COMPARING 3 CERTIFICATION METRICS THAT DRIVE SUSTAINABILITY IN AFFORDABLE MULTI-FAMILY HOUSING

NESEA BUILDING ENERGY 2018
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Moderator: Betsy Harper, Sustainability Program Developer at MA Department of Housing and Community Development (DHCD)

Enterprise Green Communities: Darien Crimmin, VP Energy and Sustainability at Winn Development

Zero Net Energy: Julie Klump, VP Design and Building Performance at POAH

Passive House: Michael Hindle, Principal of Passive to Positive

Metric Comparisons

	Enterprise Green Communities (Rehab)
HERS Rating (MA Low-rise New Construction = 55)	Typically = 85; Historic bldg. exception = 100
ACH @ 50 Pascals	Unit types range 8 – 15; No Req.
Renewable Energy?	Not required
Durability & Health Benefits	Comprehensive prescriptive point system, e.g. storm water management; low VOC products; water efficiency

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ACH @ 50 Pascals	Unit types range 8 – 15; No Req.	Not available
Renewable Energy?	Not required	Not required
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Metric Comparisons

	Enterprise Green Communities (Rehab)	Enterprise Green Communities (New Construction)	Zero Net Energy: International Living Building Challenge
HERS Rating (MA Low-rise NC=55)	Typically = 85; Historic bldg. exception = 100	No specific #; based on Energy Star reference home	HERS Score = 0
ACH @ 50 Pascals	Unit types range 8 – 15; No Req.	Not Available	Buildings range 1.3 - 1.7; No Req.
Renewable Energy?	Not required	Not required	Necessary to get to Net Zero
Durability & Health Benefits	Comprehensive prescriptive point system, e.g. storm water management; low VOC products; water efficiency		Non-prescriptive, Living Building Petals

Metric Comparisons

	Enterprise Green Communities (Rehab)	Enterprise Green Communities (New Construction)	Zero Net Energy: International Living Building Challenge	Passive House (Rehab)
HERS Rating (MA Low-rise NC=55)	Typically = 85; Historic bldg. exception = 100	No specific #; based on Energy Star reference home	HERS Score = 0	Not applicable; modeled differently (would be 30 or less)
ACH @ 50 Pascals	Unit types range 8 – 15; No Req.	Not Available	Buildings range 1.3 - 1.7; No Req.	0.05 CFM50 / sf (variable)
Renewable Energy?	Not required	Not required	Necessary to get to Net Zero	Frequently included, but not required
Durability & Health Benefits	Comprehensive prescriptive point system, e.g. storm water management; low VOC products; water efficiency		Non-prescriptive, Living Building Petals	Non-prescriptive, but best practices result in high IAQ

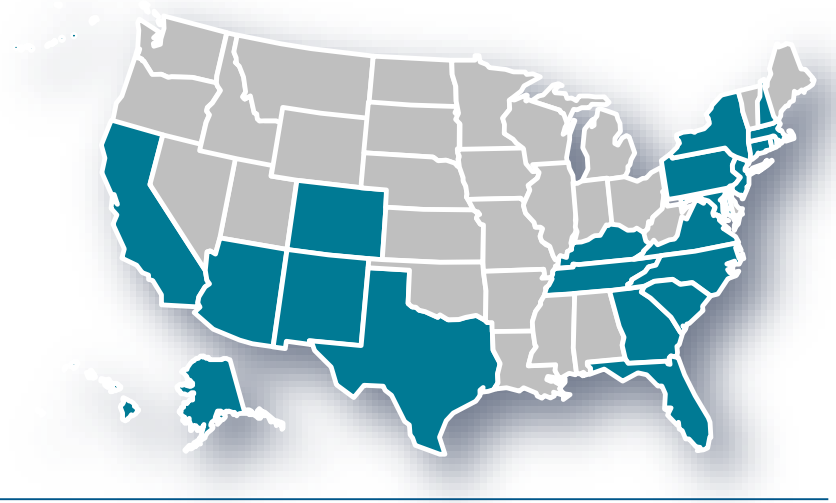
Comparing Certification Metrics in Affordable Multifamily Housing

Enterprise Green Communities

WinnCompanies
Development | Residential | Military

WinnCompanies – At A Glance

- We are the **5th largest** multifamily management company in the nation with **121 million square feet** under management.
- WinnCompanies is the largest privately held management company; owning and managing real estate holdings valued at approximately **$14 Billion**.
- We operate multifamily housing in urban, suburban and metro markets nation-wide. Our assets include luxury high rise, mid-rise, historic re-use and garden style residences totaling more than **100,000 units** in more than **580 apartment communities**.
- We operate in **22 states** and have 3,000 employees, including 318 veterans.



Sustainability Initiatives

- **Green Building Certification:** All acquisitions, rehabs, and new developments embrace sustainability.
- **Deep Energy Retrofits:** Completed the nation's largest deep energy retrofit at Castle Square, saving more than 50 percent of energy usage
- **Better Buildings Challenge:** U.S. Department of Energy Better Buildings Challenge partner, committed to saving 20% energy usage across portfolio within the next decade.
- **Green Financing:** Developing effective models to finance energy improvements in affordable multifamily housing
- **Solar Power:** Leading the multifamily industry in solar power development, transforming rooftops into power plants with more than 2 megawatt of PV installed

WinnGreen Case Study:
Castle Square | *Boston, MA*

Our $125mm+ reconstruction of the 500 unit property won multiple industry awards, including Best Urban Tower and Best Urban Low Rise.

Former U.S. Secretary of HUD remarked the development “made history” as “the largest ‘deep’ green retrofit ever undertaken in the United States”.

Enterprise Green Communities: What and Why?

meet mandatory criteria

+

35

optional points

NEW CONSTRUCTION

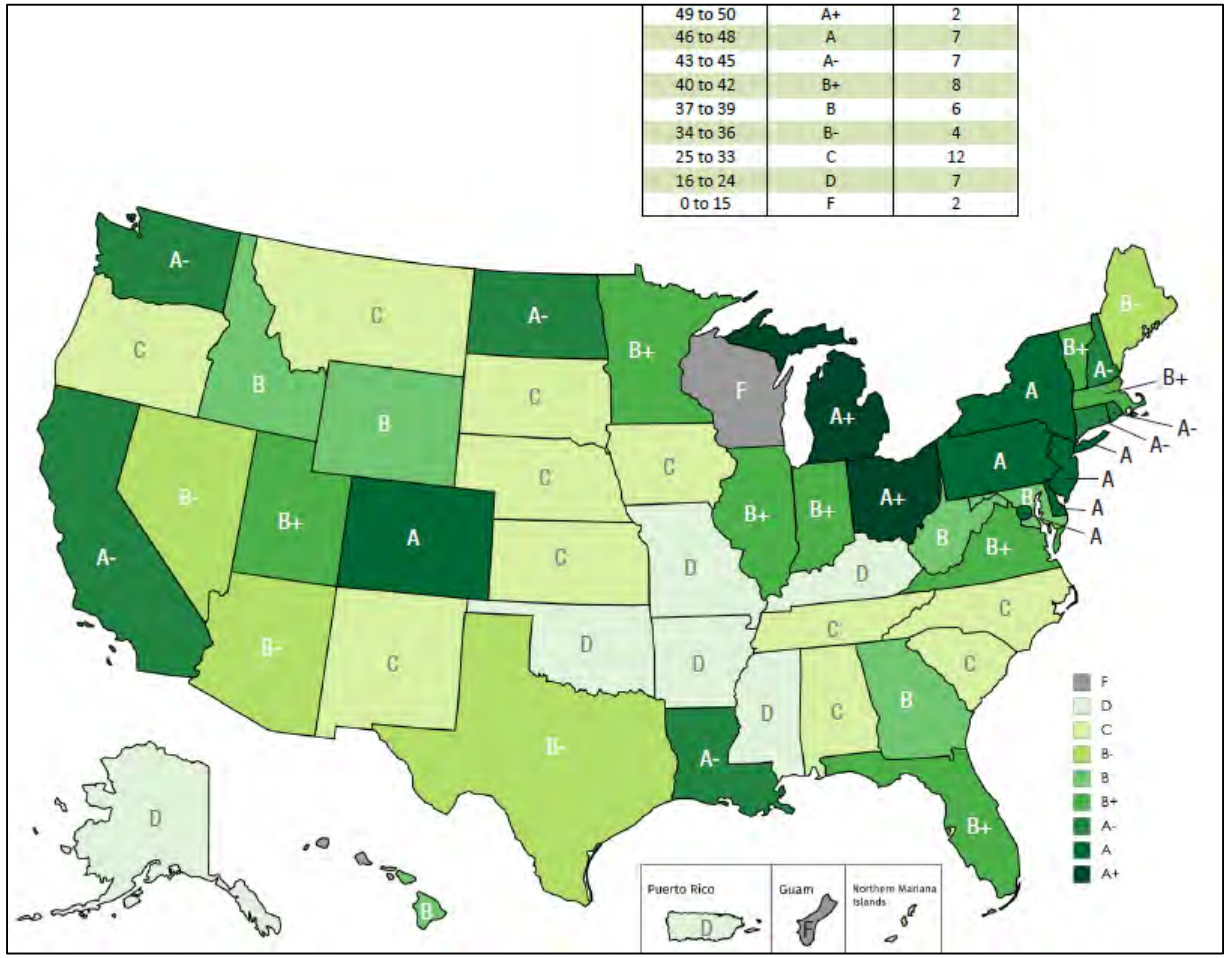
30

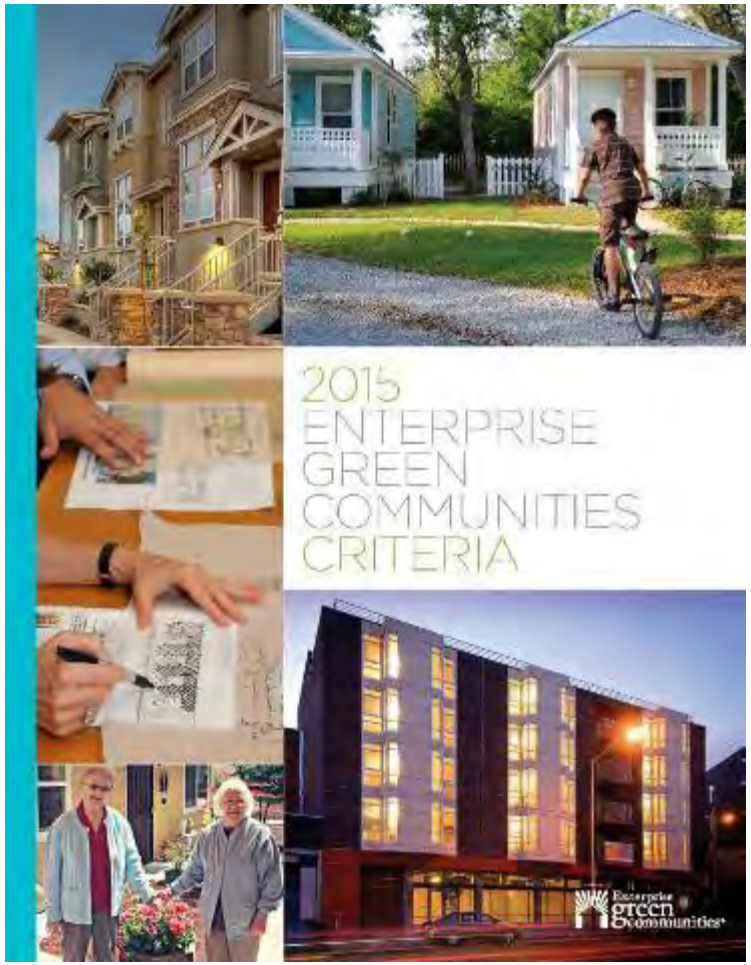
optional points

SUBSTANTIAL & MODERATE REHABILITATIONS

Enterprise Green Communities: What and Why?

49 to 50	A+	2
46 to 48	A	7
43 to 45	A-	7
40 to 42	B+	8
37 to 39	B	6
34 to 36	B-	4
25 to 33	C	12
16 to 24	D	7
0 to 15	F	2





EGC Impact

Standard Mod Rehab:

- Capital Needs
- Deferred Maintenance
- Compliance w/ Code & QAP

With EGC:

- Capital Needs
- Integrated approach
- Comprehensive green specs
- Resident and O&M manuals
- Performance and Data Driven
- Energy Modeling (HERS Index or ASHRAE 90.1)

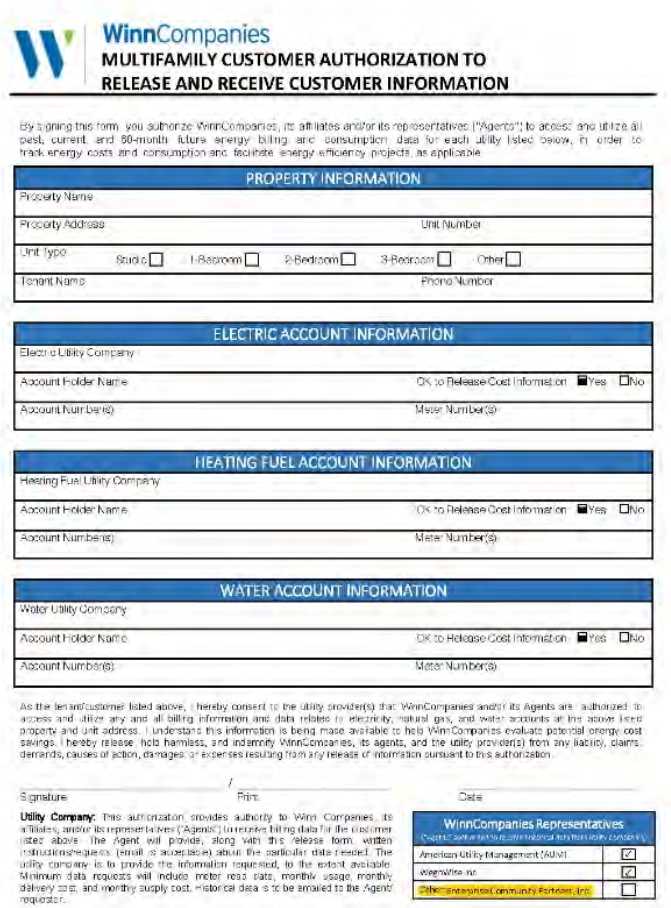
EGC Impact

Performance Drivers:

- Blower doors → air sealing
- Duct blasters → aeroseal

Prescriptive:

- LED, WaterSense, FloorScore, low-VOC
- Resident Manuals and Orientations
- Utility Monitoring: owner and tenant
- Resiliency and health



WinnCompanies

MULTIFAMILY CUSTOMER AUTHORIZATION TO RELEASE AND RECEIVE CUSTOMER INFORMATION

By signing this form, you authorize WinnCompanies, its affiliates and/or its representatives ("Agents") to access and utilize all past, current, and 60-month future energy billing and consumption data for each utility listed below, in order to track energy costs and consumption and facilitate energy efficiency projects, as applicable.

PROPERTY INFORMATION

Property Name

Property Address — Unit Number

Unit Type — Studio ☐ 1-Bedroom ☐ 2-Bedroom ☐ 3-Bedroom ☐ Other ☐

Tenant Name — Phone Number

ELECTRIC ACCOUNT INFORMATION

Electric Utility Company

Account Holder Name — OK to Release Cost Information ■ Yes ☐ No

Account Number(s) — Meter Number(s)

HEATING FUEL ACCOUNT INFORMATION

Heating Fuel Utility Company

Account Holder Name — OK to Release Cost Information ■ Yes ☐ No

Account Number(s) — Meter Number(s)

WATER ACCOUNT INFORMATION

Water Utility Company

Account Holder Name — OK to Release Cost Information ■ Yes ☐ No

Account Number(s) — Meter Number(s)

As the tenant/customer listed above, I hereby consent to the utility provider(s) that WinnCompanies and/or its Agents are authorized to access and utilize any and all billing information and data related to electricity, natural gas, and water accounts at the above listed property and unit address. I understand this information is being made available to help WinnCompanies evaluate potential energy cost savings. I hereby release, hold harmless, and indemnify WinnCompanies, its agents, and the utility provider(s) from any liability, claims, demands, causes of action, damages, or expenses resulting from any release of information pursuant to this authorization.

Signature — Print — Date

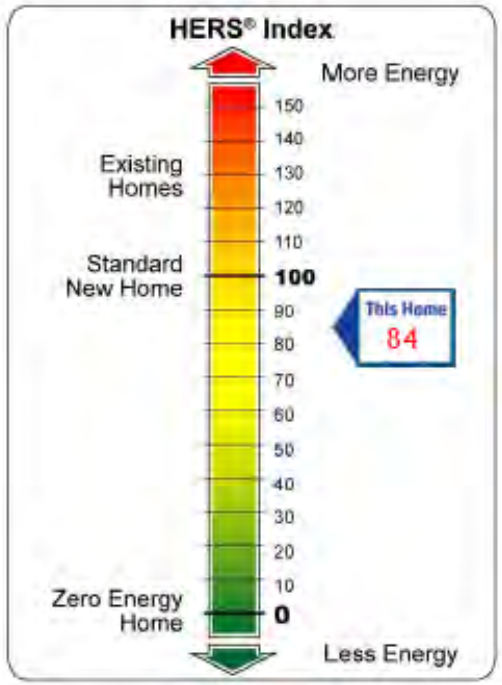
Utility Company: This authorization provides authority to WinnCompanies, its affiliates, and/or its representatives ("Agents") to receive billing data for the customer listed above. The Agent will provide, along with this release form, written instructions/requests (email is acceptable) about the particular data needed. The utility company is to provide the information requested, to the extent available. Minimum data requests will include meter read date, monthly usage, monthly delivery cost, and monthly supply cost. Historical data is to be emailed to the Agent/requestor.

WinnCompanies Representatives

American Utility Management (AUM)	☑
WegoWise Inc	☑
Other: Enterprise Community Partners, Inc	☐

HERS Index as Comparative Metric

- Applicable for low-rise multifamily with individual HVAC. EGC requires ASHRAE modeling for mid-rise/high-rise
- Model Factors: insulation, fenestration, air leakage, unit area, fuel efficiency, etc
- New construction vs existing building vs historic carve out?
- HERS of 85 is approximately equivalent to 2009 IECC and 100 is approximately equal to 2006 IECC
- A HERS Index of zero indicates zero net energy (ZNE).



