US building impacts

72% electricity consumption

39% energy use

38% CO_2 emissions

40% raw materials

30% waste output

14% potable water use

US building impacts

72% electricity consumption

39% energy use

38% CO_2 emissions

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30% waste output

14% potable water use

LAURA BLAU AIA LEED BD&C® AP

CPHC (Certified Passive House Consultant)

CPHB (Certified Passive House Builder)

CPHD (Certified Passive House Designer-pending)

Principal BLUPATH

BLUPATH is an award winning architecture and design firm focusing on high-performance building design.

blupath.us

BLUPATH

INSPIRING DESIGN FOR PLACES TO THRIVE

Certified WBENC Women's Business Enterprise

LEARNING OBJECTIVES

1. Learn how science based conservation first strategies and the ‘whole-building’ approach can be implemented to achieve energy efficiency, durability and health benefits in Historic buildings.

2. How to phase and apply both passive conservation strategies and active mechanical reduction strategies appropriately for historical buildings.

3. Apply case study examples of best practices and lessons learned, including hydrothermal issues particular to masonry walls in both custom historic residences and budget constrained affordable housing retrofit projects.

4. Understand possible administrative, design and construction challenges of renovating historic properties in both economically depressed and well-to-do neighborhoods.

AGENDA

1. Set the stage: Building’s global role. Relics or Rejuvenation.

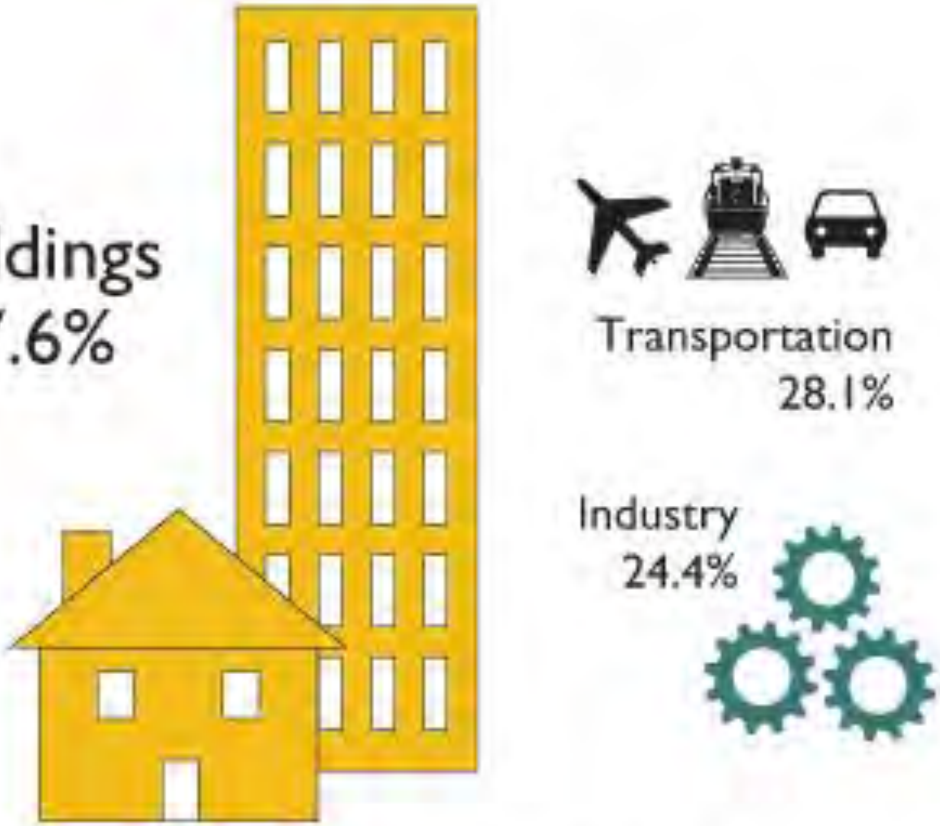
2. Describe the process of assessment to determine opportunities and constraints.

3. Explain the building science issues to be aware of using case study examples.

4. Remind us of the big picture.

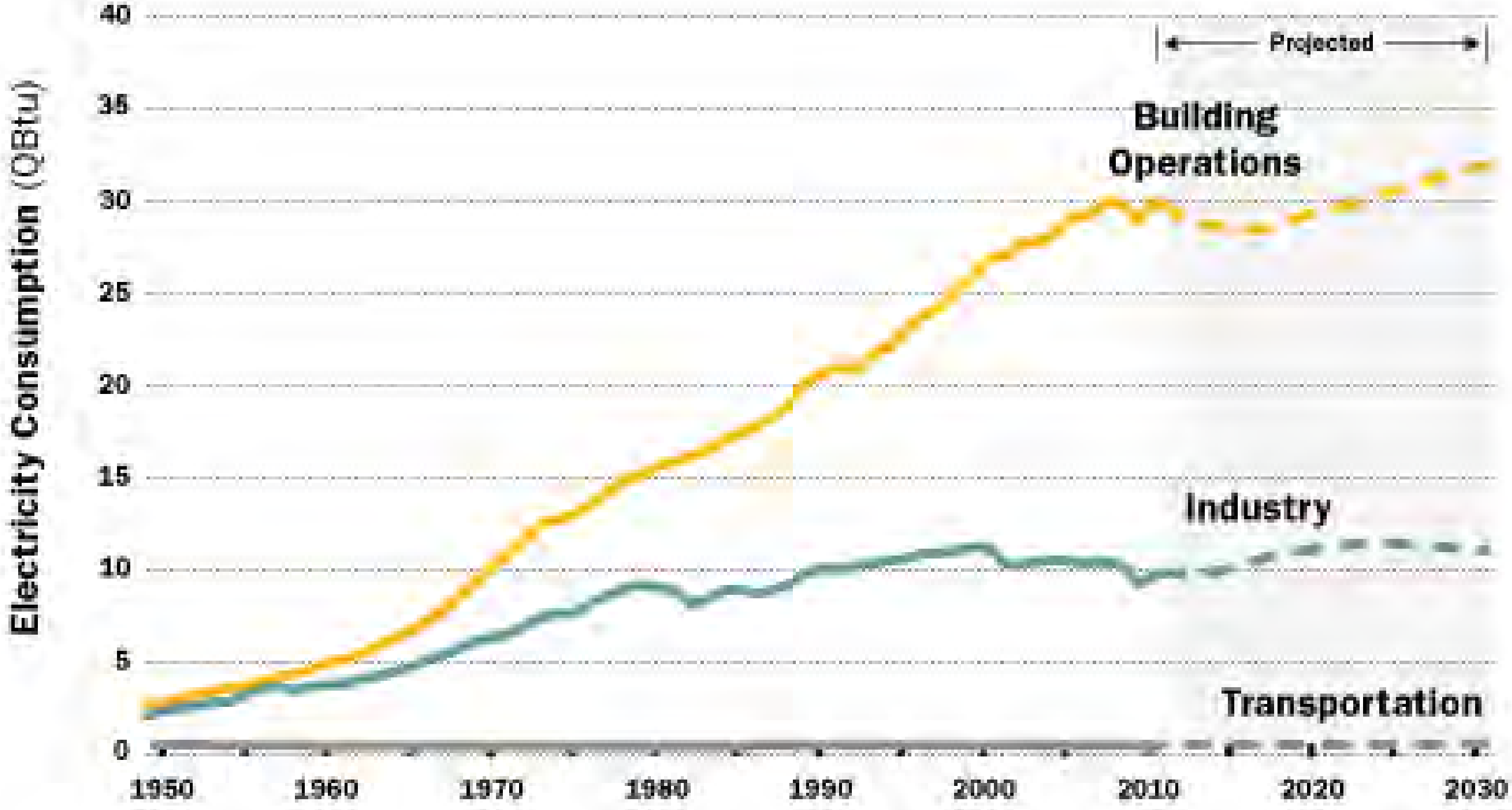
5. Discussion and Q & A.

Energy Consumption



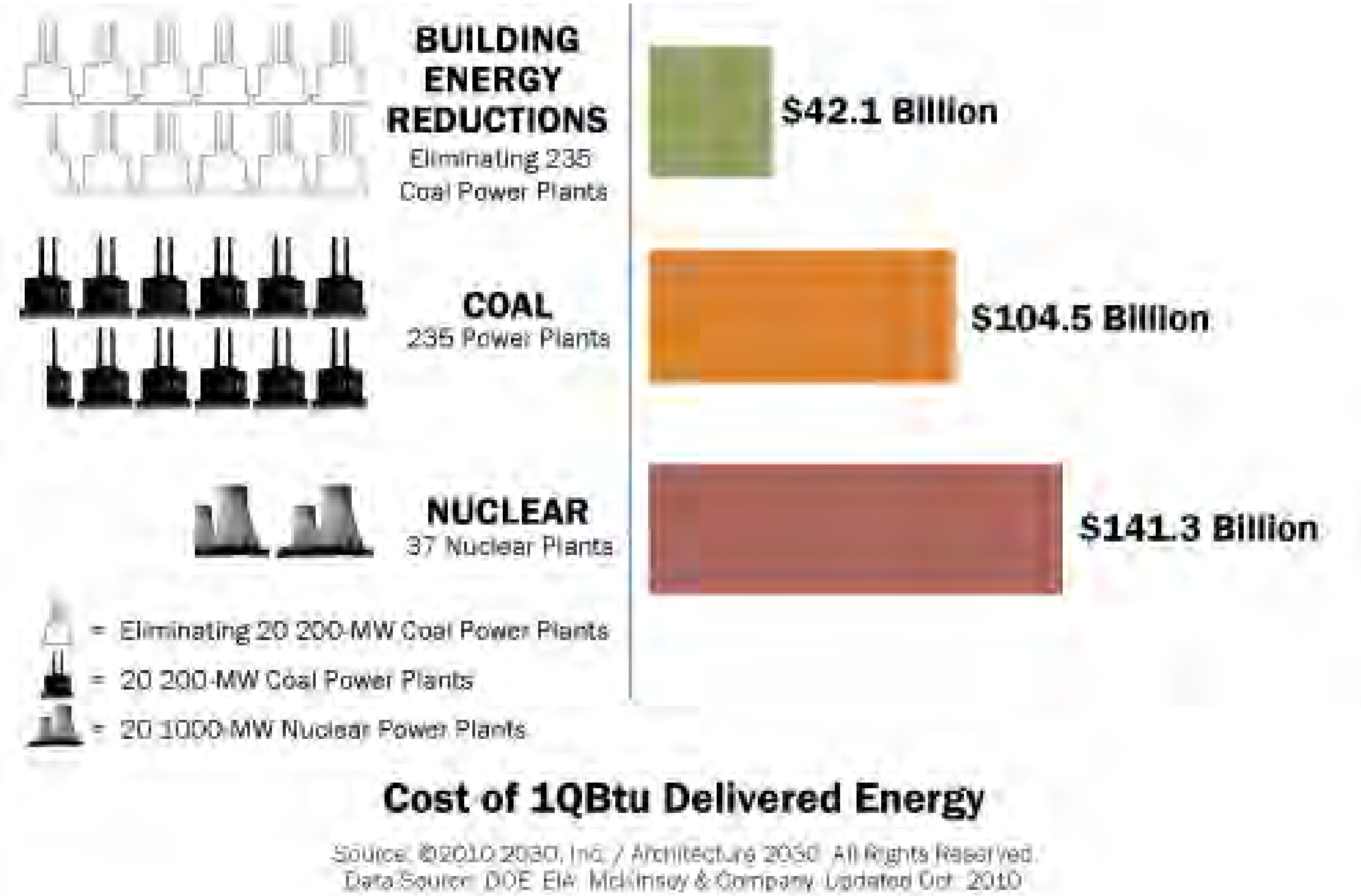
U.S. Energy Consumption by Sector

Data Source: U.S. Energy Information Administration (2012).

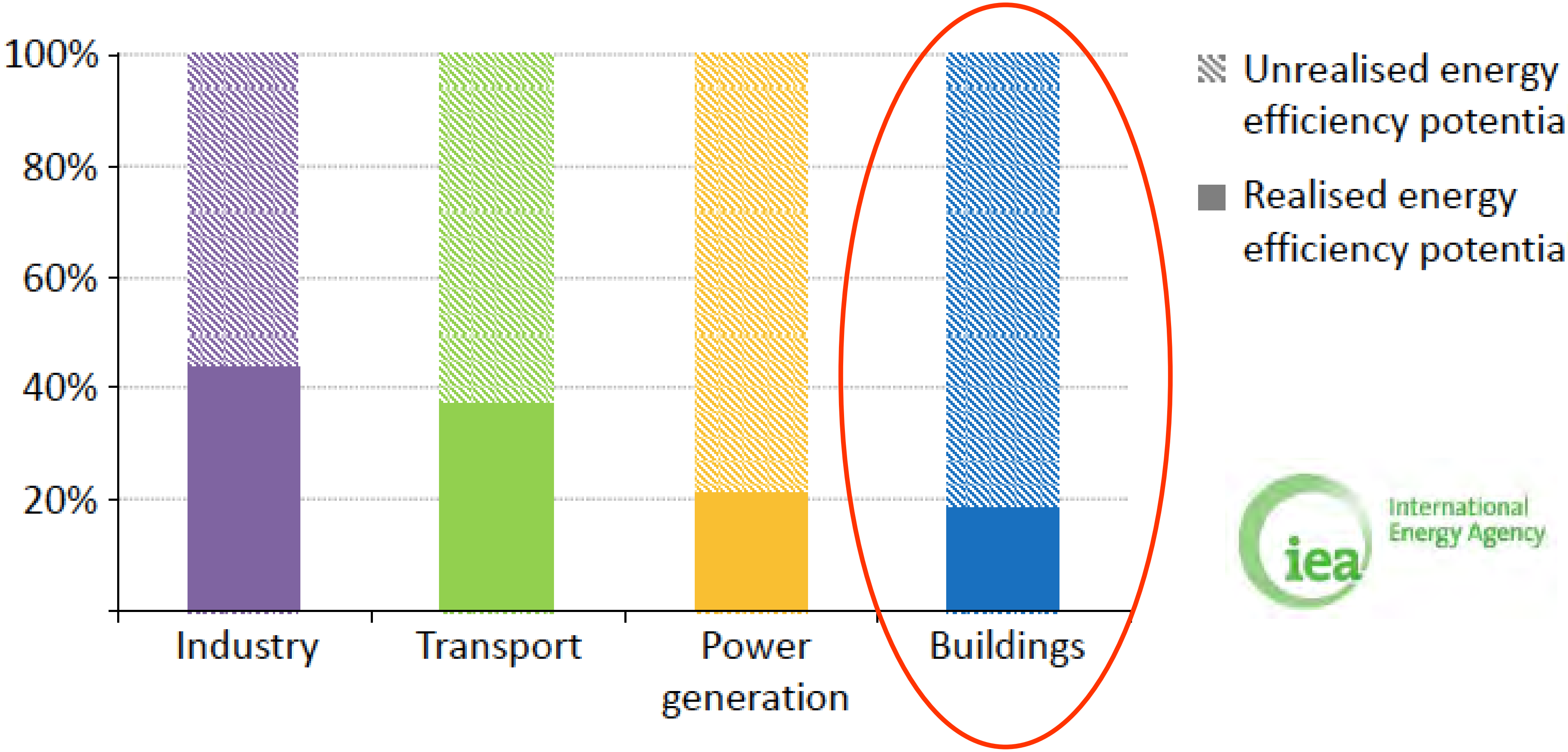


U.S. Electricity Consumption by Sector (Historic / Projected)

Data Source: U.S. Energy Information Administration (2012).



