Deep Energy Retrofits – Details, Questions, Issues

- How do we decide whether to insulate to inside or the outside?
- What's the best approach for historic buildings?
- Where should the thermal enclosure be with respect to the basement?
- Location of water control with exterior insulation
- Can't we just…?
- Continuity of control at porch, deck, roof, structure
- Chainsaw roof: why, why not, how?
- How to attach a roof overhang over continuous insulation

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Deep Energy Retrofits – Details, Questions, Issues

- How to install windows in a DER wall
  (let me count the ways…)
- How to deal with basement walls
- Where the wood meets the stone: when are we worried about the sill rotting in DER?
- Top-side basement slab retrofit options
- Strategies to get airflow control in retrofit
- Exterior insulation strategies for masonry walls

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Where to add insulation, inside or outside?

- Water control
- Vapor control and drying
- Room for growth

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Where to add insulation, inside or outside?

Existing replacement windows installed without flashing

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Where to add insulation, inside or outside?


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Where to add insulation, inside or outside?


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Where to add insulation, inside or outside?


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Where to add insulation, inside or outside?

- Drainage remediation


Siding removed to remediate flashing


Head flashing at new window


Drainage plane remediation at base of wall

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Where to add insulation, inside or outside?

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Where to add insulation, inside or outside?

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Where to add insulation, inside or outside?

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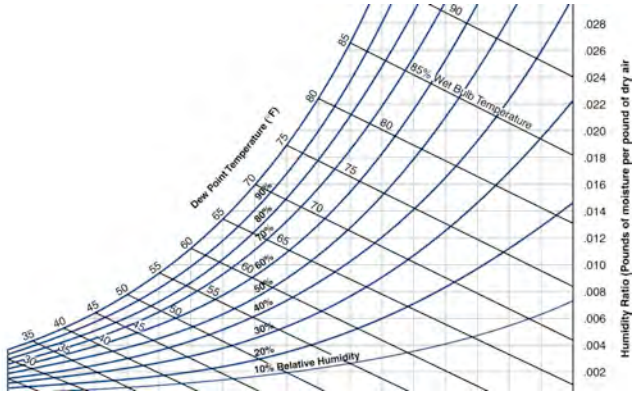
Where to add insulation, inside or outside?



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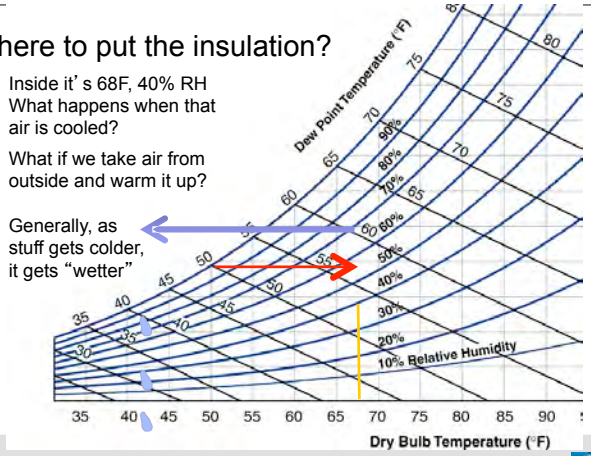
Deep Energy Retrofits – Details, Questions, Issues

- Where to put the insulation?

Inside it's 68F, 40% RH
What happens when that air is cooled?

What if we take air from outside and warm it up?

Generally, as stuff gets colder, it gets "wetter"



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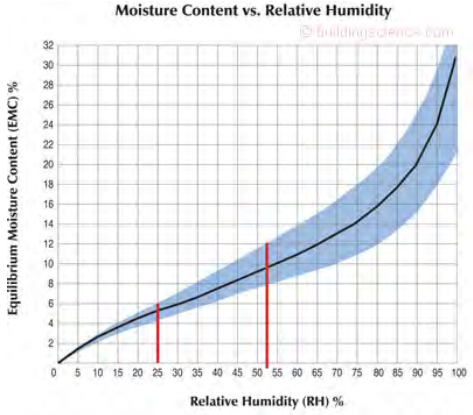
Deep Energy Retrofit



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Where to add insulation, inside or outside?

- Roof overhang and roof insulation

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Where to add insulation, inside or outside?

- Roof overhang and roof insulation

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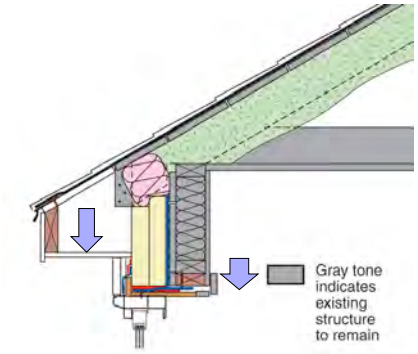
Where to add insulation, inside or outside?

- Roof overhang and roof insulation



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Where to add insulation, inside or outside?

- Water control
- Vapor control and drying
- Room for growth

- Interior space
- Disruption to occupants

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What's the best approach for historic buildings?

- Durability
  - Water control
  - Drying potential
  - Sacrificial cladding
- What will make the building viable?
  - Comfort
  - Maintenance costs
  - Operating costs
  - Short term capital

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What's the best approach for historic buildings?

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What's the best approach for historic buildings?

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What's the best approach for historic buildings?