The Atlantics

Atlantic Terrace – 195 units

Atlantic Terrace – 108 units

WinnCcompanies
Development | Residential | Military

The Atlantics - Scope

Atlantic Terrace – 195 units

- Kitchens, baths, flooring
- High Efficiency Lighting
- Energy Star Appliances

- Air Sealing to <10 ACH50
- Duct sealing to <10%
- DHW: Energy Star Direct Vent

Atlantic Terrace – 108 units

- Kitchens, baths, flooring
- High Efficiency Lighting
- Energy Star Appliances

- Air Sealing to <15 ACH50
- A/C: 15 SEER
- Furnace: 95 AFUE
- DHW: Energy Star Direct Vent
- Window Upgrade: Energy Star Performance

Driving down HERS

	Energy Efficiency Opportunity	Electricity Savings (kWh)	Natural Gas Savings (therm)	Annual Cost Savings ($)	HERS Index Impact*
Mechanical Opportunities					
1	10 EER A/C (available in Magic Pak)	110-214	0	$10-17	2-4
2	13 SEER A/C (split system)	412-655	0	$34-52	7-11
3	15 SEER A/C (split system)	543-848	0	$44-67	10-14
4	90 AFUE Gas Furnace (split system)	25-131	15-24	$11-22	3-5
5	95 AFUE Gas Furnace (split system)	56-153	21-34	$16-33	4-7
Hot Water Opportunities					
6	Direct Vent Water Heater (Energy Star)	2,905-3,050	(140-145)	$163-164	4-5
7	On Demand Gas Water Heater (Energy Star)	2,905-3,050	(112)	$177-178	8-9
Lighting Opportunities					
8	100% Fluorescent Lighting	882	(17)	$62	7
Appliance Opportunities					
9	Refrigerator (Energy Star)	406	(8)	$29	3
10	Dishwasher (Energy Star)	138	(1)	$11	1
Diagnostic items (must be measured and based on actual performance)+					
11	Air sealing to 15 ACH (from 20 ACH)	1,440-2,125	23-45	$126-191	Up to 13
12	Duct Sealing to 10%	2,125-2,139	45-87	$191-213	Up to 13

EEO Description	HERS Impact
Blower Door (Infiltration)	
10 ACH_{50}	13
12 ACH_{50}	11
14 ACH_{50}	8
16 ACH_{50}	6
18 ACH_{50}	3
Existing - 20 ACH_{50}	--
Duct Blaster (duct leakage)	
5%	17
10%	14
20%	9
30%	4
Existing - 40%	--

Initial Findings

- 20 ACH50 Typical Air Leakage (Very High)
- 40% Duct Leakage (Very High)
- **Base HERS Indexes typically range from 125 to 135** (significant improvements required to reach HERS Index of 85)

Paths to 85

Option 1
Current Scope Items
Air Sealing to <10 ACH50
Duct Sealing to <10% Leakage
High Efficiency Tankless Water Heater

Option 2
Current Scope Items
Replace Magic Park with 15 SEER Split System with 95% AFUE Furnace
High Efficiency Direct Vent Hot Water Heater

Paths to HERS <85

Option 3
Current Scope Items
Replace Magic Park with 13 SEER Split System with 90% AFUE Furnace
High Efficiency Direct Vent Hot Water Heater
Duct Sealing to <10% Leakage

Option 4
Current Scope Items
Air Sealing to <10 ACH50
Replace Magic Park with 13 SEER Split System with 90% AFUE Furnace
High Efficiency Direct Vent Hot Water Heater

Figure 1: Summary of Potential Paths to HERS <85

Multiple pathways to achieve performance requirement

Assessment allows for flexibility based on costs comparison and other factors

Initial Findings

- 20 ACH50 Typical Air Leakage (Very High)
- 40% Duct Leakage (Very High)
- **Base HERS Indexes typically range from 125 to 135** (significant improvements required to reach HERS Index of 85)

+ $563,125

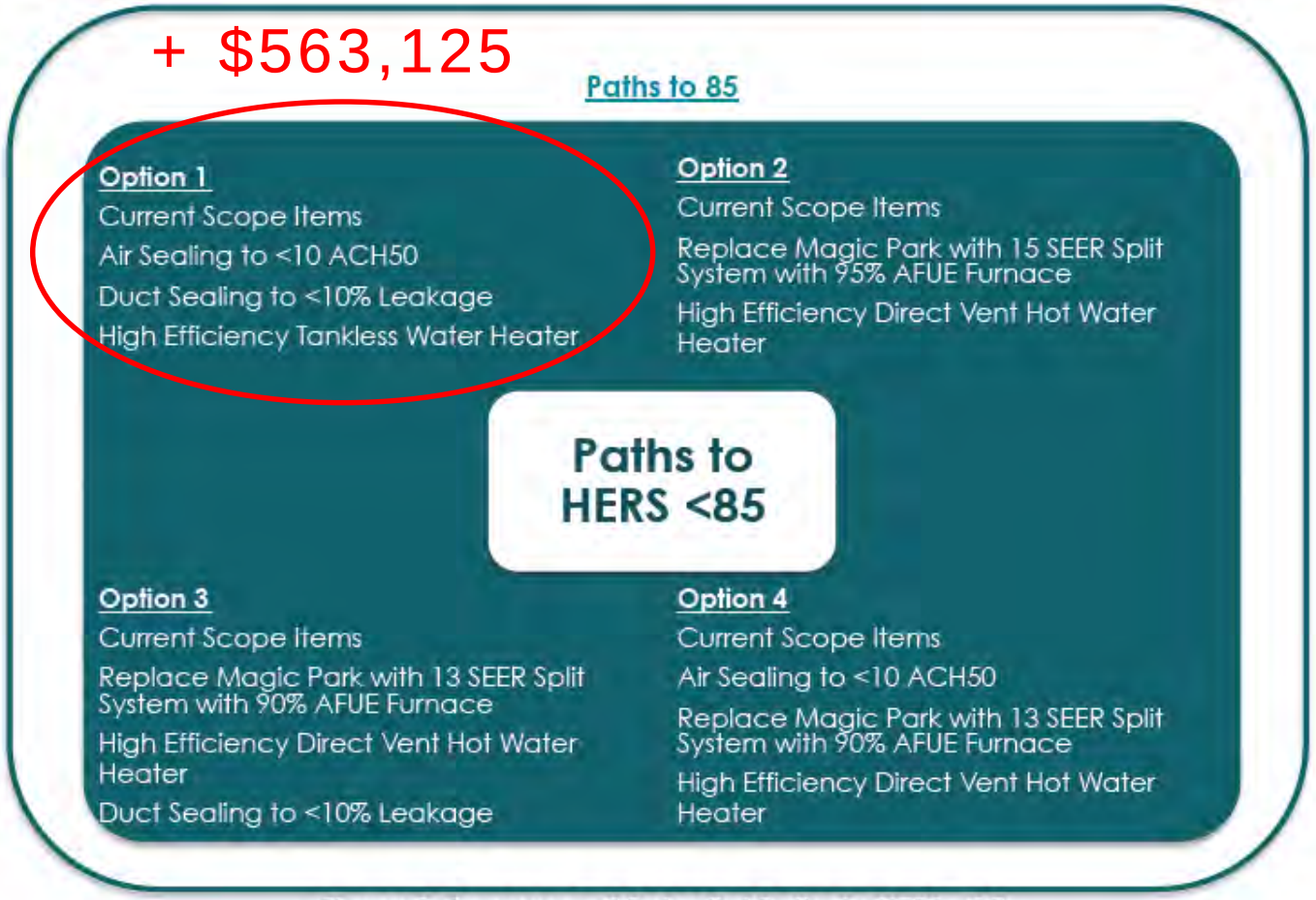


Figure 1: Summary of Potential Paths to HERS <85

Added costs due to:

AeroSealing to reduce duct leakage @ $1200/unit

Air Sealing runs $500-1000/unit depending on extent

New tankless DHW

Pre vs. Post Rehab: Energy Performance

- Pre-rehab HERS Index 120-135
- 20 ACH_{50} Air Infiltration
- 40% Duct Leakage

- Final post rehab HERS Index 76-85
- 8-15 ACH_{50} Air Infiltration
- <10% Duct Leakage

Pre vs. Post Rehab: Utility Allowances

	Atlantic Terrace Utility Allowances					
	1-BR Electric	1-BR Gas	2-BR Electric	2-BR Gas	3-BR Electric	3-BR Gas
Pre-Rehab Actual	$ 44.27	$ 29.58	$ 71.57	$ 31.56	$ 89.61	$ 39.19
Post-Rehab Modeled	$ 33.86	$ 20.47	$ 40.41	$ 25.25	$ 45.53	$ 32.30
Savings	24%	31%	44%	20%	49%	18%

Pre vs. Post Rehab: Portfolio Manager

Atlantic Terrace

Atlantic Gardens

Metrics Summary

Metric	Jan 2015 (Other)	Dec 2017 (Energy Current)	Change	Jan 2015 (Other)	Nov 2017 (Energy Current)	Change
ENERGY STAR Score (1-100)	72	93	21.00 (29.20%)	53	89	36.00 (67.90%)
Source EUI (kBtu/ft²)	110.6	84.9	-25.70 (-23.20%)	127.8	90.8	-37.00 (-29.00%)

Challenges and Lessons Learned

- EGC drives quality and comprehensive approach to moderate and substantial renovations;
- Applicable to rehabs and new construction;
- Replicable owner driven process;
- Occupied rehab with existing hazards (ACM in walls);
- Budget restrictions always apply;
- Missed air sealing opportunities in occupied units.

Solar at Atlantic Terrace

Thank You

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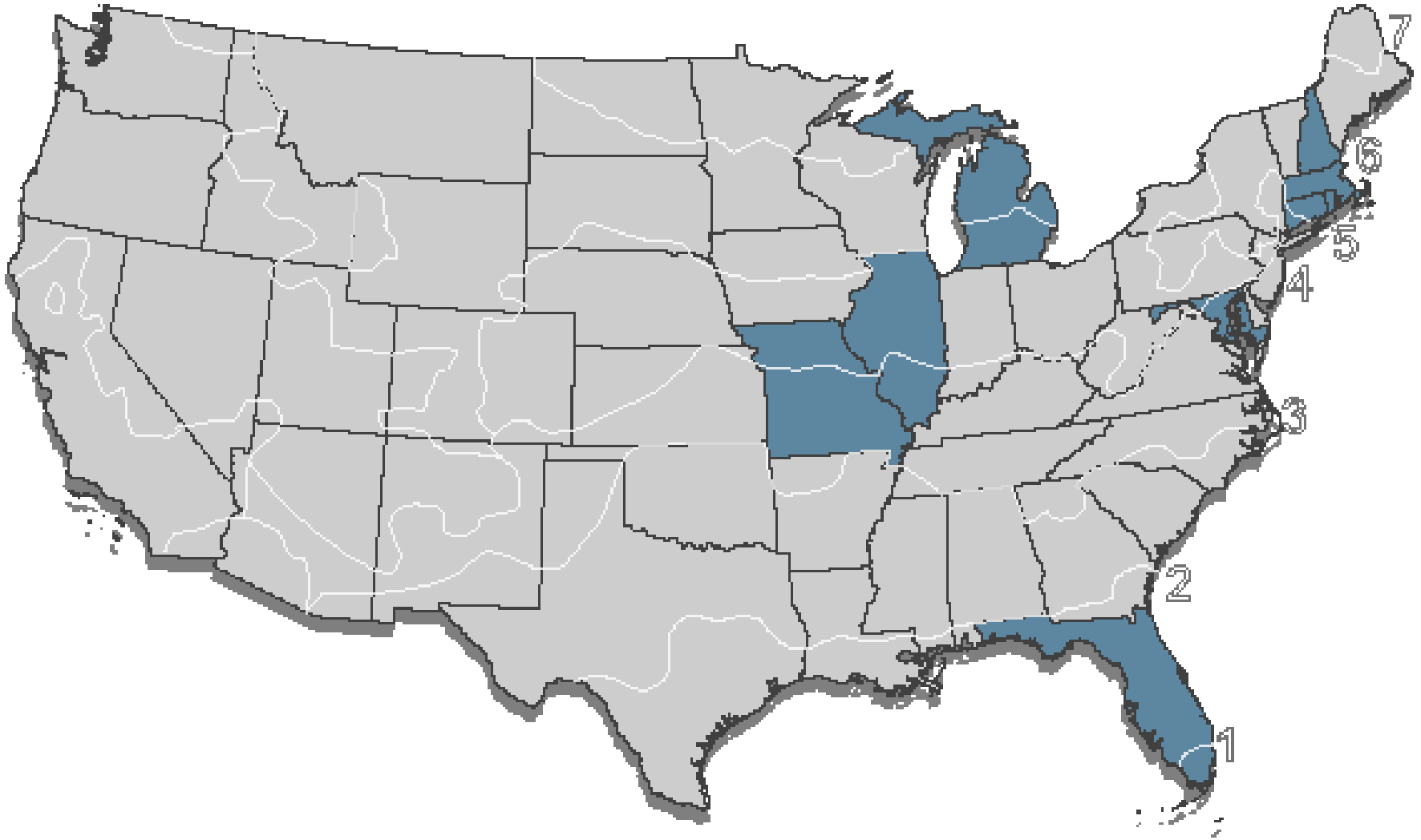
Non-Profit Developer and Owner



Non-Profit Developer and Owner

POAH's Foray into Green Building Certifications

Certification	Motivation	Results
LEED Certifications: Platinum and Gold level	Grant Funds and City of Boston Requirement	Not our best performing buildings
Enterprise GC Rehab	Piloting for Company Wide Adoption	Tenants heating use down by 34%
Enterprise GC New Construction	QAP Points	Still Under Construction
Passive House	QAP Points (CT)	Under review for tax-credit funding
Net Zero Ready	Proof of concept for funders and in-house team	Still collecting data

Net Zero Certifications

International Living Future Institute: Zero Energy Building Certification Standard:

100% of the Building's Energy Needs Met on an Annual Basis by on-site renewable energy. No combustion is allowed.

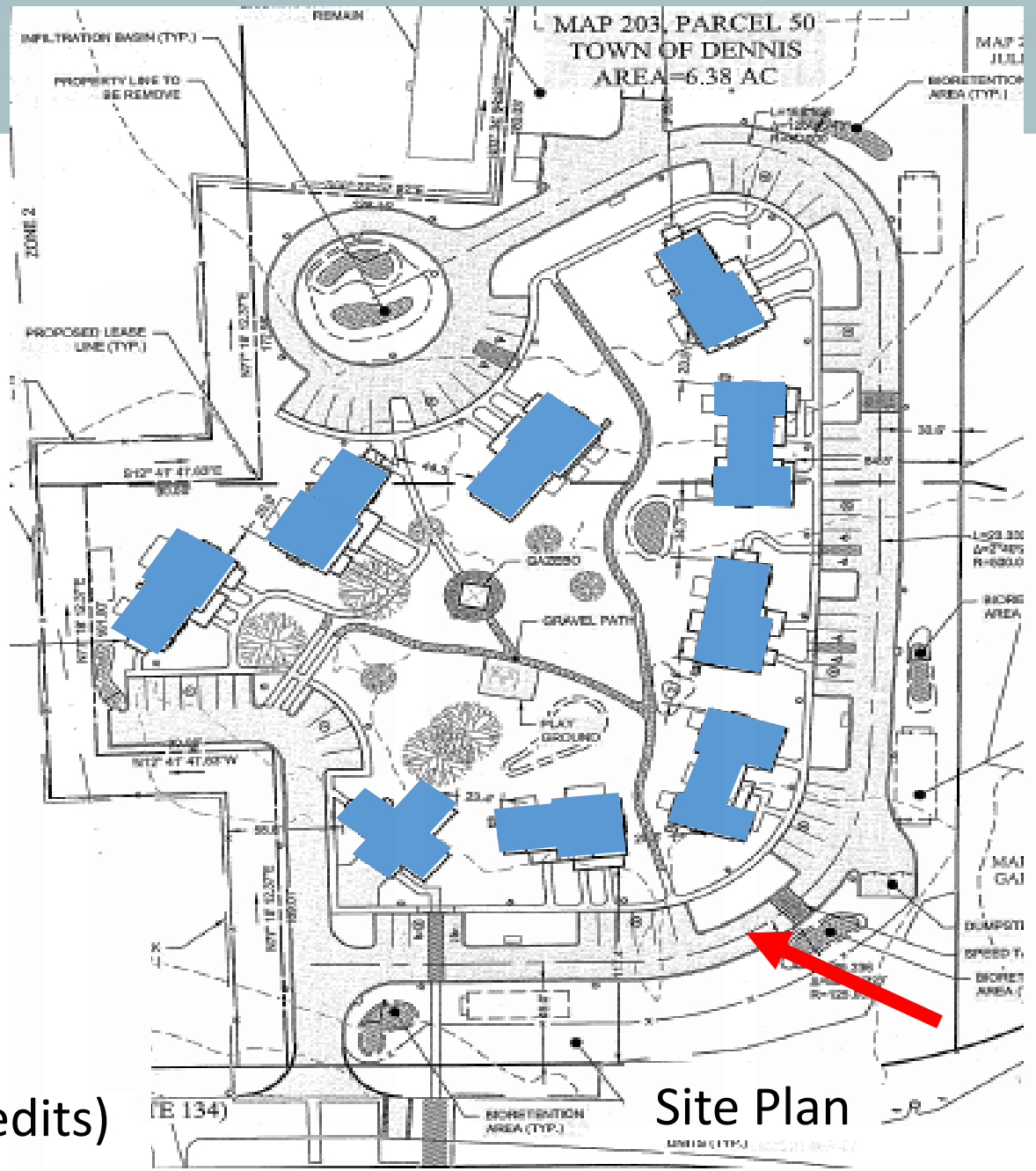
- Created in 1917 as a partnership of ILFI and New Buildings Institute (NBI)
- Simple
- Metric has to be Verified, Certification not granted until a year of Net Zero has been achieved.

DOE Zero Energy Ready Home

- Similar to EGC uses a Provider and a Verifier to confirm construction is completed per the HERS model
- Program designed to allow builders and architects to certify their projects
- Energy Ready, renewable system not required for certification but building has to be solar ready.

Near Net Zero?: Melpet Farm, Dennis, MA

27 Units in 8 buildings
Affordable Housing
Construction Cost Per Unit ~ $350,000
Solar PV: $500,000 (paid loan with SRECs and tax credits)



Site Plan

Near Net Zero: Initial Parameters

Base Case: Code Compliant

12 variations on the base case

- Final Case "Sweet Spot"
  - R-25 Walls, R-18 Basement Walls
  - .05 cfm/50/ssf
  - HRV per unit
  - Mini Split Heating and Cooling with One Cassette and supplemental heating in Bedrooms
  - R-5 Windows, SHGC .56
  - Unit electric loads 14,400 kWh
  - Total kBtu per building 67,710
  - Solar Production 17 kW sized to offset total kBTU

* Heating and DHW as modeled would be half the plug loads modeled

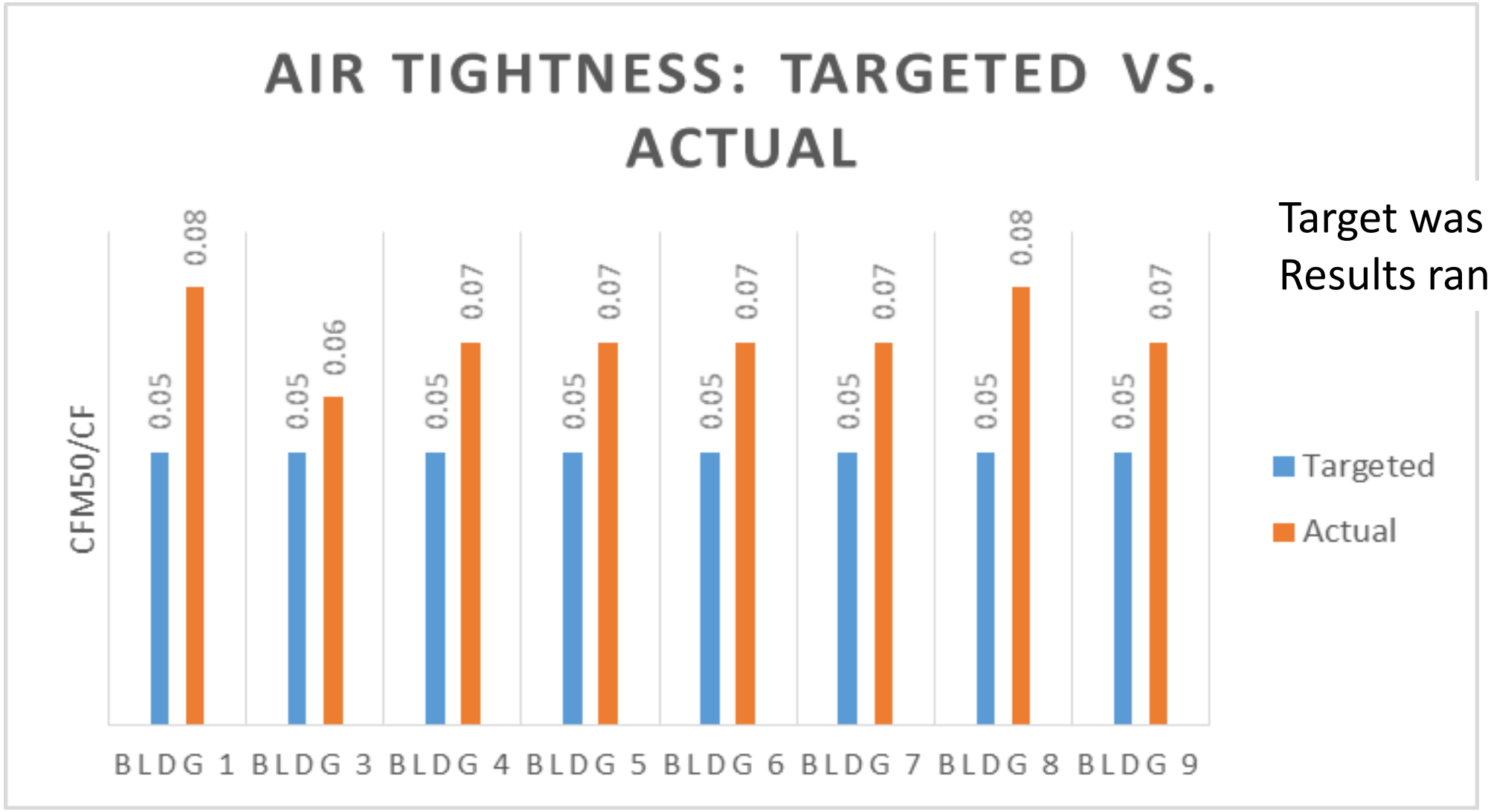
Near Net Zero: What Changed

Base Case: Code Compliant

12 variations on the base case

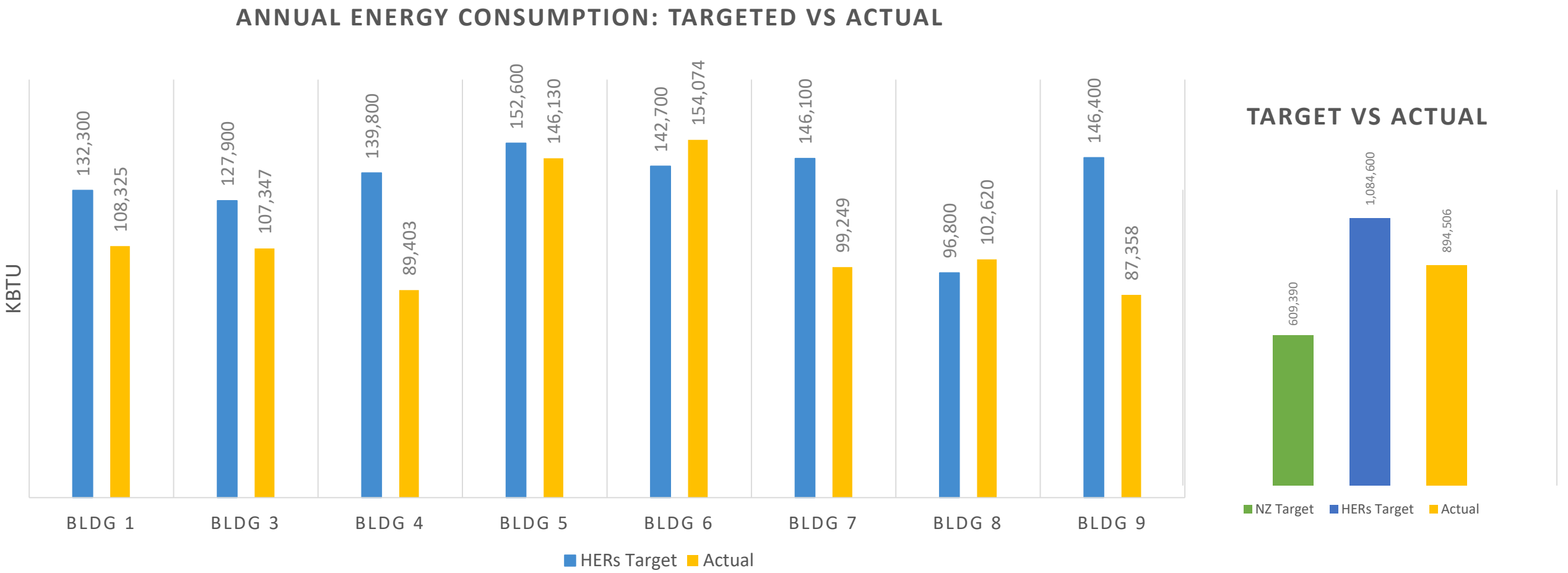
- Final Case "Sweet Spot"
  - R-25 Walls, R-18 Basement Walls
  - Removed Basements in all but One Building
  - Changed HPWHs to standard electric DHW
  - .05 cfm/50/ssf
  - Lunos with Bath Exhaust (minimal recovery)
  - VRF per Building with Heads in each room and resistance heater in bathrooms
  - R-5 Windows, SHGC .56
  - Unit electric loads 14,400 KWH
  - 17 kw solar per building
  - Building Average total 130,000 kBTU without solar according to HERS model

