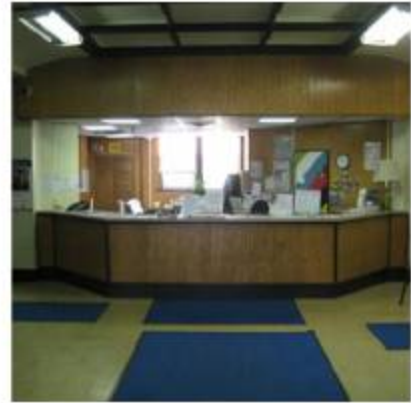


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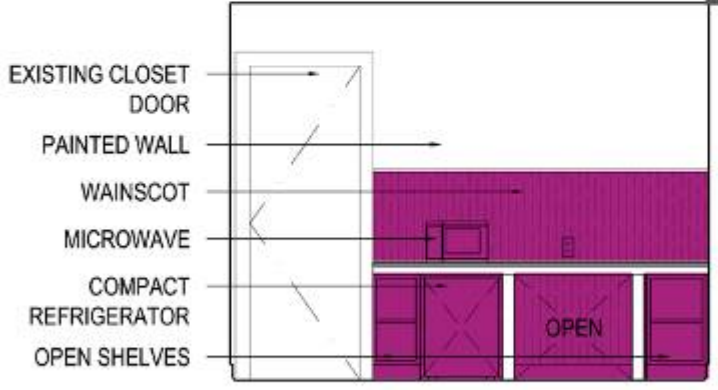




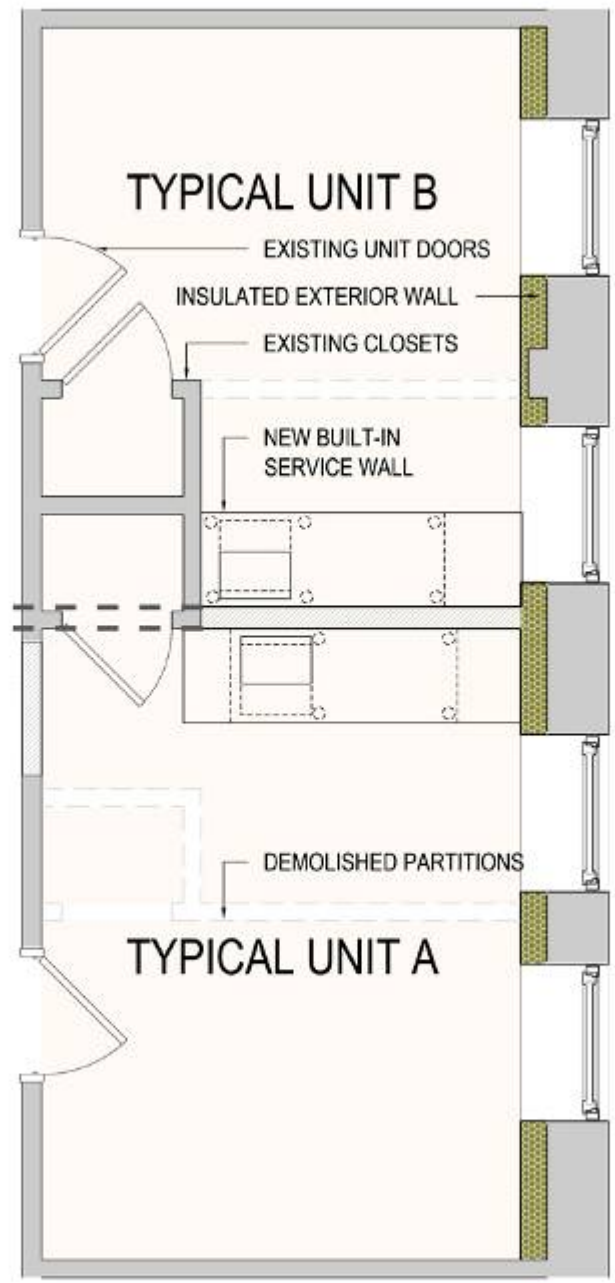




BUILT-IN 'B'



BUILT-IN 'A'