EFFICIENT BUILDINGS ARE **LESS EXPENSIVE** THAN POWER PLANTS



THE BUILDING SECTOR OFFERS THE **GREATEST OPPORTUNITIES** TO REALIZE ENERGY SAVINGS

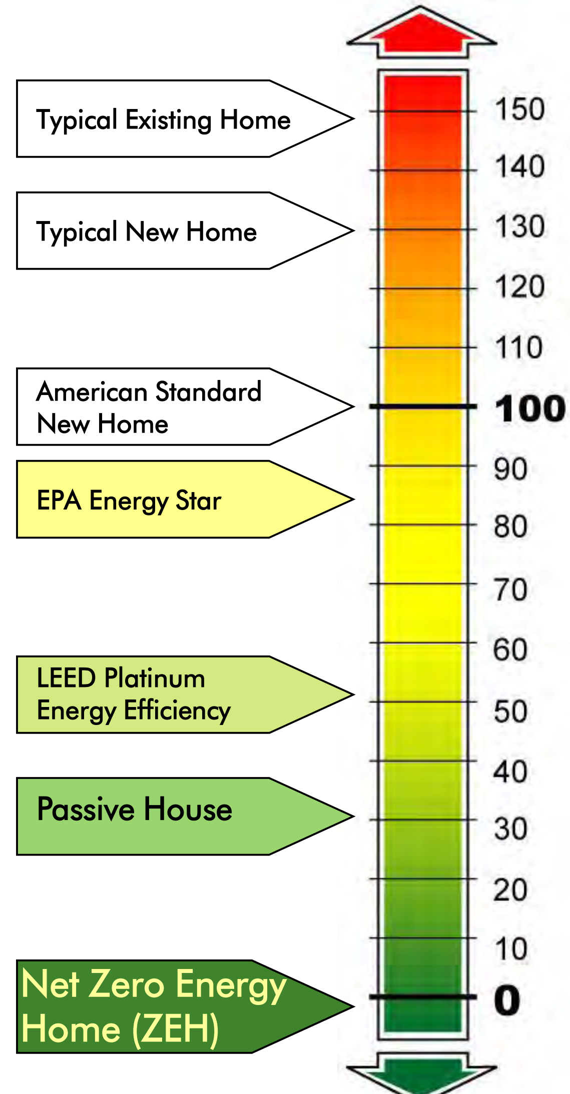
WHAT'S YOUR ENERGY PROFILE???

Site Energy Consumption

Specific heating demand (TFA -30%)
4 story, 4 unit Multi family
75 kBtu/sq ft/yr

Site energy consumption
My Green Dinosaur< kBtu/sq ft/yr
2010 = 24.0 kBtu/sf/yr
2013 = 25.0 kBtu/sf/yr
2014 = **36.0** kBtu/sf/yr

Convert to **Primary energy** (factor of 2.71)
2010 = 65.0 kBtu/sf/yr
2013 = 67.8 kBtu/sf/yr
2014 = **97.6** kBtu/sf/yr (humidifier added!)



BUILDING ENERGY CHALLENGE

RESNET HERS Rating Scale

Passive House – Heat demand (TFA-30%)

New	<	4.75 kBtu/sq ft/yr
Retrofit	<	8.00 kBtu/sq ft/yr
Primary Energy	<	38.10 kBtu/sq ft/yr

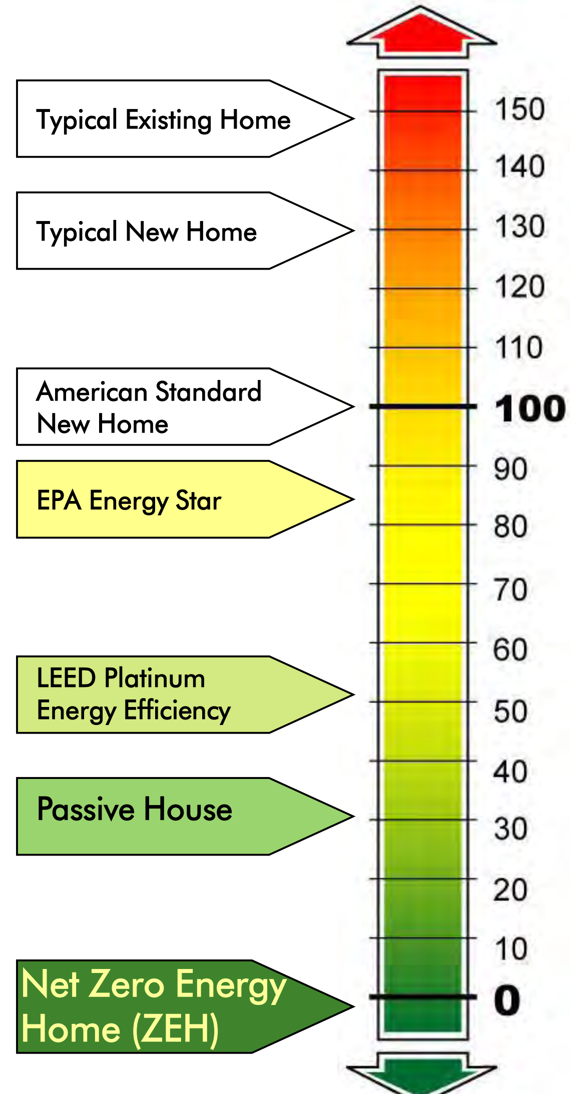
Convert to Site energy (factor of 2.71)

Primary Energy = 14.1 kBtu/sf/yr

Site energy consumption US single family

1975	=	94.5 kBtu/sf/yr
2009	=	105 kBtu/sf/yr
Multi family		
2009	=	77.0 kBtu/sf/yr

*2009 RECS Survey Data



BUILDING ENERGY CHALLENGE

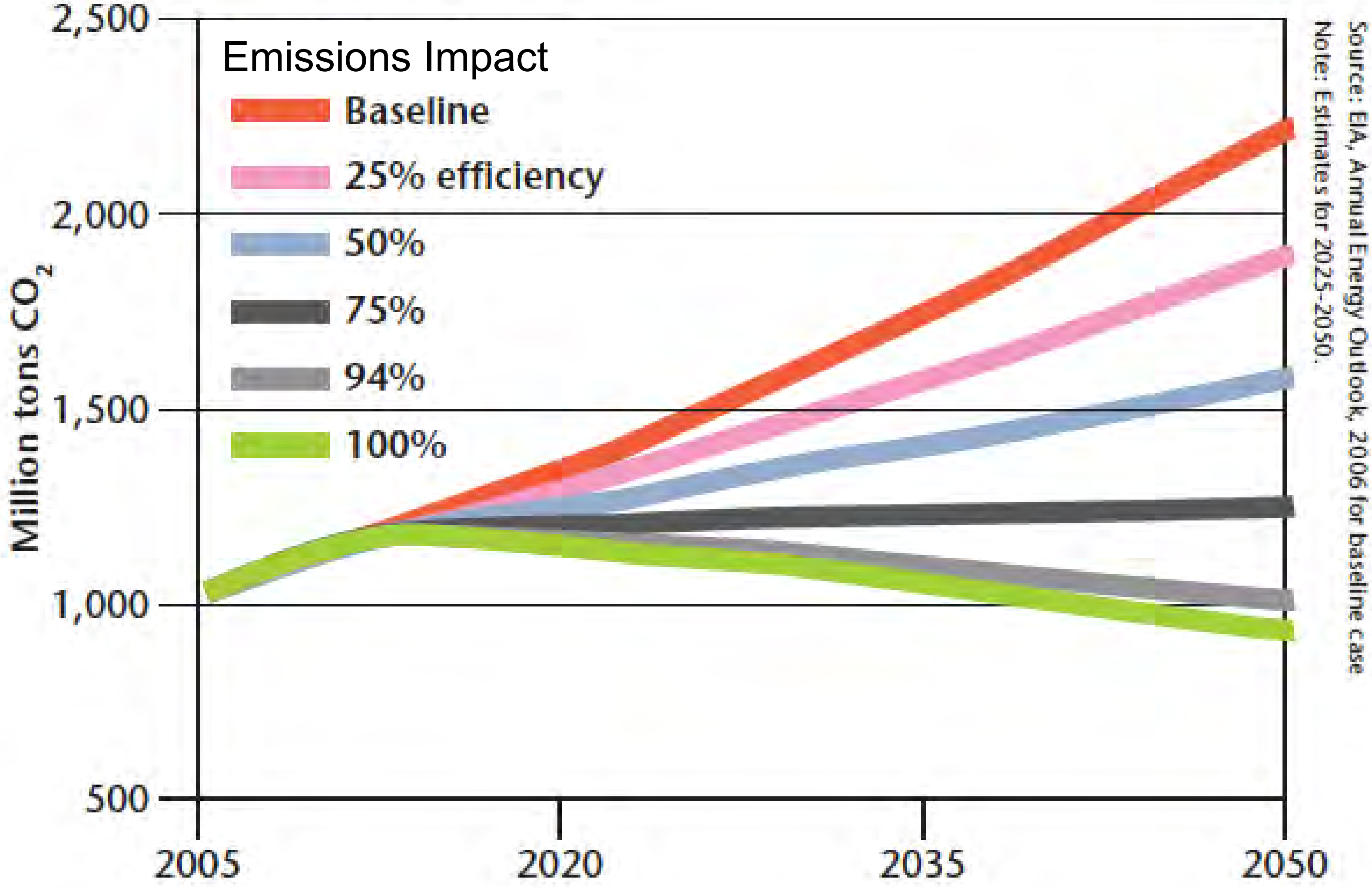
Air tightness

Passive House (new)	$<$	0.6 ACH_{50}
Passive House (Retrofit)	$<$	1.0ACH_{50}
EnergyStar 2.5, 3.0	$=$	4.0 ACH_{50}
EnergyStar 2.0	$=$	5.0 ACH_{50}

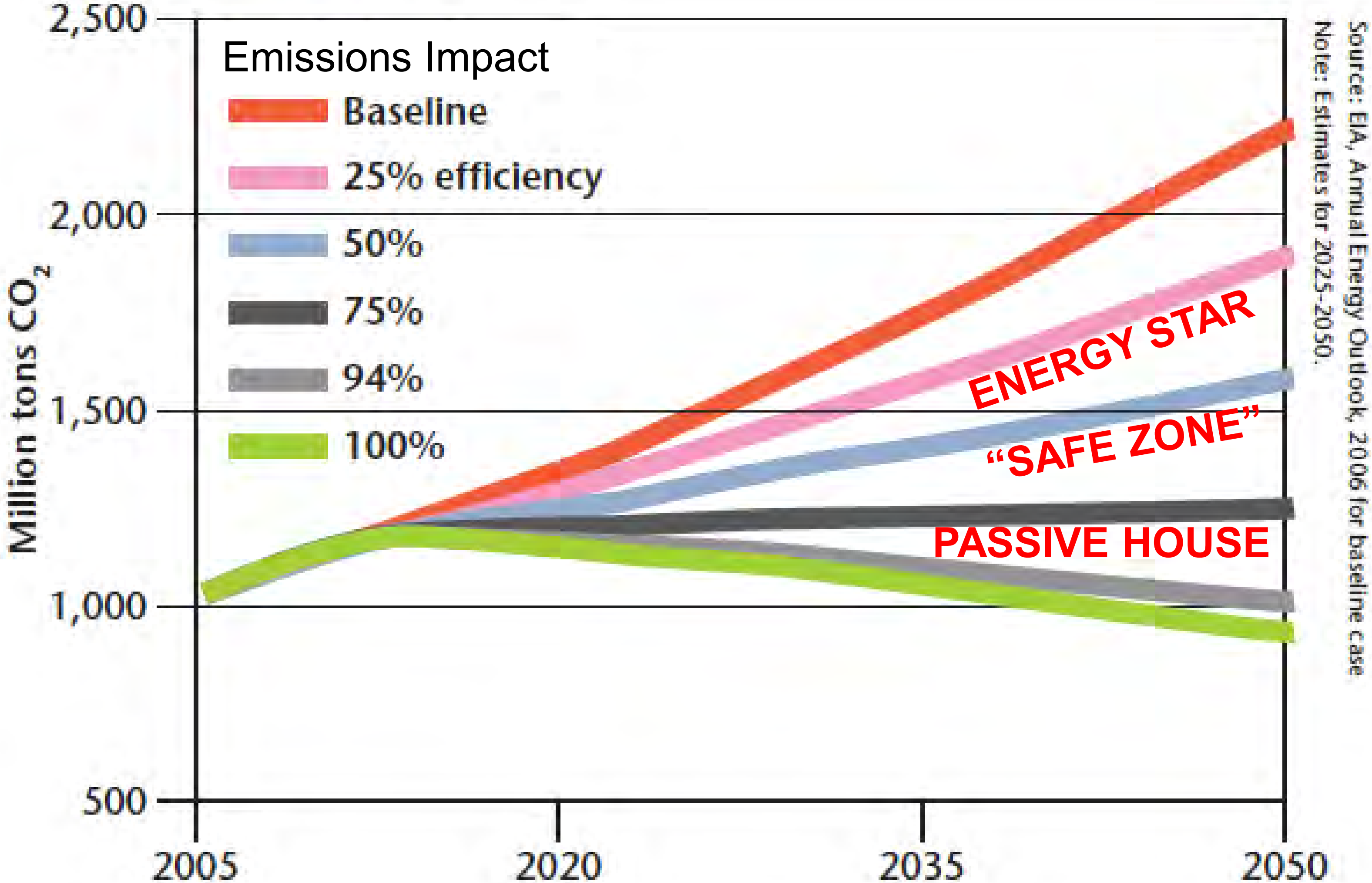
1998 Survey	1 of 100 houses	$<$	5.0 ACH_{50}
	20 of 100 houses	$>$	20.0 ACH_{50}

Mean of 12,000 buildings $=$ 29.7 ACH_{50}

BUILDING ENERGY CHALLENGE



BUILDING ENERGY CHALLENGE



What is Passive House?