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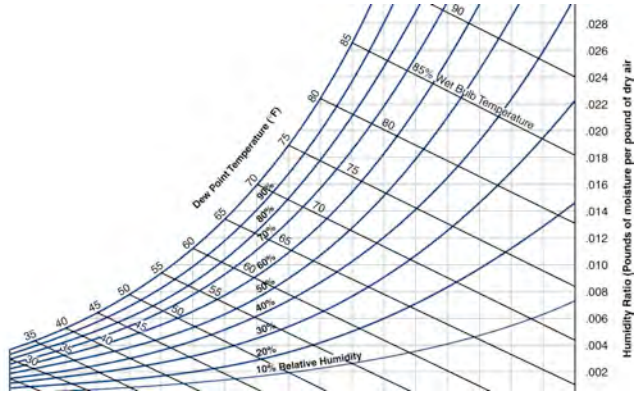
What's the best approach for historic buildings?



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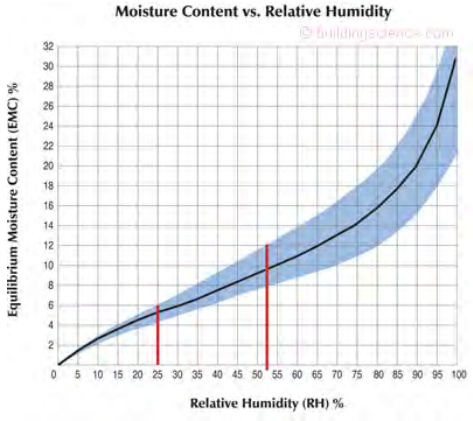
What's the best approach for historic buildings?



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What's the best approach for historic buildings?

What's the best approach for historic buildings?

- Durability
  - Water control
  - Drying potential
  - Sacrificial cladding
- What will make the building viable?
  - Comfort
  - Maintenance costs
  - Operating costs
  - Short term capital

Should the basement be in or out?

- What is a basement?
  - Damp
  - Stinky
  - Cold
  - Funky
  - Wet
  - Made of rocks
  - Expensive to build
  - Useful space
- Potential amenity
- Space for mechanical systems
- Made of rocks

Should the basement be in or out?

Do we have a choice?

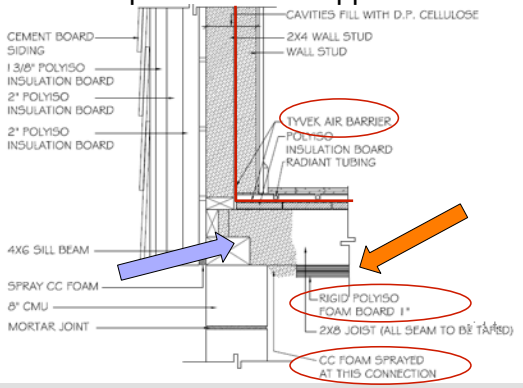
What is in the basement?

Deep Energy Retrofits – Details, Questions, Issues

- 4.6 ACH50; 2129 CFM 50 total; 1100 CFM 50 through floor over basement
- 7.3 ACH50; 3590 CFM 50 total; 1740 CFM 50 through floor over basement

Deep Energy Retrofits – Details, Questions, Issues

- Basement Separation: Bold Approach



Deep Energy Retrofits – Details, Questions, Issues

- Extraordinary approach to basement separation:
  - ~400 cfm50 across basement ceiling (of ~1,900 total)
  - More than leakage between apartments (~200 cfm50 inter-unit leakage)
  - ~20% of total enclosure leakage area for combined living area
  - ~30% of total enclosure leakage for lower apartment
  - ~15% of total enclosure leakage for upper apartment

Should the basement be in or out?

- The basement is connected to the living space.
- Important things may be in the basement
- (psst! It's not about the energy!)

Location of water control with exterior insulation

- Where is the water control?
- Major impact on sequence

Location of water control with exterior insulation

Location of water control with exterior insulation

Drainage plane is not where it used to be

Location of water control with exterior insulation

Exterior insulation drainage planes sequencing:

Location of water control with exterior insulation

- Roof-Wall flashing sequence

Location of water control with exterior insulation

As always, avoid concentrating water on the building.

Location of water control with exterior insulation

- Can be in front of or behind the insulation
- All flashing details must respect location of water control layer
- Sequence matters

Can't we just… Short cuts to a world of hurt

If it can't be done right, should it be done?

- Does it pose a risk to health and safety?
- Does it pose a risk to the building?
- Is it easily reversible if/when resources are available to go further?

Can't we just… Short cuts to a world of hurt

Are you sure you want to do that?

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Can't we just… Short cuts to a world of hurt

Are you sure you want to do that?

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Can't we just… Short cuts to a world of hurt

Are you sure you want to do that?

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Can't we just… Short cuts to a world of hurt

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Can't we just… Short cuts to a world of hurt


Can't we just… Short cuts to a world of hurt

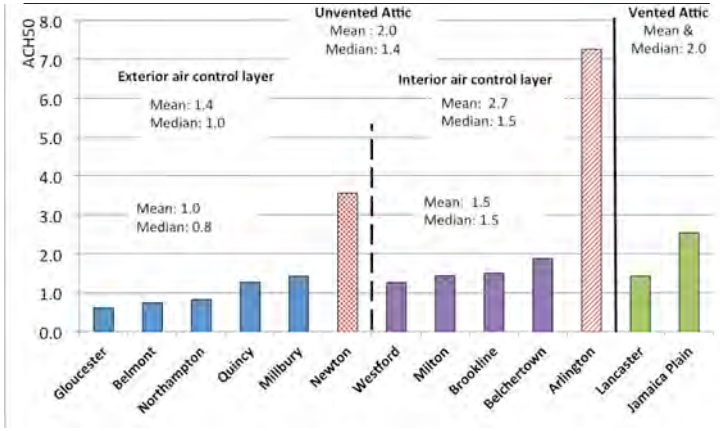
If it can't be done right, should it be done?