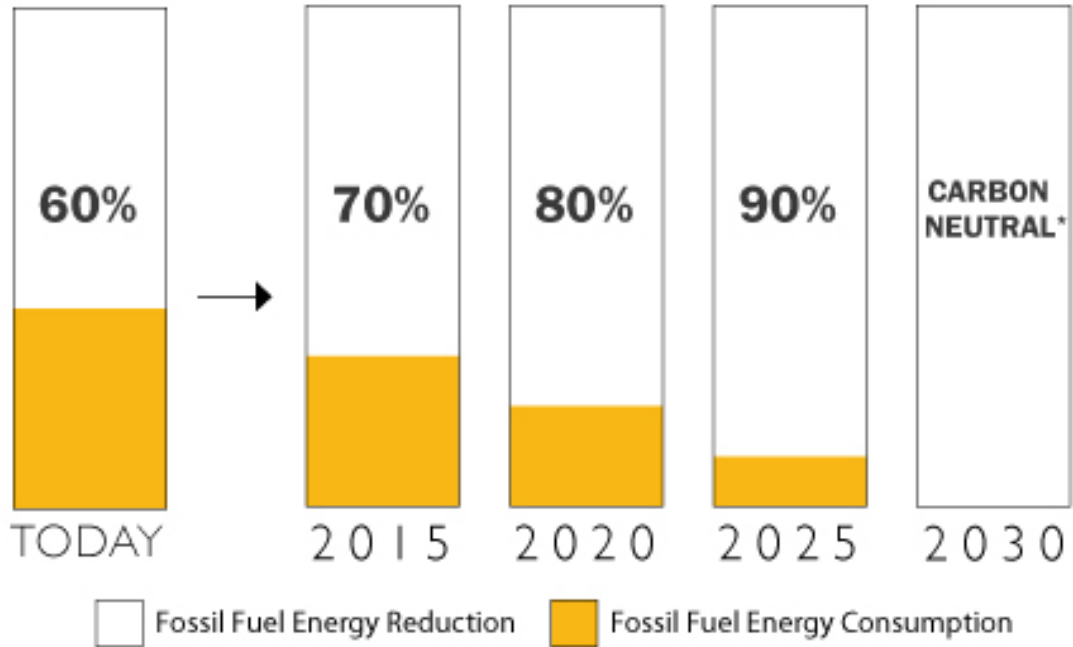


# **PASSIVE HOUSE MEP SYSTEMS**

## ***MCKEESPORT YMCA***

- MULTIPLE GEOTHERMAL HEAT PUMPS
- ULTIMATE AIR ENERGY RECOVERY UNITS
- PRE-CONDITIONING LOOP VIA COMPRESSOR-LESS GEOTHERMAL WELLS
- MINIMAL DUCTWORK
- HIGH EFFICIENCY LIGHTING FIXTURES

# **WRESTLING WITH RETROFITS**



### The 2030 Challenge

Source: ©2010 2030, Inc. / Architecture 2030. All Rights Reserved.  
\*Using no fossil fuel GHG-emitting energy to operate.



