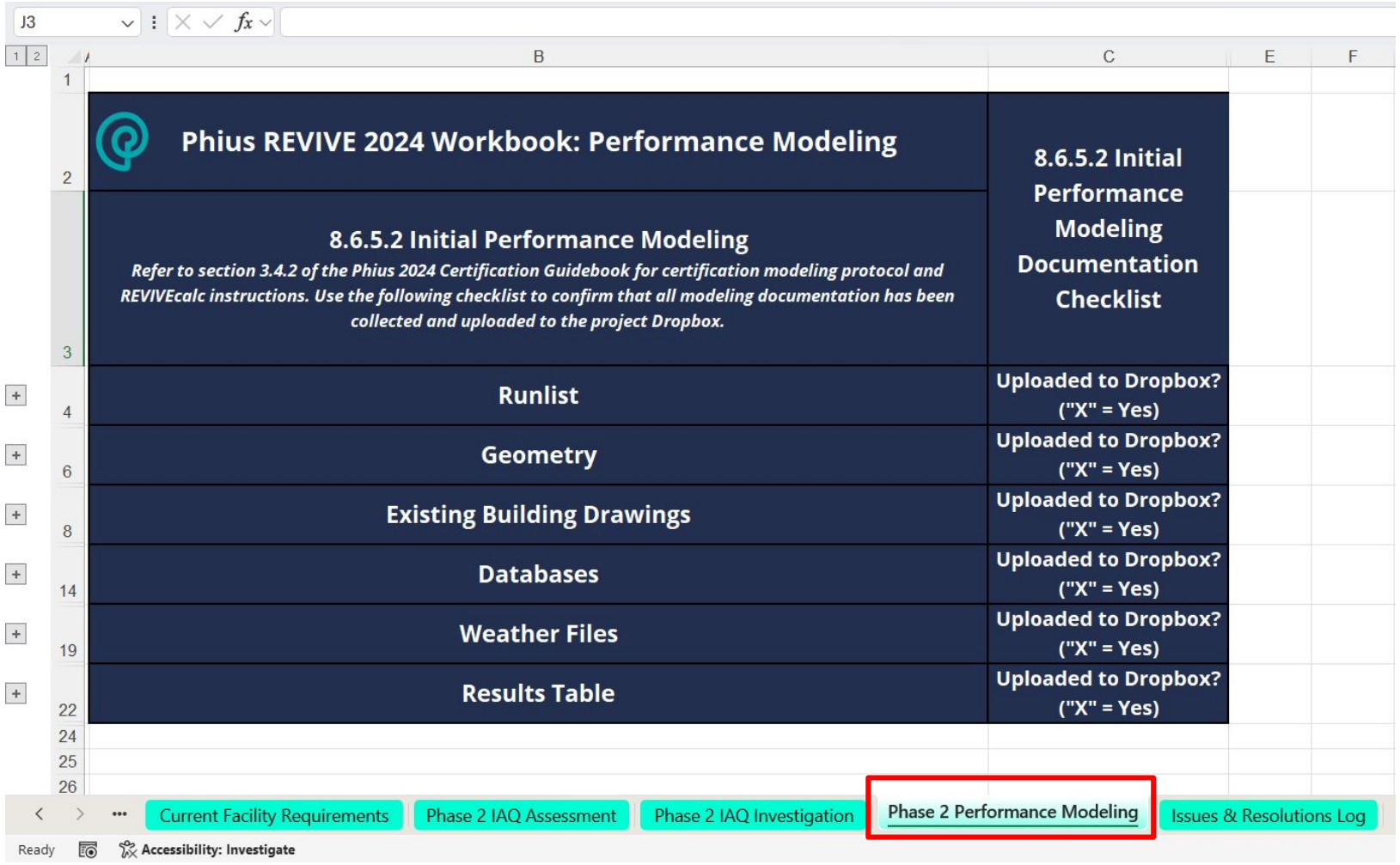
Priority Issue 1: Asbestos		**CxP Investigation Planning Notes** *Complete pre-investigation*	**Current status?**	**CxP Investigation Reporting Notes** *Complete post-investigation*	**Final status?**
Asbestos	AP1.1 Determine Potential Asbestos Hazard		No further investigation required		[Select Dropdown]
Priority Issue 2: Below Ground Contaminants (Except Radon)		**CxP Assessment Planning Notes** *Complete pre-assessment*	**Assess or Defer**	**CxP Assessment Reporting Notes** *Complete post-assessment*	**Status?**
Below Ground Contaminants (except radon)	AP2.1 Evaluate Sources		No further investigation required		[Select Dropdown]
	AP2.2 Evaluate Sewer Vent System	Evaluate sewer vent system per protocol	Needs further investigation	No issue with sewer vent.	Resolved
Priority Issue 3: Building Products & Material Emissions		**CxP Assessment Planning Notes** *Complete pre-assessment*	**Assess or Defer**	**CxP Assessment Reporting Notes** *Complete post-assessment*	**Status?**
Building Products / Material Emissions	AP3.1 Assess Product Choices	Defer to design / implementation planning. Refer to minimum actions	Needs further investigation	Refer to minimum actions when selecting products	Remediation required
	AP3.2 Carpet	Carpet to be replaced, remediation required	Remediation required	Replace carpet with hard surface flooring. Refer to minimum actions	Remediation required
	AP3.3 Ventilation	Ventilation system not sufficient, remediation required	Remediation required	Ventilation system not sufficient, remediation required	Remediation required

Use the right two columns to complete all site visit reporting notes, and indicate whether or not the issue has been resolved or if remediation is required

REVIVE Process Checkpoint: Performance Modeling Checklist

Perform initial performance modeling to determine possible retrofit options

Standard Section: 6
Guidebook Section: 3.4.2.10



Phius REVIVE 2024 Workbook: Performance Modeling

8.6.5.2 Initial Performance Modeling

Refer to section 3.4.2 of the Phius 2024 Certification Guidebook for certification modeling protocol and REVIVEcalc instructions. Use the following checklist to confirm that all modeling documentation has been collected and uploaded to the project Dropbox.

8.6.5.2 Initial Performance Modeling Documentation Checklist	Uploaded to Dropbox? ("X" = Yes)
Runlist	
Geometry	
Existing Building Drawings	
Databases	
Weather Files	
Results Table	

Phase 2 Performance Modeling Checklist

	B	C
4	**Runlist**	**Uploaded to Dropbox? ("X" = Yes)**
5	'.csv' File	x
6	**Geometry**	**Uploaded to Dropbox? ("X" = Yes)**
7	'.idf' File	x
8	**Existing Building Drawings**	**Uploaded to Dropbox? ("X" = Yes)**
9	Schematic Plans	x
10	iCFA Takeoff (est.)	x
11	Schematic Elevations	x
12	Assembly Assumptions	x
13	Equipment Assumptions / Specs	x
14	**Databases**	**Uploaded to Dropbox? ("X" = Yes)**
15	Carbon Correction	x
16	Construction (Assemblies)	x
17	Materials	x
18	Windows	x
19	**Weather Files**	**Uploaded to Dropbox? ("X" = Yes)**
20	'.ddy' File	x
21	'.epw' File	x
22	**Results Table**	**Uploaded to Dropbox? ("X" = Yes)**
23	'.csv' File	x

This checklist is a summary of the minimum documentation required to be submitted to Phius for certification.

Mark an 'X' in the light blue cells to indicate the files have been submitted. This would be the last step before submitting for Phius review

Most are REVIVEcalc-specific files, but schematic drawings and documentation about existing conditions and the proposed design (if envelope / geometry changes are intended) should be provided to validate the modeled geometry, as well as inputs used to build the cases in the Runlist

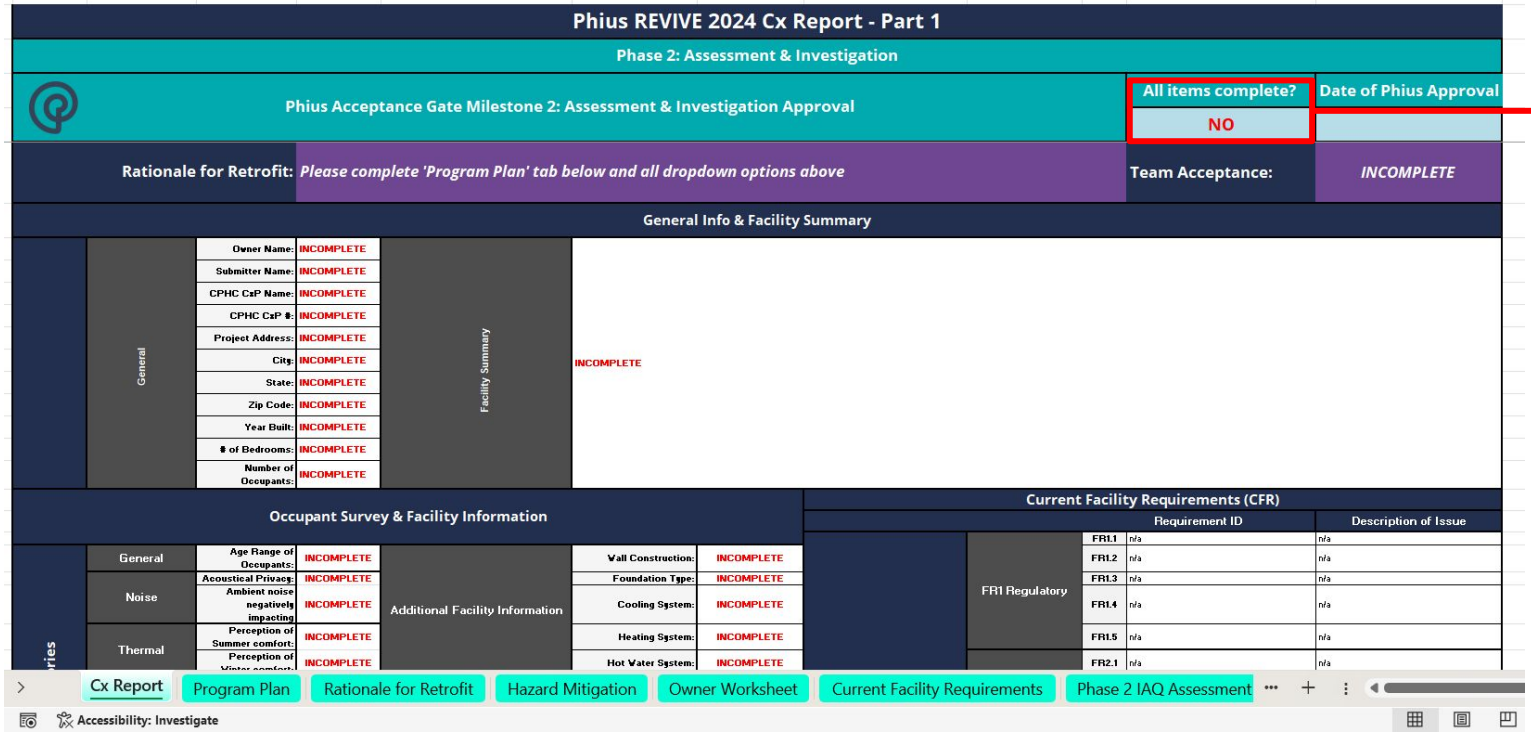
Final Deliverables (A&I Phase)