(PassivHaus)

Science based

Conservation focused

Better built

Cost effective

=

SMART DESIGN

Efficient, comfortable, healthy

ZEC - Zero Energy Capable

SINGLE FAMILY ADDITION
Philadelphia, PA
BluPath, Architect
Green Builder Green Home of the Year “Best Life Cycle Extension”

SINGLE FAMILY RENOVATION
Philadelphia, PA
BluPath, Architect


SINGLE FAMILY ADDITION
Philadelphia, PA
BluPath, Architect

SINGLE FAMILY RESTORATION
Philadelphia, PA
BluPath, Architect

SINGLE FAMILY HISTORIC RENOVATION
Washington DC
BluPath, Architect

BROWNSTONE HISTORIC RENOVATION
Brooklyn, NY
Prospect Architecture, Architect

GLASSWOOD PASSIVE HOUSE RETROFIT
Portland, Oregon
Scott|Edwards, Architects, with Hammer and Hand

HATZOLAH CENTRAL AMBULANCE DISPATCH CALL CENTER
Brooklyn, NY
Alex E Romeo, Architect / Duncan Architect, CPHC

HIGH SCHOOL RETROFIT
Baesweiler, Germany
Ludwig Rongen, Architect

MULTI_FAMILY HISTORIC RETROFIT
MCKEESPORT YMCA, ACTION-HOUSING
Pittsburgh, PA
Thoughtful Balance, Architect

RENOVATION OF COUNTY HOSPITAL
Eschwege, Germany
Willi Kirschner + Partner, Architect


CHRIST CHURCH RETROFIT
Heinberg, Germany
Ludwig Rongen, Architect

BUILDING ENVELOPES CHANGE

BUILDING SYSTEMS CHANGE

Paradigm Shift

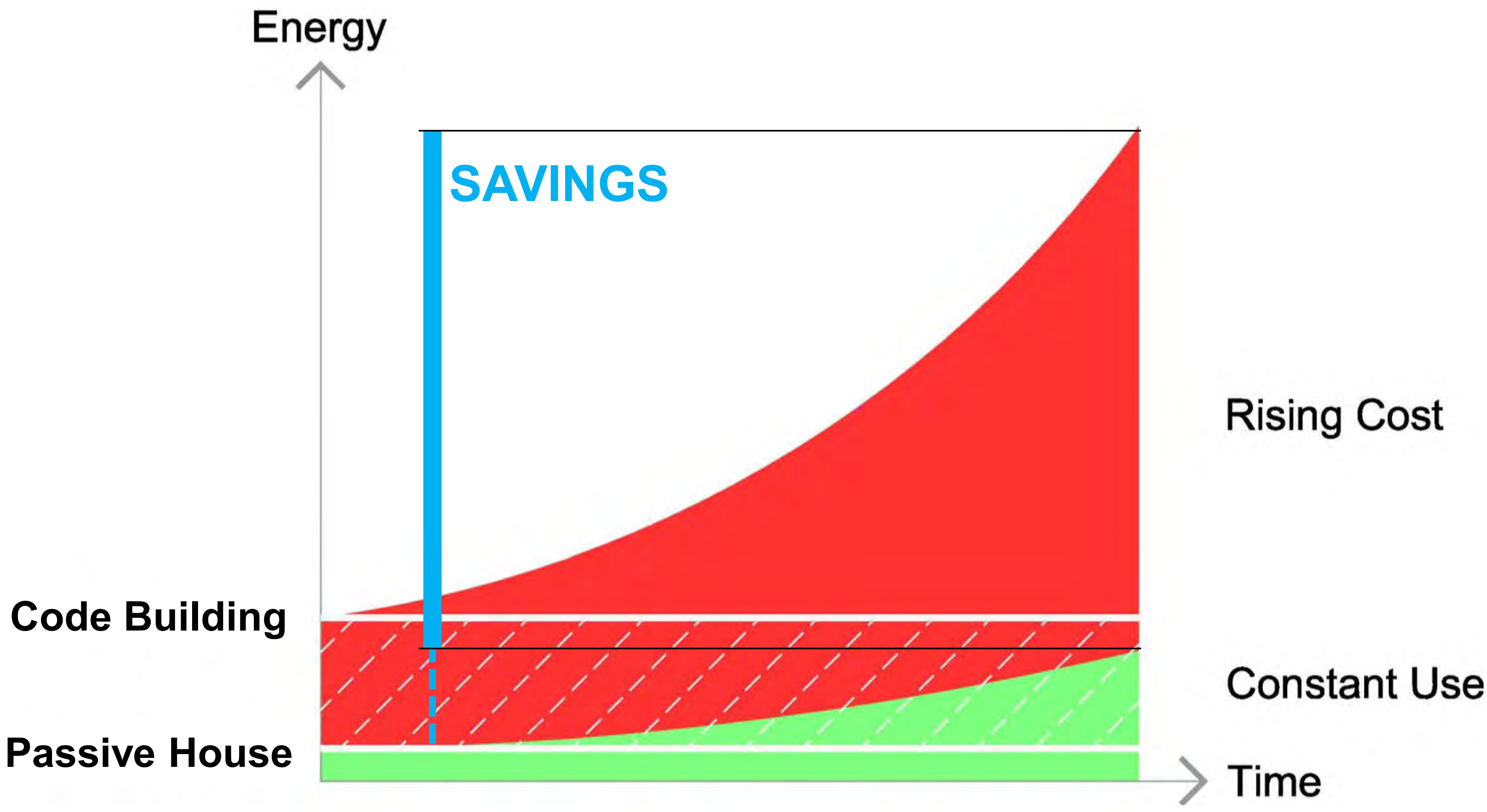
Coffee Analogies

Energy Star

Passive House

Standard

Passive House



Energy Savings Over Time

Passivhaus Institut

PH™

ECONOMICS OF PASSIVE HOUSE

RETURN ON INVESTMENT

LIFE CYCLE ANALYSIS

PRESENT VALUE ANALYSIS

$$\text{Price of Saved Energy} = \frac{(a_{loan} * (I_{add} - R) + Z)}{E_{saved}}$$