# NEED FOR UNDERSTANDING HOW TO MAKE RETROFITS ENERGY EFFICIENT

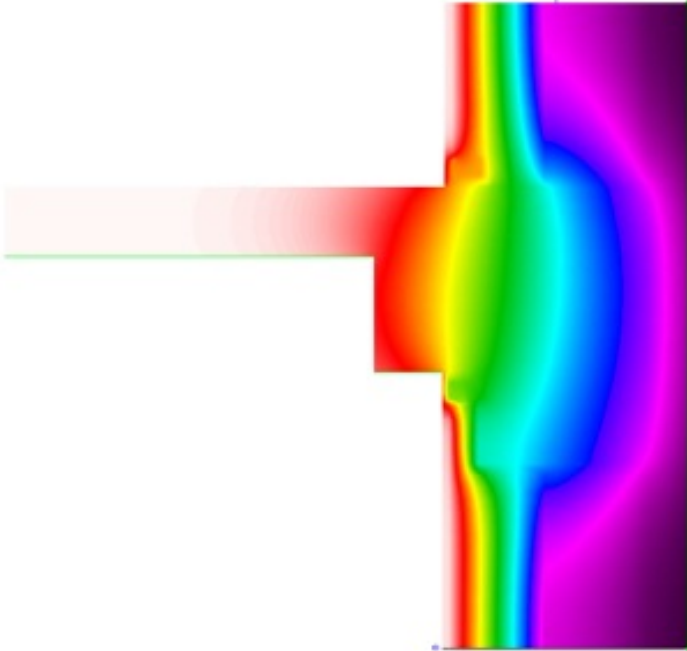


**OUTSULATION VERSUS INSULATION  
CULTURAL ATTACHMENT TO EXTERIORS**





## EXISTING WINDOW OPENINGS



U-Factors

	U-factor Btu/h <sup>2</sup> ·ft <sup>2</sup> ·F	delta T F	Length inches	Rotation	
Lvl - Interior	0.0544	54.0	132	N/A	Total Length
SHGC Exterior	0.1283	54.0	96	N/A	Total Length