- Does it pose a risk to health and safety?
- Does it pose a risk to the building?
- Is it easily reversible if/when resources are available?

Continuity of control at porch roof and deck

- Does the gravity load need to be transferred to the house?
- Where is the water control layer?

Continuity of control at porch roof and deck



Continuity of control at porch roof and deck

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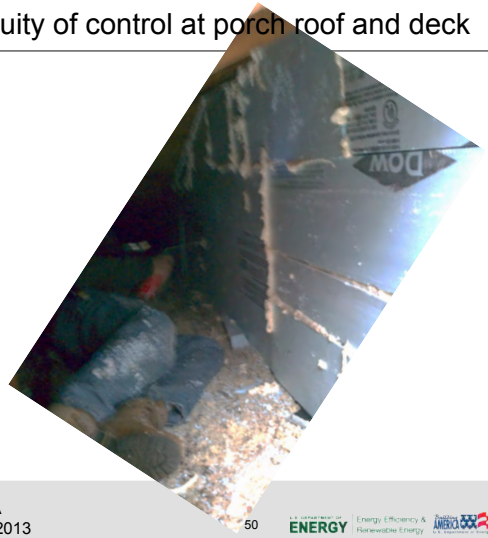
Continuity of control at porch roof and deck



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Continuity of control at porch roof and deck

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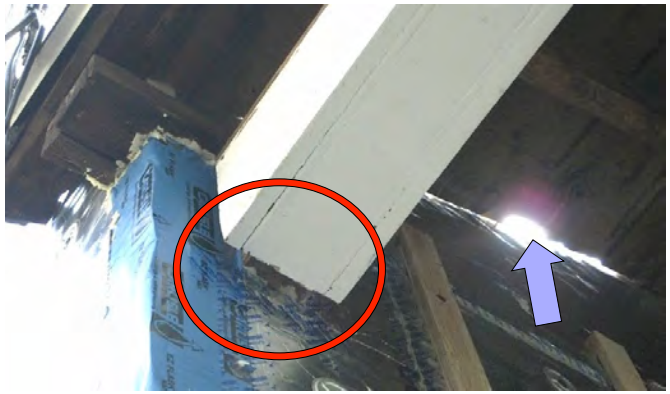
Deep Energy Retrofit Measures Verification



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Continuity of control at porch roof and deck

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Continuity of control at porch roof and deck

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Continuity of control at porch roof and deck

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Continuity of control at porch roof and deck

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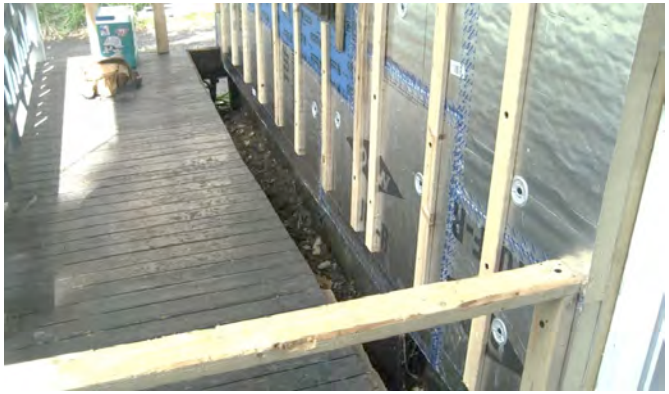
Continuity of control at porch roof and deck



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Continuity of control at porch roof and deck

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Continuity of control at porch roof and deck

- Built up siding detail over foam

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Continuity of control at porch roof and deck

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Continuity of control at porch roof and deck

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Continuity of control at porch roof and deck

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Continuity of control at porch roof and deck

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Continuity of control at porch roof and deck

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Continuity of control at porch roof and deck

- Continuity appears to matter for air tightness
- Does the gravity load need to be transferred to the house?
- Where is the water control layer?

Chainsaw roof: why, why not, how?

- Continuity of air and thermal control
- Sometimes not accommodated by structure

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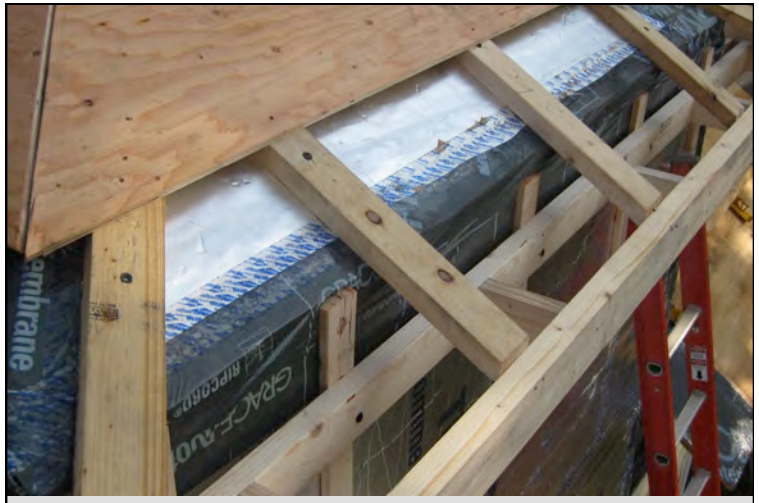