Cx Plan / Cx Report

- Primary deliverables of the Assessment & Investigation Phase
- Summarizes all documented processes & project information
- Documents are being built in the background while tabs in the workbook are completed - they are locked on purpose!
- Phius will use to:
  - Ensure all required processes have been completed or, at minimum, addressed as “no concern” (with a valid reason)
  - Transfer to the *Design Workbook** to generate project-specific Certification Requirements

Additional deliverables are satisfied by completing the various workbook pages & REVIVEcalc modeling

Cx Report



Phius REVIVE 2024 Cx Report - Part 1

Phase 2: Assessment & Investigation

Phius Acceptance Gate Milestone 2: Assessment & Investigation Approval	All items complete?	Date of Phius Approval
	NO	
Rationale for Retrofit: *Please complete 'Program Plan' tab below and all dropdown options above*	**Team Acceptance:**	*INCOMPLETE*

General Info & Facility Summary

General			Facility Summary	
	Owner Name:	INCOMPLETE		INCOMPLETE
	Submitter Name:	INCOMPLETE		
	CPHC CxP Name:	INCOMPLETE		
	CPHC CxP #:	INCOMPLETE		
	Project Address:	INCOMPLETE		
	City:	INCOMPLETE		
	State:	INCOMPLETE		
	Zip Code:	INCOMPLETE		
	Year Built:	INCOMPLETE		
	# of Bedrooms:	INCOMPLETE		
	Number of Occupants:	INCOMPLETE		

Occupant Survey & Facility Information

General	Age Range of Occupants:	INCOMPLETE	Additional Facility Information	Wall Construction:	INCOMPLETE
Noise	Acoustical Privacy:	INCOMPLETE		Foundation Type:	INCOMPLETE
	Ambient noise negatively impacting	INCOMPLETE		Cooling System:	INCOMPLETE
Thermal	Perception of Summer comfort:	INCOMPLETE		Heating System:	INCOMPLETE
	Perception of Winter comfort:	INCOMPLETE		Hot Water System:	INCOMPLETE

Current Facility Requirements (CFR)

		Requirement ID	Description of Issue
FR1 Regulatory	FR1.1	n/a	n/a
	FR1.2	n/a	n/a
	FR1.3	n/a	n/a
	FR1.4	n/a	n/a
	FR1.5	n/a	n/a
	FR2.1	n/a	n/a

Cx Report | Program Plan | Rationale for Retrofit | Hazard Mitigation | Owner Worksheet | Current Facility Requirements | Phase 2 IAQ Assessment

Accessibility: Investigate

When this cell reads 'YES' in green, the workbook is complete and read to be submitted to Phius for review.

Phius will record the 5 retrofit options generated by the REVIVEcalc files submitted and indicate whether or not the cases meet the performance requirements for REVIVE

No red text will be left when workbook is complete.

Site Hazard Risk Report

Hazard Categories					
5.2.1	Earthquake		INCOMPLETE	!	
5.2.2	Flood		INCOMPLETE	!	
5.2.3	Hail		PV Modules must be FM Approved for hail. Refer to Section 3.3.2.2 of the Phius 2024 Certification Guidebook for alternate compliance paths for Flexible and Rigid PV Panels	✓	
5.2.4	Structural/High Wind	Foundation	INCOMPLETE	!	
		Roof	INCOMPLETE	!	
5.2.5	Snow Load & Ice Dams		INCOMPLETE	!	
5.2.6	Wildfire		INCOMPLETE	!	

Initial Performance Modeling Documentation Checklist

REVIVEcalc Documentation	Documentation Categories	Uploaded?		Case List (Phius Reviewer ONLY)	Meets requirements?
	Runlist	INCOMPLETE	X	Baseline Case	[Select Dropdown]
	Geometry	INCOMPLETE	X	Case 1: [Copy case name]	[Select Dropdown]
	Existing Building Drawings	INCOMPLETE	X	Case 2: [Copy case name]	[Select Dropdown]
	Databases	INCOMPLETE	X	Case 3: [Copy case name]	[Select Dropdown]
	Weather Files	INCOMPLETE	X	Case 4: [Copy case name]	[Select Dropdown]
	Results Table	INCOMPLETE	X	Case 5: [Copy case name]	[Select Dropdown]

Cx Report vs Cx Plan

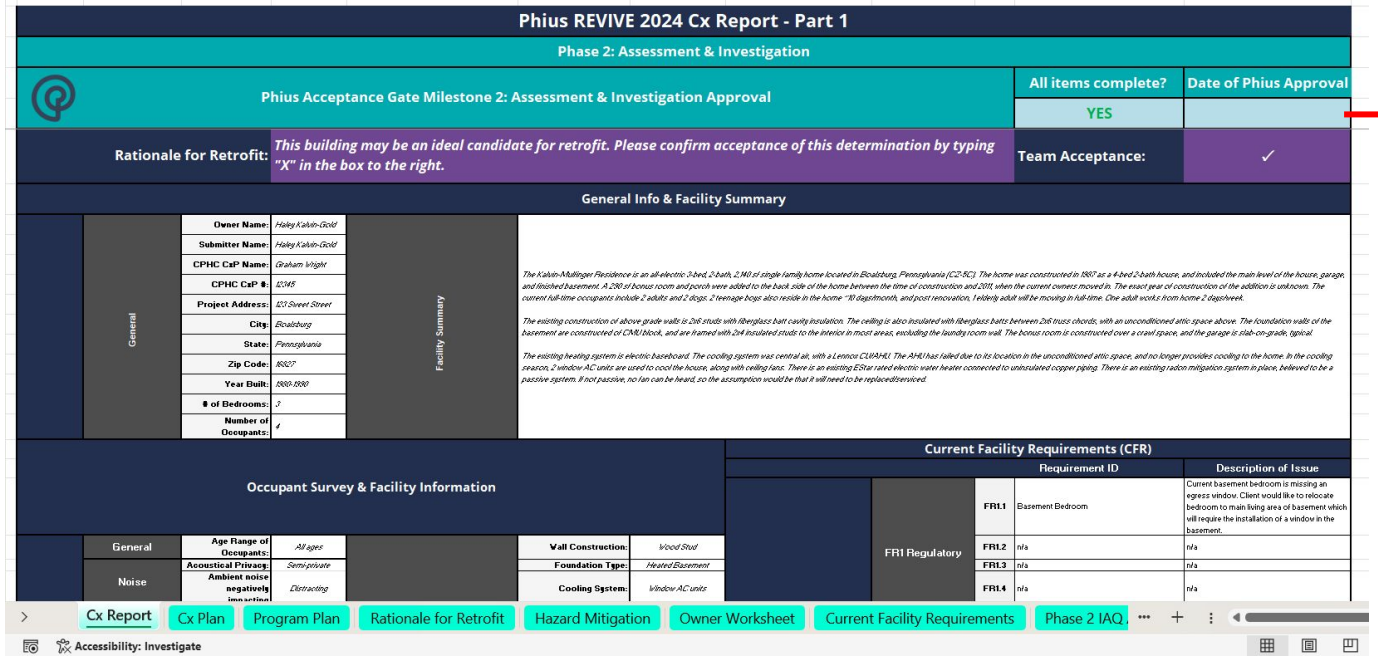
Phius REVIVE 2024 Cx Report - Part 1								
Phase 2: Assessment & Investigation								
Phius Acceptance Gate Milestone 2: Assessment & Investigation Approval							All items complete?	Date of Phius Approval
							NO	
Building Products / Material Emissions	AP3.2 Carpet	INCOMPLETE	INCOMPLETE	Building Products / Material Emissions	AP3.2 Carpet	INCOMPLETE	INCOMPLETE	INCOMPLETE
	AP3.3 Ventilation	INCOMPLETE	INCOMPLETE		AP3.3 Ventilation	INCOMPLETE	INCOMPLETE	INCOMPLETE
CO & Other Combustion Appliance Emissions	AP4.1 Conduct Assessment of CO Sources	INCOMPLETE	INCOMPLETE	CO & Other Combustion Appliance Emissions	AP4.1 Conduct Assessment of CO Sources	INCOMPLETE	INCOMPLETE	INCOMPLETE
	AP4.2 Ambient CO Testing	INCOMPLETE	INCOMPLETE		AP4.2 Ambient CO Testing	INCOMPLETE	INCOMPLETE	INCOMPLETE
Environmental Tobacco Smoke	AP5.1 Look for Signs of Smoking Indoors	INCOMPLETE	INCOMPLETE	Environmental Tobacco Smoke	AP5.1 Look for Signs of Smoking Indoors	INCOMPLETE	INCOMPLETE	INCOMPLETE

The Cx Report tracks the status and notes of the assessment & investigation EPA ES+H site visits

Phius REVIVE 2024 Cx Plan - Part 1						
8.6.5.1 IAQ Assessment Site Visit Planning *With respect to the EPA energy savings plus health documents, list the assessment protocol items that can be accomplished in a walkthrough*			CxP Assessment Planning Notes *Complete pre-assessment*	Assess or Defer	CxP Investigation Planning Notes *Complete pre-investigation*	Current status?
EPA Energy Savings Plus Health IAQ Guidelines	Asbestos	AP1.1 Determine Potential Asbestos Hazard	INCOMPLETE	INCOMPLETE	INCOMPLETE	INCOMPLETE
	Below Ground Contaminants (except radon)	AP2.1 Evaluate Sources	INCOMPLETE	INCOMPLETE	INCOMPLETE	INCOMPLETE
		AP2.2 Evaluate Sewer Vent System	INCOMPLETE	INCOMPLETE	INCOMPLETE	INCOMPLETE
	Building Products / Material Emissions	AP3.1 Assess Product Choices	INCOMPLETE	INCOMPLETE	INCOMPLETE	INCOMPLETE
		AP3.2 Carpet	INCOMPLETE	INCOMPLETE	INCOMPLETE	INCOMPLETE
		AP3.3 Ventilation	INCOMPLETE	INCOMPLETE	INCOMPLETE	INCOMPLETE

The Cx Plan tracks the planning notes of the assessment & investigation EPA ES+H prior to the site visits

Cx Report



Phius REVIVE 2024 Cx Report - Part 1

Phase 2: Assessment & Investigation

Phius Acceptance Gate Milestone 2: Assessment & Investigation Approval	All items complete?	Date of Phius Approval
	YES	
Rationale for Retrofit: *This building may be an ideal candidate for retrofit. Please confirm acceptance of this determination by typing "X" in the box to the right.*	**Team Acceptance:**	✓

General Info & Facility Summary

General		Facility Summary
Owner Name:	Haley Kalvin-Gold	The Kalvin-Mullinger Residence is an all-electric 3-bed, 2-bath, 2,140 sf single family home located in Bicalsburg, Pennsylvania (IC2-5C). The home was constructed in 1987 as a 4-bed 2-bath house, and included the main level of the house, garage, and finished basement. A 290 sf bonus room and porch were added to the back side of the home between the time of construction and 2011, when the current owners moved in. The exact year of construction of the addition is unknown. The current full-time occupants include 2 adults and 2 dogs. 2 teenage boys also reside in the home 'til days/month, and post renovation, 1 elderly adult will be moving in full-time. One adult works from home 2 days/week. The existing construction of above grade walls is 2x6 studs with fiberglass batt cavity insulation. The ceiling is also insulated with fiberglass batts between 2x6 truss chords, with an unconditioned attic space above. The foundation walls of the basement are constructed of CMU block, and are framed with 2x4 insulated studs to the interior in most areas, excluding the laundry room wall. The bonus room is constructed over a crawl space, and the garage is slab-on-grade, typical. The existing heating system is electric baseboard. The cooling system was central air, with a Lennox CUHA/H1. The AHU has failed due to its location in the unconditioned attic space, and no longer provides cooling to the home. In the cooling season, 2 window AC units are used to cool the house, along with ceiling fans. There is an existing EStar rated electric water heater connected to uninsulated copper piping. There is an existing radon mitigation system in place, believed to be a passive system. If not passive, no fan can be heard, so the assumption would be that it will need to be replaced/serviced.
Submitter Name:	Haley Kalvin-Gold	
CPHC CaP Name:	Graham Wright	
CPHC CaP #:	10345	
Project Address:	123 Sweet Street	
City:	Bicalsburg	
State:	Pennsylvania	
Zip Code:	86027	
Year Built:	1980-1990	
# of Bedrooms:	3	
Number of Occupants:	4	

Occupant Survey & Facility Information

General	Age Range of Occupants:	All ages	Wall Construction:	Wood Stud
Noise	Acoustical Privacy:	Semi-private	Foundation Type:	Heated Basement
	Ambient noise negatively impacting:	Distracting	Cooling System:	Window AC units

Current Facility Requirements (CFR)

		Requirement ID	Description of Issue
FR1 Regulatory	FR1.1	Basement Bedroom	Current basement bedroom is missing an egress window. Client would like to relocate bedroom to main living area of basement which will require the installation of a window in the basement.
	FR1.2	n/a	n/a
	FR1.3	n/a	n/a
	FR1.4	n/a	n/a

Cx Report | Cx Plan | Program Plan | Rationale for Retrofit | Hazard Mitigation | Owner Worksheet | Current Facility Requirements | Phase 2 IAQ ...