$$\text{Net Present Value (NPV)} = K_0 * \frac{1 - (1+p)^{-n}}{p}$$

BENEFITS BEYOND ENERGY SAVINGS

LONG TERM VALUE

Envelope is permanent to the building

Less or smaller mechanical equipment

Lower O&M costs

BENEFITS BEYOND ENERGY SAVINGS

LABOR IS LOCAL

PEOPLE POWER IS A RENEWABLE RESOURCE

Contributes to the local economy

BENEFITS BEYOND ENERGY SAVINGS

LOWER RISK – MORE DURABLE

Studies show
most envelope failures
are from air leakage and
thermal bridging

BENEFITS BEYOND ENERGY SAVINGS

HIGHER PRODUCTIVITY

More comfortable,

healthier indoor air quality

higher user satisfaction

BENEFITS BEYOND ENERGY SAVINGS

MORE FUTURE-PROOF – SURVIVABLE

Mitigates issues surrounding

extreme weather

global energy

and

material

availability, cost and scarcity

ASSESSMENT

Know your science facts

Correct tools **Prioritize**

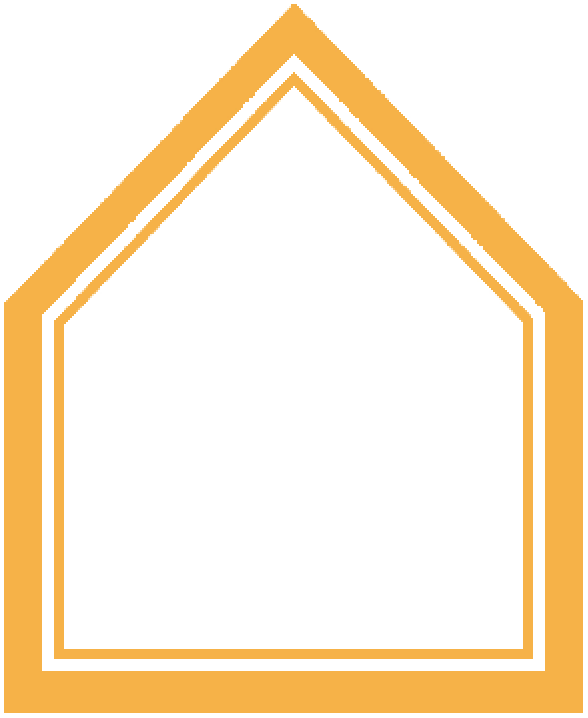
Be honest **Be brave**

Future-plan **Future-proof**

ASSESSMENT

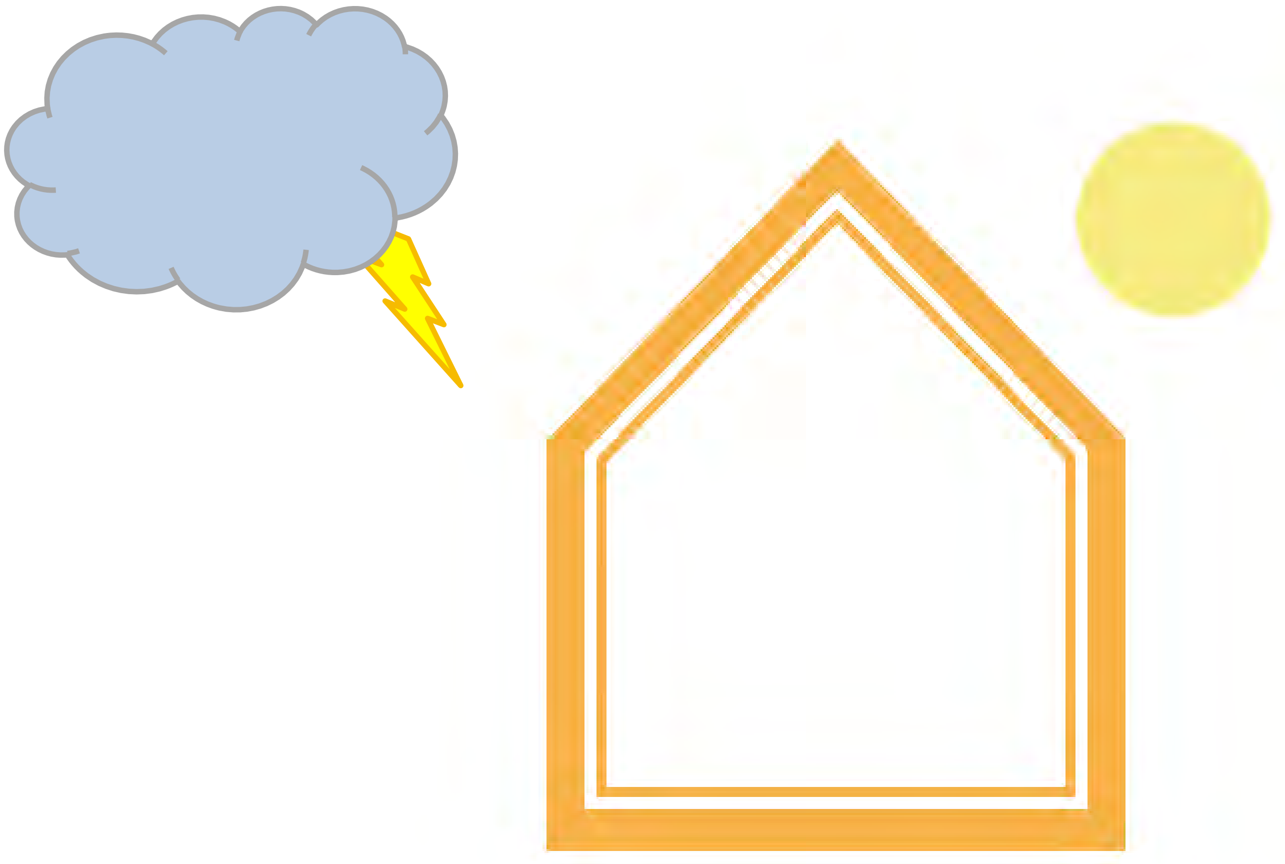
Relic or Rejuvenation

Fabric or Feature



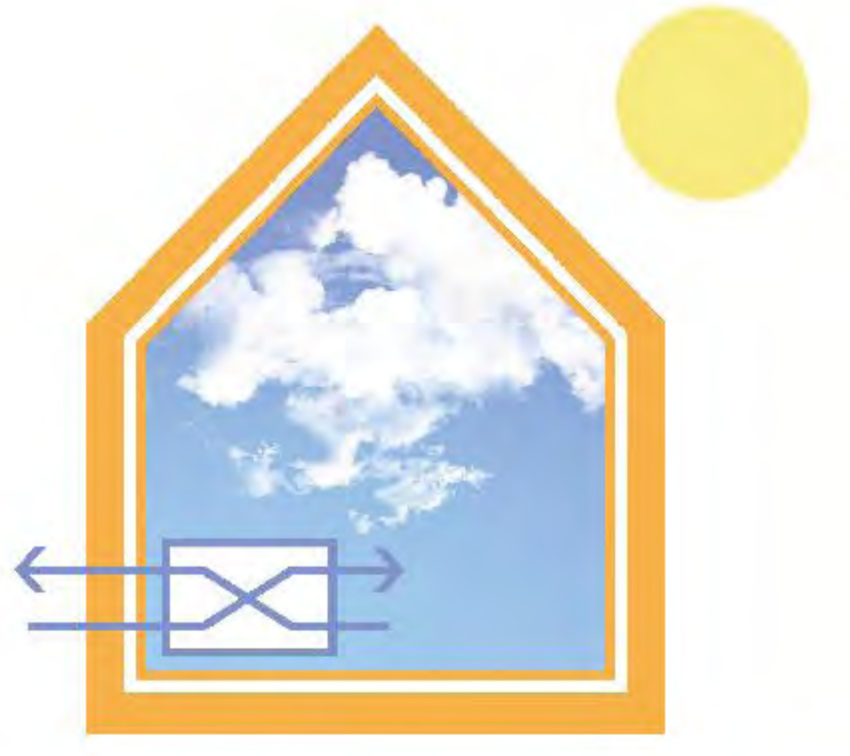
Super Insulated Air Tight Shell

Blower Door Test for Air Tightness



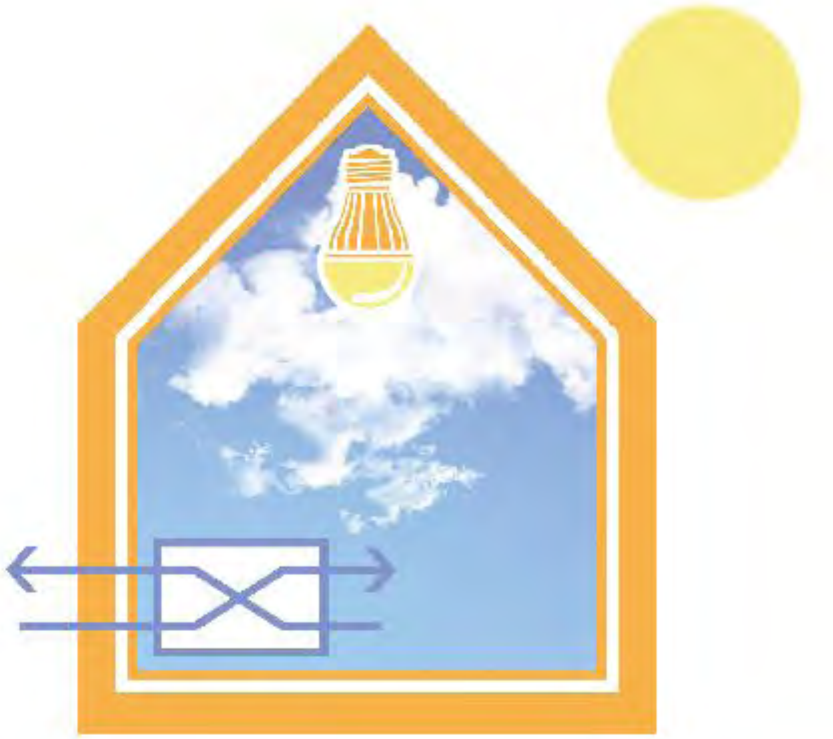
Optimized Solar Energy

Orientation, wind and rain
Opportunities & Constraints



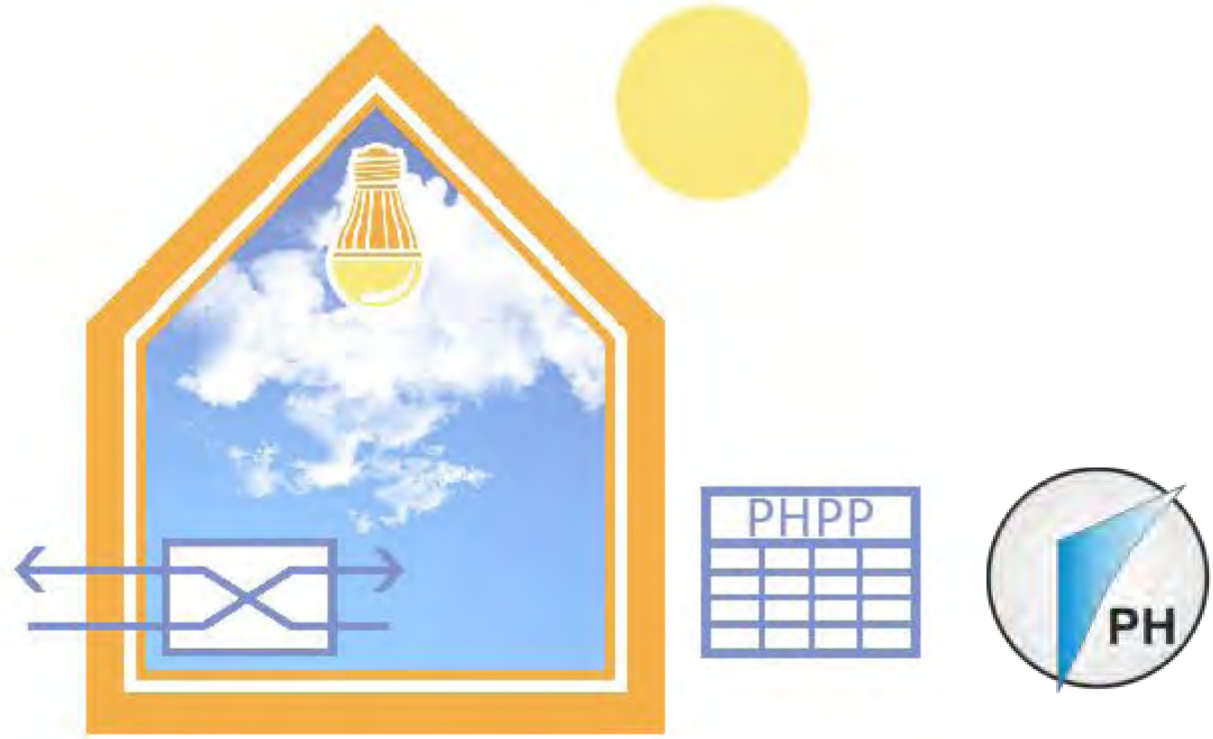
Continuous Ventilation

Building Dynamics and Healthy IAQ
(know your science)



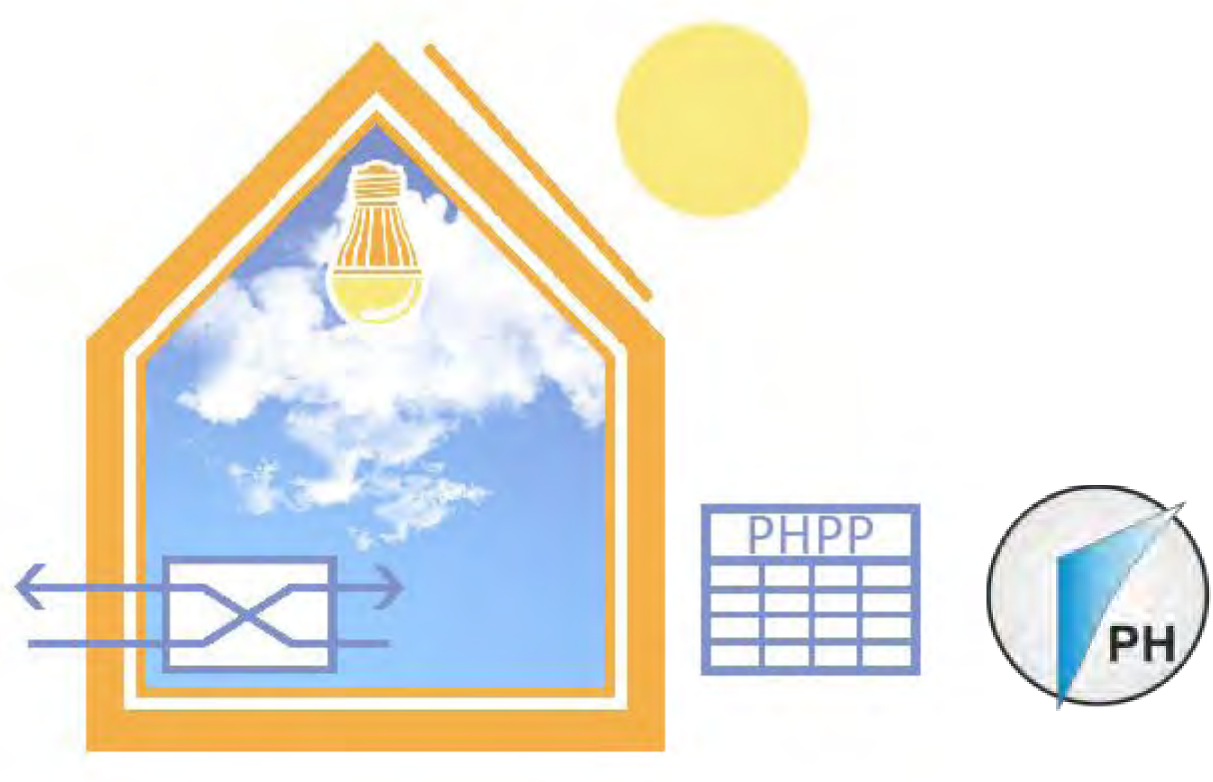
Efficient Appliances

Planned and Phased Obsolescence
Future Proof and Future Planning



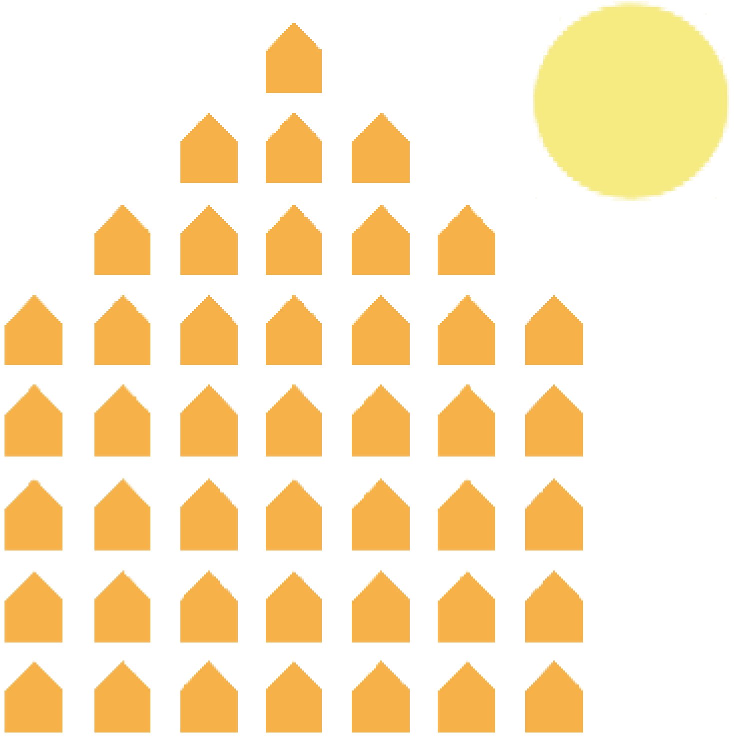
Accurate and Proven Analysis

Hygrothermic Modeling and Testing
(every model has a bias)



Passive House + Solar Array =
Net Zero Energy

Plan for Future Optimization



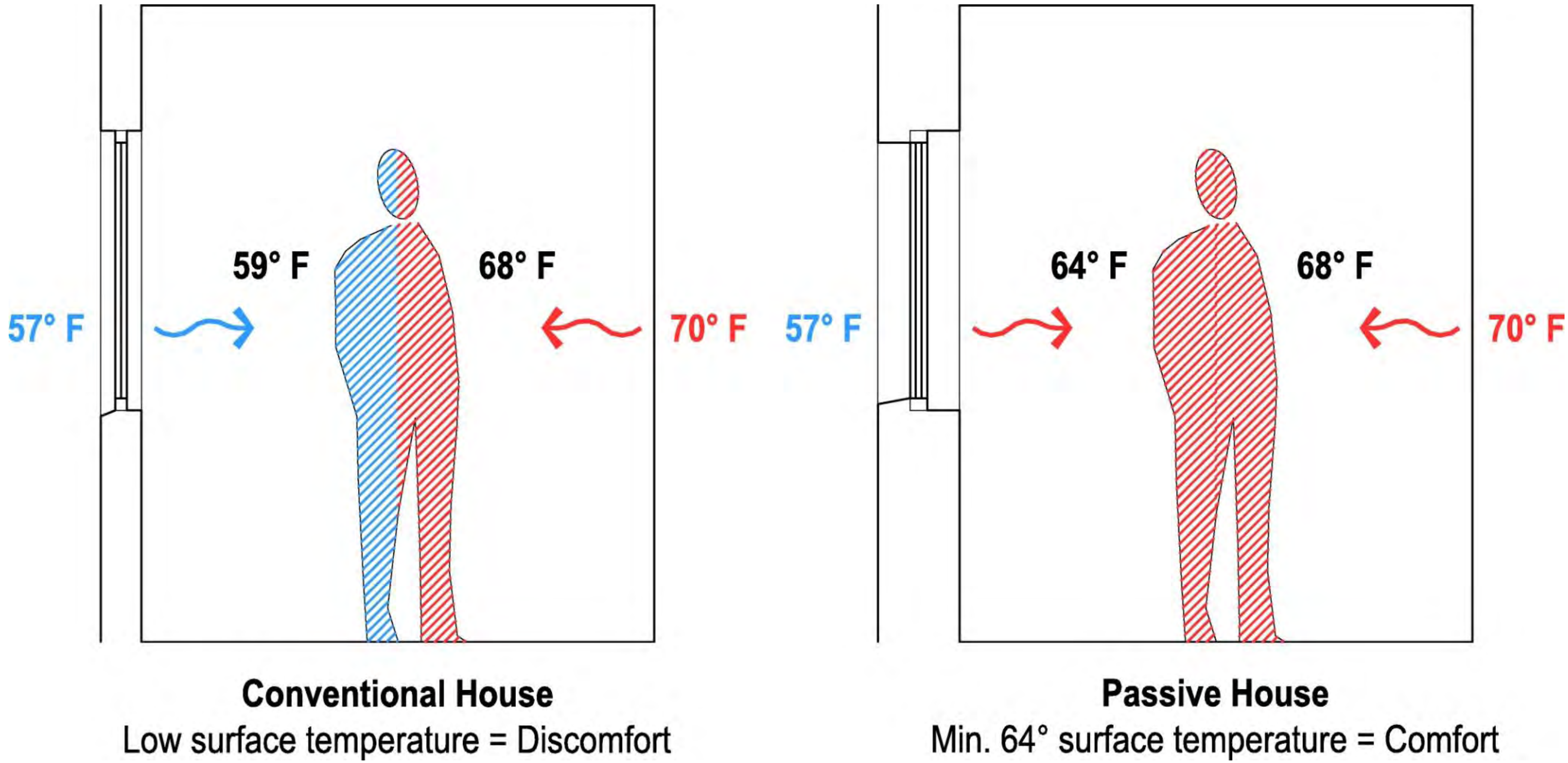
25 Years + ~~55,000~~ Units (2012)