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Deep Energy Retrofits – Details, Questions, Issues

- Window/door flashing

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Deep Energy Retrofits – Details, Questions, Issues

- Window flashing

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Deep Energy Retrofits – Details, Questions, Issues

Flashing challenges

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Deep Energy Retrofits – Details, Questions, Issues

Window flashing challenges

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Window flashing challenges

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Flashing challenges

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Flashing challenges

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Deep Energy Retrofits – Details, Questions, Issues

Mock-up makes perfect

- Window flashing mock up

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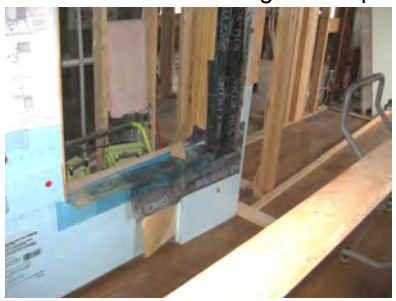
Deep Energy Retrofits – Details, Questions, Issues

Mock-up makes perfect

- Window flashing mock up



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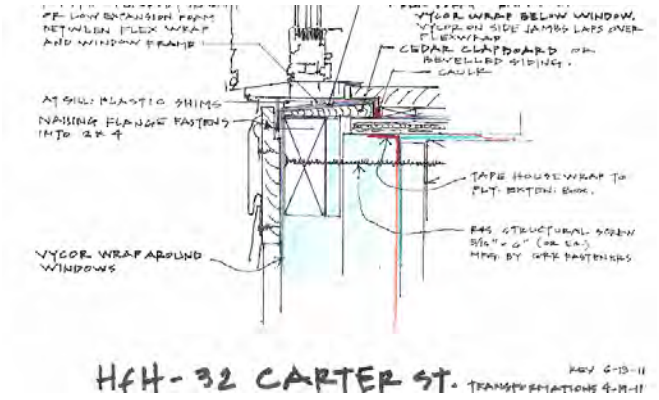
Deep Energy Retrofits – Details, Questions, Issues



Deep Energy Retrofits – Details, Questions, Issues

Window aligned with drainage plane

Deep Energy Retrofits – Details, Questions, Issues

Window installed with minimal disruption to interior

Deep Energy Retrofits – Details, Questions, Issues

Window flashing saved

Deep Energy Retrofits – Details, Questions, Issues

- Window/door flashing

Foundation Walls

- Gravity wins
- Water + Gravity wins
- Provide drainage

- Flat or bumpy?
- Finished or unfinished?

When are we worried about rotting the sill?

Risk factors:

- Foundation constructed of capillary (wicking) materials
- Liquid water in contact with foundation wall
- Water vapor condensing in or on the foundation wall
- Limited drying of the foundation wall

When are we worried about rotting the sill?

When are we worried about rotting the sill?

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When are we worried about rotting the sill?

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When are we worried about rotting the sill?

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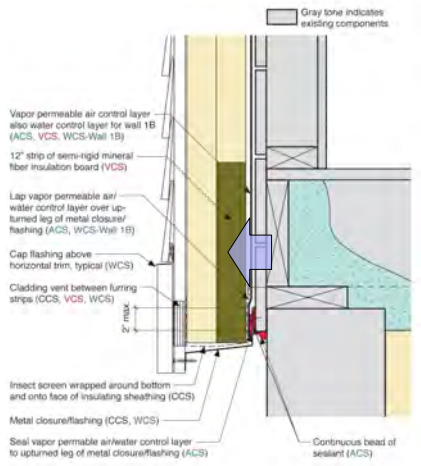

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Top-side basement slab retrofit

- What's the water load/risk?
- What's in the basement?
- What's the head height?

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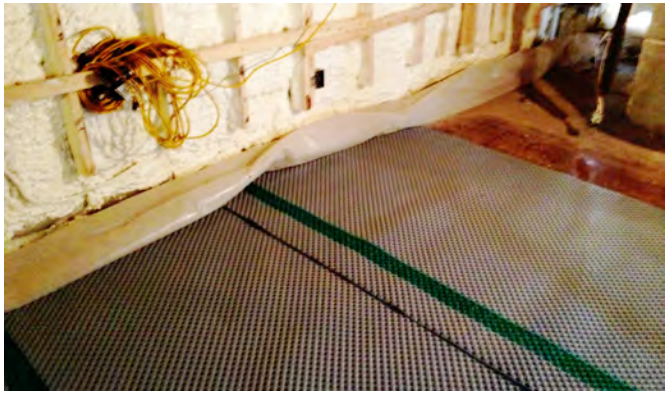
Top-side basement slab retrofit



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Top-side basement slab retrofit

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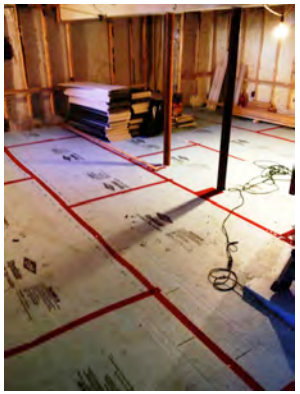
Top-side basement slab retrofit