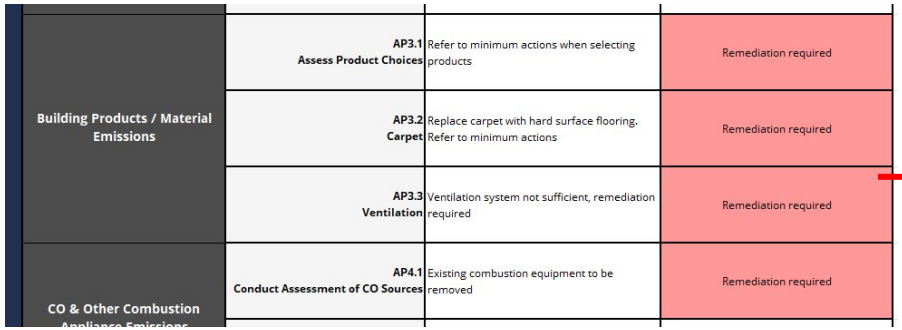
Accessibility: Investigate

Phius will track the date of approval to move forward to the design phase

Site Hazard Risk requirements are summarized at the bottom of the report

Site Hazard Risk Report

Hazard Categories					
	5.2.1	Earthquake		No requirement	✓
	5.2.2	Flood		No requirement	✓
	5.2.3	Hail		PV Modules must be FM Approved for hail. Refer to Section 3.3.2.2 of the Phius 2024 Certification Guidebook for alternate compliance paths for Flexible and Rigid PV Panels	✓
	5.2.4	Structural/High Wind	Foundation	No requirement	✓
			Roof	IBHS FORTIFIED Roof (High Wind designation) or FEMA P-804 Sec. 4.1	✓
	5.2.5	Snow Load & Ice Dams		n/a	✓
	5.2.6	Wildfire		No requirement	✓



Building Products / Material Emissions	AP3.1 Assess Product Choices	Refer to minimum actions when selecting products	Remediation required
	AP3.2 Carpet	Replace carpet with hard surface flooring. Refer to minimum actions	Remediation required
	AP3.3 Ventilation	Ventilation system not sufficient, remediation required	Remediation required
CO & Other Combustion Appliance Emissions	AP4.1 Conduct Assessment of CO Sources	Existing combustion equipment to be removed	Remediation required

Follow the minimum actions in the EPA ES+H Guideline for every priority issue where remediation is required in column N of the report

Issues & Resolutions Log

Phius REVIVE 2024 Workbook			Issues & Resolutions Log							
Issue No.	Description/Photo	Date found	Found By	Cause & Effects	Recommendation	Assigned to	Status?	Solution	Date Resolved	Phius Comments
1							[Select Dropdown]			
2							[Select Dropdown]			
3							[Select Dropdown]			
4							[Select Dropdown]			
5							[Select Dropdown]			
6							[Select Dropdown]			
7							[Select Dropdown]			
8							[Select Dropdown]			
9							[Select Dropdown]			
10							[Select Dropdown]			
11							[Select Dropdown]			
12							[Select Dropdown]			
13							[Select Dropdown]			
14							[Select Dropdown]			
15							[Select Dropdown]			
16							[Select Dropdown]			
17							[Select Dropdown]			
18							[Select Dropdown]			
19										
20										

Not required, but recommended to act as a channel of communication and tracking project progress among Cx team since there may be multiple people working through the workbook

Phius REVIVE 2024 Workbook			Issues & Resolutions Log							
Issue No.	Description/Photo	Date found	Found By	Cause & Effects	Recommendation	Assigned to	Status?	Solution	Date Resolved	Phius Comments
1	AP18 Fire extinguisher expired (date?)	3/18/2023	HKG	-	Get new fire extinguisher	HKG	Resolved	New extinguisher provided		
2	4.6.5.2 Initial performance modeling not started.	1/12/2024	GW	Tool not ready for use	Start performance modeling	AM	[Select Dropdown]			
3	T-6 Budget for performance related upgrades not started.	1/12/2024	GW	-	Discuss budget with owner	HKG				
4	T-6 Budget for Cx not started.	1/12/2024	GW	-	Discuss budget with owner	HKG				
5	T-2 Assessment plan incomplete - No phase plan, M&V, or maintenance	1/12/2024	GW	-	Complete assessment plan, initial phase plan, & discuss and choose M&V electives w owner	HKG	[Select Dropdown]			
6	T-2 Investigation plan incomplete.	1/12/2024	GW	-	Complete plan	HKG	[Select Dropdown]			
7	T-6 Investigation report incomplete.	1/12/2024	GW	-	Complete report	HKG	[Select Dropdown]			
8	Investigate options to replace clg system in basement	2/1/2024	HKG	Basement clg (most) is ACT drop clg with height 6'-10", so technically doesn't count as iCFA	Update investigation report, consider phase plan impact. Consider alternate ceiling options	HKG	Resolved	Design to include ceiling replacement		
9	CFR D.1.2 Look for available Community Solar options.	3/12/2024	GW	https://www.energy.gov/communitysolar/community-solar-resources	Find a Community Solar Project - Solar United Neighbors	HKG	Resolved	Per SUN - no community solar projects currently exist in PA -Utility company offers option to switch to 'clean energy' provider. Could this option satisfy the requirement?		
10	AP13 Does ACCA Standard 4 address control of baseboard electric heat?	1/12/2024	GW	This is an inspection / maintenance standard not a control standard. Does not mention baseboard specifically but does cover electric furnace.	Attempt Checklist 5.6 items c thru j.	HKG	Resolved			

[Select Dropdown]
Resolved
Unresolved

Current Facility Requirements | Phase 2 IAQ Assessment | Phase 2 IAQ Investigation | Phase 2 Performance Modeling | Issues & Resolutions Log

lect destination and press ENTER or choose Paste

85%

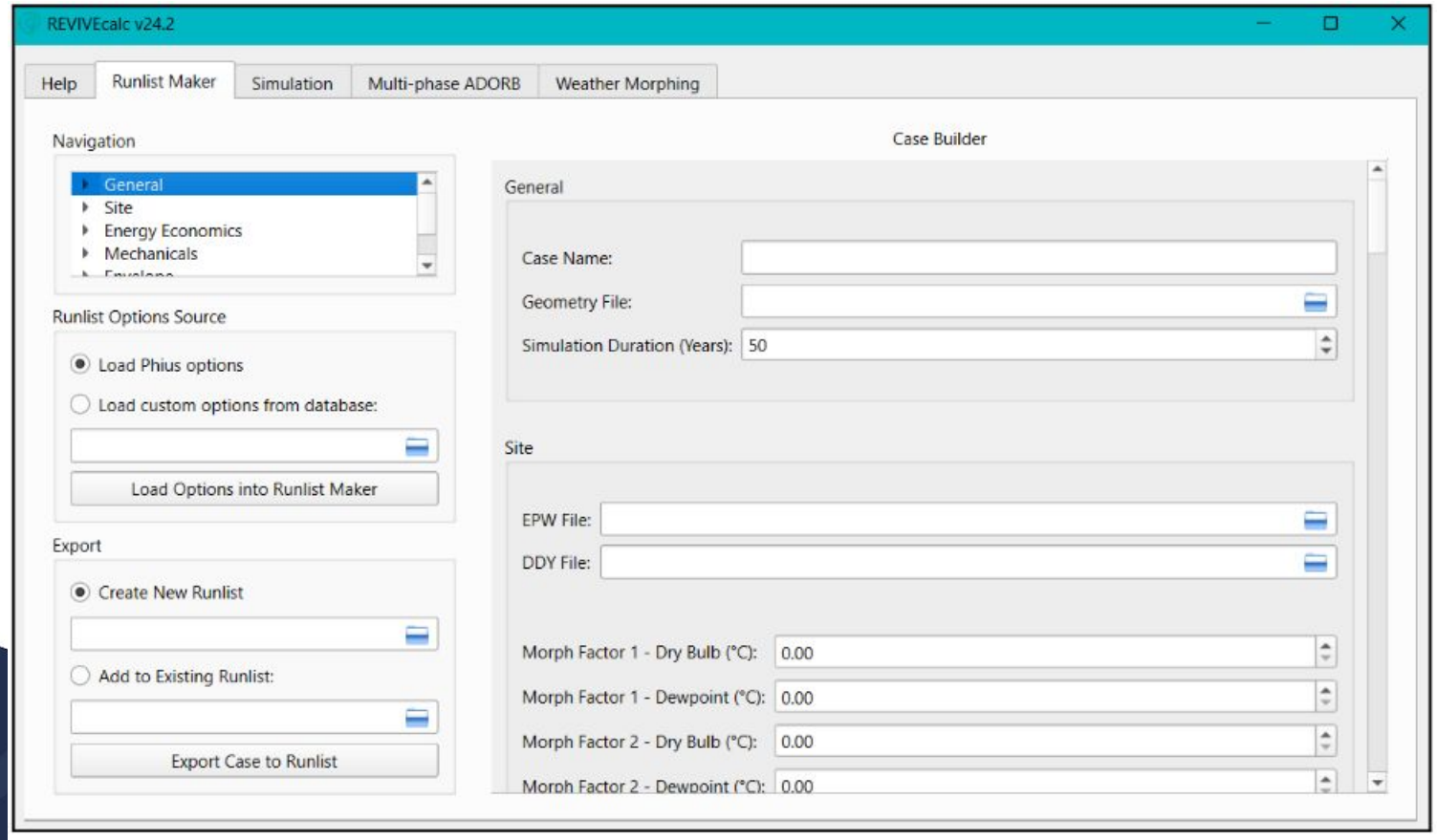
What's next?

- At this point, all existing conditions have been assessed and investigated
- Certification requirements have been determined
- Performance modeling has been completed
- Phius has approved the assessment and investigation workbook as well as 5 project specific retrofit options determined by REVIVEcalc

What's next?