Air Tightness: results were “not bad”



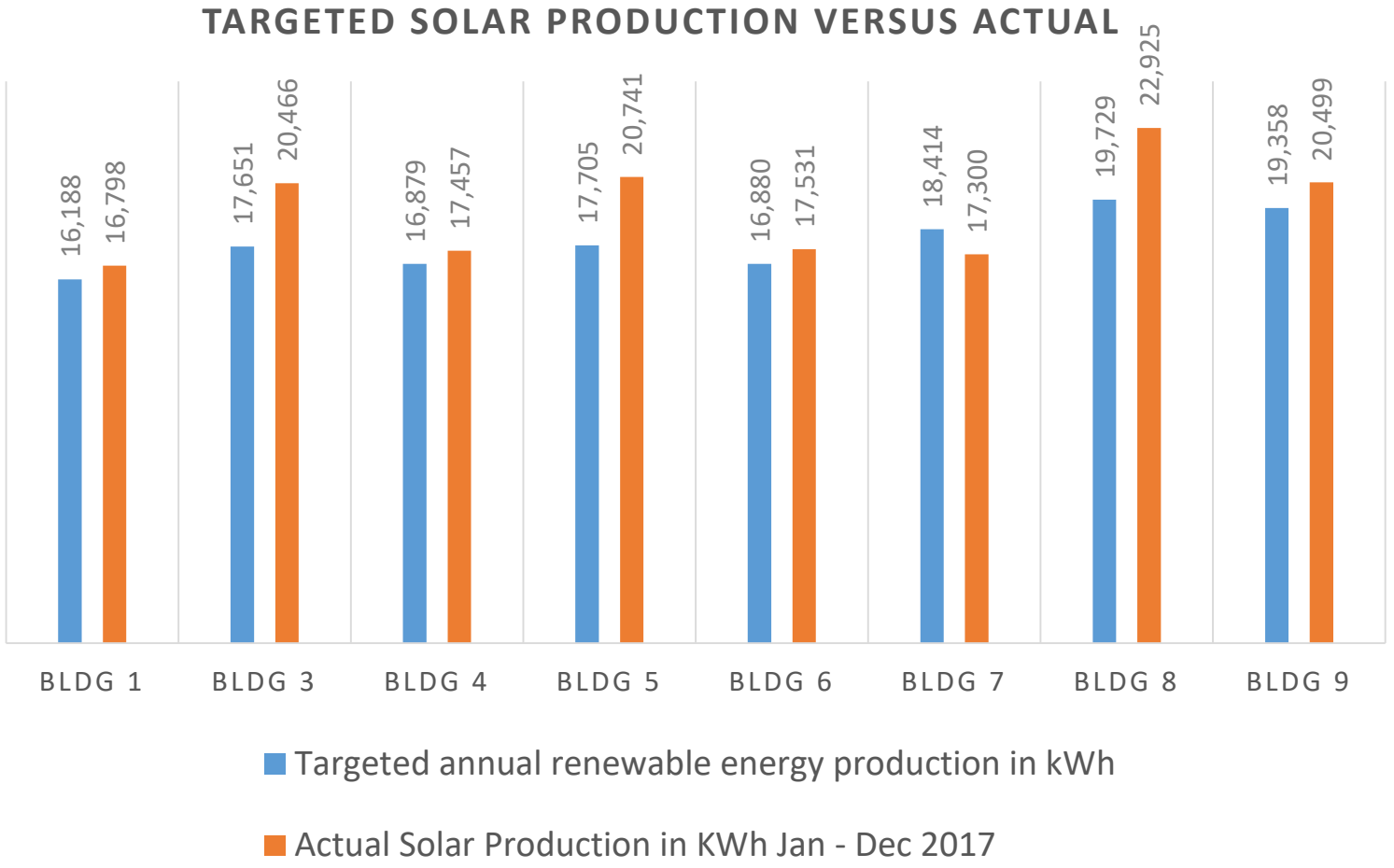
Target was .05 cfm50/cf
Results ranged from .06 to .08

Annual kBtu Consumption per Building:

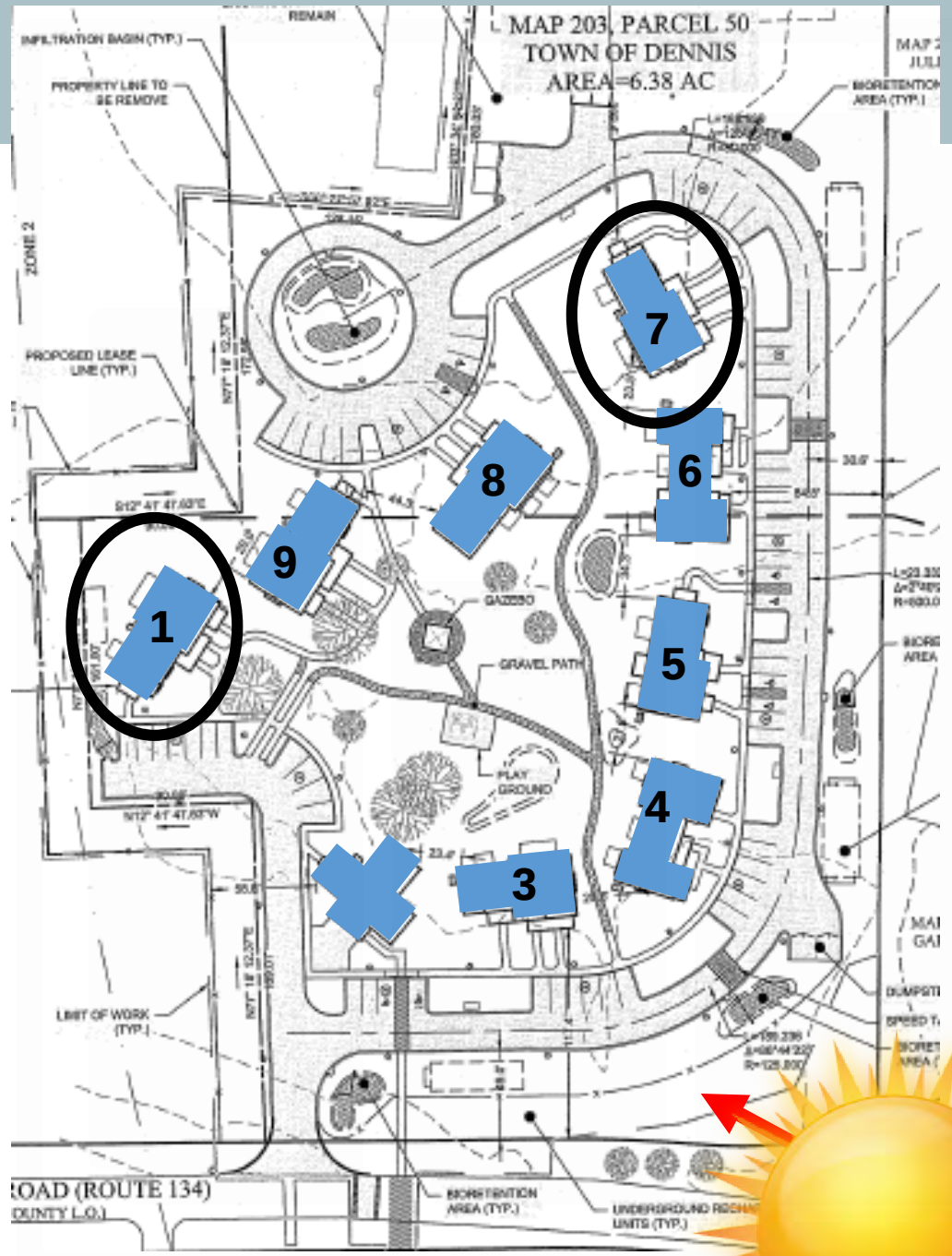


- Results varied by building, but overall, actual has been lower than targeted
- Actual is about half way between the NZ target and HERS target

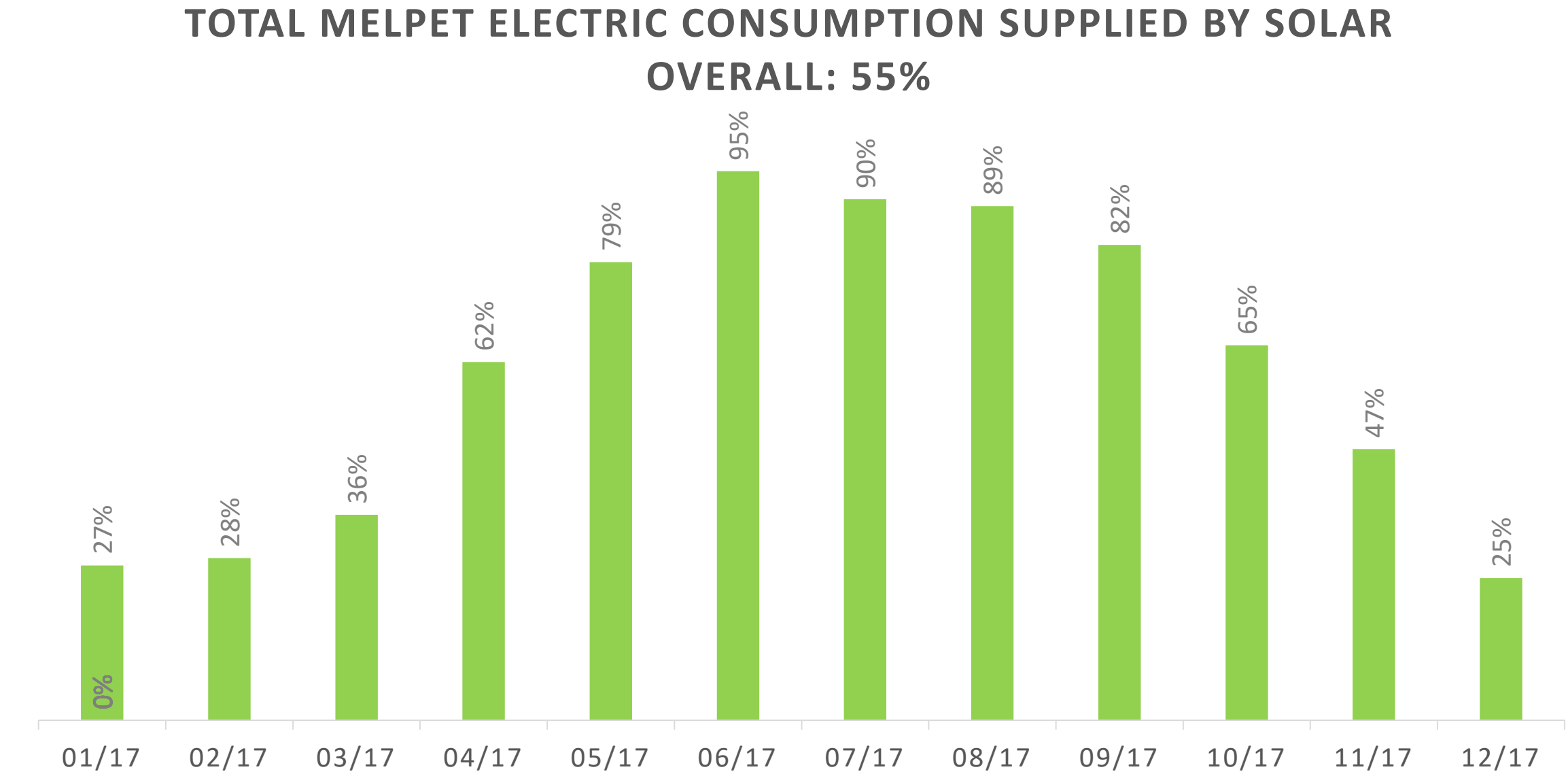
Solar Production: Meeting Targets



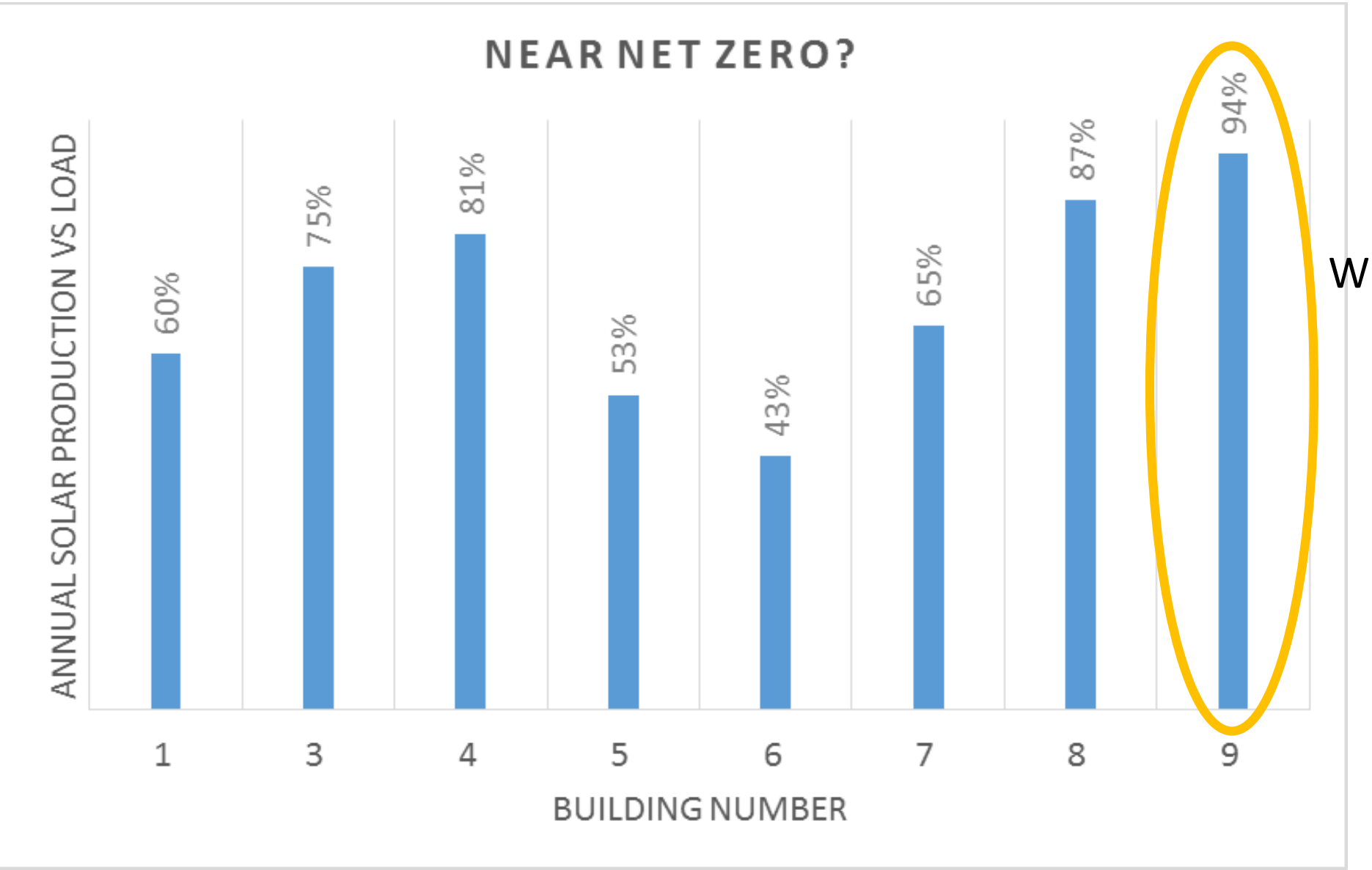
No big surprise on building 7 given orientation



Solar Production Per Month: Only Hitting Half of the Total Load

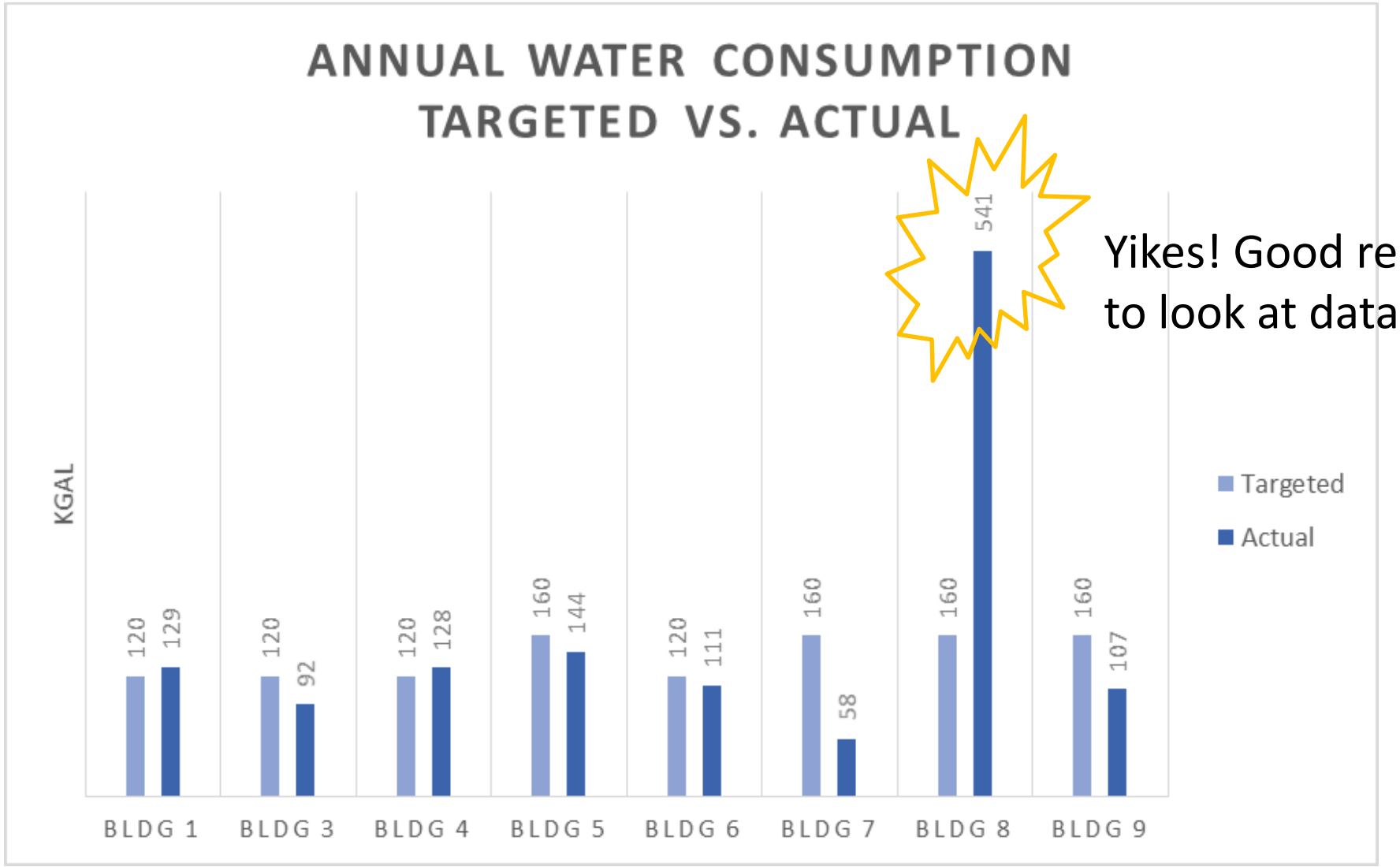


Per Building Net Zero:



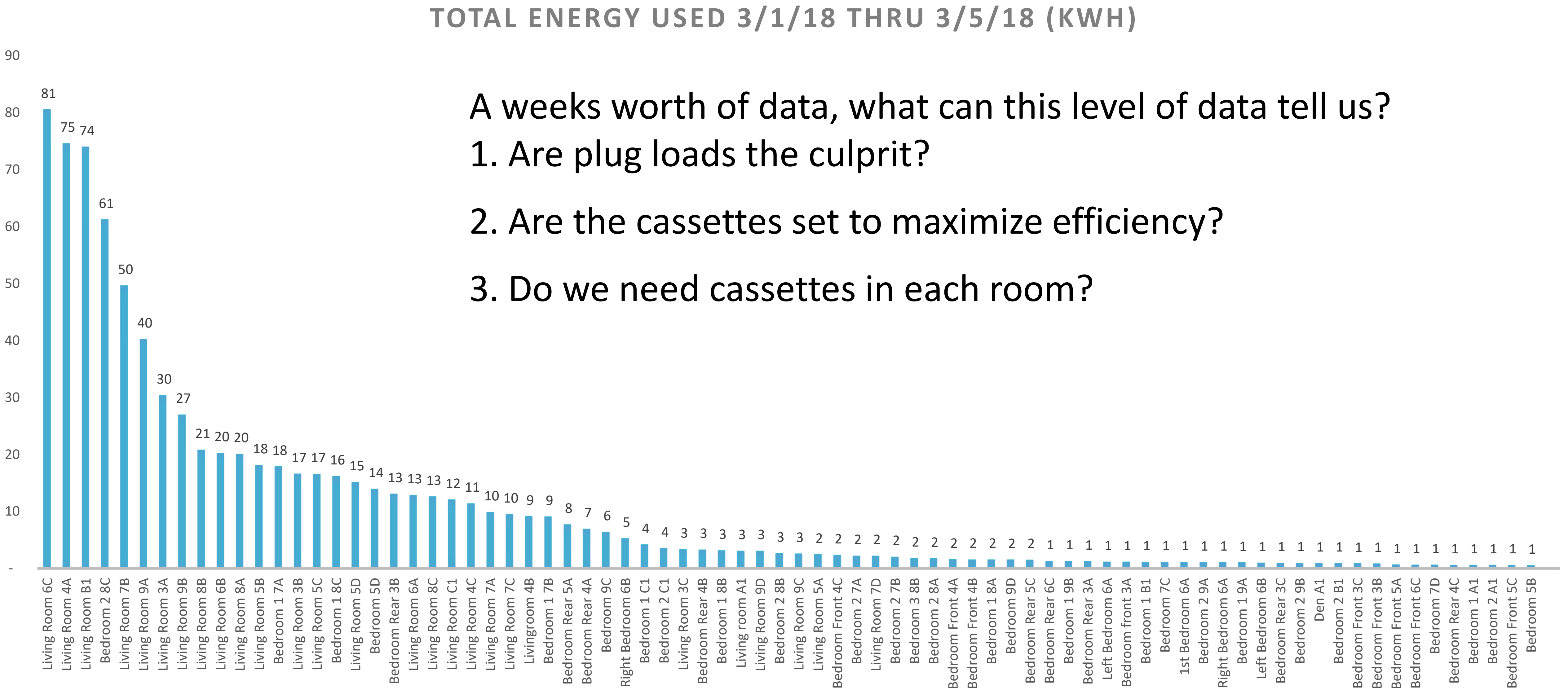
Who is living in Building 9?

Water usage was on target…..



Yikes! Good reason to look at data.

Projected and Actual Data: Per Unit Per Heat Pump Cassette



A weeks worth of data, what can this level of data tell us?

1. Are plug loads the culprit?
2. Are the cassettes set to maximize efficiency?
3. Do we need cassettes in each room?

Lessons Learned

Lessons learned:

1. The three Cs:
    a. **Cost**, balance cost with what you can achieve getting to Net Zero or PH and
    b. **Contractors**, Don't stop with integrative design, do integrative construction, involve subs in preconstruction meetings, diagnostic testing, and understanding goals of the project
    c. **Customers**, educate residents on the goals of the project and how to use equipment. This education has to be ongoing. What are the residents in Building 9 doing?
2. It takes some time to get things right including data collection
3. Maybe the 4th C is **Collect data**: the systems may not be working correctly including renewable systems or settings by residents so it is important to have access to data and take the time to look a it.
4. Use certifications that verify performance. Deemed savings without verification doesn't move the market.

Thank you!

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PH TEAM

Passive to POSITIVE
PASSIVE HOUSE AND LOW IMPACT DESIGN

ZA+D, LLC

MATT FINE, CPHC®, LEED AP®

- *DIRECTOR, ZA+Dpassiv*
- *SENIOR PROJECT MANAGER, ZA+D, LLC*

PASSIVE TO POSITIVE

MICHAEL HINDLE, CPHC®,

- *PASSIVE HOUSE CONSULTANT*

FORMER*PRESIDENT, BOARD OF MANAGERS*
PASSIVE HOUSE ALLIANCE – UNITED STATES

HAMEL BUILDERS

TERESA HAMM, CPHC®, CPHB®, HERS

- *PROJECT MANAGER*

THC, AFFORDABLE HOUSING

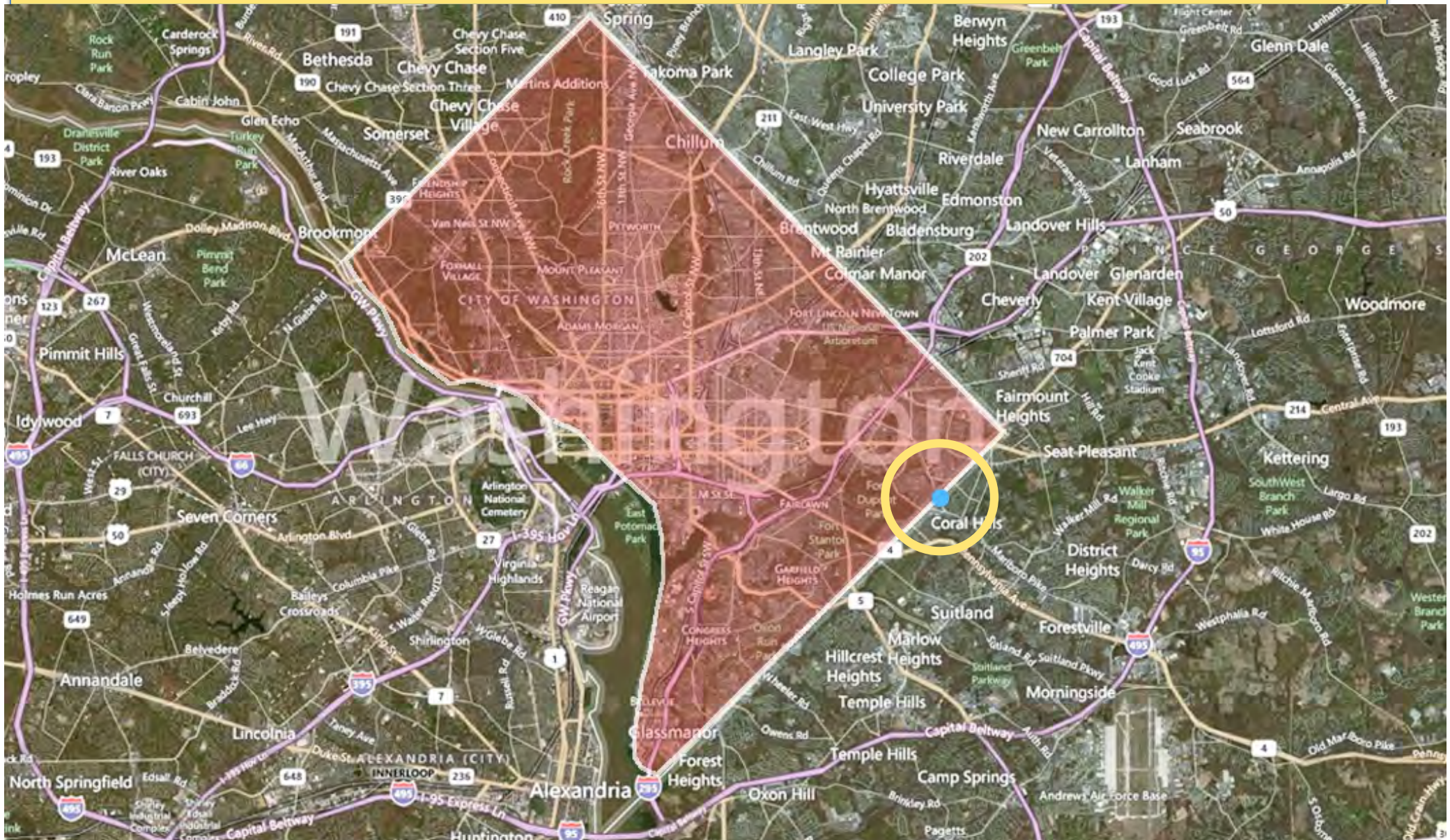
BLAISE RASTELLO

- *DIRECTOR OF AFFORDABLE HOUSING*

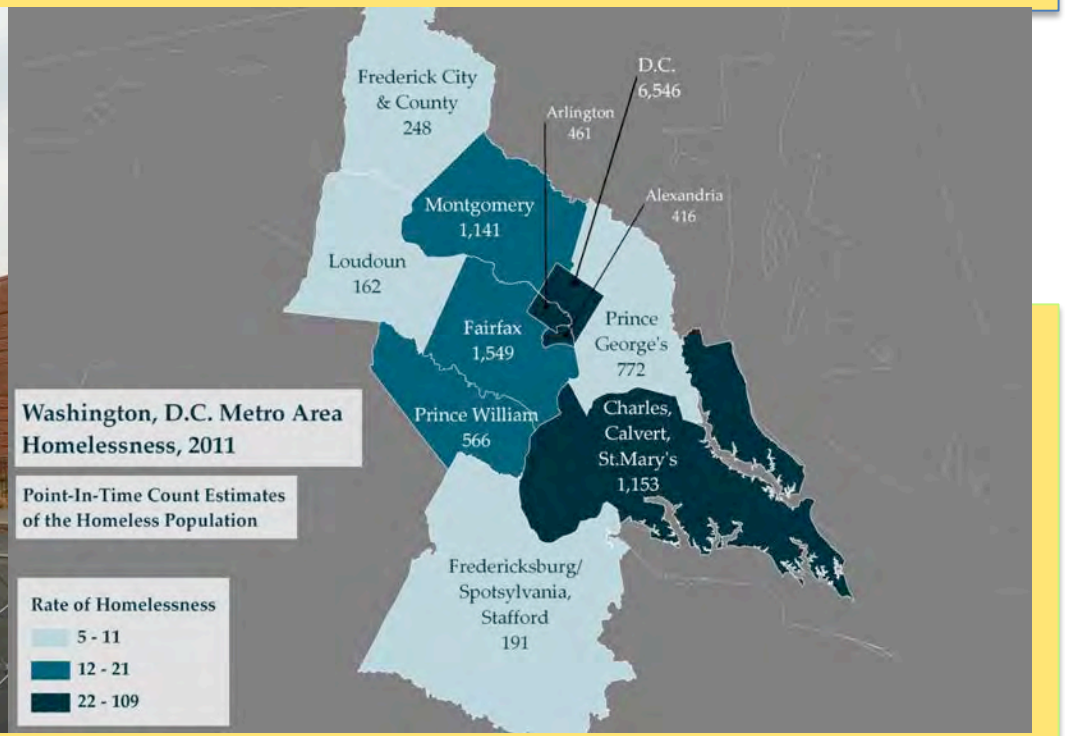
WEINBERG COMMONS

A PASSIVE HOUSE RETROFIT TALE OF EPIC PROPORTIONS

A LONG, LONG TIME AGO IN SE, D.C.



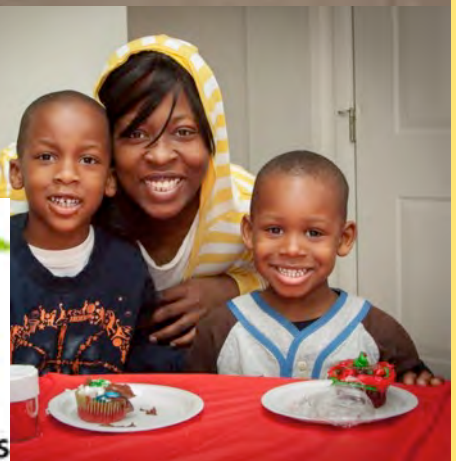
NEIGHBORHOOD & HOMELESSNESS



SOURCE: HOMELESSNESS RESEARCH INSTITUTE

DEVELOPER ETHICS

- **TRUE AFFORDABILITY: health, comfort and economic stability**



THC Housing Families, Transforming Lives

- HEALTH: GOOD IAQ ASSURED
- COMFORT: COMFORTABLE BY DESIGN, NATURALLY AND EASILY
- FINANCIAL STABILITY: LOW AND RELIABLE COST THROUGH EFFICIENCY – NO SPIKES – VERY PREDICTABLE

PROJECT BACKGROUND

- (3) BLDGS. / 36 (2) BR UNITS
- 675 NRSF EA.
- PARTIAL BASEMENT / CRAWL SPACE
- (3) STORIES

NON-DESCRIPT SENSE OF PLACE

WASTEFUL, INAPPROPRIATE, AND OUT-DATED SYSTEMS

PROJECT BACKGROUND

LOW-TECH,
UN-INSULATED BUILDING ENCLOSURE

UNHEALTHY INTERIOR
ENVIRONMENT

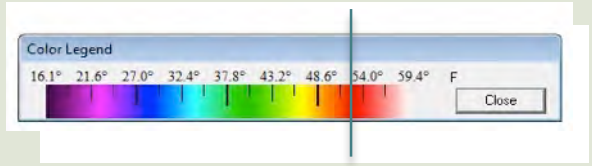
AN ORDINARY RENOVATION?

REPAIR-UPGRADE FINISHES, MINIMAL IF ANY INSULATION

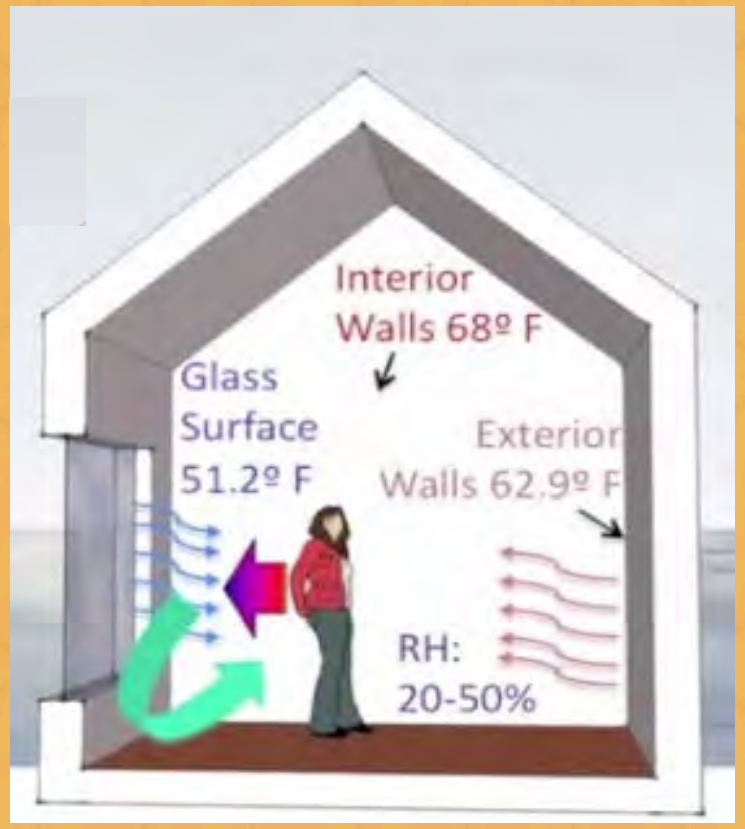
NO MANAGEMENT OF CONDENSATION PLANE TEMPERATURES –

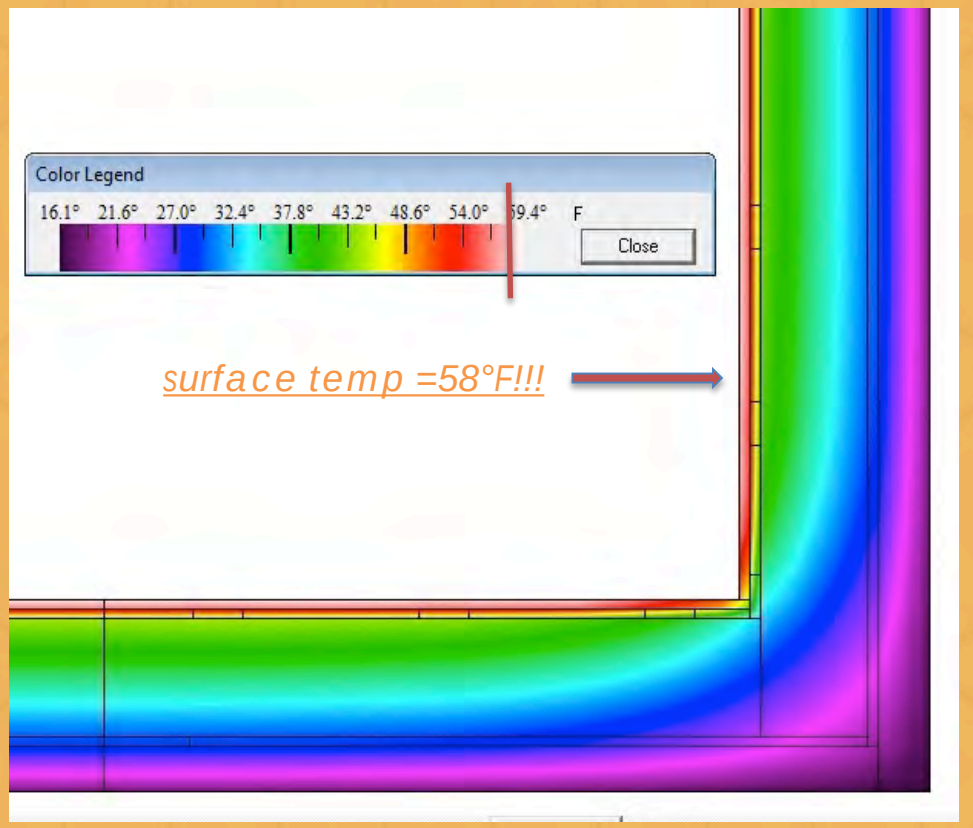
MOLD GROWTH STILL ASSURED!!

Dew point of interior air = @ 52.5°F



The entire furred out cavity is below dew point of interior air ! @ 53°F





UNINSULATED MASONRY?

COMFORT FACTORS?

Air temp

RH

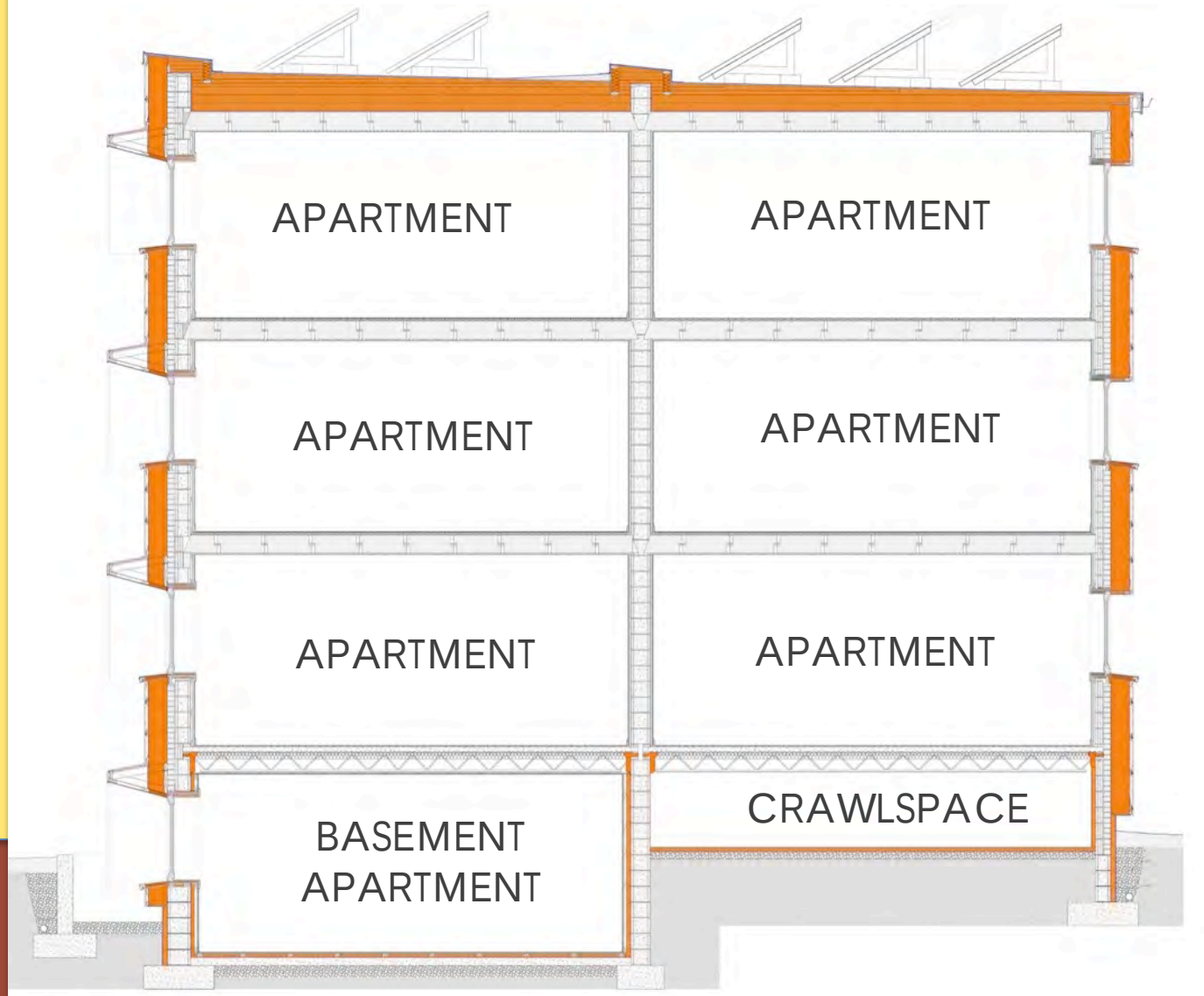
Air velocity

Mean radiant surface temps

ENTER: THE PH RETROFIT

ELIMINATE LOSS: (almost!)