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Exterior insulation of masonry

- Insulated Metal Panel

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Exterior insulation and over-clad of masonry

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Exterior insulation and over-clad of masonry

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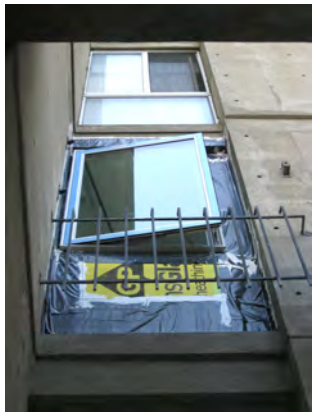
Exterior insulation and over-clad of masonry



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Exterior insulation and over-clad of masonry

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Exterior insulation and over-clad of masonry

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Exterior insulation and over-clad of masonry

Photo credit: Elton + Hampton Architects

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Exterior insulation and over-clad of masonry

- Weatherization program implementation

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Exterior insulation and over-clad of masonry

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Exterior insulation and over-clad of masonry

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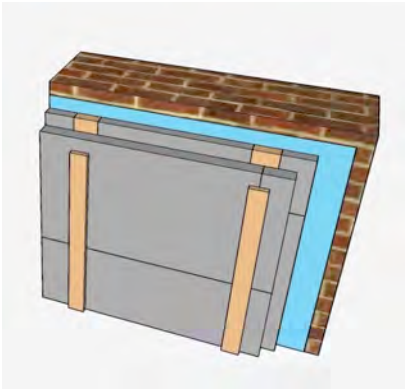
Exterior insulation and over-clad of masonry



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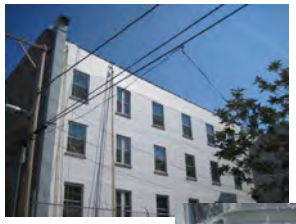
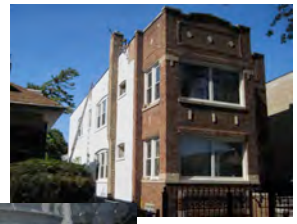
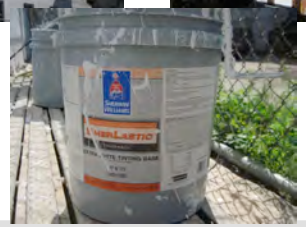
Exterior insulation and over-clad of masonry







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Exterior insulation and over-clad of masonry

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Exterior insulation and over-clad of masonry

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Exterior insulation and over-clad of masonry

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Exterior insulation and over-clad of masonry

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Exterior insulation and over-clad of masonry

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Exterior insulation and over-clad of masonry

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Deep Energy Retrofits – Details, Questions, Issues

- What if we can only do part of it now?

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DER Project Plans – Staged DER

- Staged DER = Long range planning
  - We do what we can now
  - Anticipate where we want to go in the future

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Staged DER

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DER Project Plans – Staged DER

- Staged DER = Long range planning
  - High performance retrofit measures
    - Connect to existing components
      Transfer control functions to existing components
    - Anticipate connection to future components
      Transfer control functions to new components
    - Make the next guys job easier

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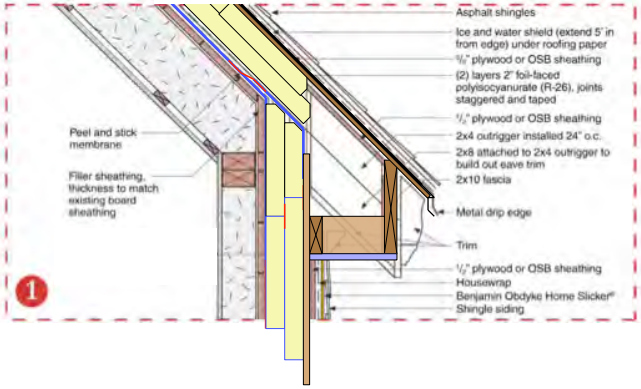
Staged DER – Roof First



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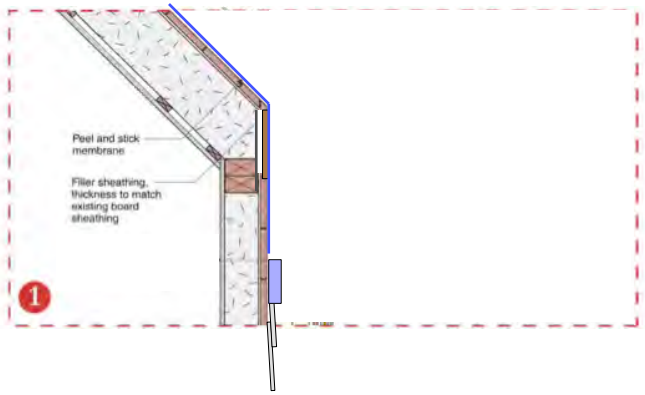
Staged DER – Roof First