(Ask us about Brussels 2015)

Typical building

Passive House

EFFICIENT



COMFORTABLE

Minimize Disequilibrium

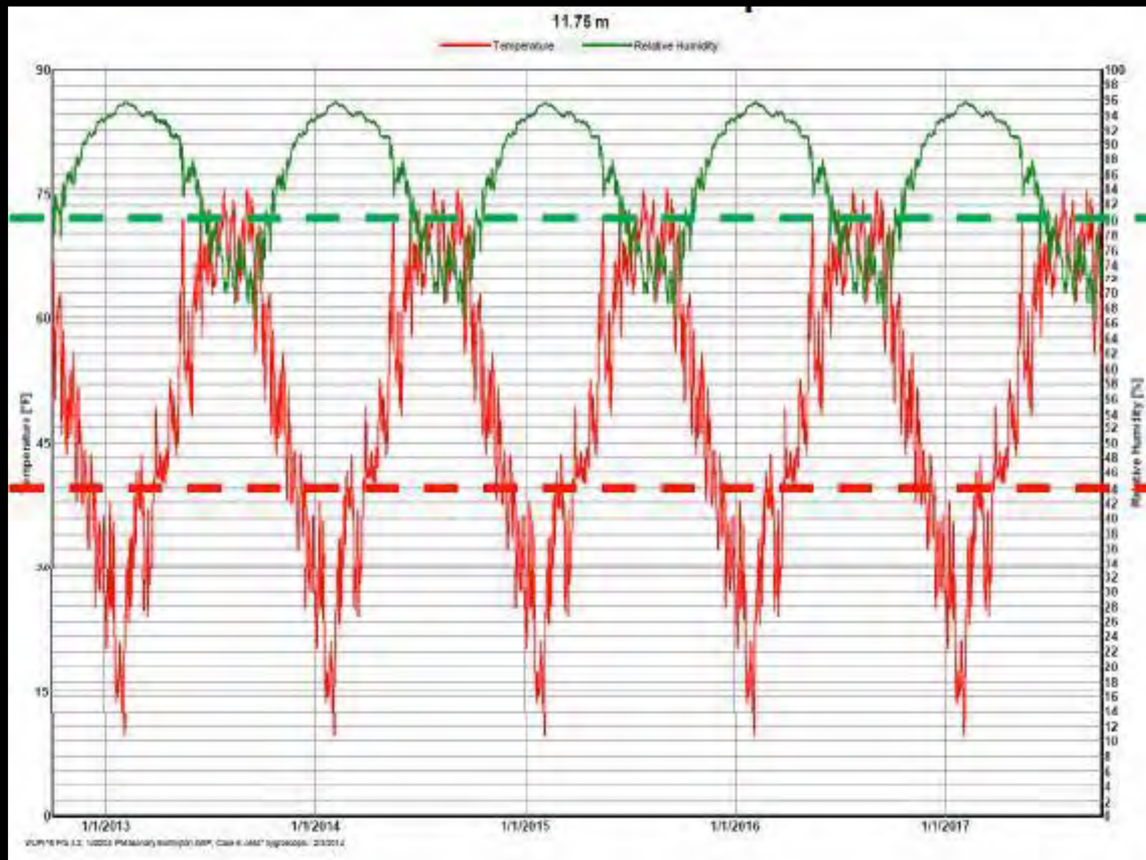
Masonry moisture testing

Red=$^{\circ}$ F

Green=RH

80%RH

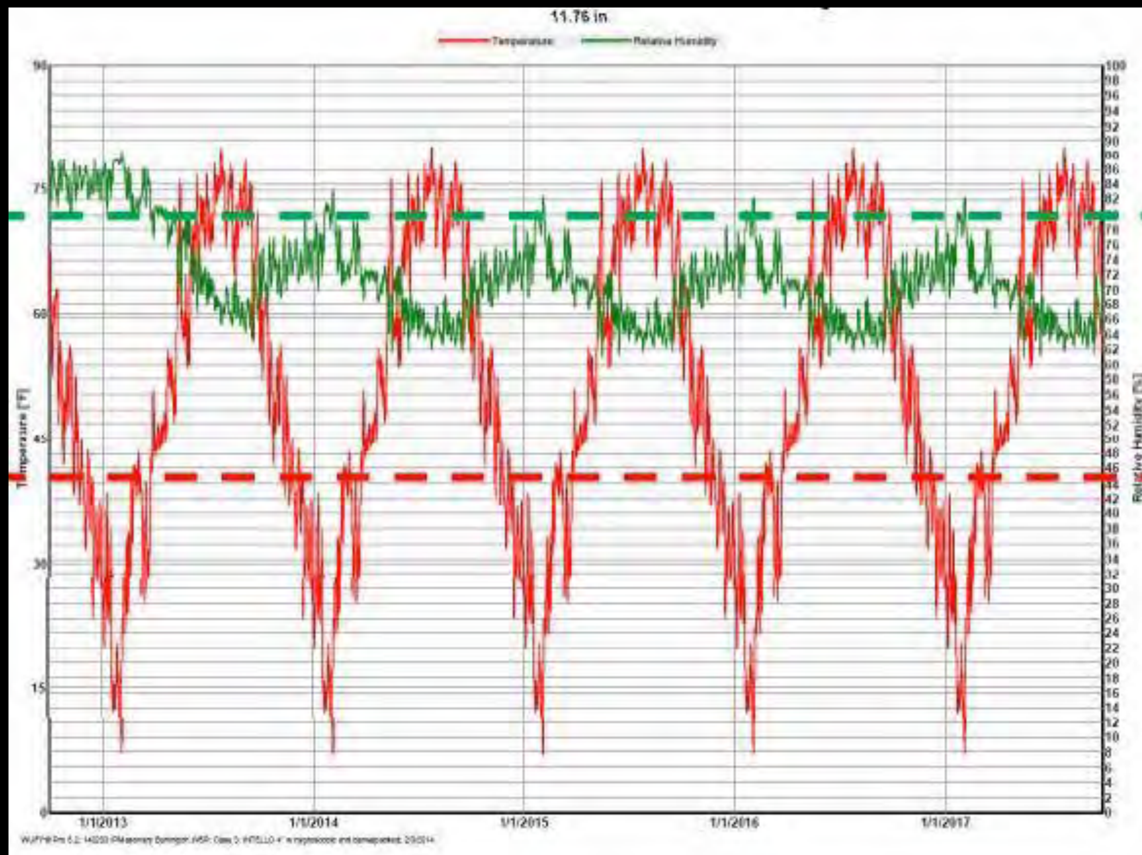
41° F



4″ dense pack cellulose
without interior vapor barrier

Red=°F

Green=RH



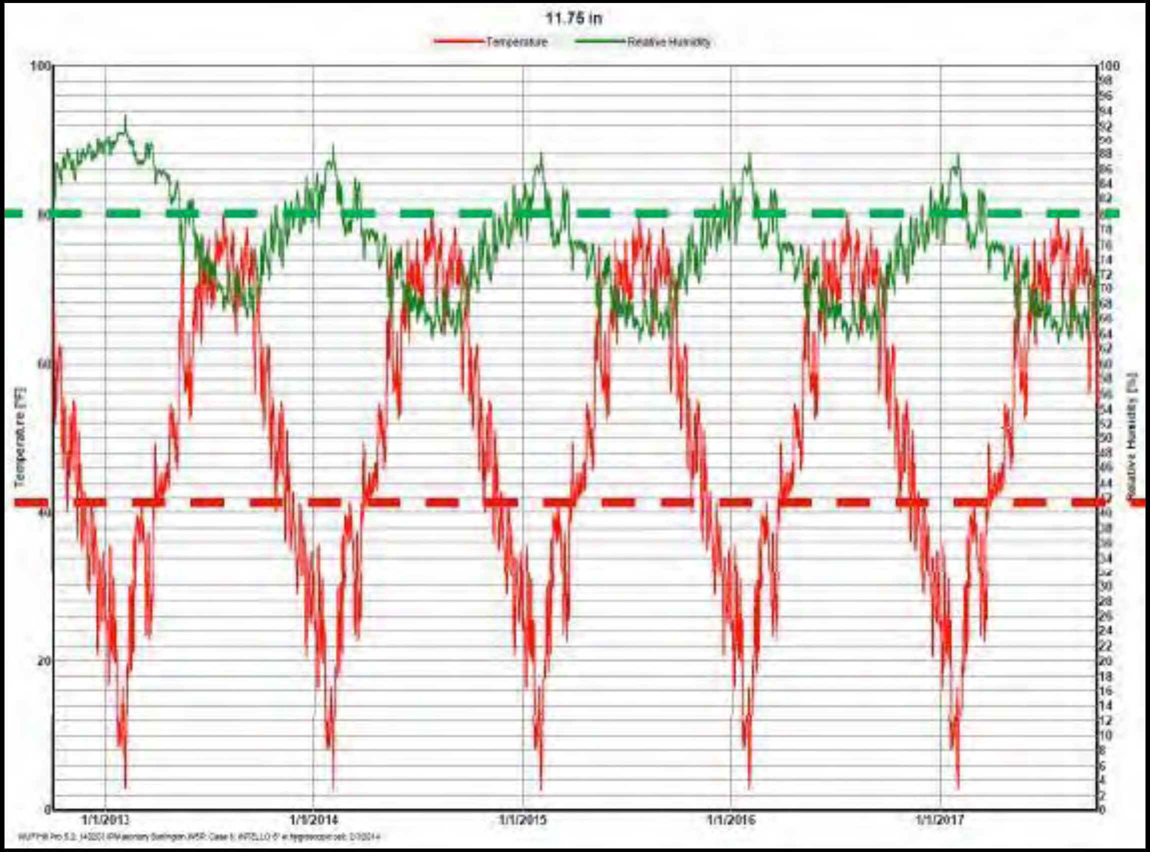
4″ dense pack cellulose
with smart interior vapor barrier