CONTINUOUS INSULATION DEFINING THE THERMAL ENVELOPE

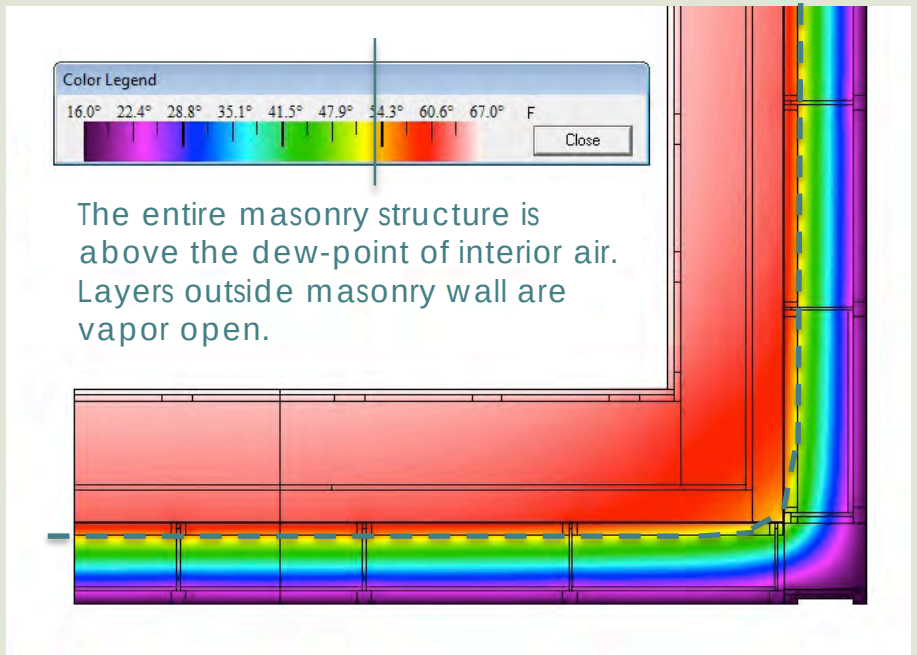


ENVELOPE DESIGN + OCCUPANT HEALTH

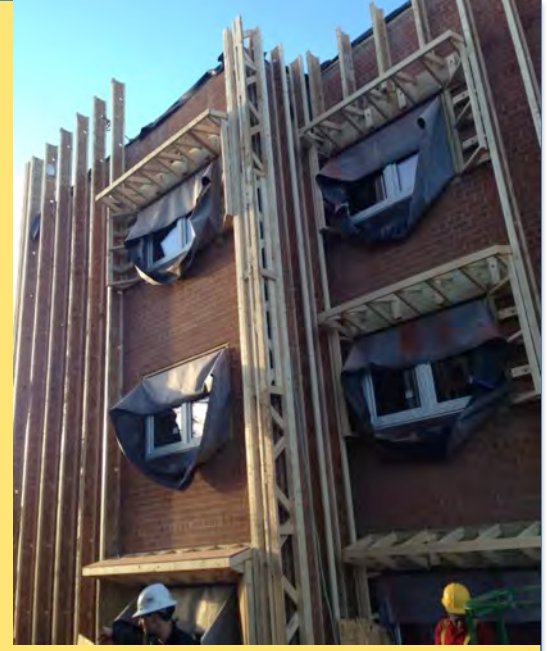
RETROFIT-
MANAGE CONDENSATION PLANE TEMPERATURES –

THIS WALL WILL NOT GROW MOLD

Dew point of interior air = @ 52.5°F



The entire masonry structure is above the dew-point of interior air. Layers outside masonry wall are vapor open.



CASE STUDY:
CONSTRUCTION PROCESS

PRE-CONSTRUCTION MODEL/PROCESS

"Hey, could you give us some cost feedback on assemblies options?"

"Get all your "A-Team" subs in here and we will explain it all before they price it."

"**THAT MINERAL WOOL AND PROSOCO ARE UN-GODLY EXPENSIVE – YOU GOTTA GET THAT OUTTA THERE**"

"Why is this an add? I thought you said the mineral wool and Prosoco were ungodly expensive"

ESTIMATING – HOW DO YOU PRICE SOMETHING NONE OF "YOUR GUYS" EVER HEARD OF??

"PUT IN IN THE DRAWINGS AND I'LL PRICE IT"

"WE'RE GONNA PUT THIS OUT ON THE STREET."

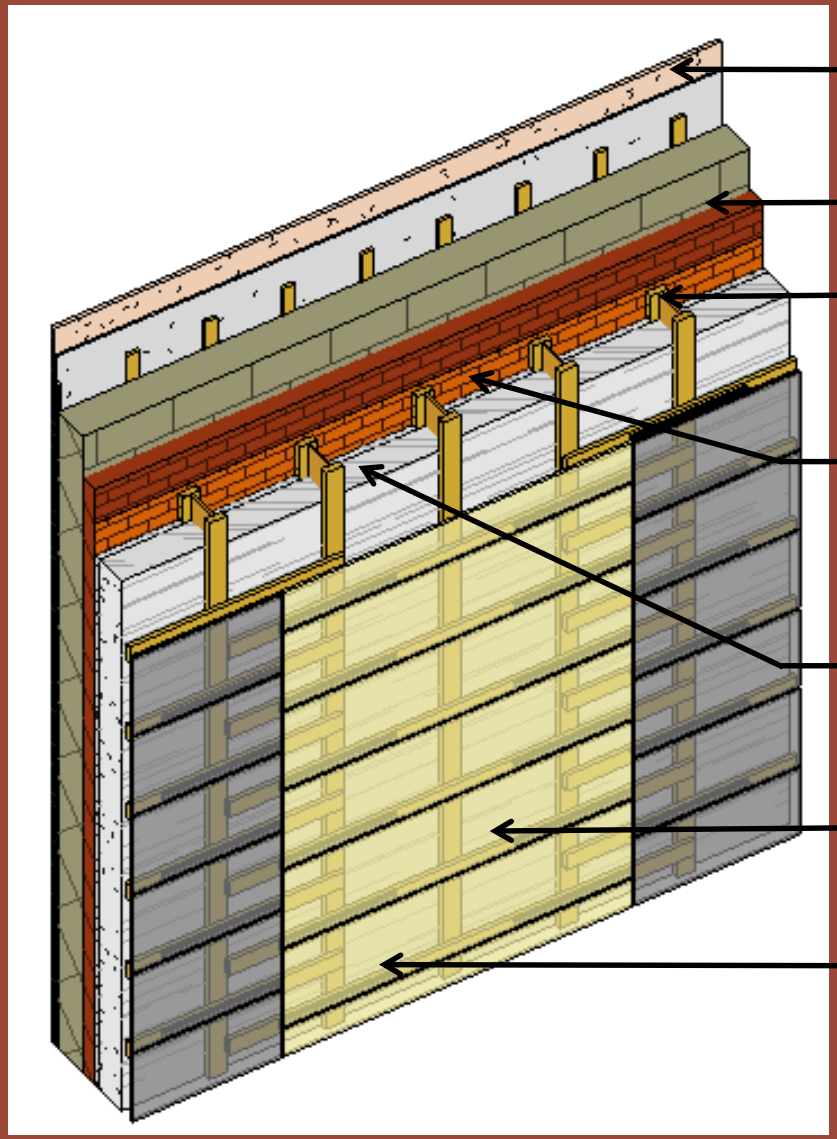
"Well it is not as robust, but if you are sure it will save us real money we can go with . . ."

"**MY GUYS HAVE NEVER DONE THIS– THEY WAY UNDER-BID IT**"

PRE-CONSTRUCTION CHALLENGES

SUBCONTRACTOR BUY-IN

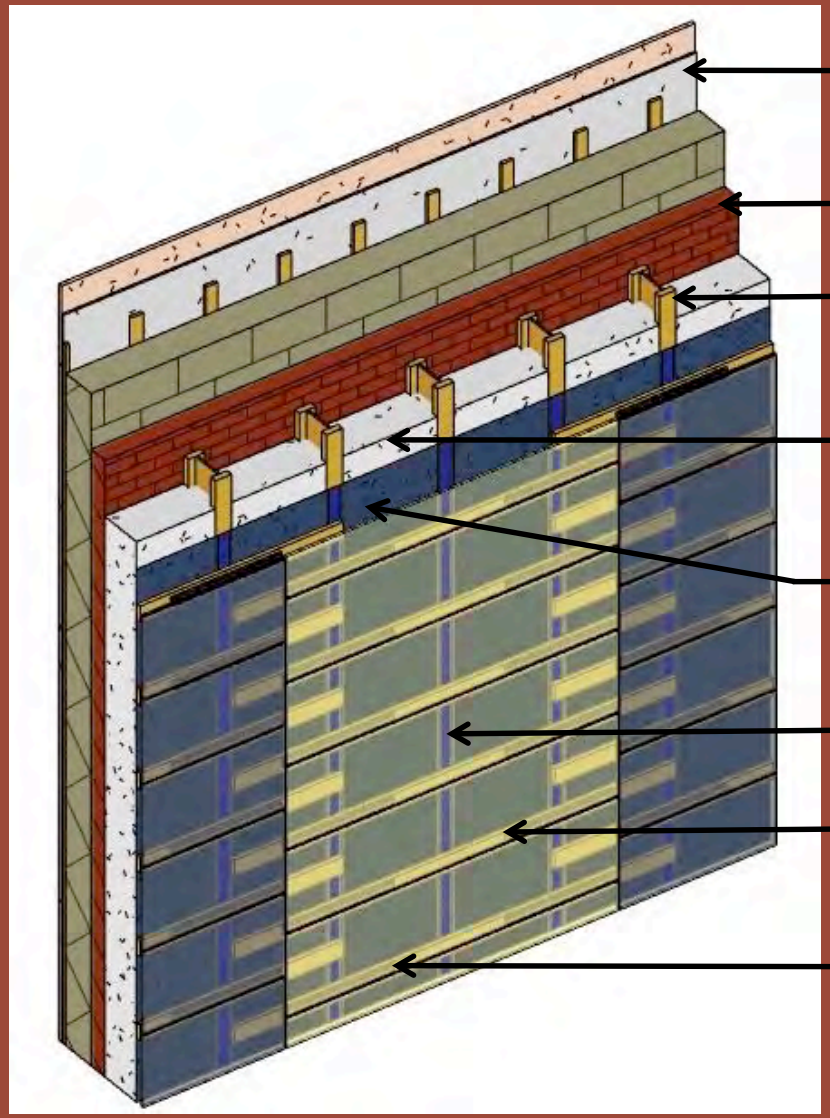
SUPER-INSULATED AND VAPOR OPEN



PRE “VE” ENCLOSURE

- EXIST. PLASTER OVER GYP. BD. SUBSTRATE & VERT. 1X FURRING
- BRICK & CMU BACK-UP
- 9 ½” WD. ‘I’-JOISTS @ 24” O.C., MECH. ATTACH. @ 36” O.C., STAGGERED
- **FLUID-APPLIED AIR AND WATER RESISTIVE BARRIER**
- 8” MINERAL WOOL INSULATION @ 6 LB./CU. FT. DENSITY
- HORIZ. 5/4 WD. FURRING @ 18” O.C., STAGGERED
- 5/8” FIBER CEMENT CLADDING ON PROPRIETARY CLIPS

LESS ROBUST AND HARDER TO BUILD



POST “VE” ENCLOSURE

- EXIST. PLASTER OVER GYP. BD. SUBSTRATE & VERT. 1X FURRING
- BRICK & CMU BACK-UP
- 9 ½” WD. ‘I’-JOISTS @ 24” O.C., MECH. ATTACH. @ 36” O.C., STAGGERED
- 2.2 LBS./CU. FT. DENSITY SPRAY-APPLIED FIBERGLASS
- **REINF. WRB SERVES AS AIR-TIGHT LAYER**
- VERT. 2 3/8” W. AIR SEALING TAPE
- HORIZ. 5/4 WD. FURRING @ 18” O.C., STAGGERED
- 5/8” FIBER CEMENT CLADDING ON PROPRIETARY CLIPS

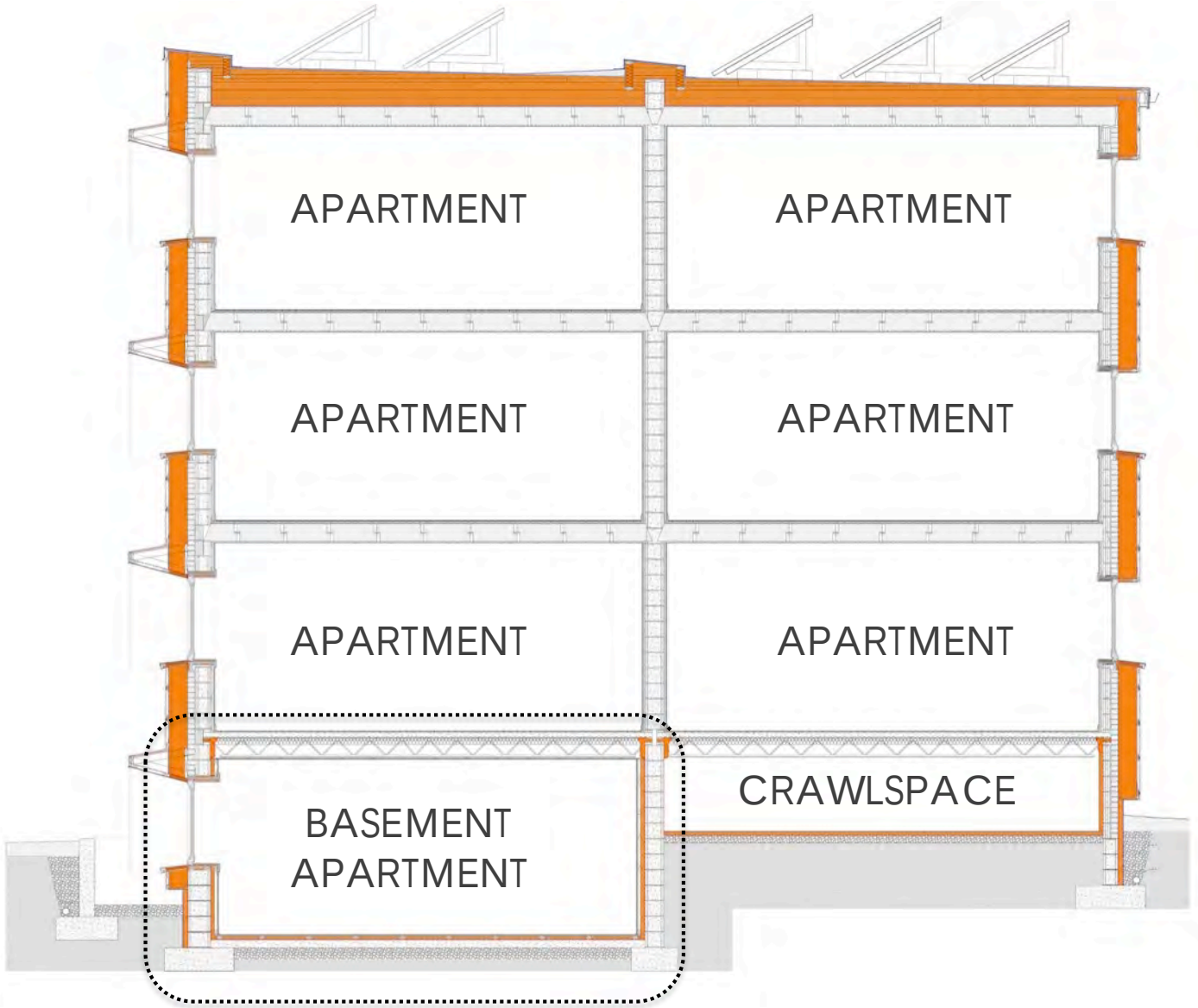
THE ROOF RETROFIT: AN AIR SEALING AND SEQUENCING CHALLENGE

THE ROOF RETROFIT: AN AIR SEALING AND SEQUENCING CHALLENGE

CREATING THE INSULATION CAVITY

AIR-TIGHTNESS:
NOW TO THE EXTERIOR

DETAILS AS A RESULT OF “VALUE-ENGINEERING”



CHALLENGE:
BASEMENT
TREATMENT

CHALLENGES WITH BUILDING

...CAPILLARY...

CHALLENGES WITH BUILDING

...AND HYDROSTATIC MOISTURE...