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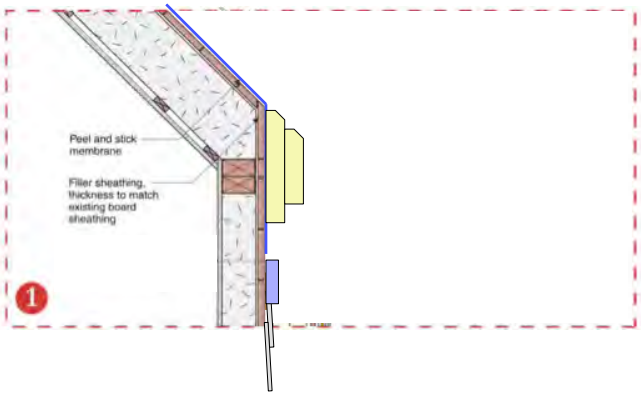
Staged DER – Roof First



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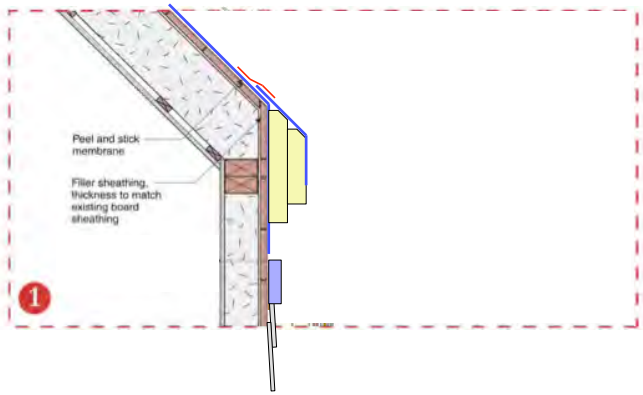
Staged DER – Roof First



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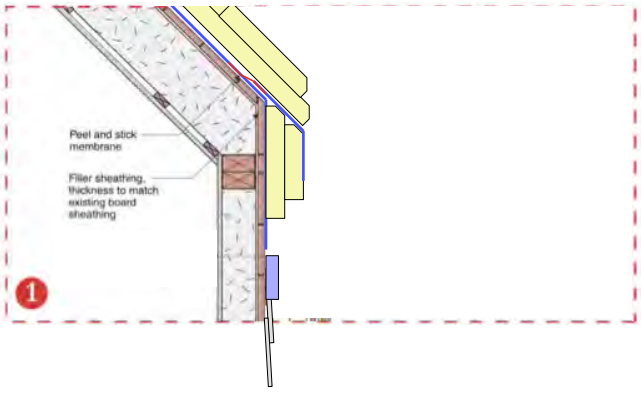
Staged DER – Roof First



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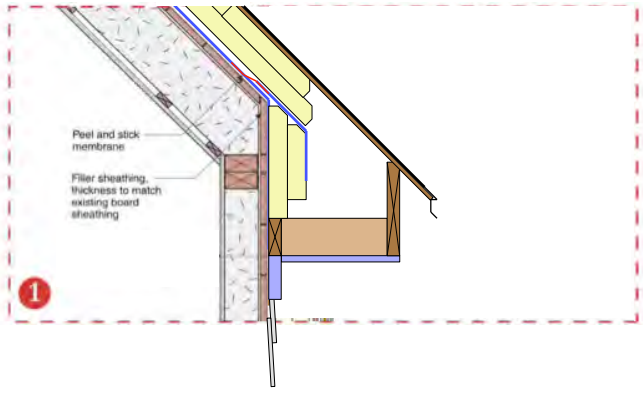
Staged DER – Roof First



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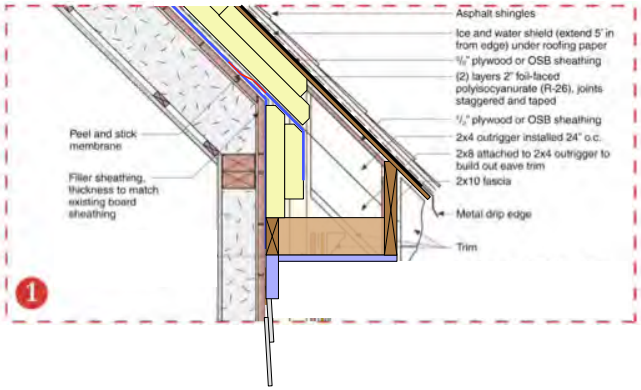
Staged DER – Roof First



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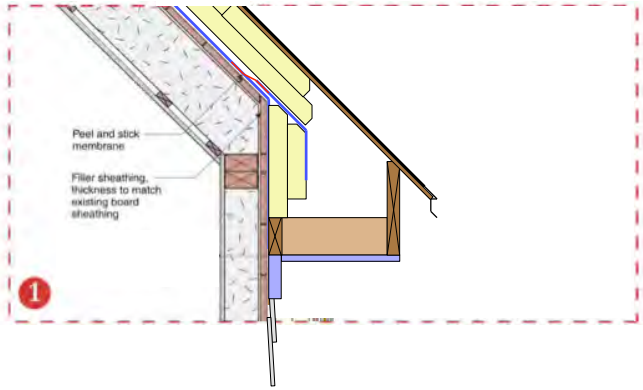
Staged DER – Roof First