% Error Energy Norm: 8.09%

Export  
OK



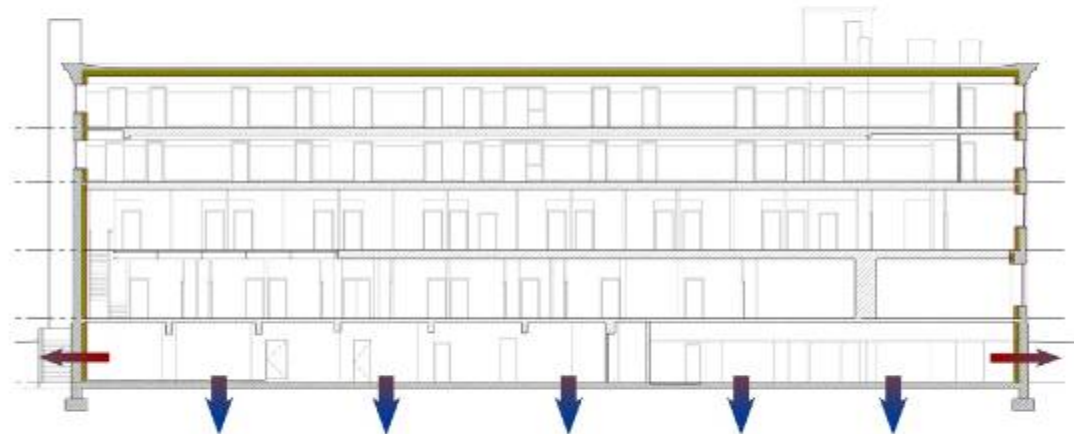
## THERMAL BRIDGING AT FLOOR SLAB

HEAT LOSS THROUGH THE SLAB

30%



BASEMENT OUTSIDE THERMAL ENVELOPE



BASEMENT INSIDE THERMAL ENVELOPE

## UNINSULATED SLAB AT BASEMENT





**UNVENTED INSULATED ROOF**

# **DESIGN PROCESS ISSUES**



**LEAVING STAIRS INSIDE OR OUT OF THE THERMAL BOUNDARY**



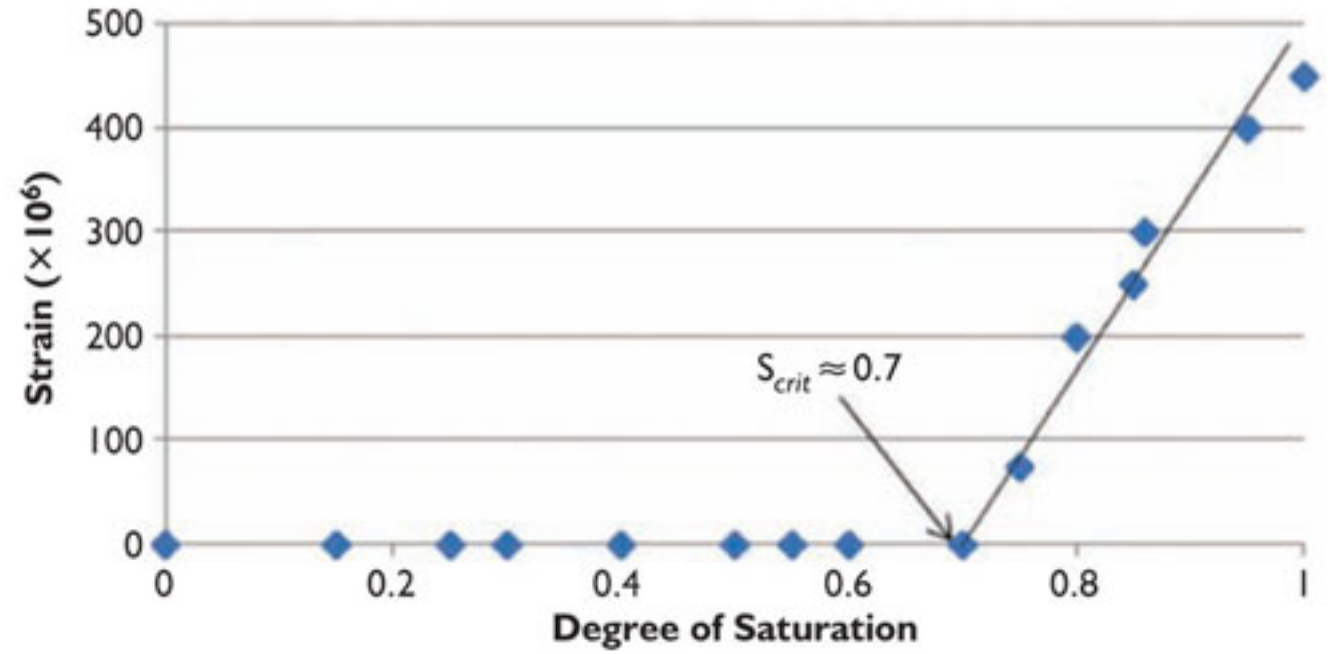


## RETROFIT VERSUS NEW CONSTRUCTION CRITERIA



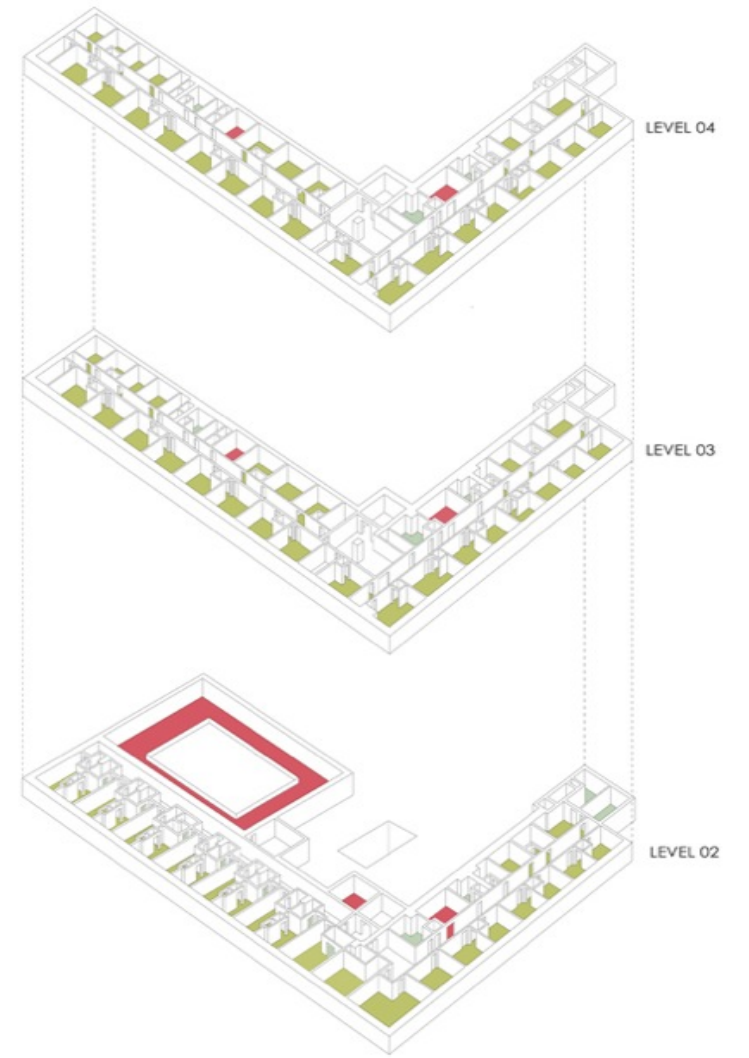