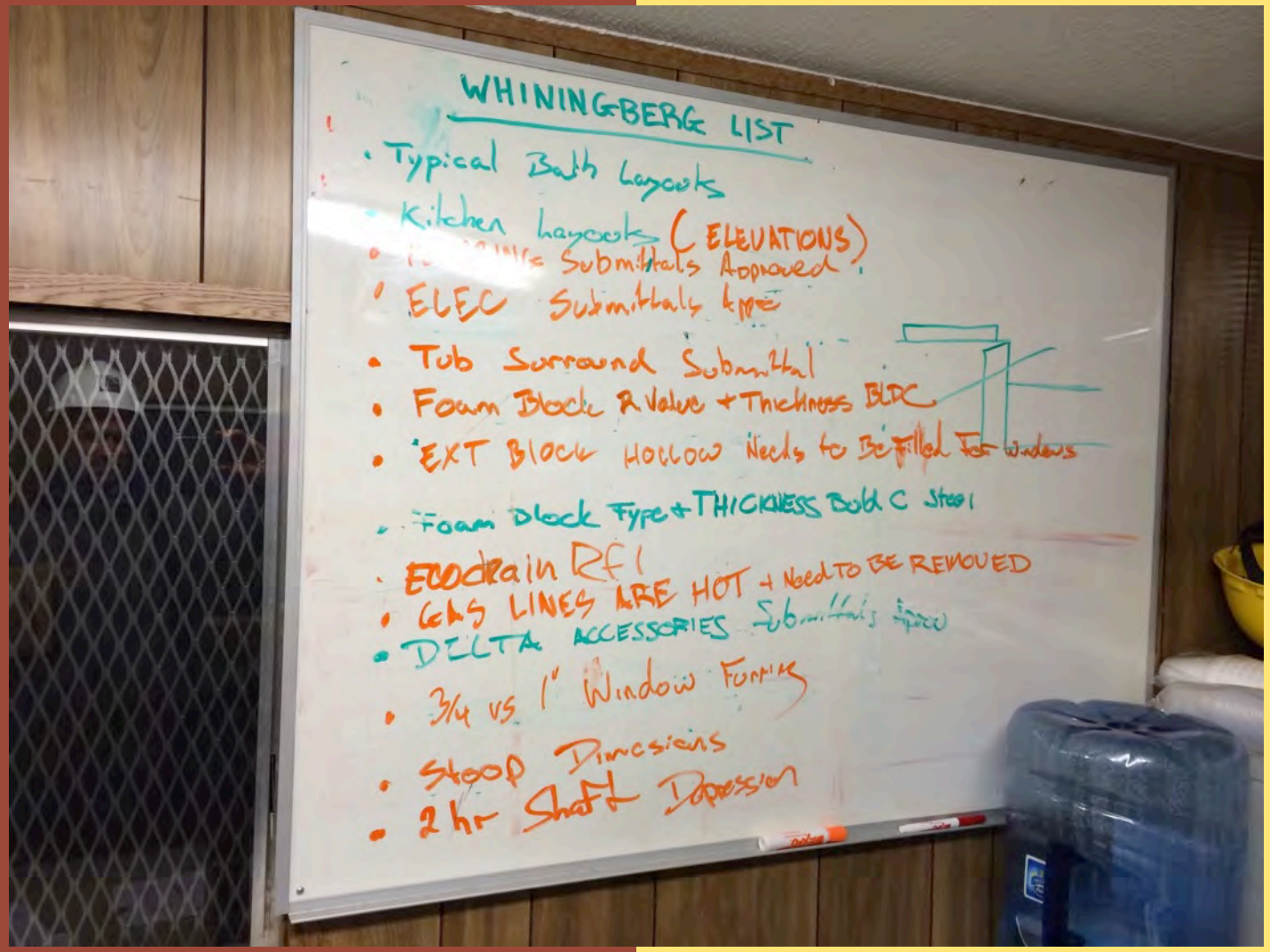
UTILIZE HARDY CONTROL LAYERS

CRAWLSPACE INSULATION AND VAPOR CONTROL SEQUENCE

CRAWLSPACE INSULATION AND VAPOR CONTROL SEQUENCE

CONSTRUCTION CHALLENGES

COORDINATION INTENSITY



CONSTRUCTION CHALLENGES

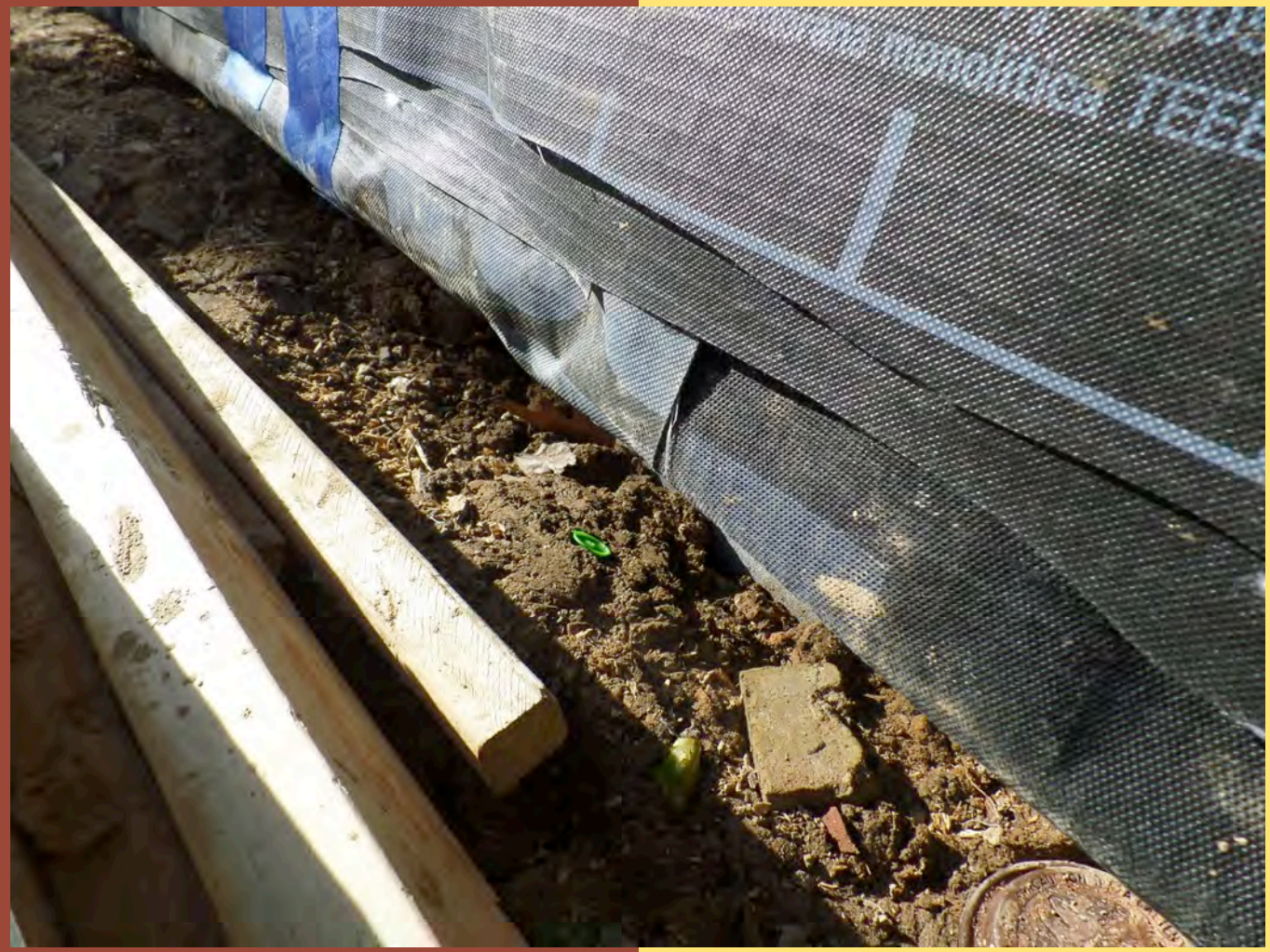
SUBSTITUTION REQUESTS

CONSTRUCTION CHALLENGES

TEMPORARY MATERIAL PROTECTION AND SEQUENCE

CONSTRUCTION CHALLENGES

LACK OF SUBCONTRACTOR CONTROL



CONSTRUCTION CHALLENGES

INSTALLATION QUALITY

FIELD CONDITION CHALLENGES

MOCK-UP

CONSTRUCTION CHALLENGES

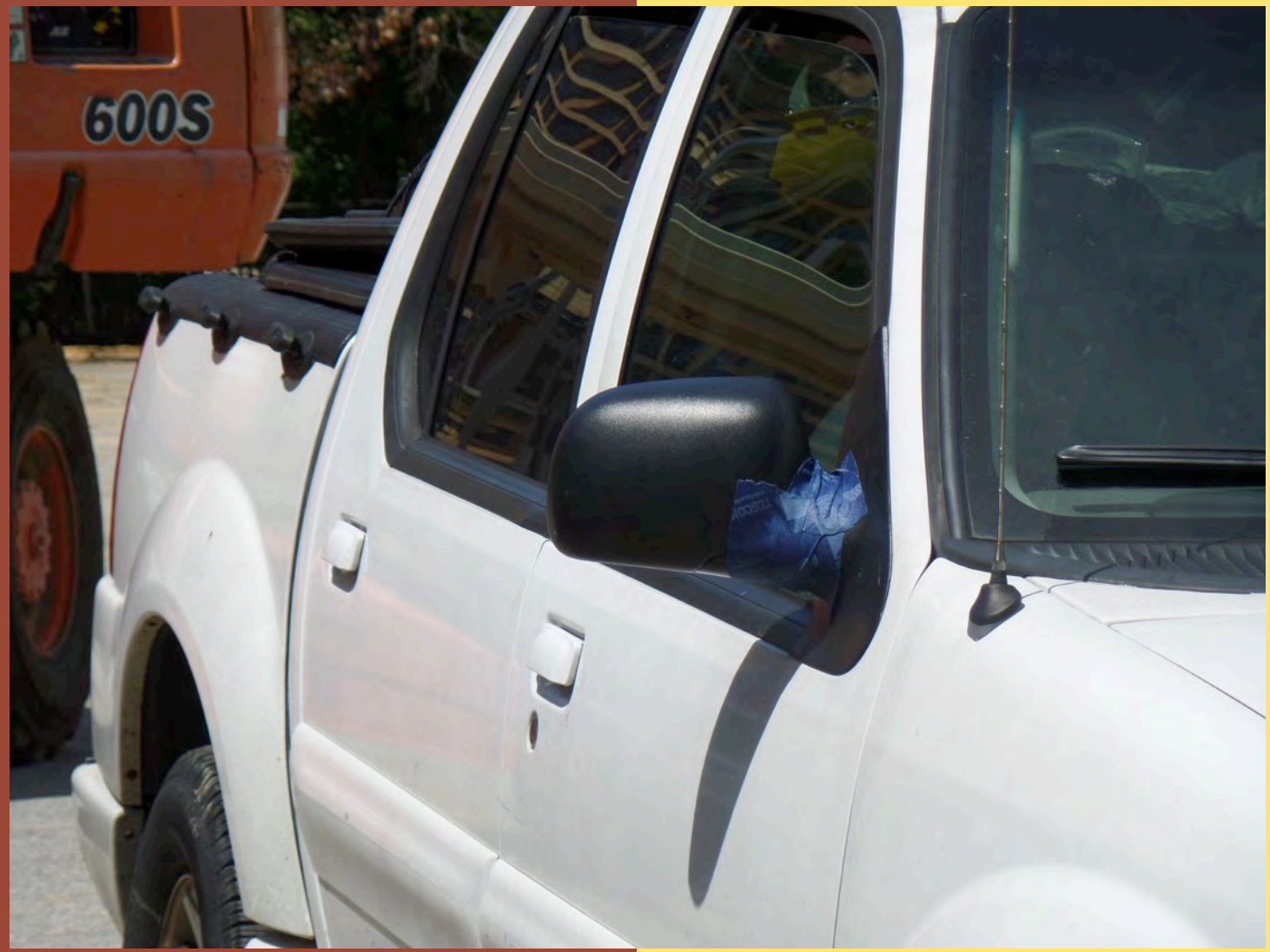
MOCK-UP

FIELD CONDITION CHALLENGES

MOCK-UP

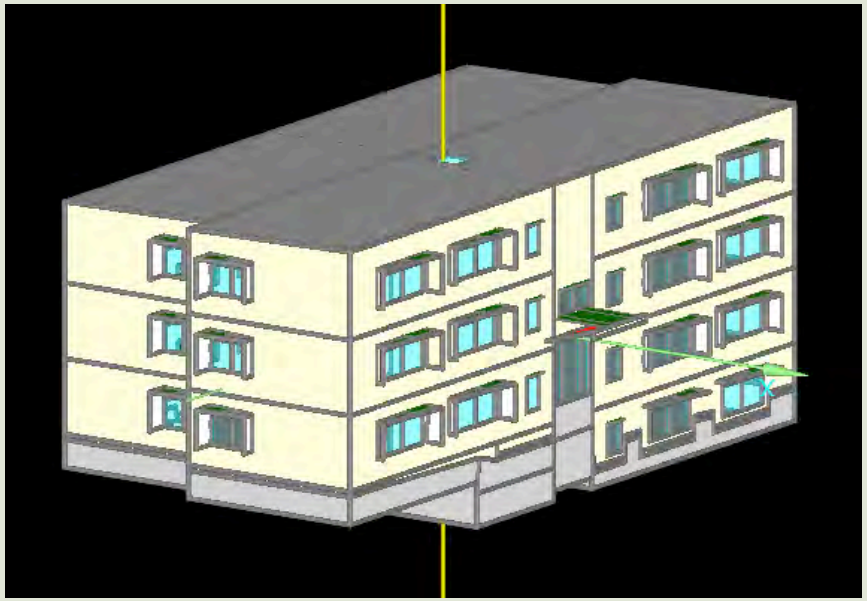
CONSTRUCTION CHALLENGES

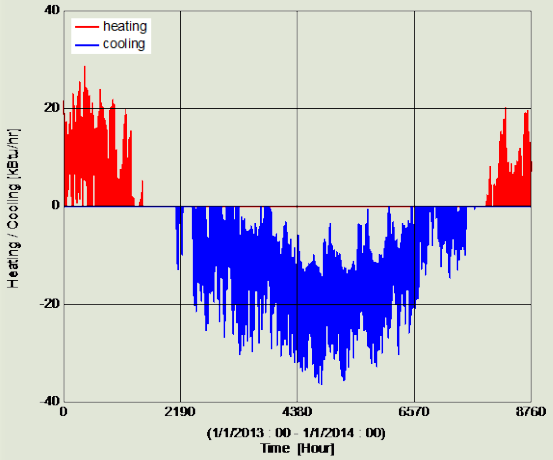
AHH.... ASSIMILATION

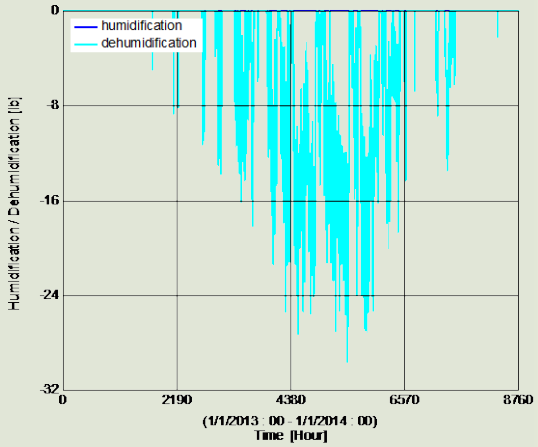


RESULTS:

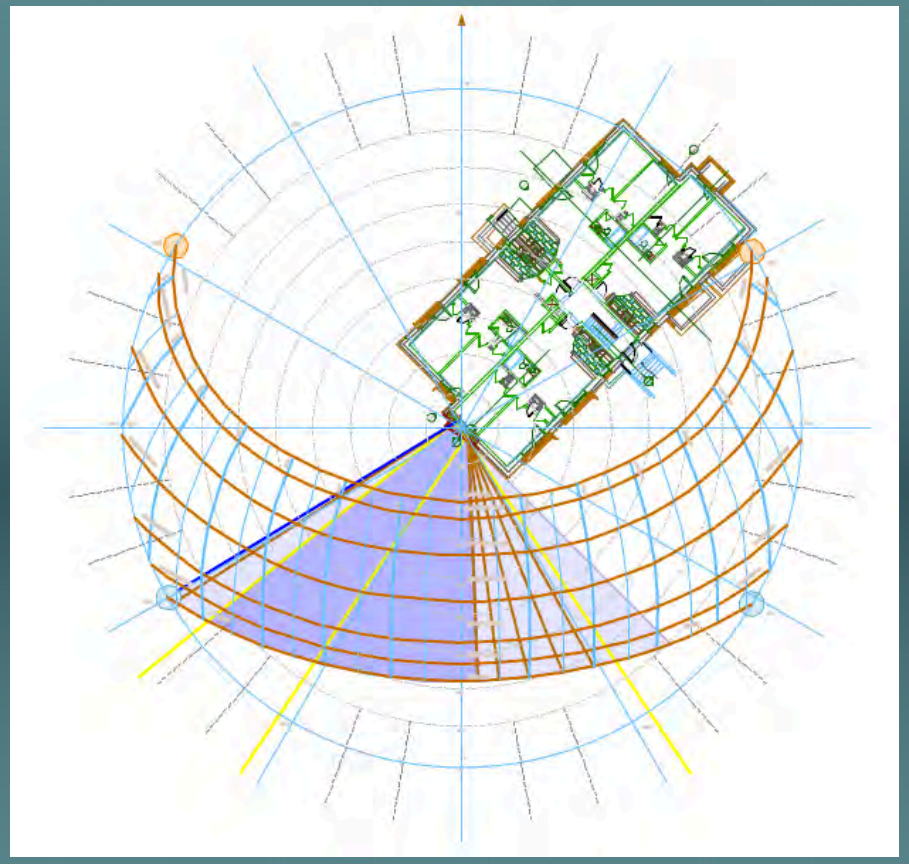
SMALL SYSTEMS,
LOW LOADS
IMPROVED COMFORT
AFFORDABILITY
REDUCED CARBON LOAD

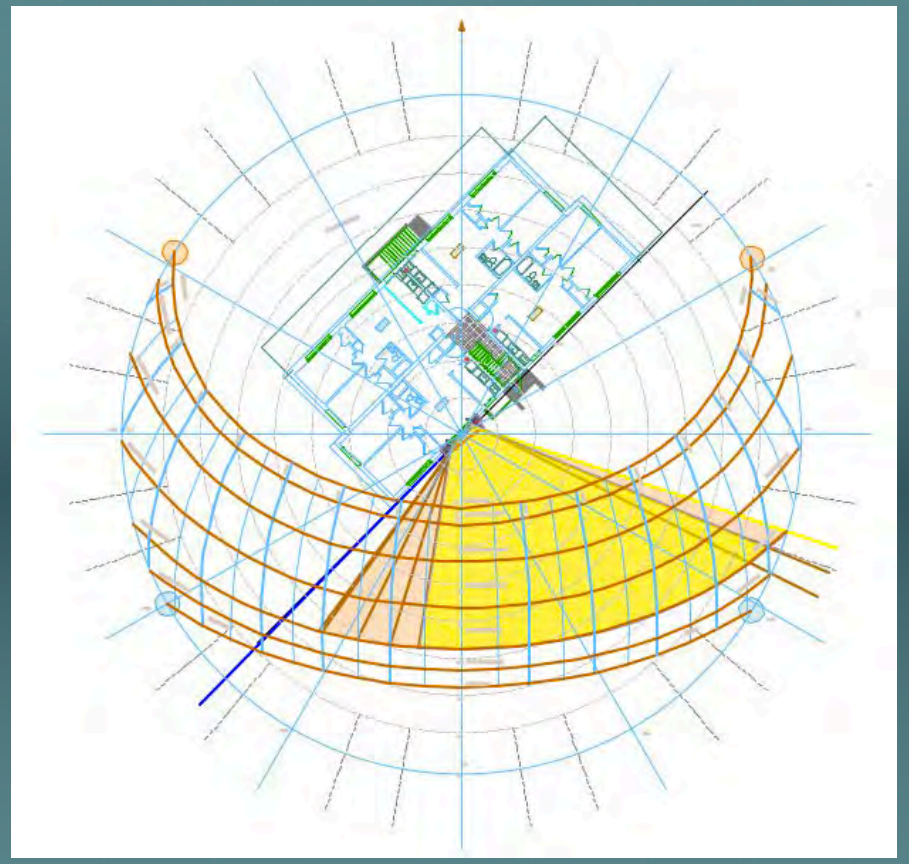




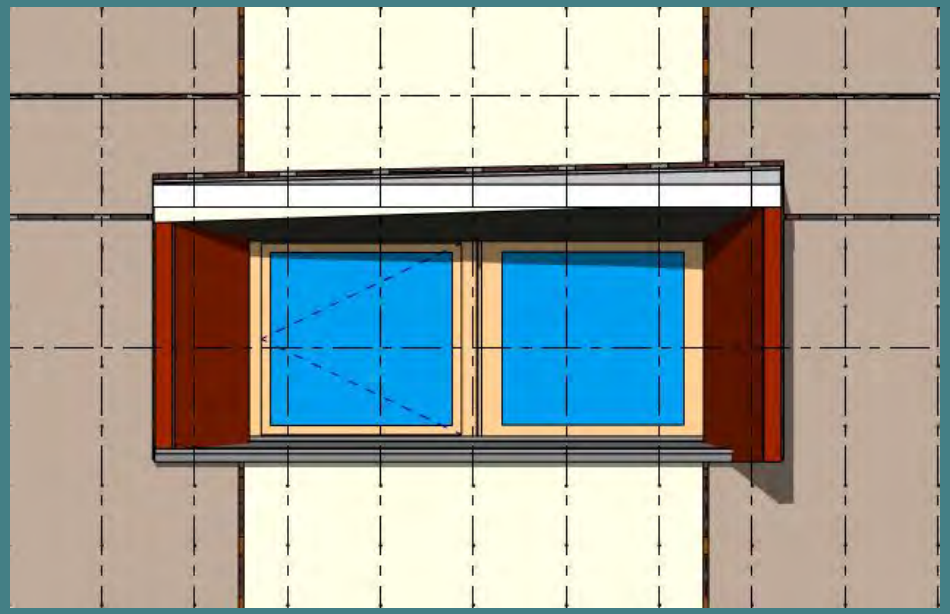


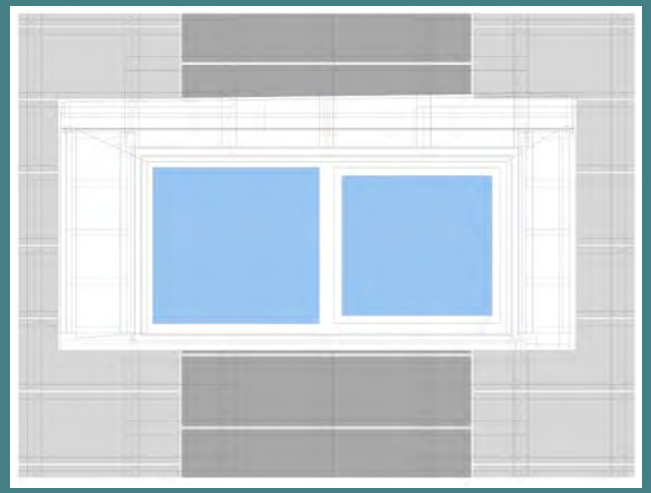
PASSIVE MEASURES MATTER!