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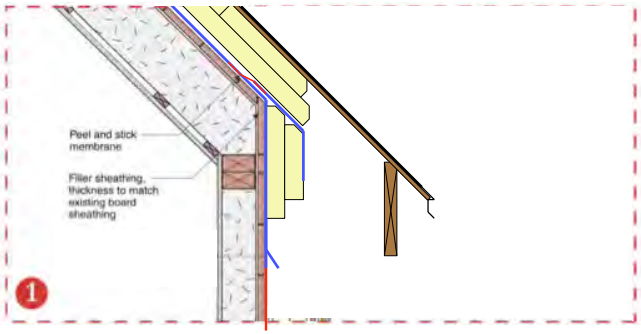
Staged DER – Roof First



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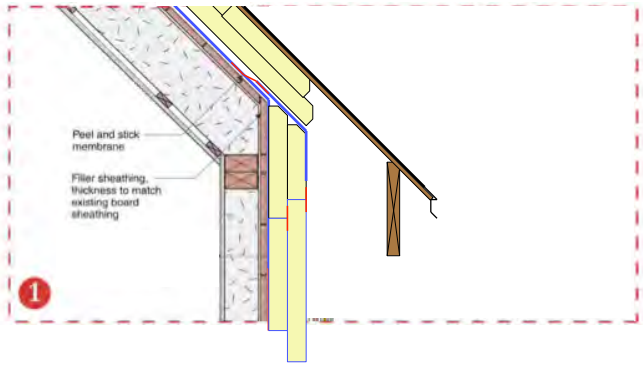
Staged DER – Roof First



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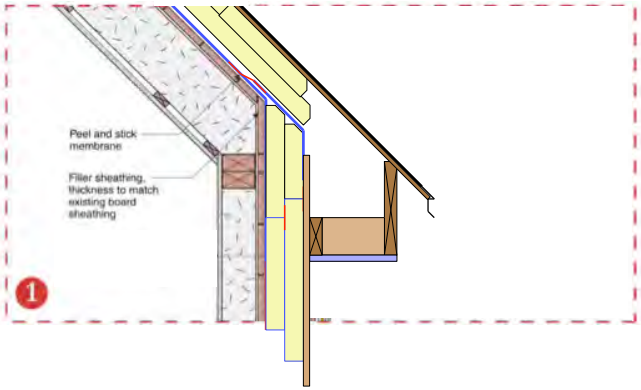
Staged DER – Roof First



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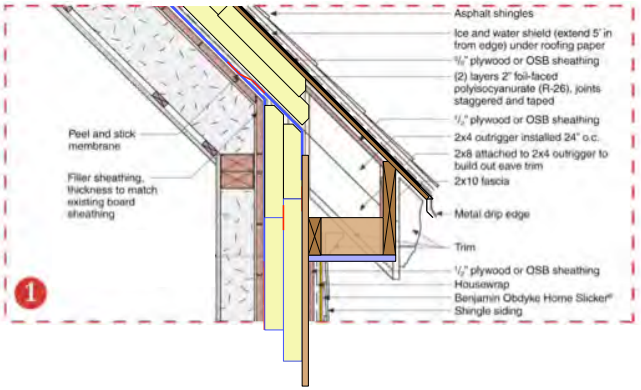
Staged DER – Roof First



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Staged DER

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Staged DER

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Staged DER

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Staged DE

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Staged DER

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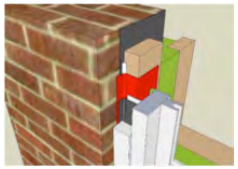
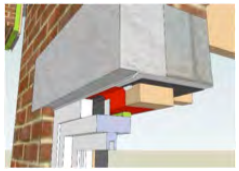
Staged DER

- Window Retrofit

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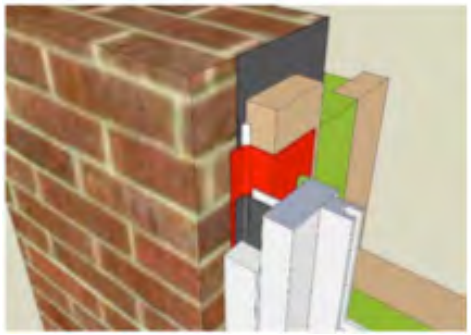
Staged DER

- Window Retrofit



Staged DER

Deep Energy Retrofits – Details, Questions, Issues

- What if we can only do part of it now?

Deep Energy Retrofits – Details, Questions, Issues

- Communicating intent to get performance built

DER Measures Specification – Be Specific!

Control Functions Guide Specification

- Enclosure:
  - Water control
  - Air flow control
  - Vapor Control
  - Thermal Control
- Mechanical:
  - Space heating
  - Space cooling
  - Ventilation
  - Air mixing
  - Water heating

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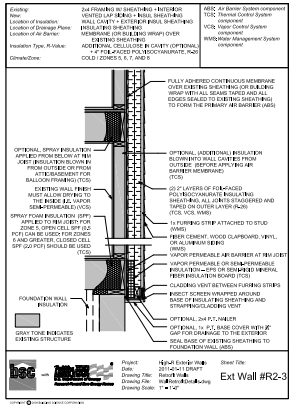
DER Measures Specification