Red=°F

Green=RH

80%RH

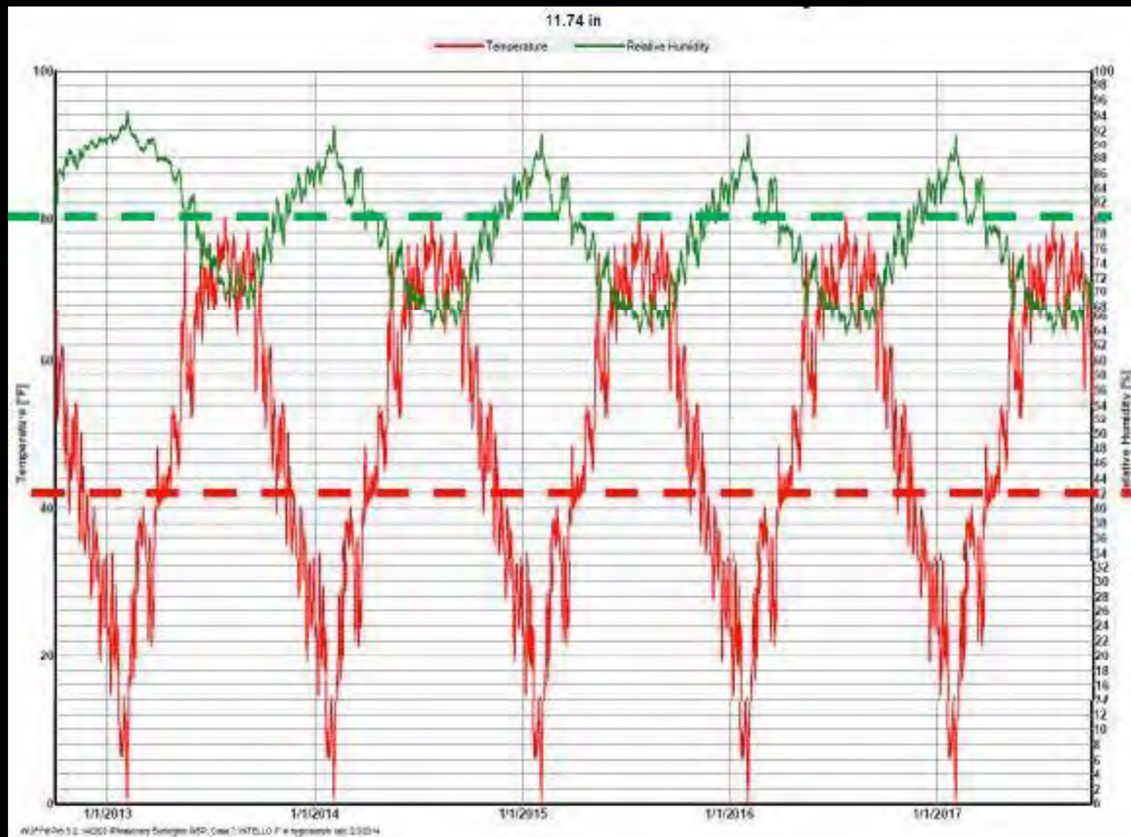
41°F



6″ dense pack cellulose
with smart interior vapor barrier

Red=°F

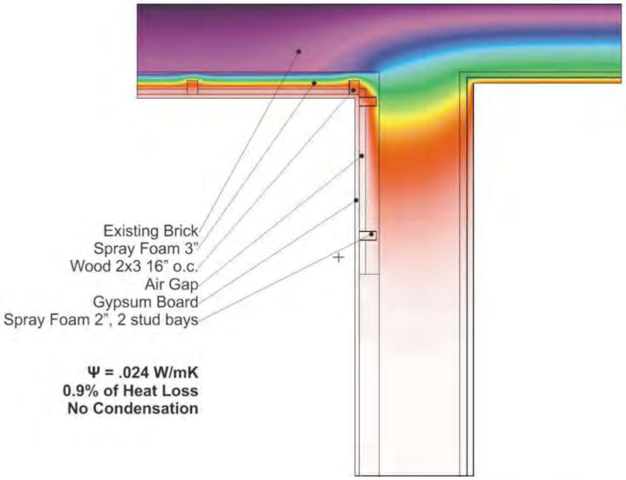
Green=RH

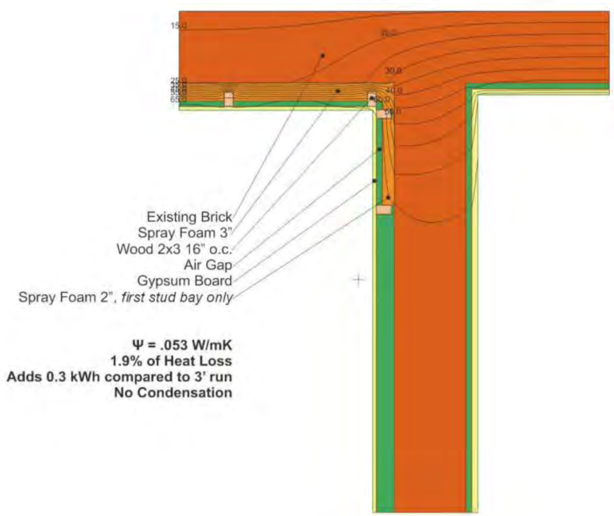


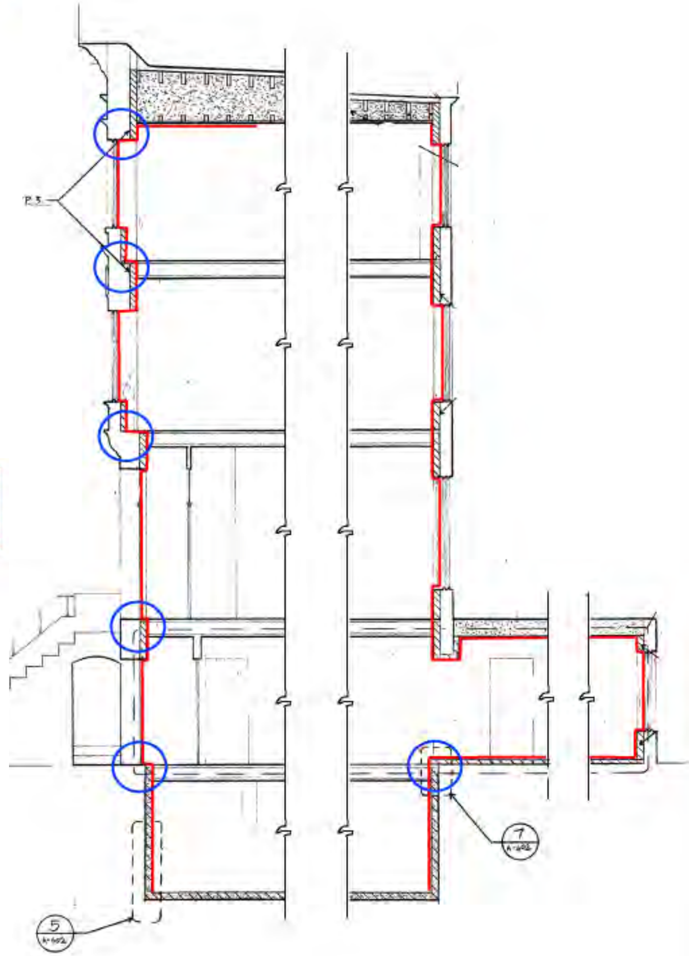
80%RH

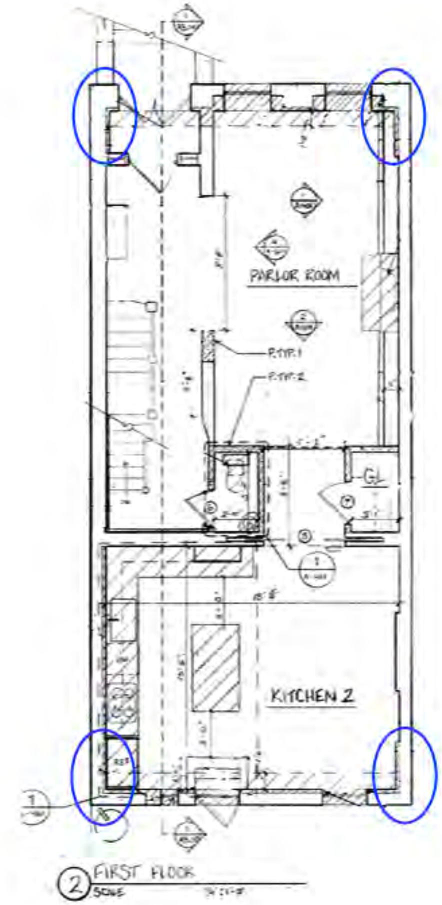
41°F

8" dense pack cellulose with smart interior vapor barrier





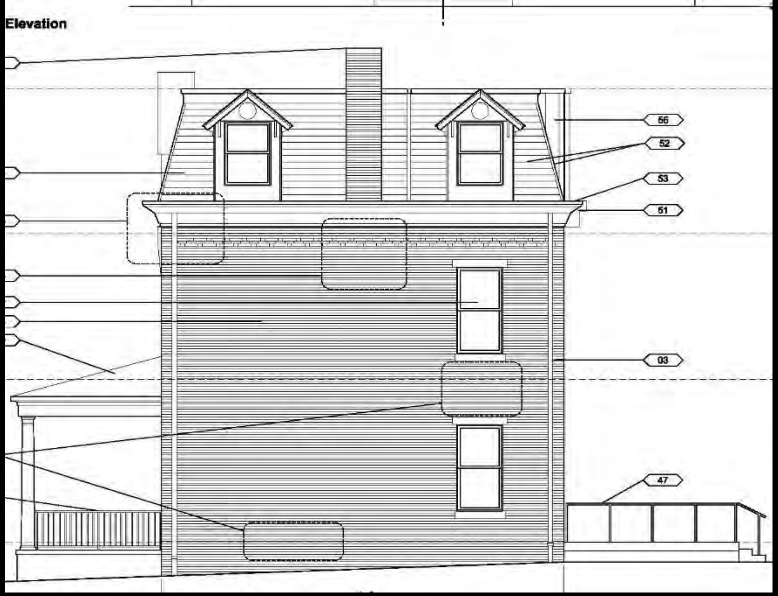




Thermal Bridge Design & Analysis

Party wall air sealing and blower door test

Tioga United-Home Ownership Program



“Right-Size” the Building
Amputation: lose the leg, save the patient

Seal & Insulate, Use new “Smart Product”

“Right-Size” Equipment, Be a Good Neighbor

Nothing's Perfect


SINGLE FAMILY HISTORIC RENOVATION
Washington DC
BluPath, Architect


Pre construction usage = 57.5 kbtu/sf/yr

Gas, oil heat & electric AC, lights, plug load

Electric only = 19.22 kbtu/sf/yr

Post construction usage

Electric usage = 17 kbtu/sf/yr

Heat pump 2nd & 3rd fl, lights, plug load

(water usage increased 40%-teenage boys)

Gas usage ??? kbtu/sf/yr

Extrapolation suggest 50% reduction

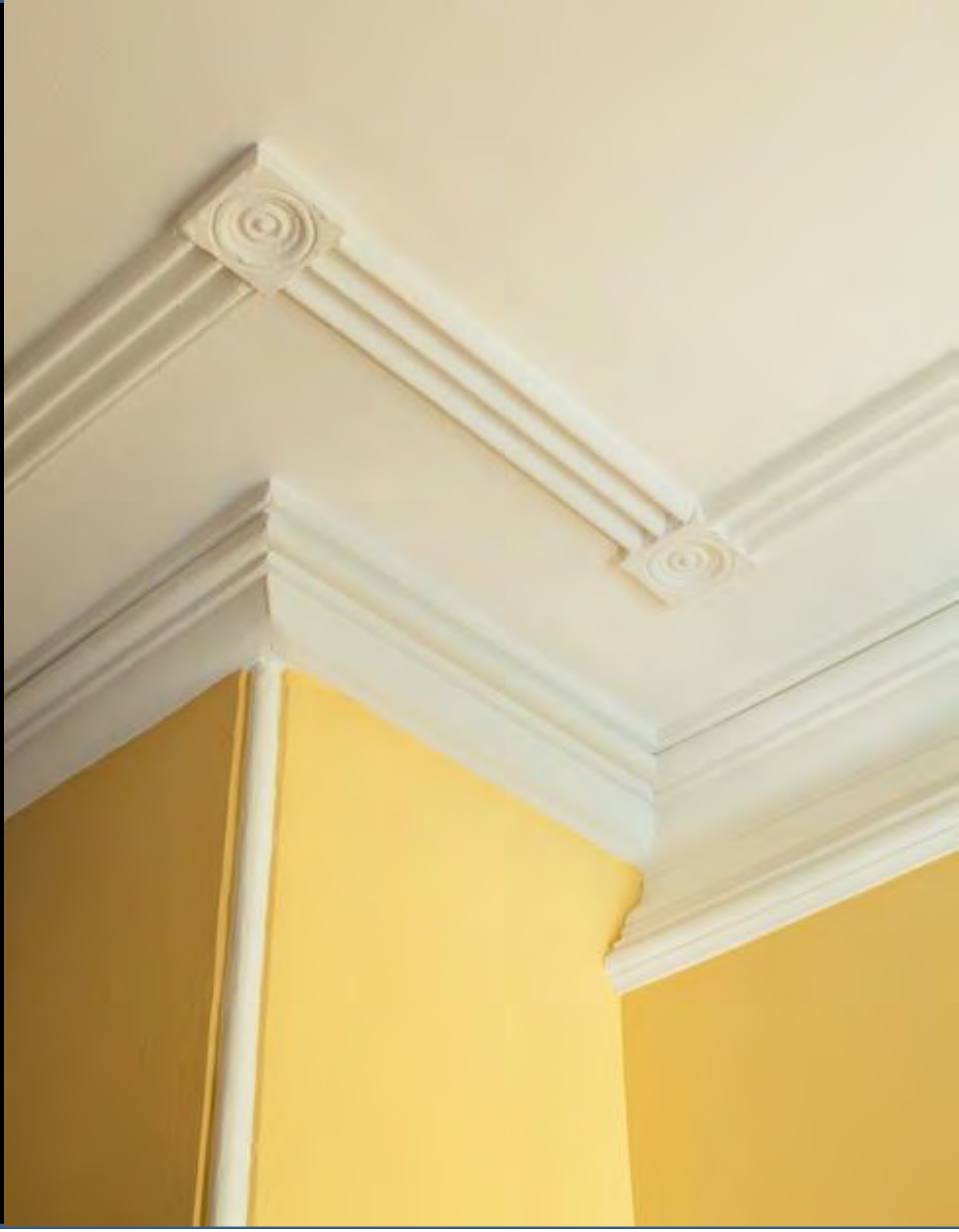
Dense pack cellulose
without a smart vapor barrier

Lapping sill ?!?

Exterior duct !?!

Society Hill- History 1963- 1999

Society Hill- 2008 and 2010



Air seal and insulate using creative details

1st Solar PV Array on Historically Certified Residence in Philadelphia

Precedent- 3 noisy neighboring air handlers


What you see from the muse

Too many systems

Based on TFA

1st year total usage = 6.29 kbtu/sf/yr

with PV generation = 3.55 kbtu/sf/yr

3rd year total usage = **5.31** kbtu/sf/yr

with PV generation = **2.57** kbtu/sf/yr

Why?