- DESIGN PHASE:
  - Choose ONE of the 5 options approved by Phius
    - All inputs for that case in REVIVEcalc must be implemented in the design (i.e. envelope upgrades, equipment upgrades, etc)
  - Submissions will be similar to the prescriptive path - drawings and documentation to be reviewed rather than an energy model
    - Exception: A phased retrofit might use the multi-phase ADORB function in REVIVEcalc to determine the best order of implementation
  - Design workbook coming in the future to support certification process

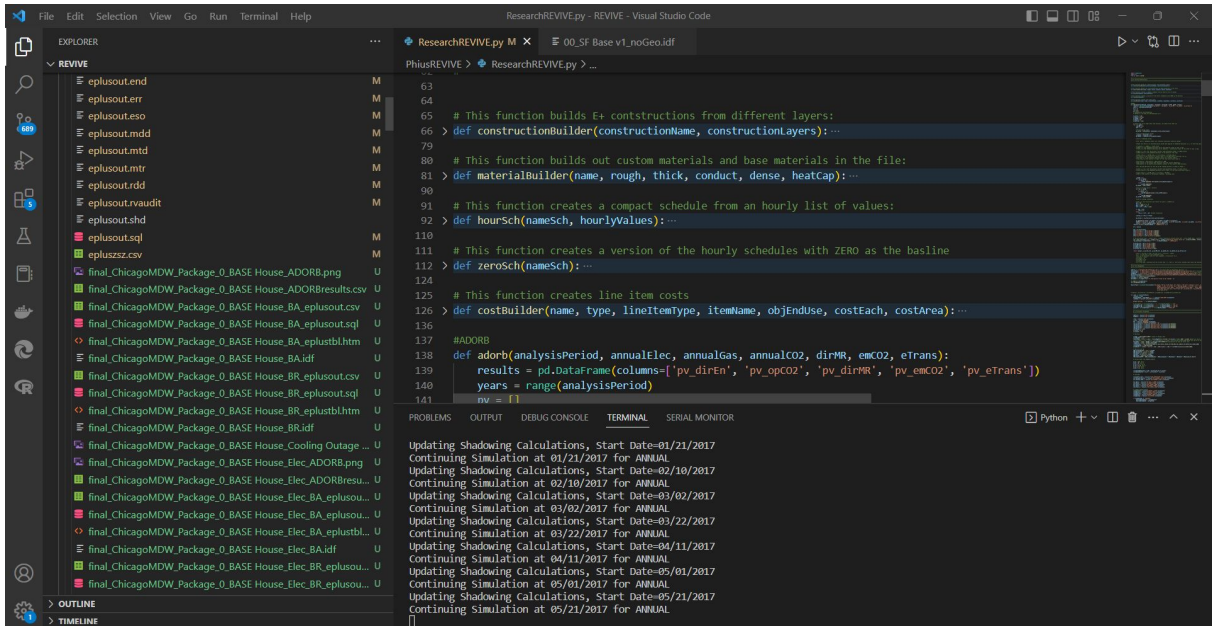
REVIVEcalc


REVIVEcalc v24.2
Help
Runlist Maker
Simulation
Multi-phase ADORB
Weather Morphing
Navigation
General
Site
Energy Economics
Mechanicals
Runlist Options Source
Load Phius options
Load custom options from database:
Load Options into Runlist Maker
Export
Create New Runlist
Add to Existing Runlist:
Export Case to Runlist
Case Builder
General
Case Name:
Geometry File:
Simulation Duration (Years):
50
Site
EPW File:
DDY File:
Morph Factor 1 - Dry Bulb (°C):
0.00
Morph Factor 1 - Dewpoint (°C):
0.00
Morph Factor 2 - Dry Bulb (°C):
0.00
Morph Factor 2 - Dewpoint (°C):
0.00

Modeling Overview

Developing a new tool to support these analyses:

- Hourly resilience simulation
- Hourly annual normal operation Simulation
- ADORB LCCA
- Future GUI Interface



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

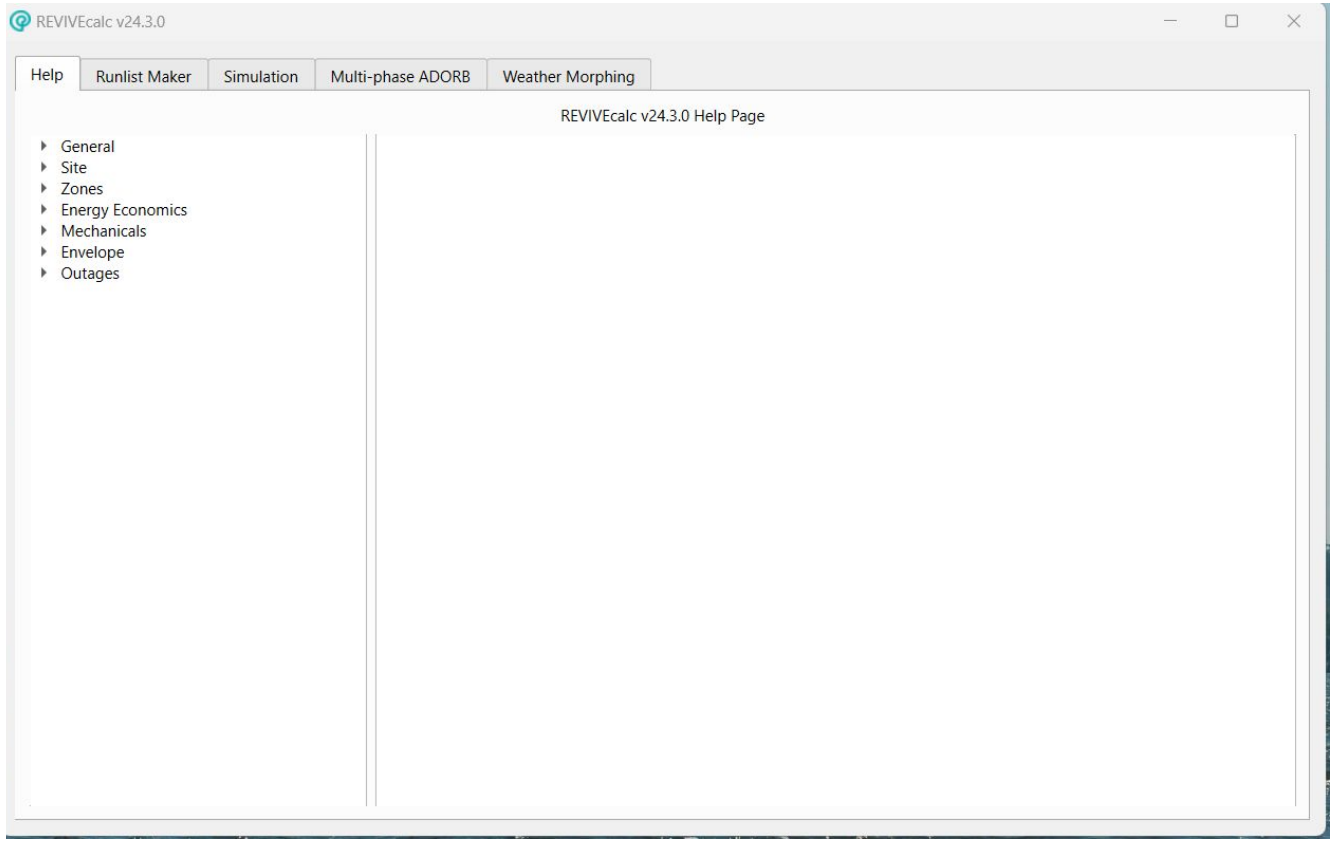
EC - evaporative cooler (B zones)

EC+Shd - evap cooler + ext. blinds

Example Building - Modeling

New, Free, Open source modeling tool: REVIVEcalc

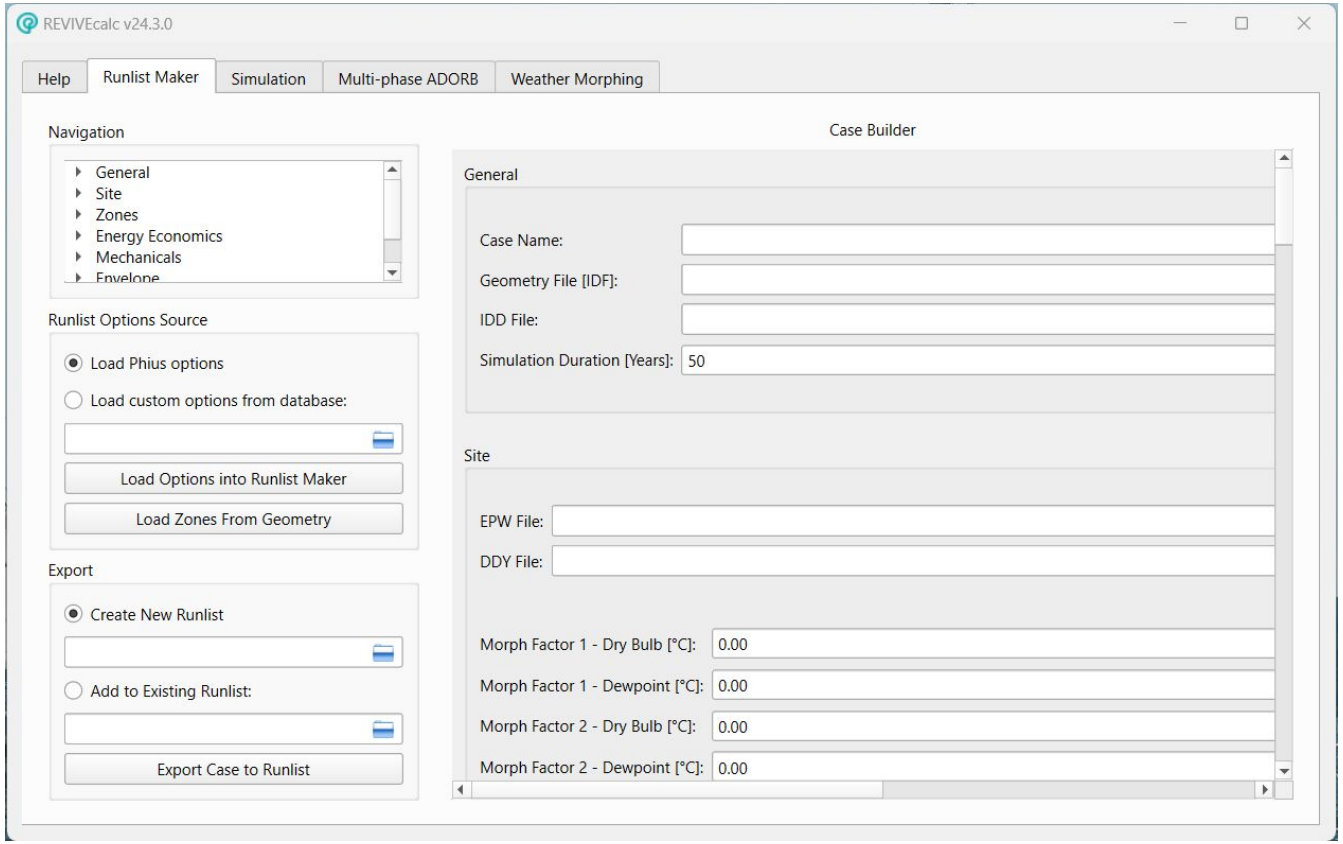
- Runs on EnergyPlus
- Automates resilience and annual simulation -> Lifecycle cost analysis
- Supports parametric iterations