## EARLY SELECTIVE DEMOLITION



IMAGES FROM BUILDING SCIENCE CORPORATION

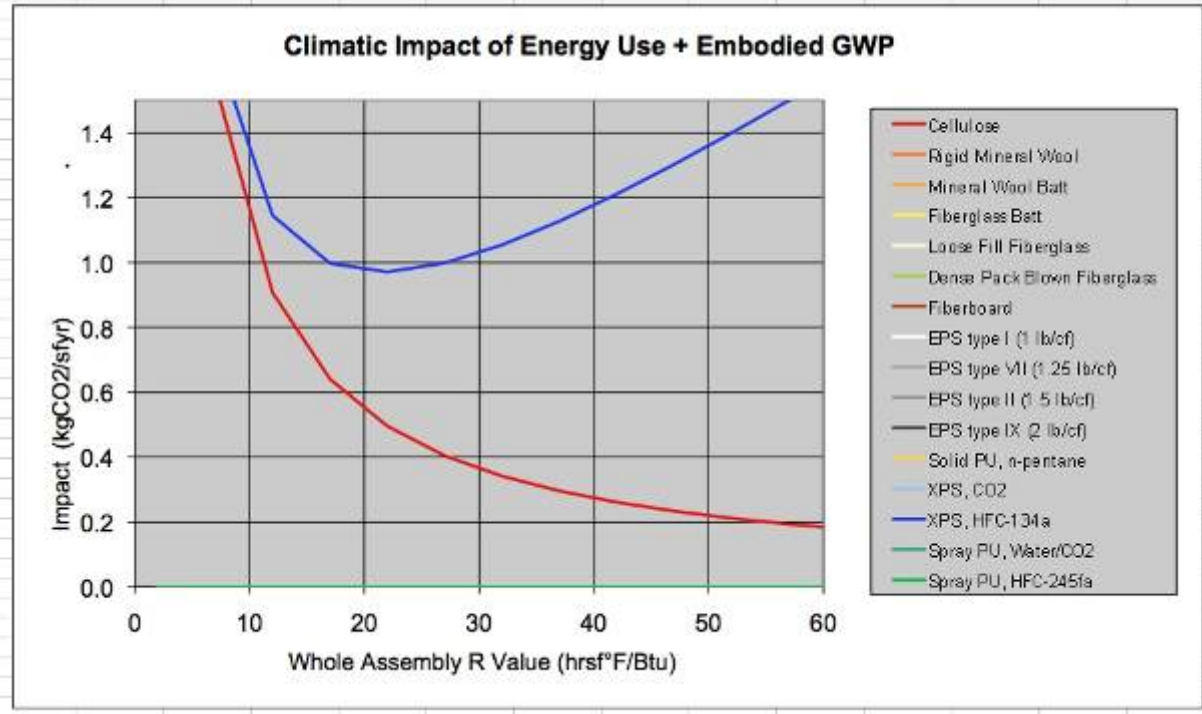
## BRICK TESTING



**COMPLEX BUILDING SHAPE**

# **THERM MODELING**





## SPRAY FOAM INSULATION

# **THE COST OF PASSIVE HOUSE**

- NO CENTRAL BOILER
- NO CHILLER
- NO SEPARATE THERMOSTATS
- SMALLER LOCALIZED SYSTEMS
- LESS PIPING BACK TO CENTRAL SYSTEMS
- SMALLER GEOTHERMAL WELLFIELD (1/3 THE SIZE)
- LESS AND SMALLER EQUIPMENT