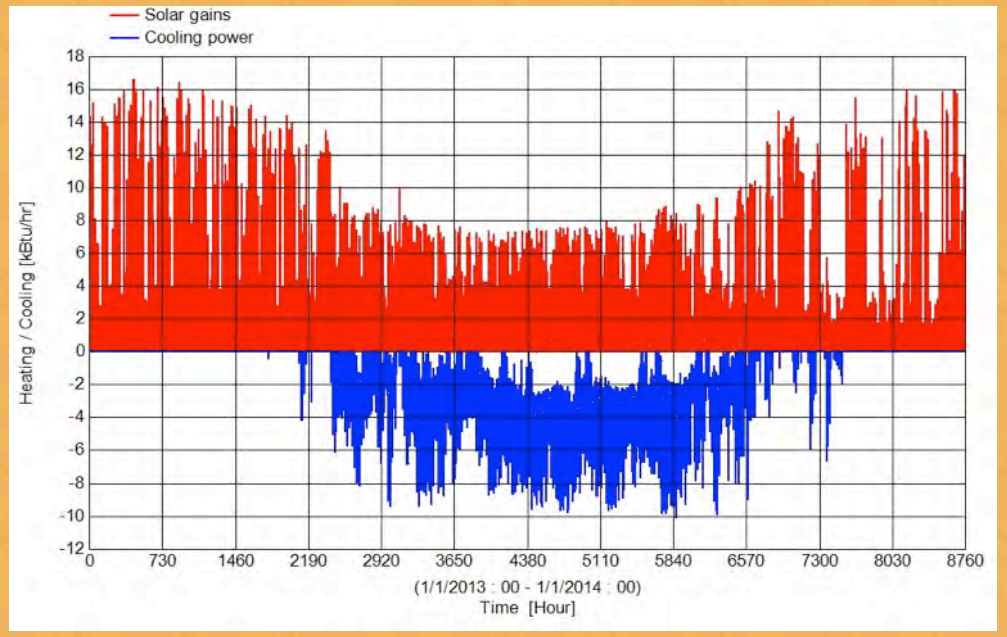




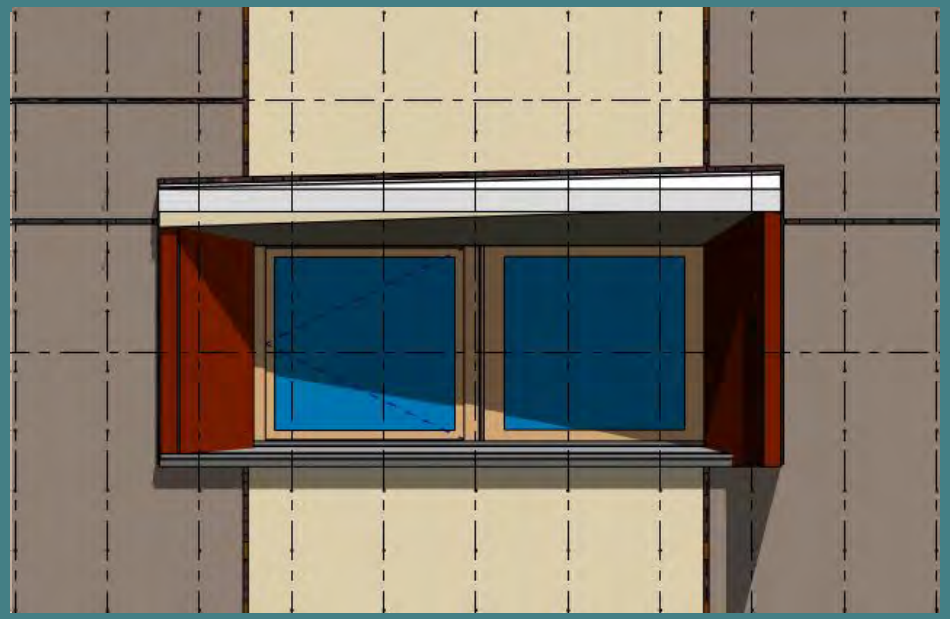
ASYMETRICAL LOADS AND COMFORT RISKS

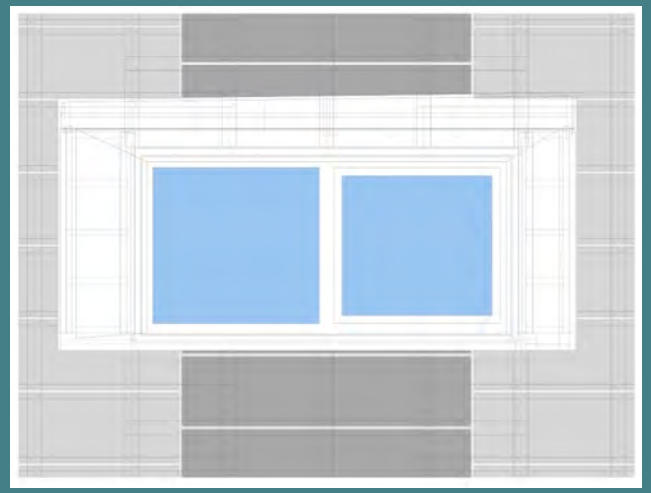


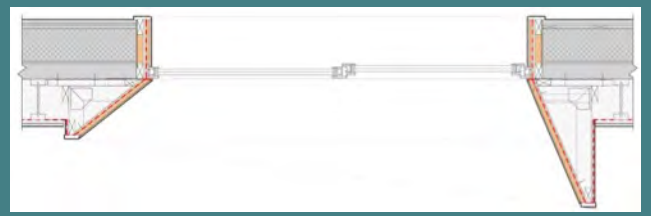


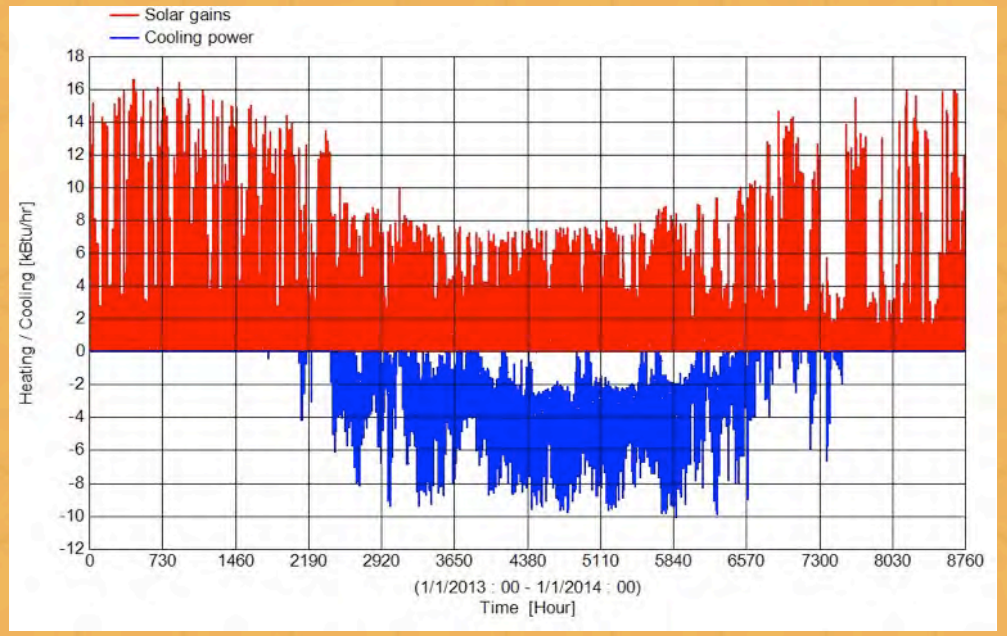


SOLAR GAIN WHEN YOU WANT IT



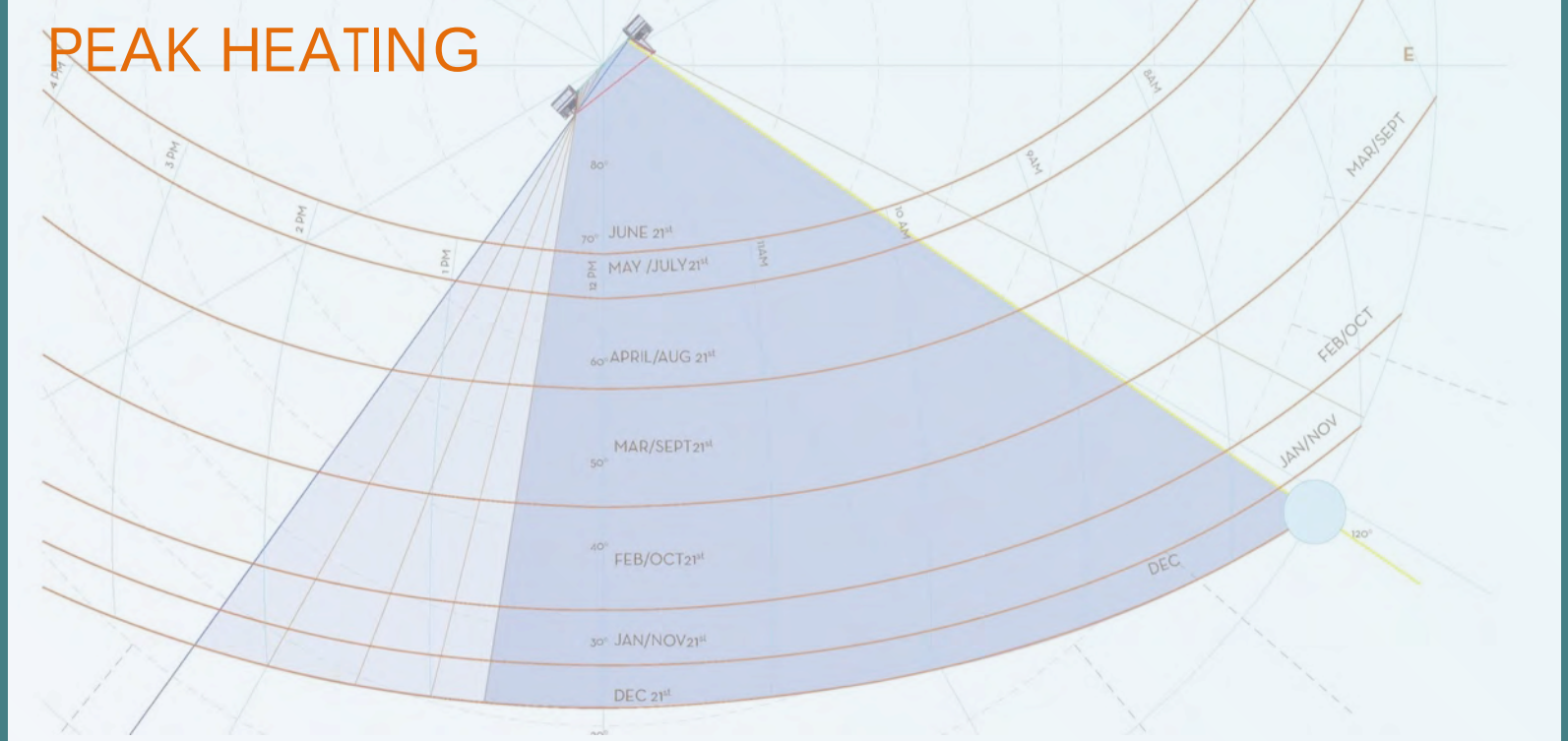


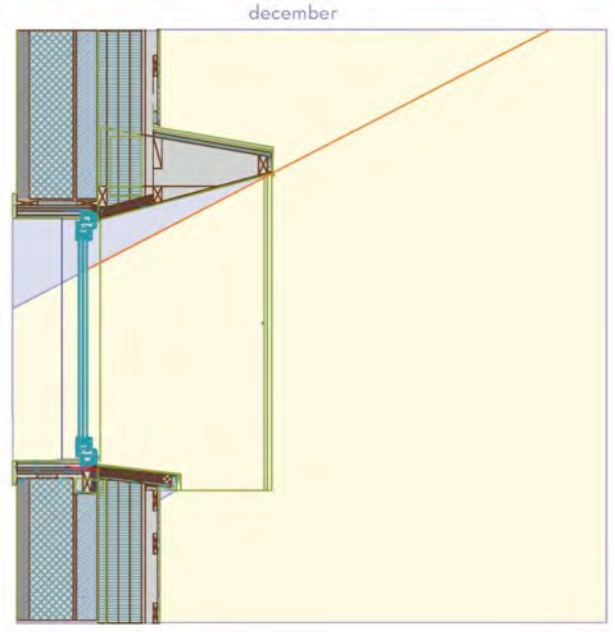


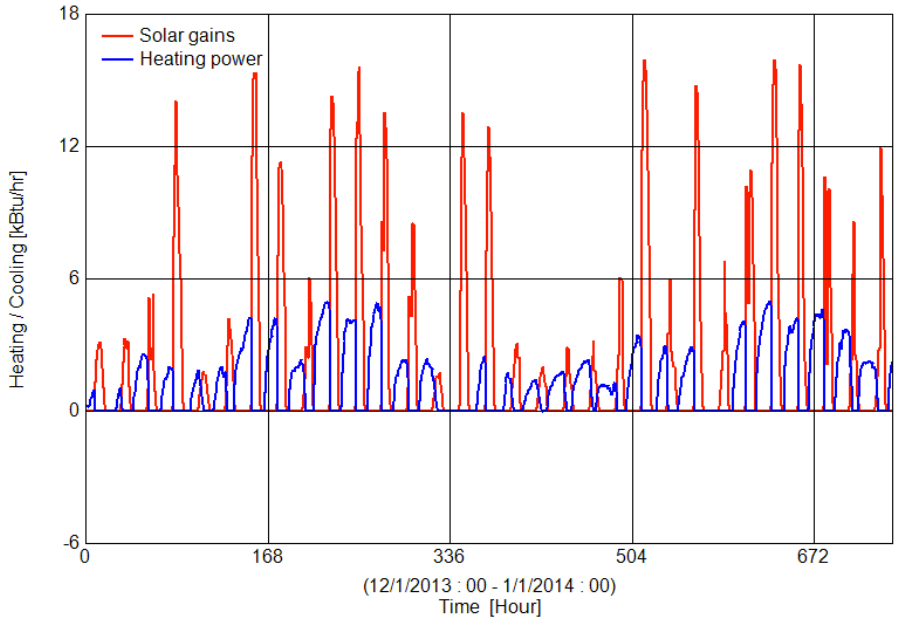


SHADING WHEN YOU DON'T

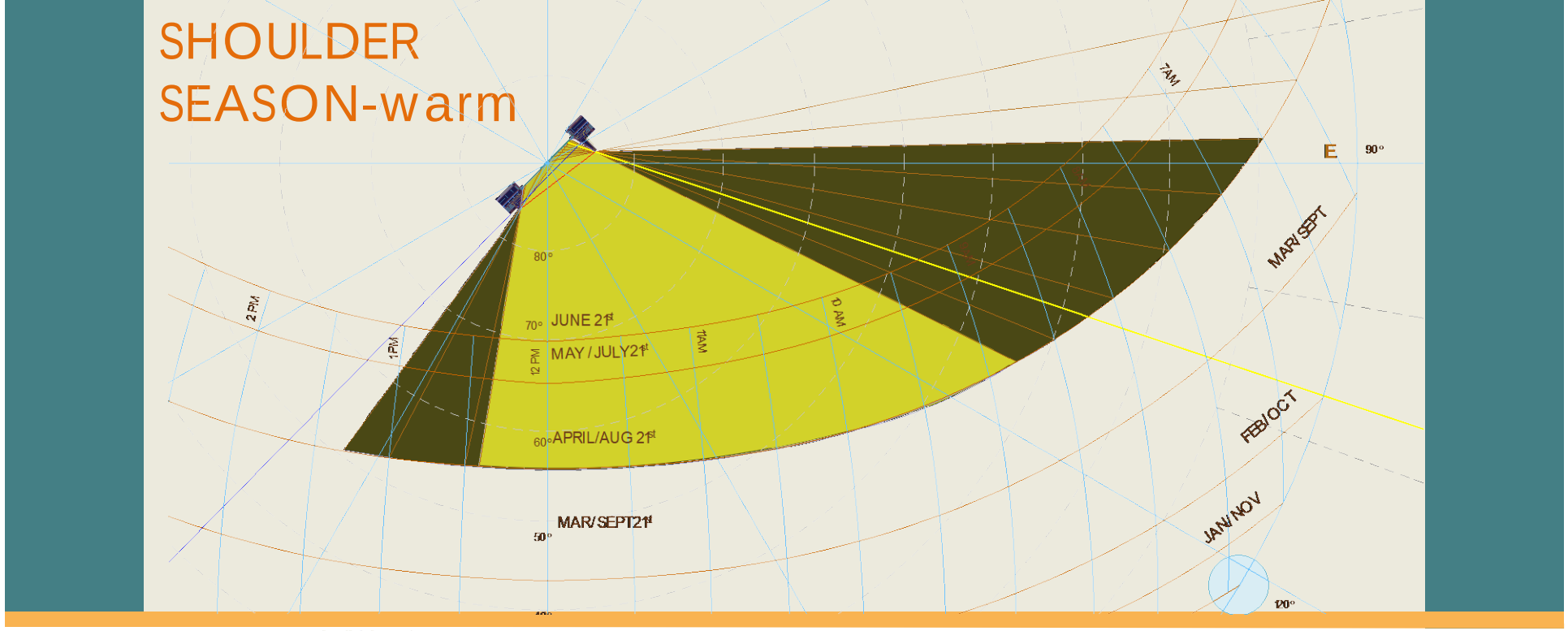
PEAK HEATING



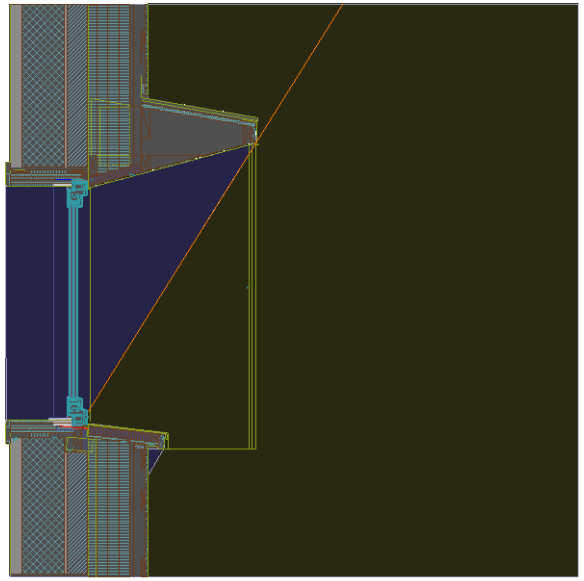




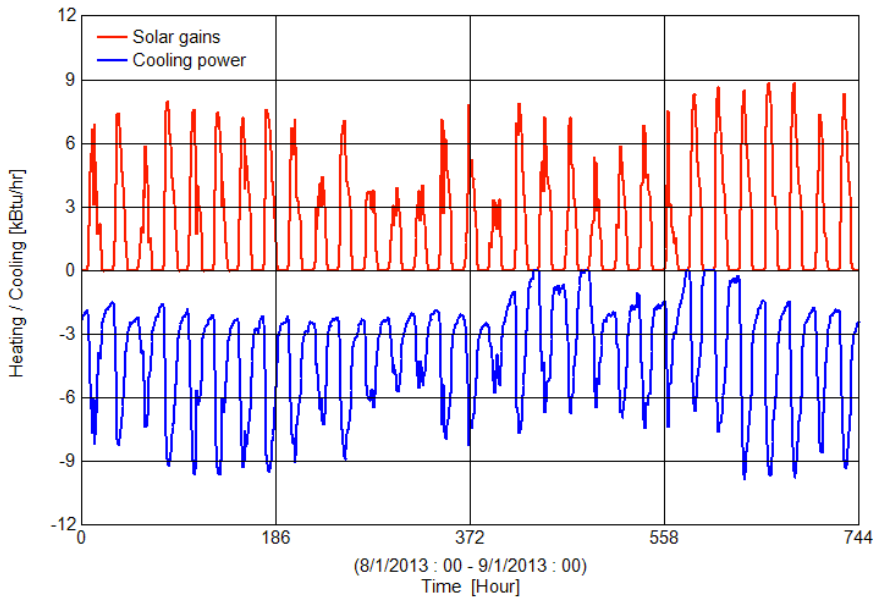
SHOULDER SEASON-warm



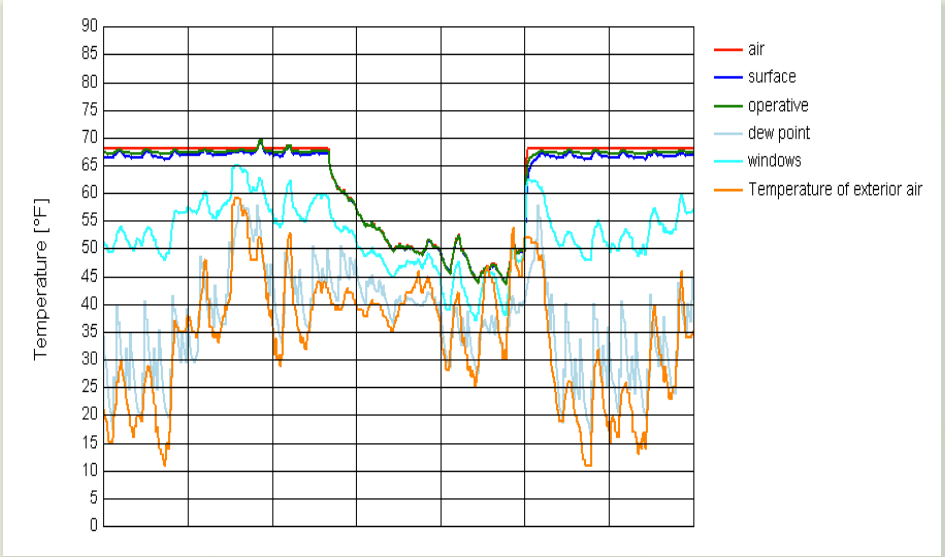
April / August



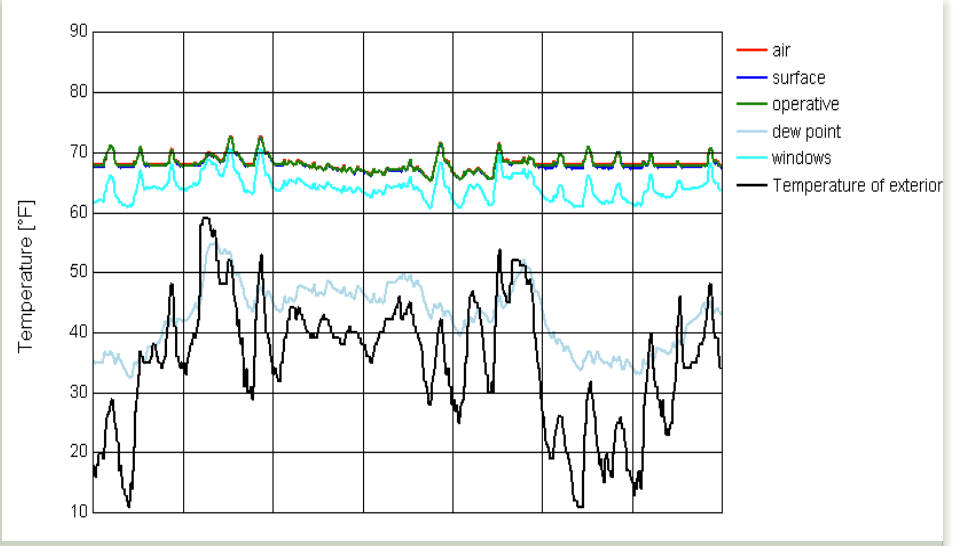
Solar Gain / cooling August



IT WORKS



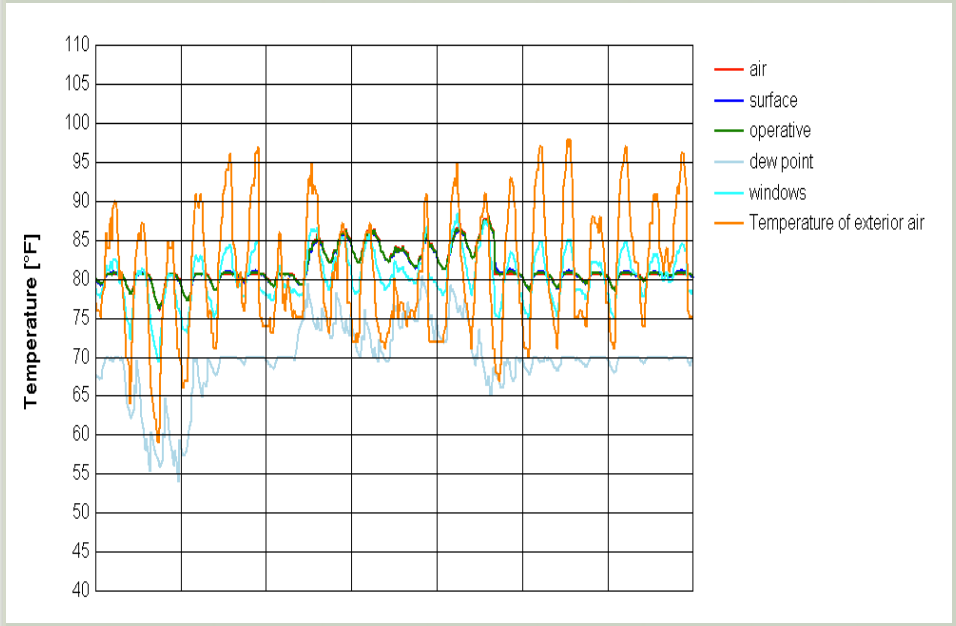
Single family 2 BR – typical row-home



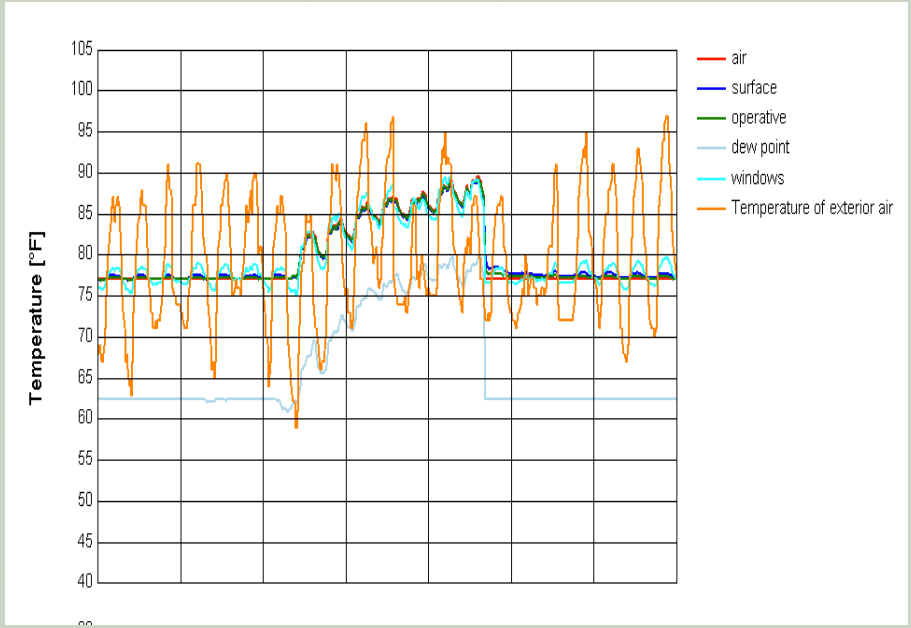
Multi-family– retrofit

ONE WEEK POWER OUT IN DECEMBER:

HIGH PERFORMANCE ENVELOPE MAINTAINS COMFORT AND SAFETY



Single family 2 BR – typical row-home



Multi-family– retrofit

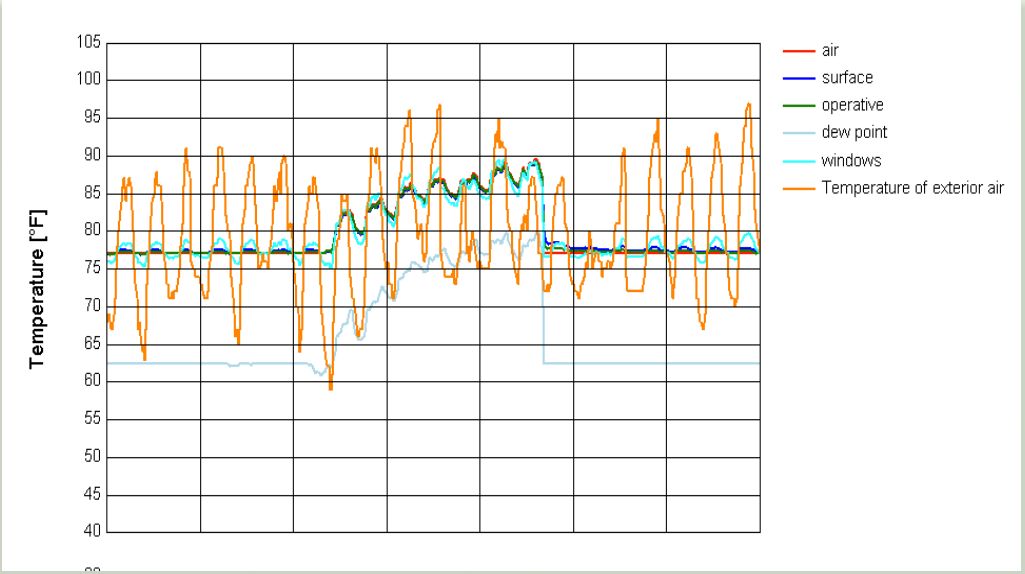
ONE WEEK POWER OUTAGE IN JULY:

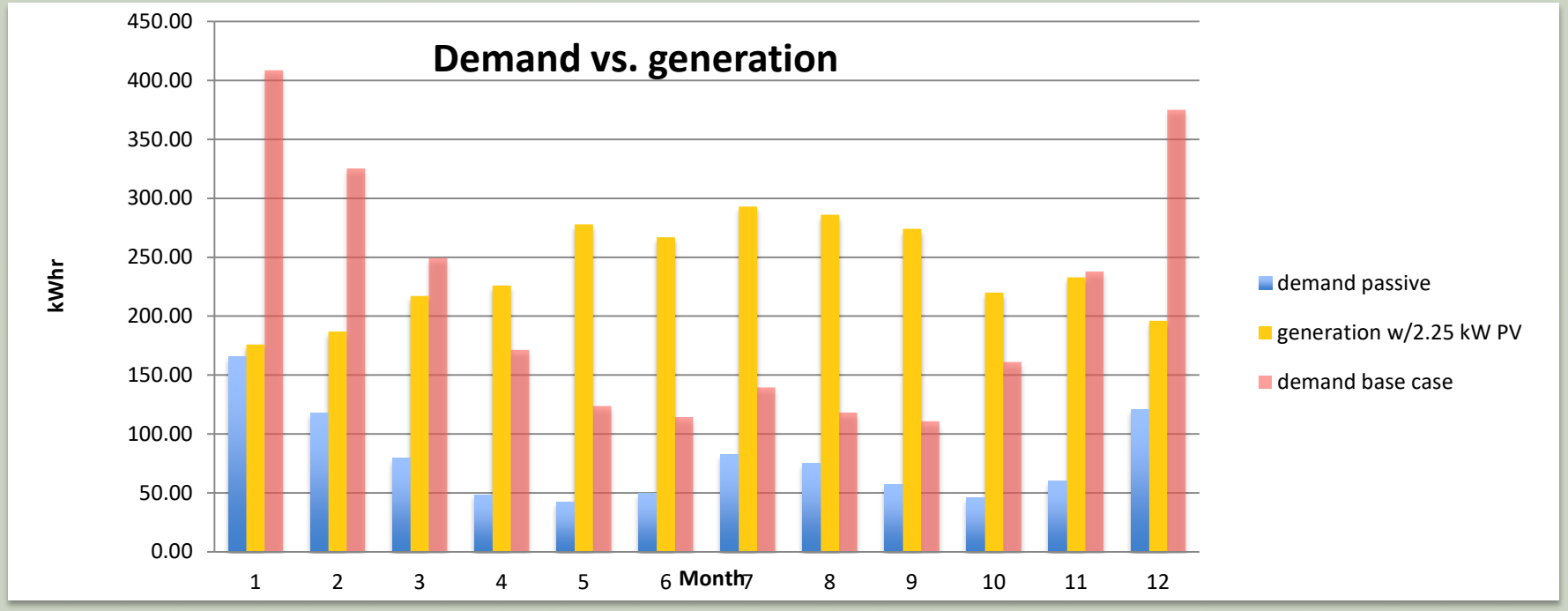
INTERNAL HEAT GAINS AND SOLAR GAIN DRIVE INCREASE IN TEMPERATURES

ONE WEEK POWER OUTAGE IN JULY:

BUT . . .

THAT IS WHEN WE HAVE SOLAR AVAILABLE





RESULTS:

DEEP ENERGY REDUCTIONS

ENERGY

- 6KBTU/SF.YR EUI
- 2988 KW/OCCUPANT PER YEAR PRIMARY ENERGY
- ___% REDUCED ENERGY DEMAND FROM BENCHMARK MODEL

THE FIRST PASSIVE HOUSE, RETROFIT APARTMENT BUILDING IN THE US

BUILDING INFORMATION

Category:	Residential
Status:	In planning
Building type:	New construction
Year of construction:	
Units:	13
Number of occupants:	24.9 (Verification)

Boundary conditions

Climate:	ANDREWS AFB MD	
Internal heat gains:	0.7	Btu/hr ft²
Interior temperature:	68	°F
Overheat temperature:	77	°F

Building geometry

Enclosed volume:	119667	ft³
Total area envelope:	15909.7	ft²