Example Building - Modeling

Runlist Maker

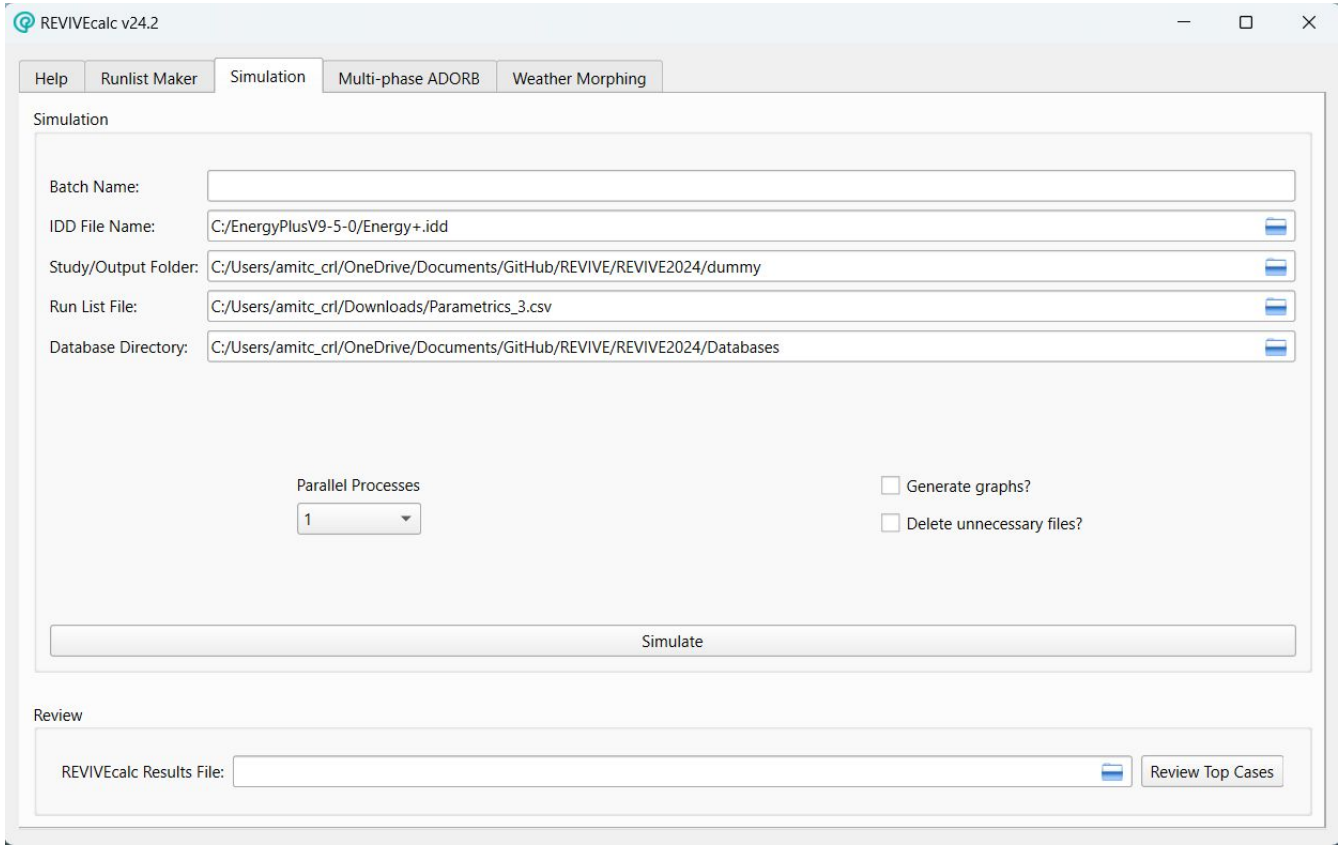
- Builds out a runlist of all cases to be considered
- Loads options from databases for easy reuse
- Editable in graphic interface or CSV format



Example Building - Modeling

Simulate Tab

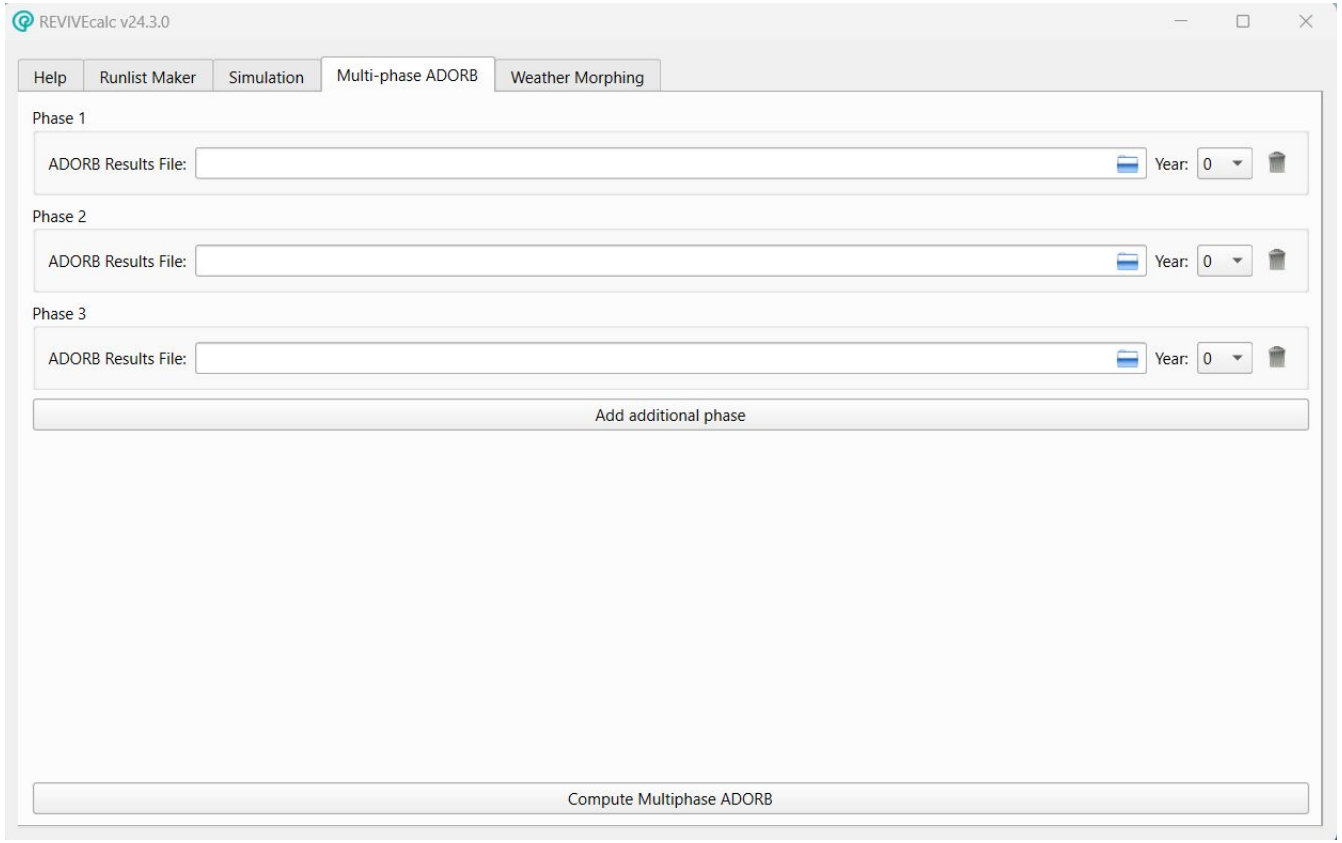
- Runs simulations in parallel
- Compiles results
- Quick results processing at the bottom to get top 5 cases



Example Building - Modeling

Multi-phase ADORB Tab

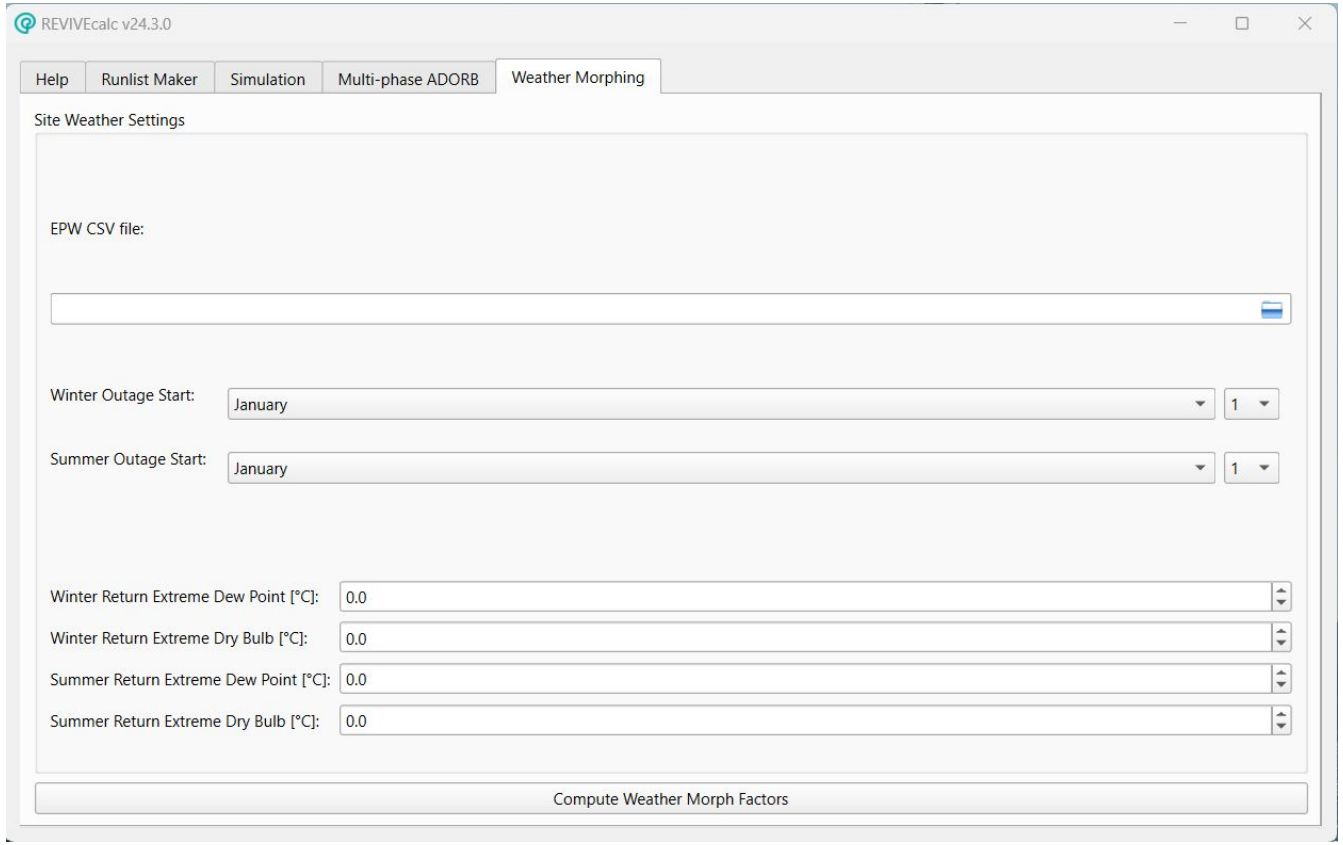
- Supports multiphase modeling
- Stitches together multiple cases into one LCCA
- Each case represents one phase of the project