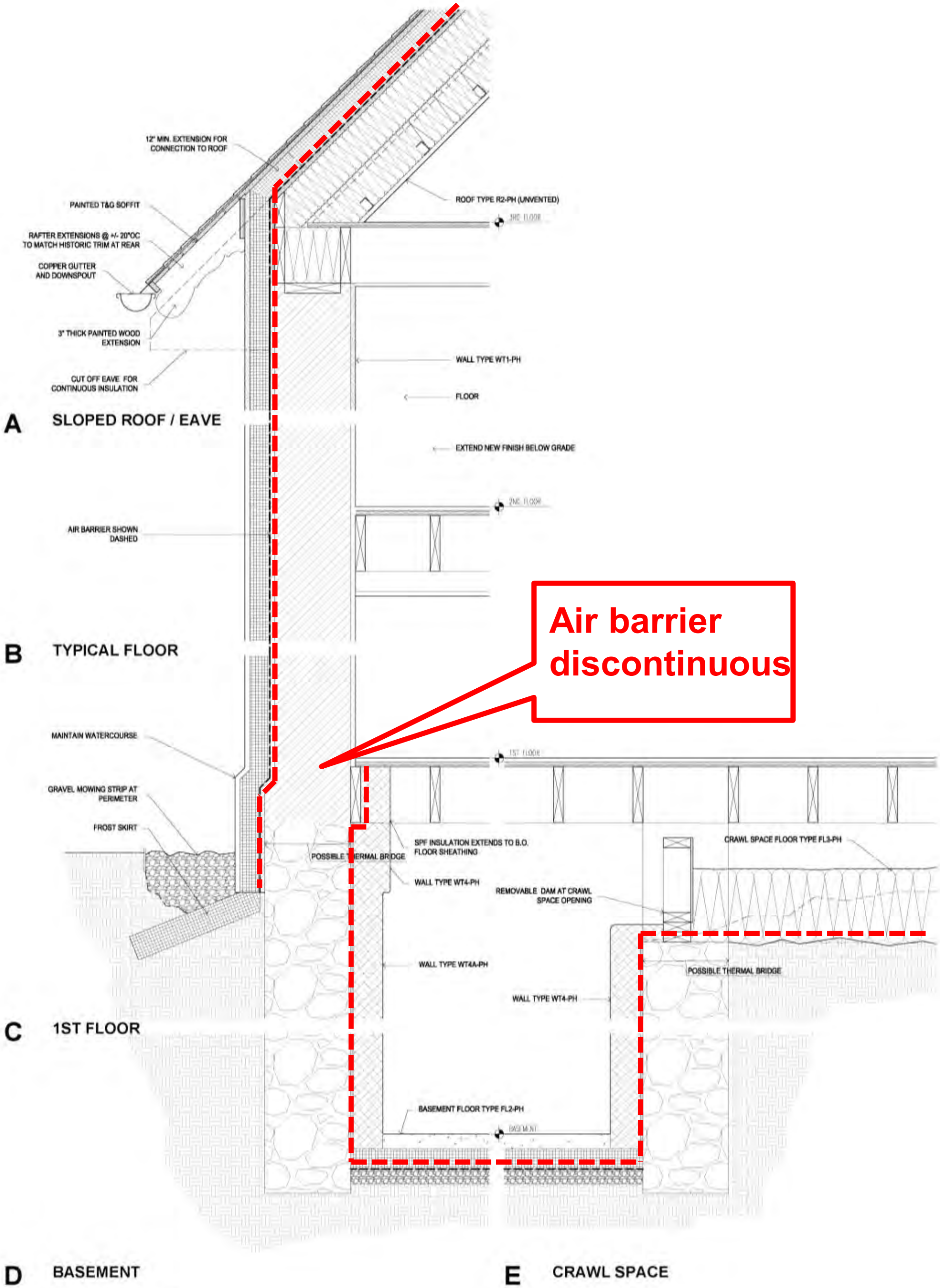
Building reaches equilibrium

Civic House Feasibility Study

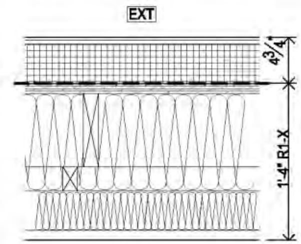
University of Pennsylvania

Existing

Passive House



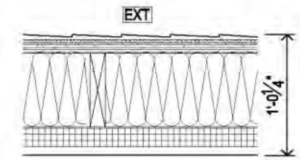
02 WALL SECTION



PROPOSED FLAT ROOF (R71)

- 1/4" MEMBRANE ROOF
- 7/16" COVER BOARD
- 4" RIGID INSULATION
- AIR BARRIER
- 16" R1-X
- (REMOVE ROOF MEMBRANE)
- (REPLACE BATT INSUL W/ CELLULOSE)

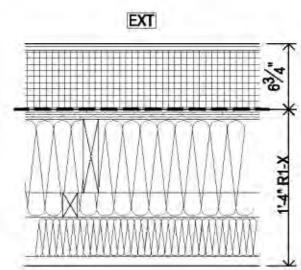
ROOF R1-W



PROPOSED SLOPED ROOF (R36)

- 1/2" ASPHALT SHINGLE
- 3/8" UNDERLAYMENT
- 1" EXISTING ROOF SHEATHING
- 7 1/2" EXIST 2 X 8 @ 16 OC ROOF JOIST
- DENSE PACK CELLULOSE
- (REMOVE FIBERGLASS INSUL)
- (REMOVE PLASTER CEILING)
- 2" RIGID INSULATION
- 5/8" GWB

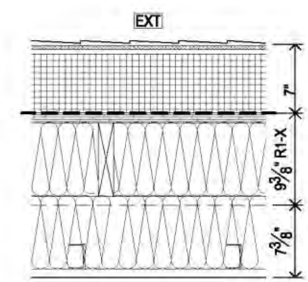
ROOF R2-W



PROPOSED FLAT ROOF (R82)

- 1/4" MEMBRANE ROOF
- 7/16" COVER BOARD
- 6" RIGID INSULATION
- AIR BARRIER
- 16" R1-X
- (REMOVE ROOF MEMBRANE)
- (REPLACE BATT INSUL W/ CELLULOSE)

ROOF R1-PH



PROPOSED SLOPED ROOF (R80)

- 1/2" ASPHALT 'COOL ROOF' SHINGLES
- 3/8" UNDERLAYMENT
- 1/2" COVER BOARD
- 6" RIGID INSULATION
- AIR BARRIER
- 9 3/8" RT R2-X
- (REMOVE ROOFING)
- (REPLACE BATT INSUL W/ CELLULOSE
- (REMOVE GWB CEILING)
- 2 1/2" 2X3 @16"OC METAL STUD
- 7 1/2" AIR SPACE
- CAVITY INSULATION
- 5/8" GWB

ROOF R2-PH

ENVELOPE

	X	W	PH
Air Tightness	20.0 ACH50	5.0 ACH50	0.6 ACH50
Windows	R1	R8	R8+
Crawlspace floor	R4	R53	R53
Basement slab	R1	R1	R20
Basement walls	R6/R4	R19/R35	R47/R21
Roof	R24/32	R36/R71	R80/R82
Walls	R6/R13/R19	R6/R13/R19	R32/R42/R52

ENERGY USAGE

	X	W	PH
Energy Usage			
kBTU/gsf/yr	**65.00**	**17.89**	**8.14**
Carbon emission			
Lb/gsf/yr	**10.00**	**8.00**	**6.00**
Utility Cost			
$/gsf/yr	**$1.00**	**$0.27**	**$0.19**
Savings $/yr		$**4,512**	**$ 5,573**
Renovation Costs			
$/gsf/yr - $/sf/yr		$**106-129**	**$144-176**

CIVIC HOUSE LESSONS LEARNED

PH STANDARD WAS MET WITHOUT SOLAR GAIN

POOR SOLAR ORIENTATION

NO FREE ENERGY = HIGHER CONSTRUCTION COSTS

SIZE AND OCCUPANCY

ASSEMBLY SPACE = ADDITIONAL EQUIPMENT

PROJECT SCOPE

ALL COSTS ARE NOT ENERGY RELATED

ACCURACY OF COST ESTIMATE

USE ESTIMATOR FAMILIAR WITH PASSIVE BUILDING METHODS AND MATERIALS

CIVIC HOUSE LESSONS LEARNED

INSTITUTIONS HAVE NEEDS AND GOALS
GOALS MAY CONFLICT WITH
ACHIEVING PASSIVE HOUSE STANDARD

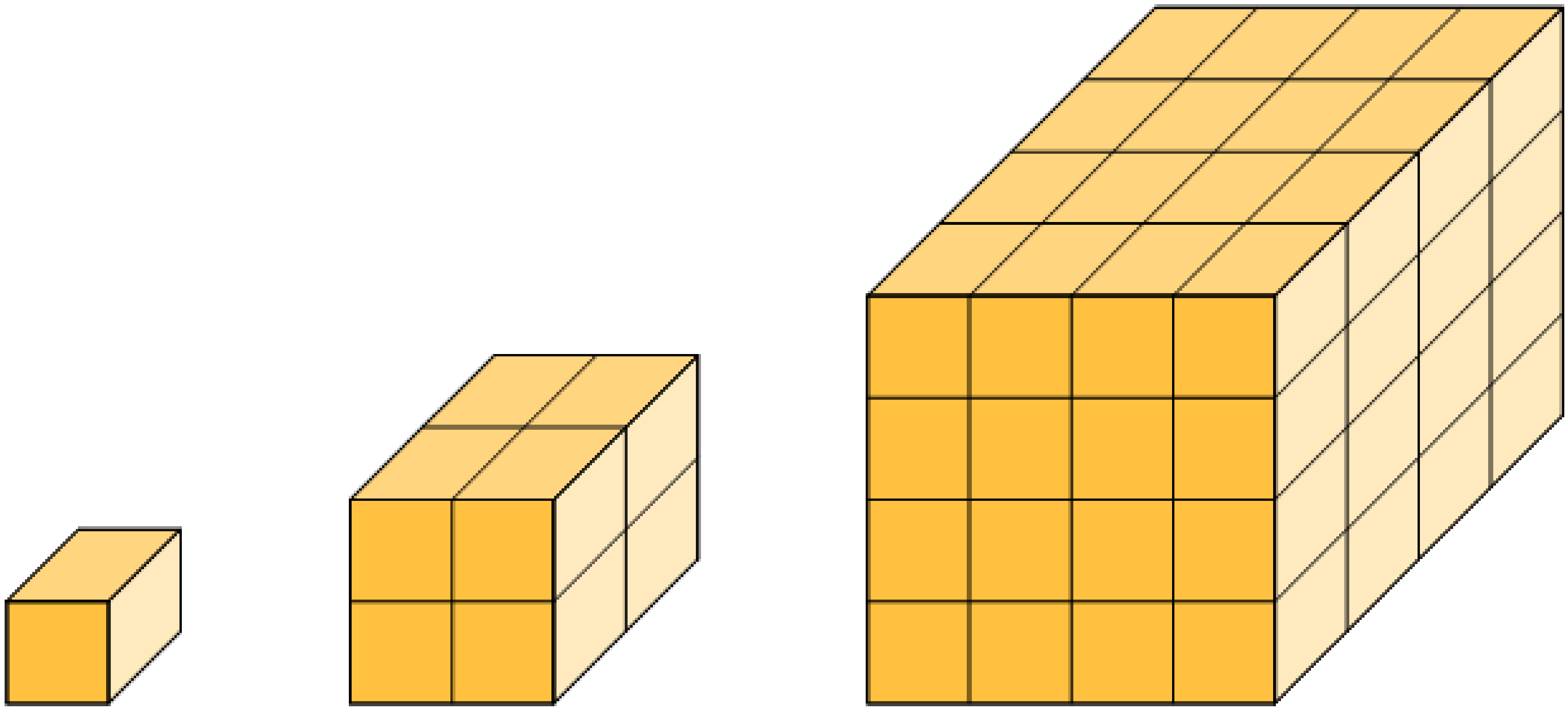
COMPARATIVELY SMALL ENERGY USE
$8000 ANNUAL ENERGY COST

CAMPUS PLANNING GOALS
BUILDING MAY BE REPLACED IN 20 YEARS

1 YEAR FINANCIAL PAYBACK
ENERGY SAVINGS IS LONG TERM BENEFIT

WHY IS PASSIVE HOUSE GOOD FOR BIGGER BUILDINGS?