**WHY THIS PROJECT IS COST NEUTRAL**

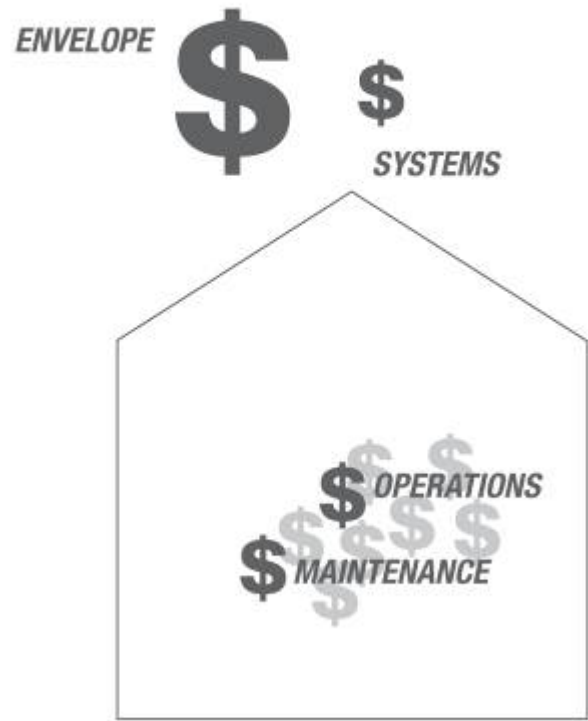
PREDICTED UTILITY EXPENSES CURRENT MODEL

**66%**  
**LESS**

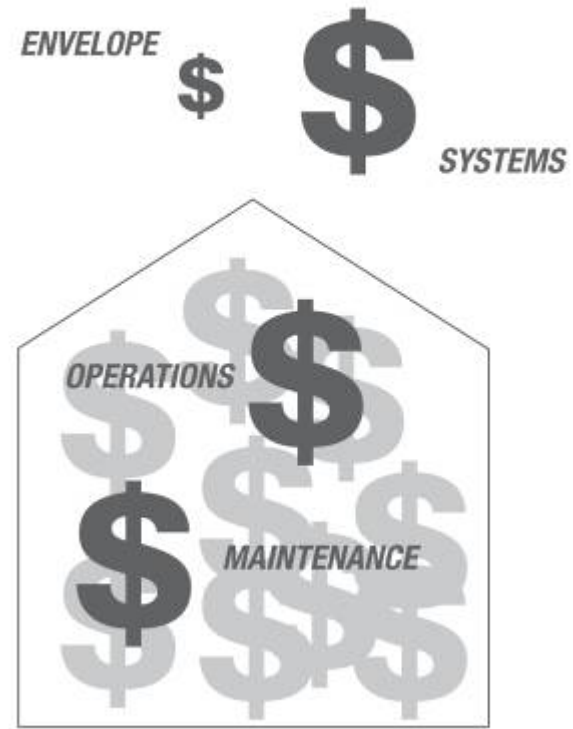


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## WHERE THE MONEY IS GOING



*PASSIVE HOUSE*



*CONVENTIONAL BUILDING*

# **ISSUES IN CONSTRUCTION**

# AIRTIGHT BUILDING



NO DRILLING  
AIRTIGHT  
CONSTRUCTION



NO CUTTING  
AIRTIGHT  
MEMBRANES



REPORT ALL PENETRATIONS TO SUPERVISOR

## AIRTIGHT BUILDING PROJECT

This is an airtight building  
DO NOT PENETRATE, CUT or DRILL in  
the exterior envelope and airtight layer



without prior permission of the Superintendent



## QUALITY CONTROL FOR AIR-TIGHTNESS



## WINDOW PROCUREMENT





## PHASED AND OCCUPIED CONSTRUCTION

**SHRINKING SPRAY FOAM**

**LESSONS LEARNED**

- What should architect's charge for Passive House (retrofits take more time than new construction)
- We need more time – how does the schedule adjust? (this is especially true for LIHTC projects)
- Making sure that brick testing and Therm modelling come first
- Should Passive House Standards be different for historic retrofits versus non-historic retrofits (where out-sulation is not an option)
- How can we test for air-tightness in partially occupied buildings

## **QUESTIONS FOR THE PASSIVE HOUSE COMMUNITY**







**PASSIVE HOUSE RETROFITS.....NOT FOR SISSIES**

LAURA NETTLETON + MICHAEL WHARTNABY

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sustainable architecture and design

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