Example Building - Modeling

Weather Morphing Tab

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

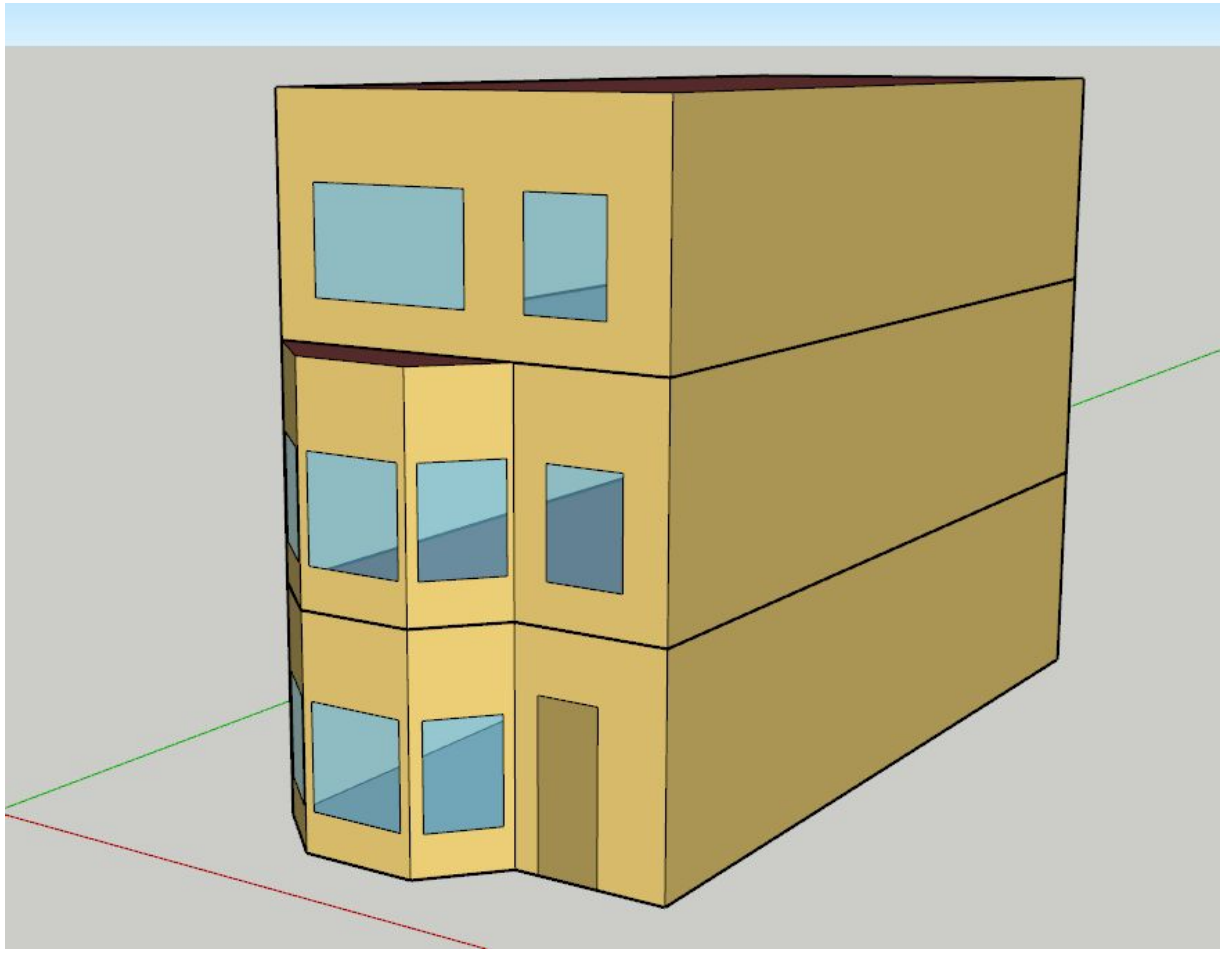


Live Modeling Tool Demo

A live Demo happened discussing modeling and the tool. New features were shown. Keep an eye on training videos

Multifamily Modeling

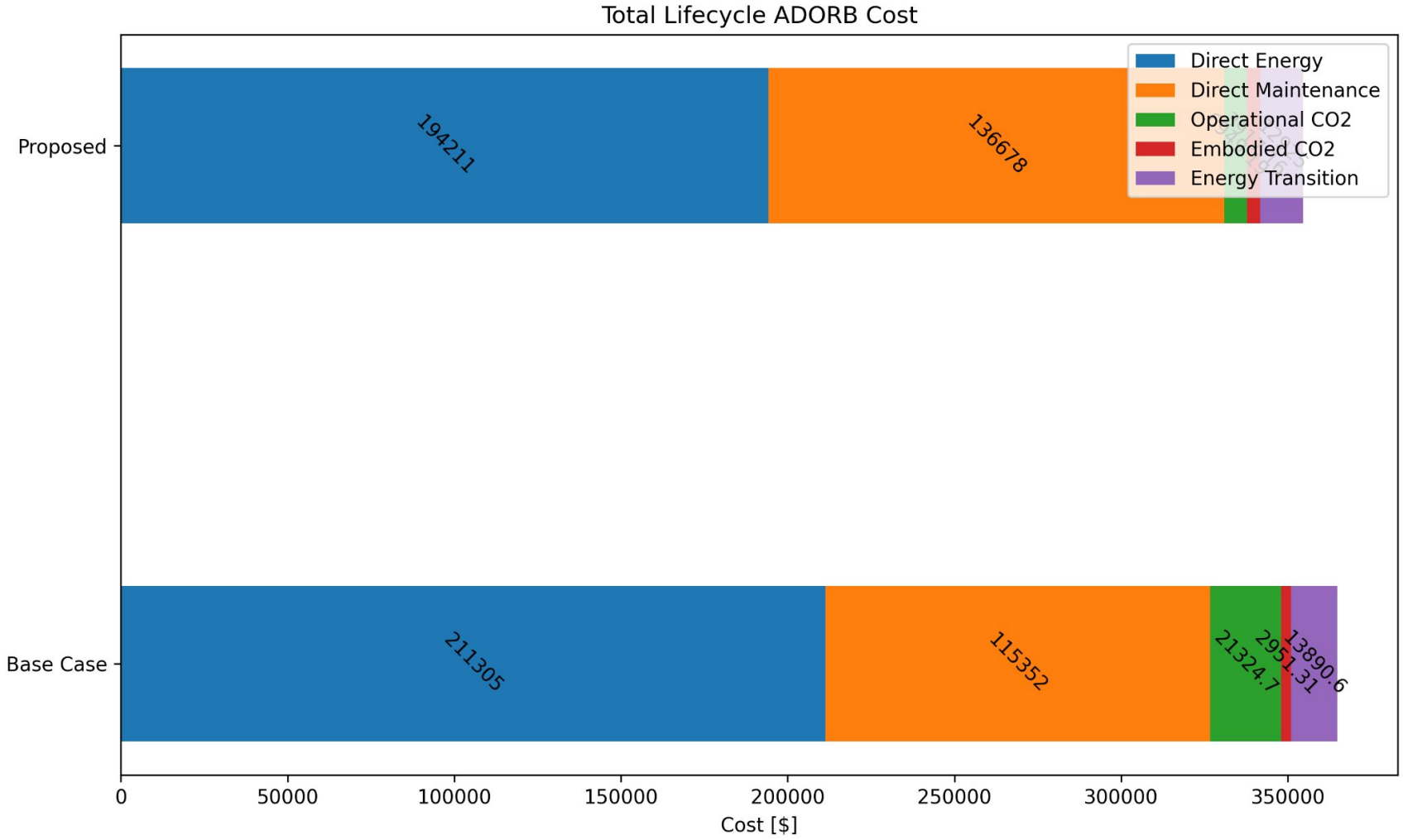
- Full multizonal modeling support
  -
- Can utilize multiple geometry editing tools
  - Output must be IDF
- Assemblies are tagged so they can be