SURFACE TO VOLUME RATIO



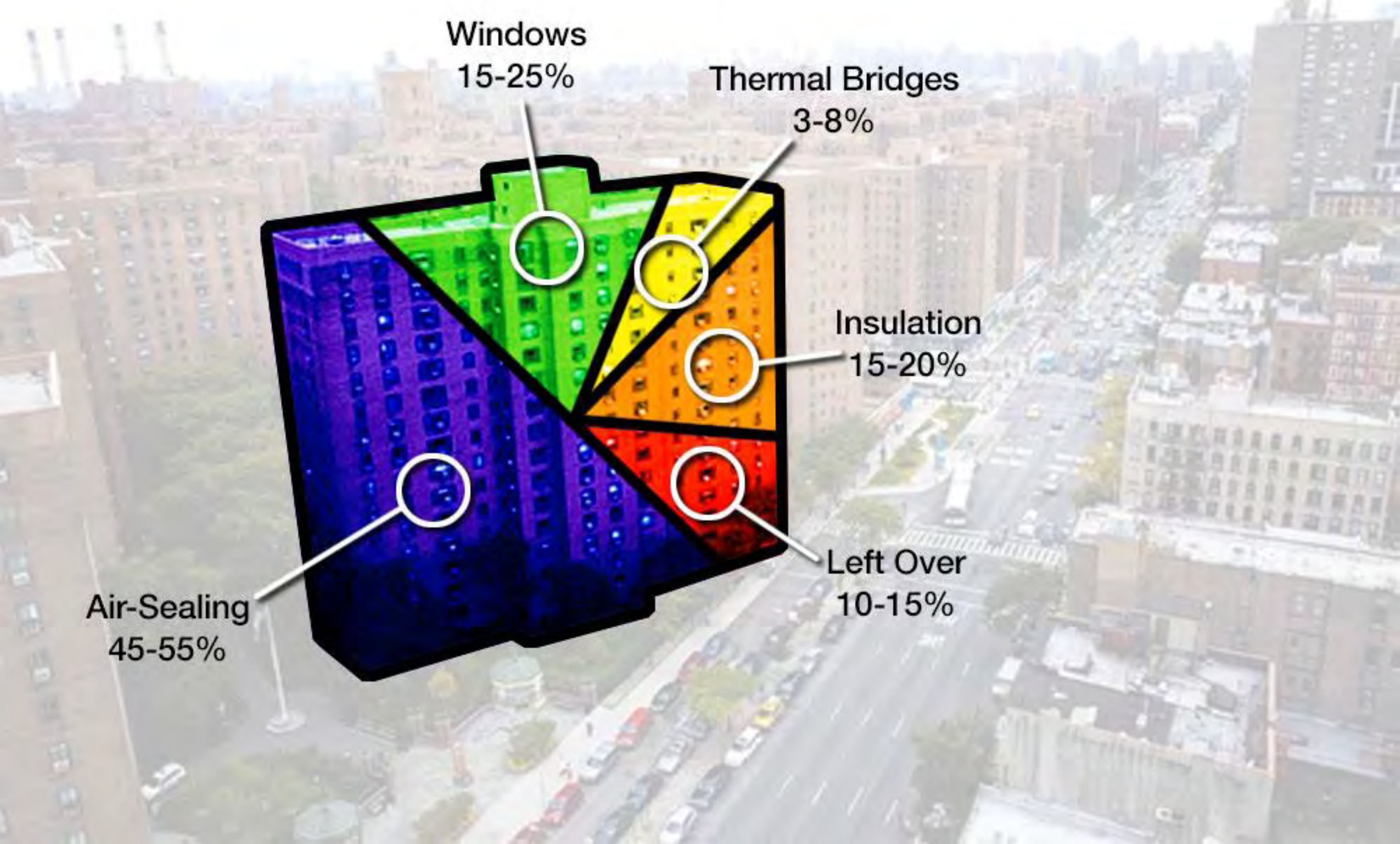
6 / 1 = 6   24 / 8 = 3   96 / 64 = 1.5

SURFACE TO VOLUME RATIO

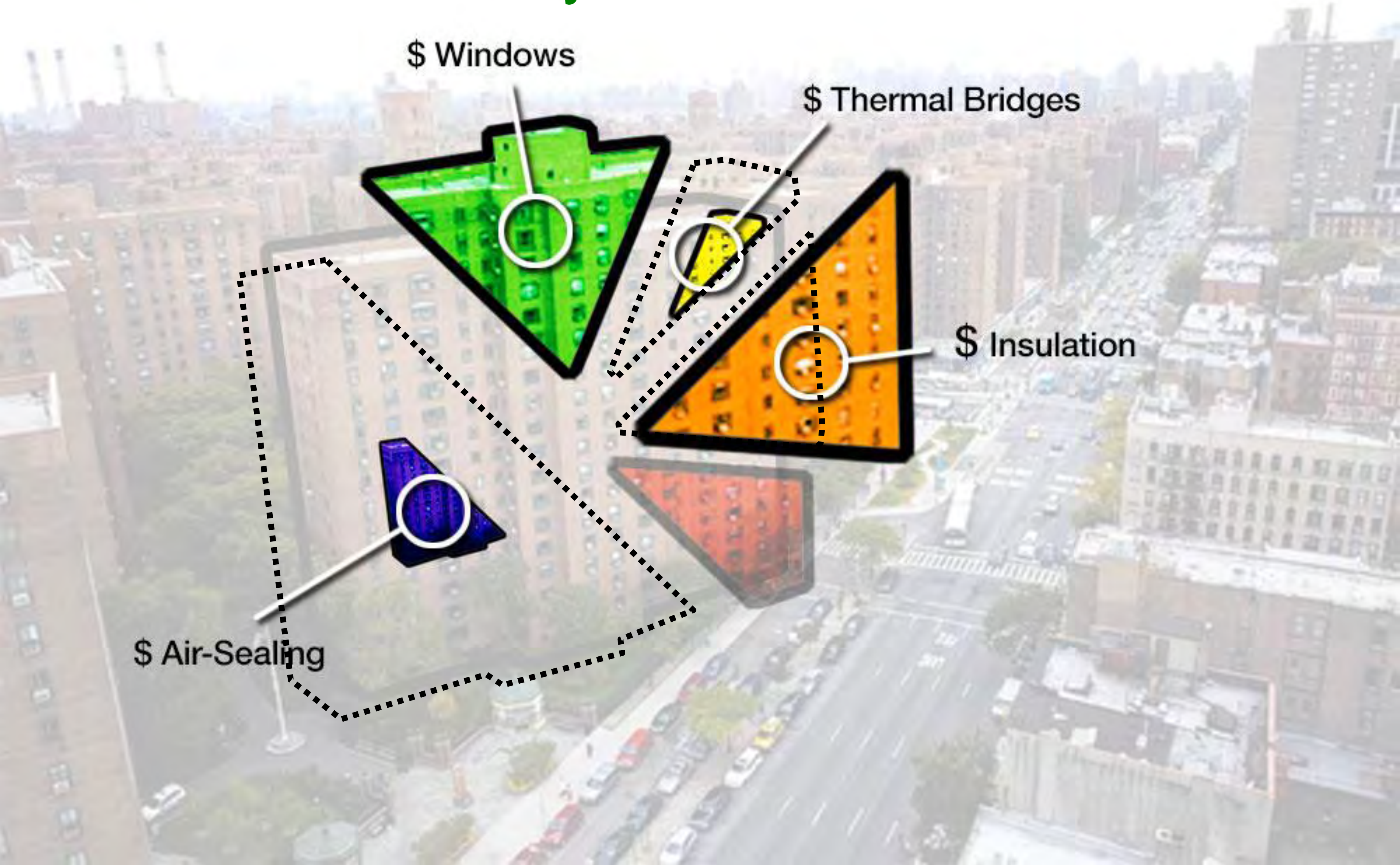
LOWER IS BETTER

A skyline of work. One at a time.

Thermal Components:
Performance breakdown towards PH goal



Thermal Components: How much do they cost?



ANOTHER PERSPECTIVE ON ENERGY USE


-90%


-90%

62Msf or 65,000 NYC apts. renovated to PASSIVE HOUSE

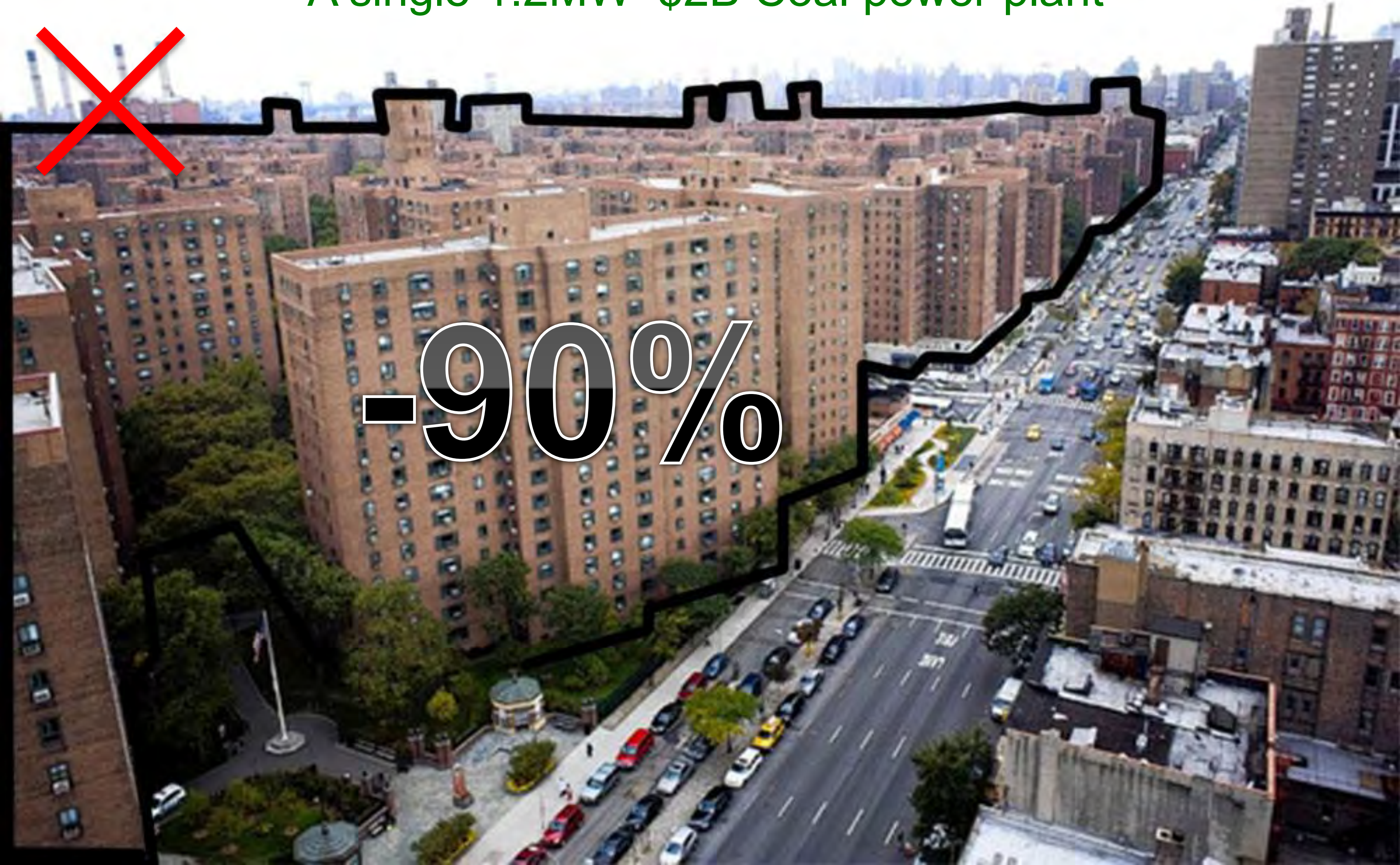
=

A single 1.2MW Coal power plant

62Msf or 65,000 NYC apts. renovated to PASSIVE HOUSE

=

A single 1.2MW $2B Coal power plant



60 % OF THE WORLD'S BUILDINGS

WILL BE REBUILT

IN THE NEXT TWO DECADES.

"That is a **huge opportunity** if we **do it right."**

– Ed Mazria, Architecture 2030

25-75 years
between renovations

WASTED $$
MISSED opportunities

RESOURCES

PHIUS Passive House Institute US
passivehouse.us

PHAUS Passive House Alliance US
phaus.org

PHI Passive House Institute (Germany)
passiv.de/en/

iPHA International Passive House Association
passivehouse-international.org

NAPHN North American Passive House Network
northamericanpassivehousenetwork.com

RESOURCES

ZERO ENERGY READY HOMES
energy.gov/eere/buildings/zero-energy-ready-home

LEED Building rating system
new.usgbc.org/leed

2000 WATT SOCIETY Global energy effects
novatlantis.ch/en/2000-watt-society

THE CLIMATE TRUST Climate solutions for government, utilities and large businesses
climatetrust.org

RESOURCES

WORLD CLASS SUPPLY High performance building supply, worldclasssupply.com

FOURSEVENFIVE High performance building supply, foursevenfive.com

FENTREND High performance window consultants fentrend.com

STRUCTURESdb Design-build structuresdb.com

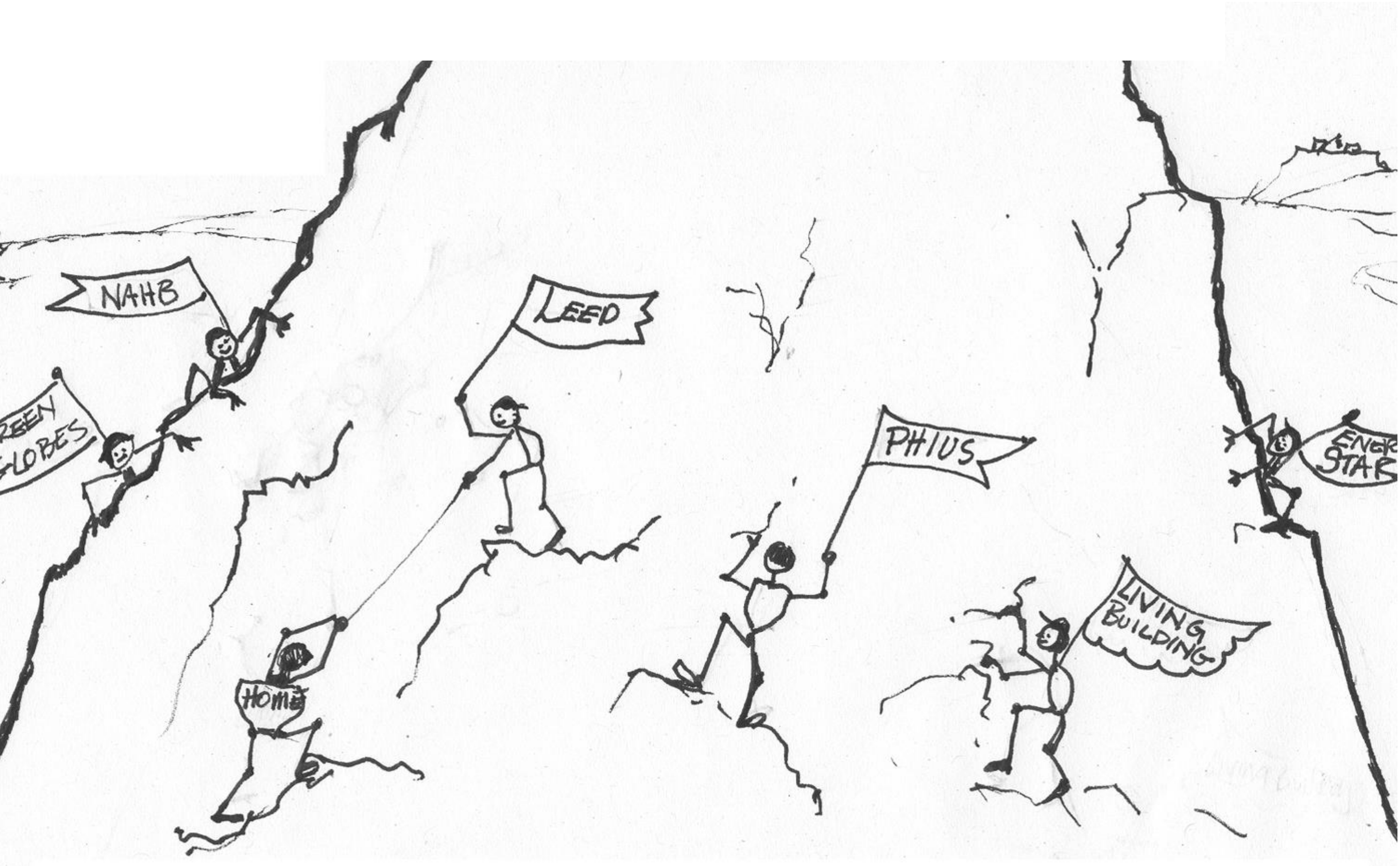
RESOURCES

blupath.us

BLUPATH

INSPIRING DESIGN
FOR PLACES TO THRIVE

PATHS UP THE MOUNTAIN



BIG PICTURE
(P.S. IT'S AN EMERGENCY!)