AV ratio:	0.1	1/ft
Floor area:	9379.9	ft²

PASSIVEHOUSE REQUIREMENTS

Certificate criteria: PHIUS+ 2015 Standard

Heating demand

specific:	3.2	kBtu/ft²yr
target:	4.4	kBtu/ft²yr
total:	30049.11	kBtu/yr

Cooling demand

specific:	3.81	kBtu/ft²yr
target:	4.9	kBtu/ft²yr
total:	35702.04	kBtu/yr
latent:	2.05	kBtu/ft²yr

Heating load

specific:	3.07	Btu/hr ft²
target:	4	Btu/hr ft²
total:	28842.1	Btu/hr

Cooling load

specific:	2.18	Btu/hr ft²
target:	4.6	Btu/hr ft²
total:	20479.97	Btu/hr

Primary energy

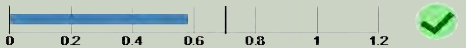
specific:	2988	kWh/Person yr
target:	6200	kWh/Person yr
total:	253834.21	kBtu/yr

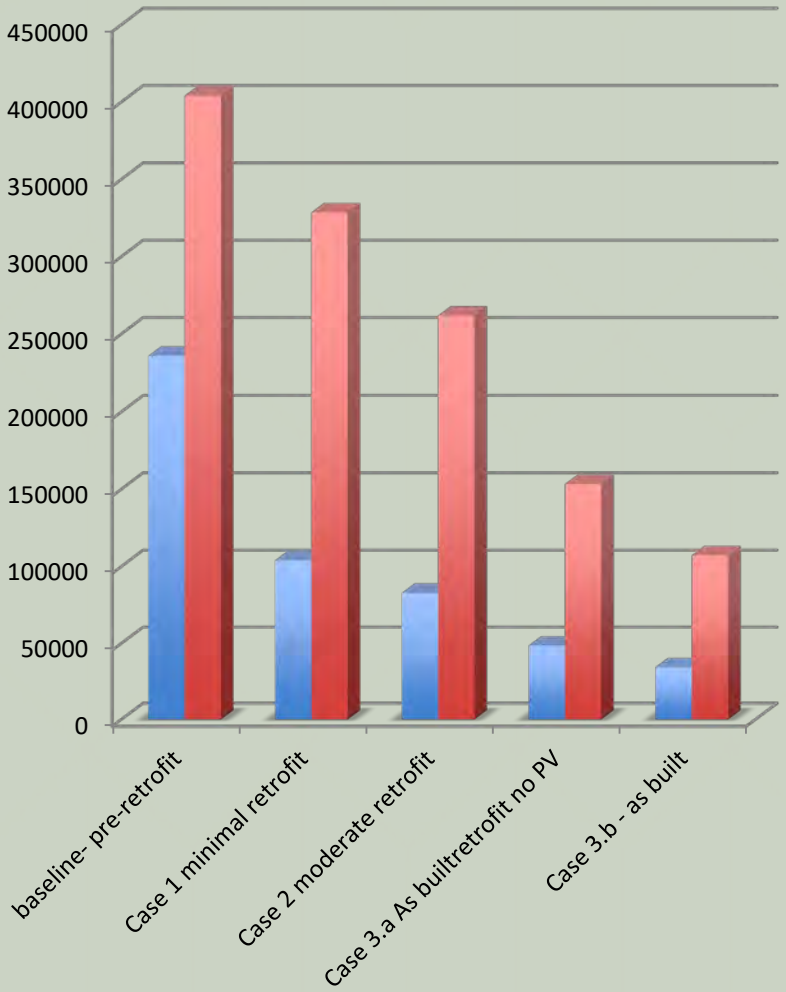
Site energy

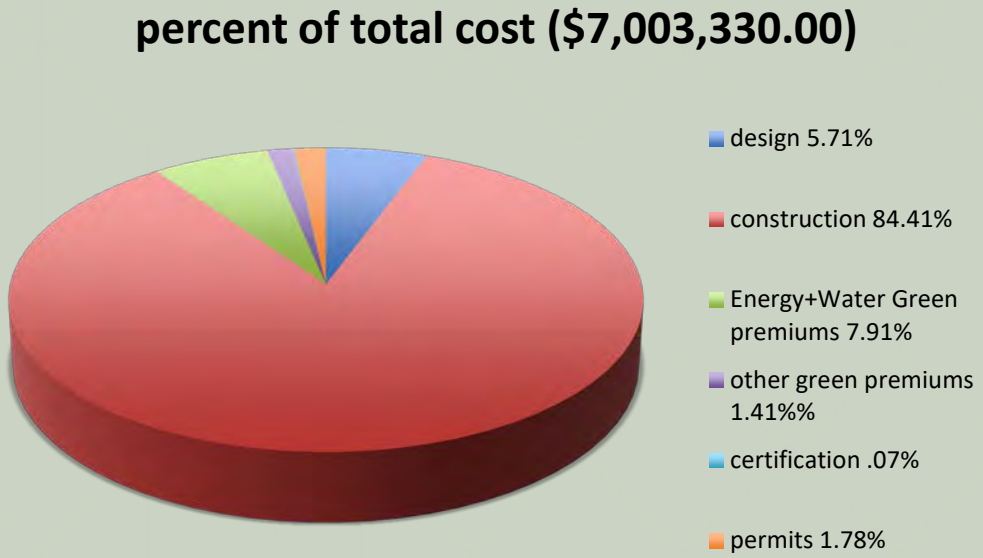
total:	6	kBtu/ft²yr
building systems:	64.08	kBtu/yr
photovoltaic savings:	6.42	kBtu/ft²yr

Air tightness

ACH50:	0.58	1/hr
target:	0.7	1/hr
CFM50 per envelope area:	0.04	cfm/ft²
target:	0.05	cfm/ft²

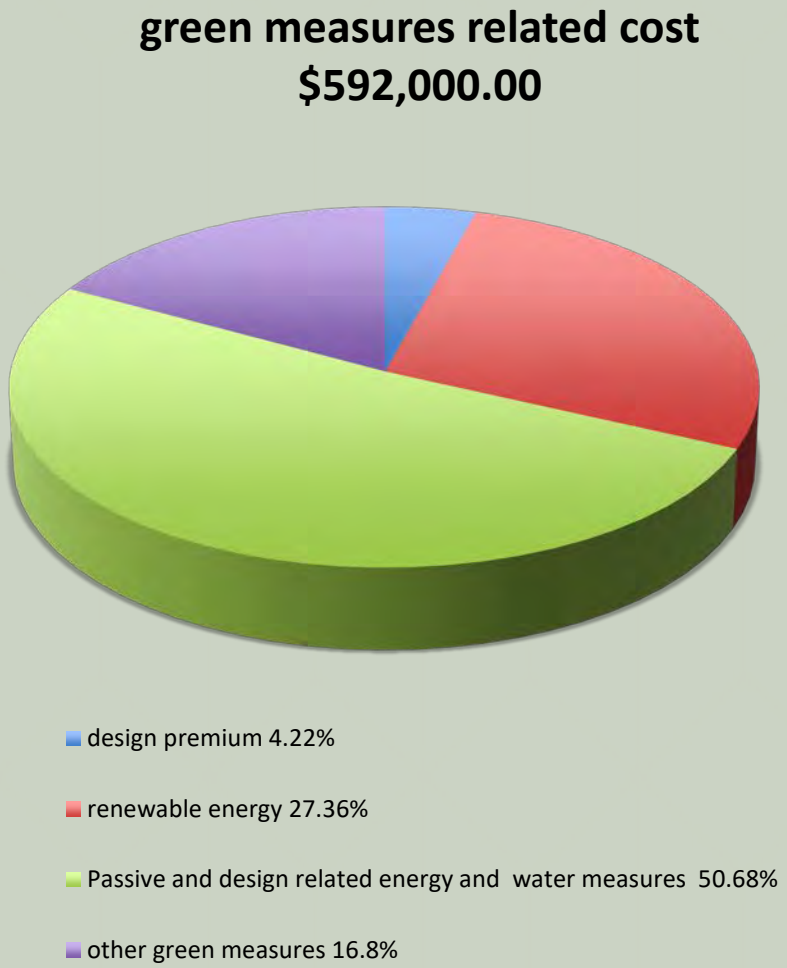






PROJECTED SAVINGS OF CASES:

EXISTING, MINIMAL, MODERATE, AS BUILT



COST OF GREEN MEASURES:

PASSIVE MEASURES vs. RENEWABLES - - $ / kWh SAVED

THANK YOU

QUESTIONS?

Characteristics of Metrics in 3 Case Studies

	Enterprise Green Communities	Zero Net Energy Ready	Passive House
PROJECT TYPE	**2 Properties, Major Rehab**	**1 Property w/ 8 buildings, New Construction**	**1 Property w/ 3 buildings, Major Rehab**
Achieved HERS rating	Range 78 - 85	Buildings range 0 - 32	Not applicable
Achieved ACH @ 50 Pascals	Unit types range 8 - 15	Buildings range 1.3 - 1.7	Average 0.6, ranging from 0.5 – 0.7
Renewable Energy?	Solar added on 1 property afterwards	Yes, was included	Yes, was included
Durability & Health Benefits	Reduced toxins; added on-site rainwater retention with bio-swales	Envelope retained heat during 4-day winter power failure; design drove high IAQ	Removed moisture problems with ERV and added moisture barrier within building envelope