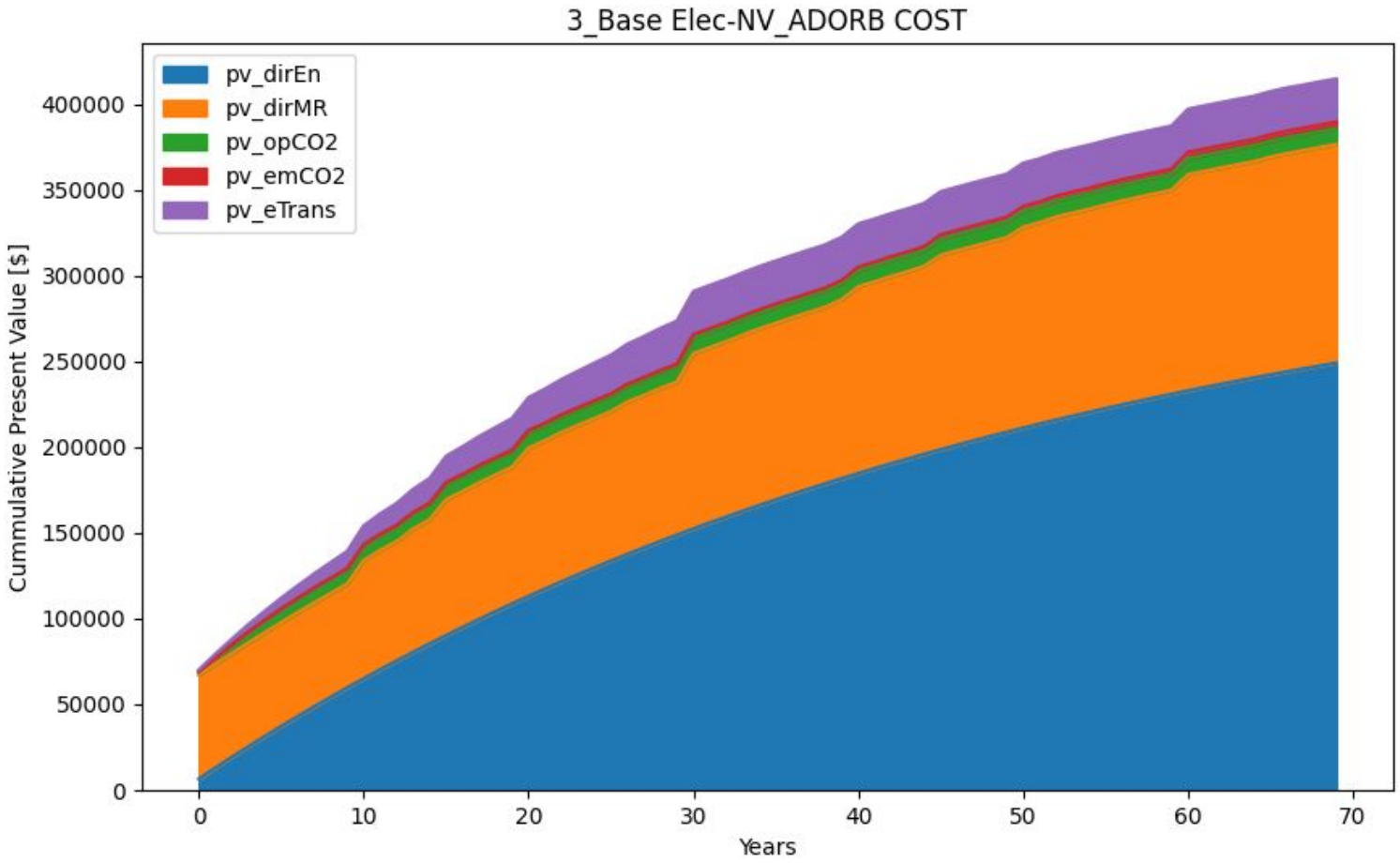
Multifamily Modeling

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

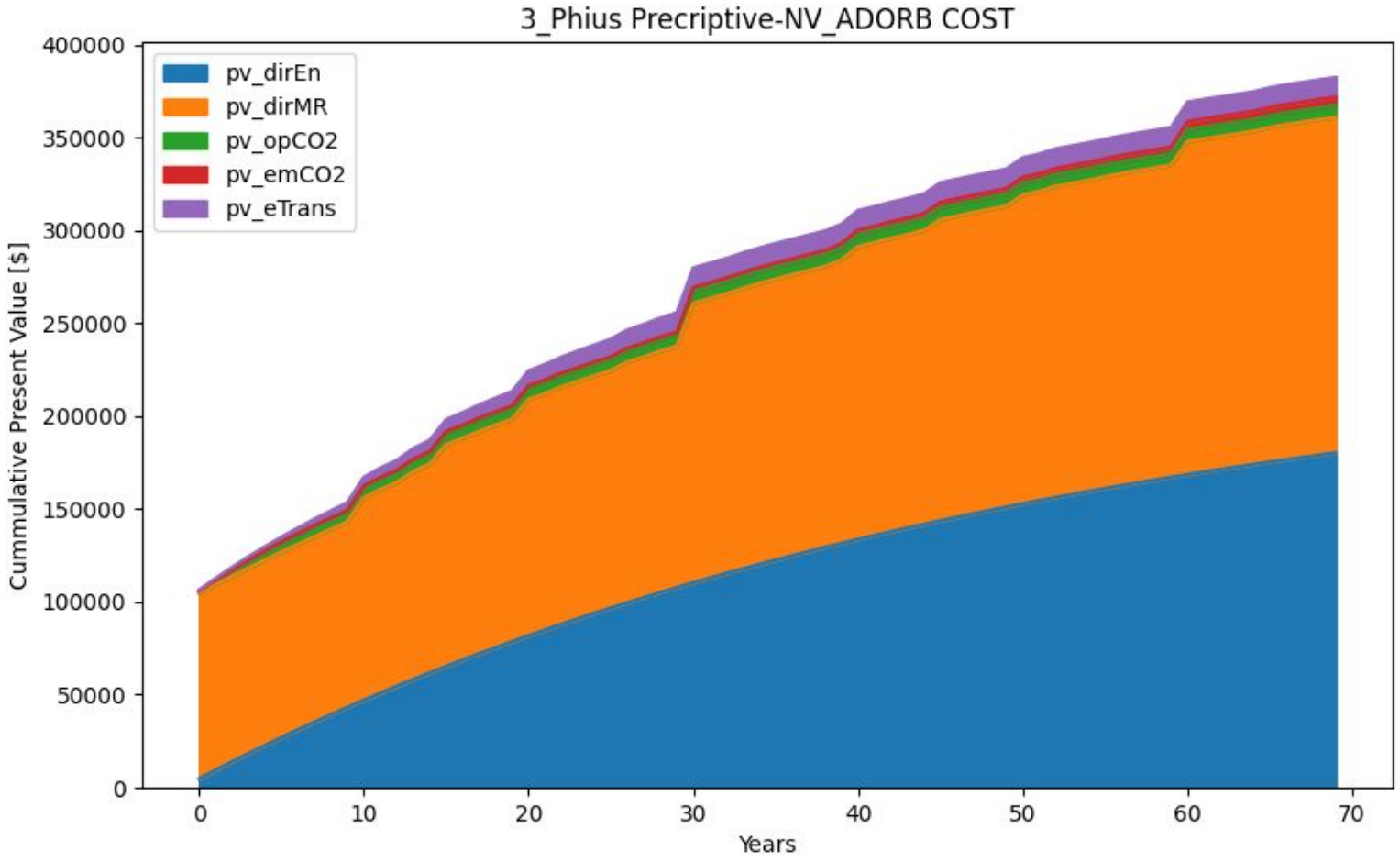
Multifamily Modeling - Outputs



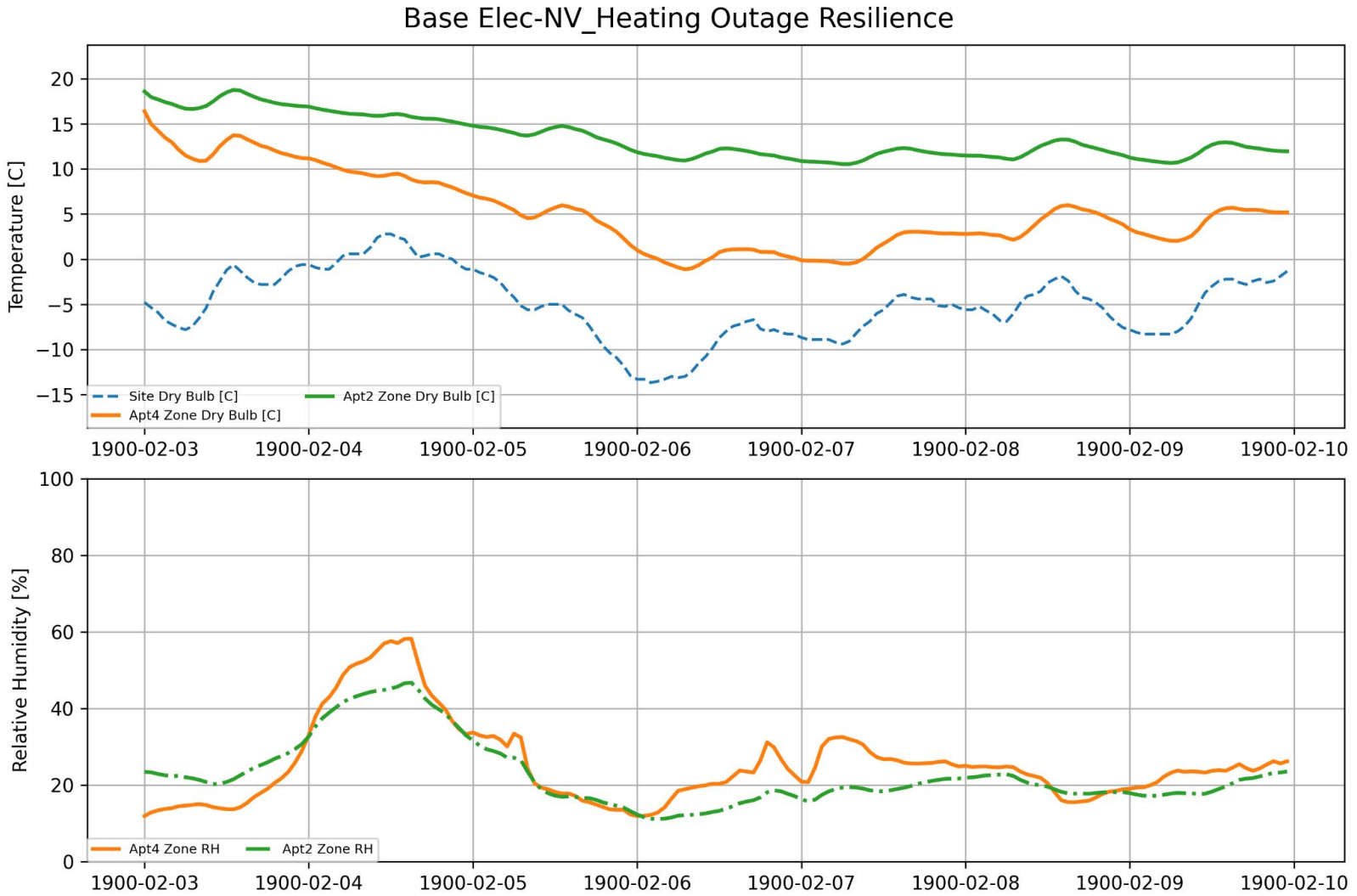
Multifamily Modeling - Outputs



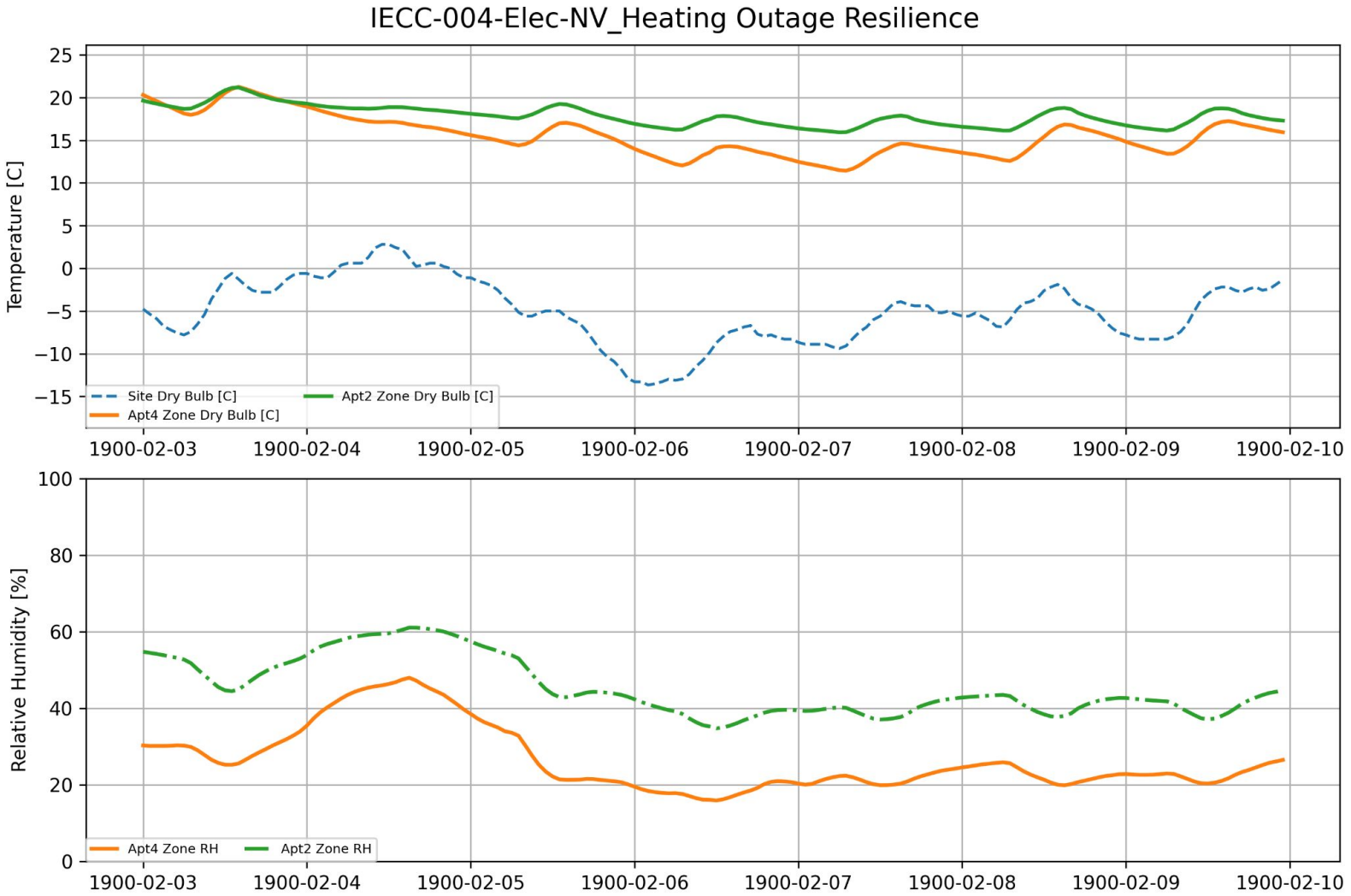
Multifamily Modeling - Outputs



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	-

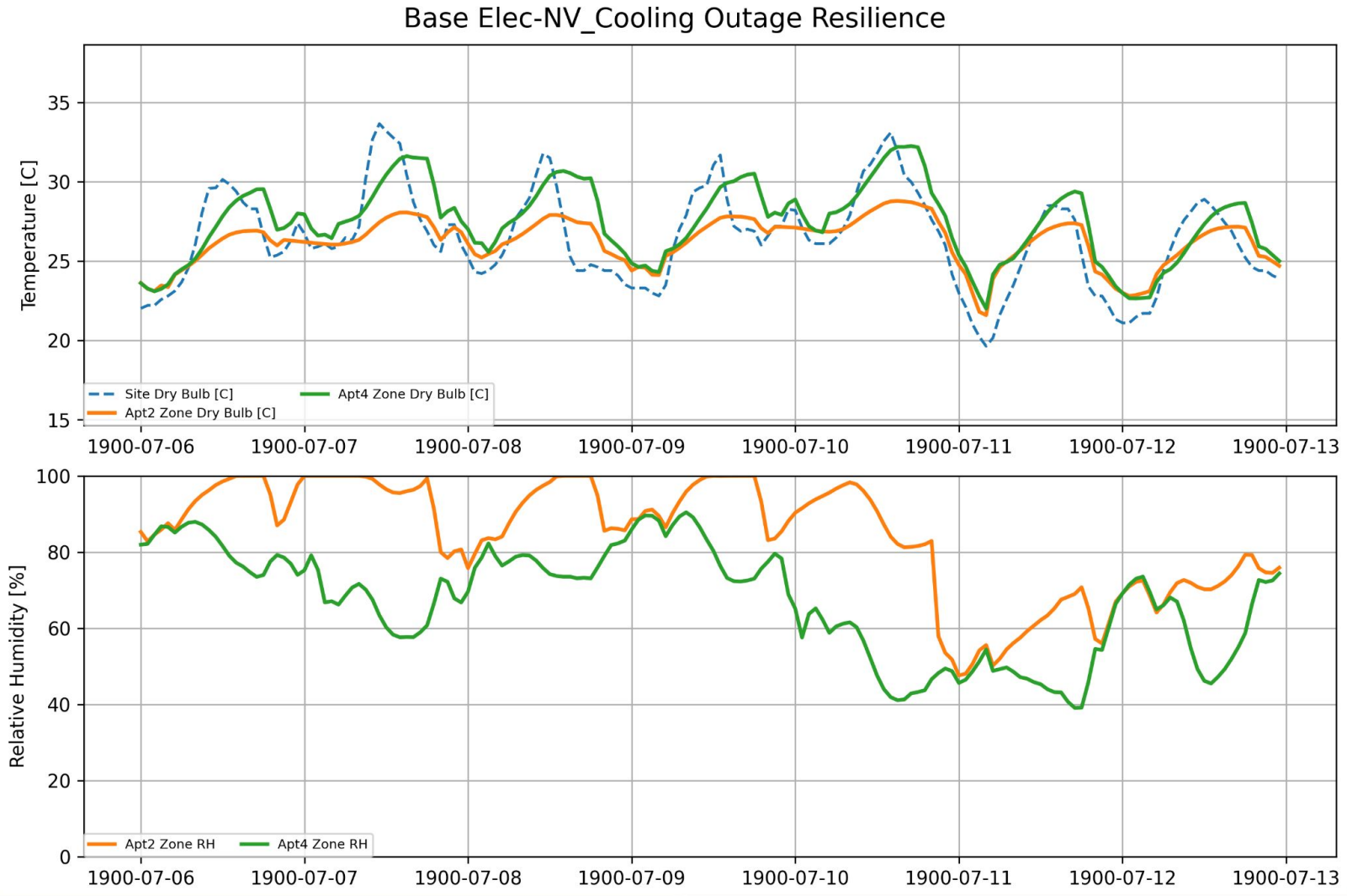
Multifamily Modeling - Outputs

IECC 2021 + Airsealing

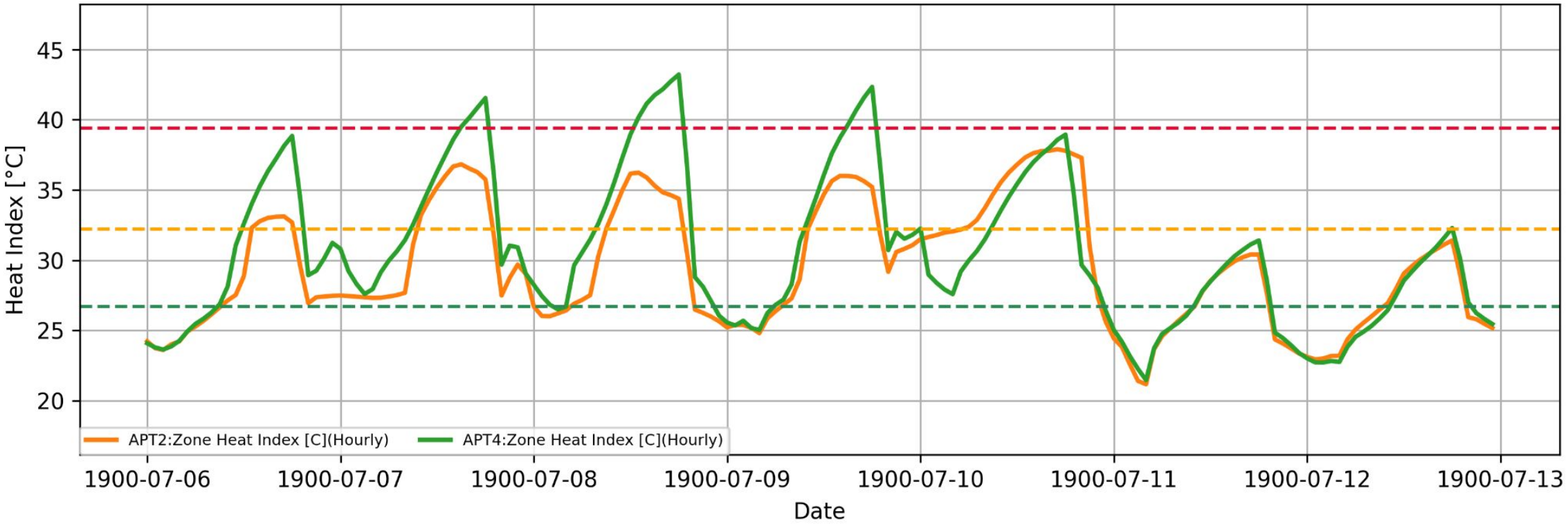
Heating SET Hours

	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

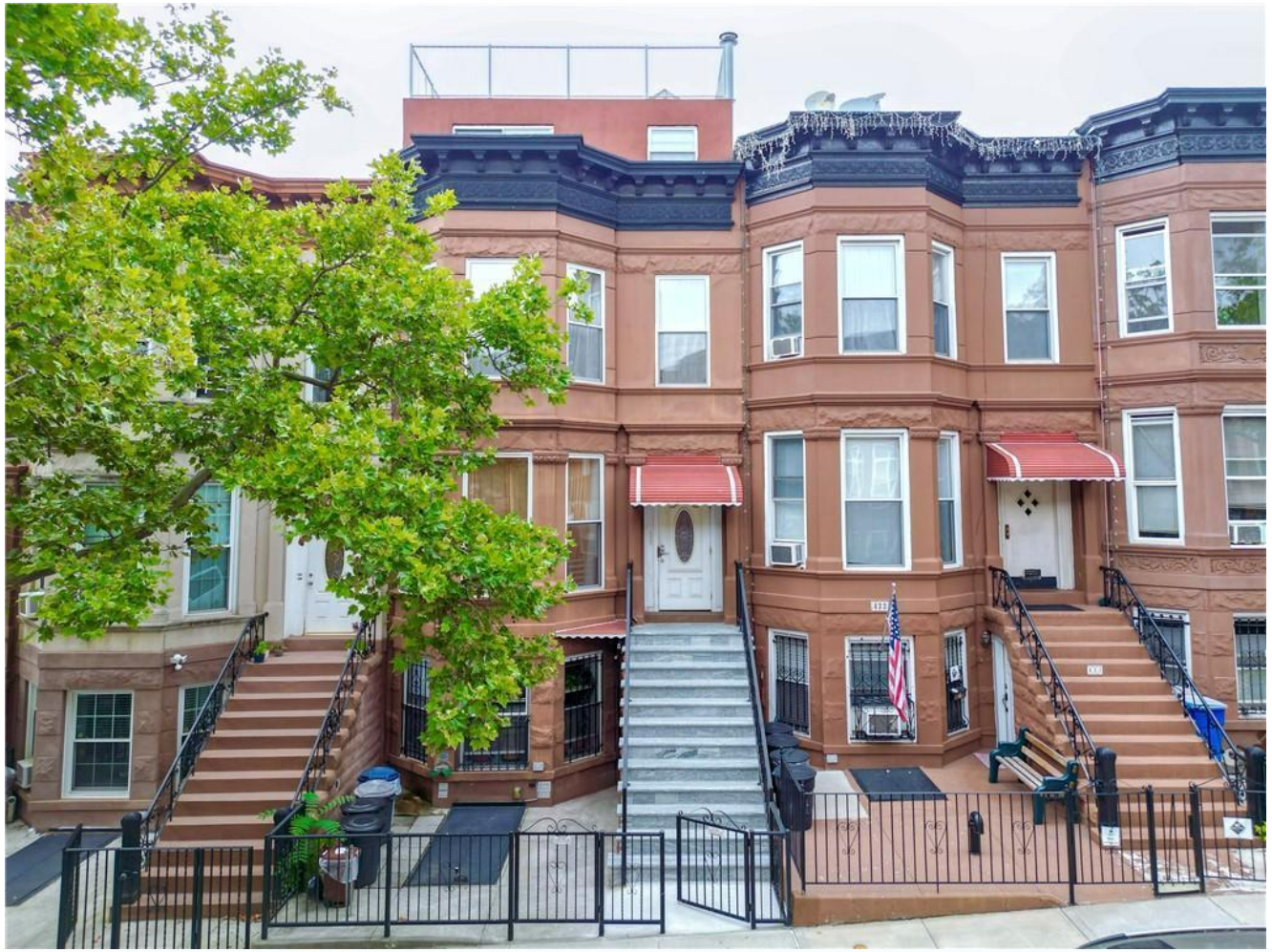
IECC 2021 + Airsealing

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

CERTIFYING PROJECTS SHARES KNOWLEDGE

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

Looking ahead

We hope REVIVE 2024 both meets the moment and will have some durability.

It will probably get longer as clarifications are added.

The software (and documentation templates) will improve.

We will seek to get big money for this.

Govt, World Bank -> decarbonization
Insurers -> hazard fortification
Health insurance -> IAQ
Owners -> outage resilience, IAQ, fortif.

Parametric studies, mixed mode cooling