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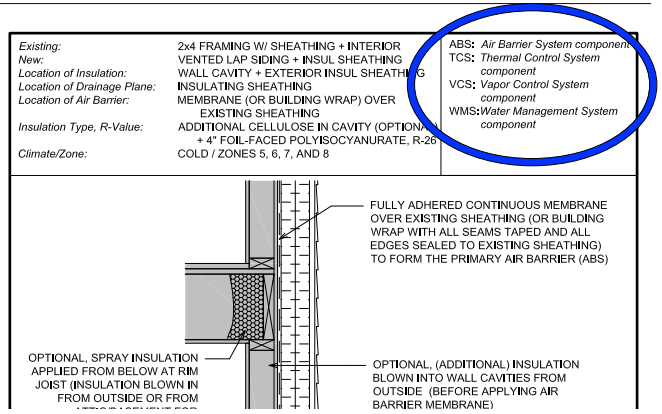
DER Measures Specification



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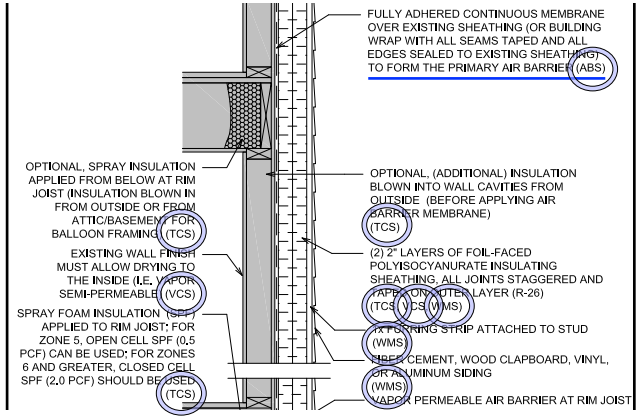
DER Measures Specification



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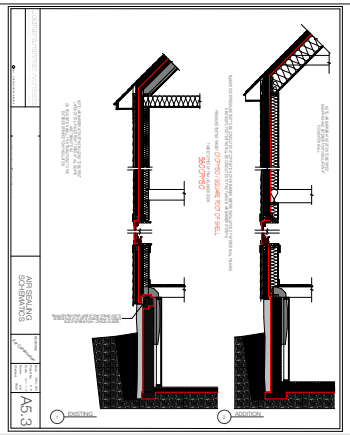
DER Measures Specification – Being Specific

- Communicate the *functional intent*
  - Very difficult to anticipate every condition
  - Empowers person in the field:
    - Water control ➔ down and out
    - Air flow control ➔ make connections air tight
    - Thermal control ➔ avoid putting bridges through it
    - Vapor control ➔ where is moisture sensitive material?
      - which direction is the vapor drive?
      - do we need to allow diffusion or control it?

DER Measures Specification



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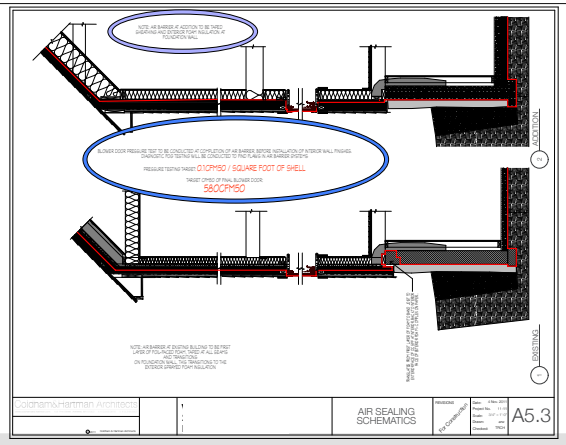

DER Measures Specification

NOTE: AIR BARRIER AT ADDITION TO BE TAPED SHEATHING AND EXTERIOR FOAM INSULATION AT FOUNDATION WALL

DER Project Plans

- It's important to have a plan!
  (It's important to plan)

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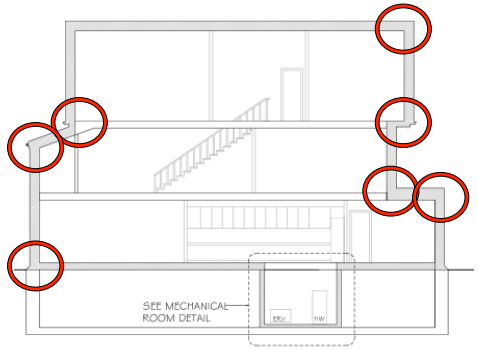
Deep Energy Retrofit Measures Verification

Plan Review - Enclosure



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Deep Energy Retrofit Measures Verification

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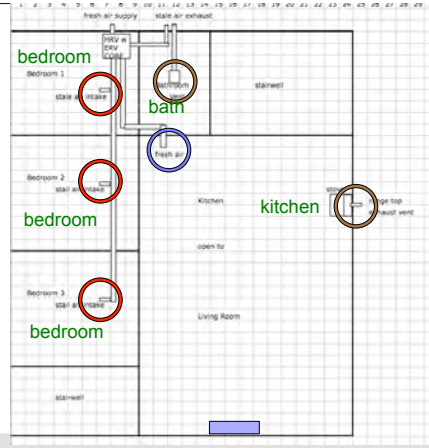
Deep Energy Retrofit Measures Verification



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Deep Energy Retrofits – Details, Questions, Issues

- Communicating intent to get performance built

Deep Energy Retrofits – Details, Questions, Issues

- It's the whole (hole) enclosure

Deep Energy Retrofit Measures Verification

You've got to see it to…

- Significant components not on plans

Deep Energy Retrofit Measures Verification

You've got to see it to…

- Significant components not on plans

Deep Energy Retrofits – Details, Questions, Issues

- It's the whole (hole) enclosure

Deep Energy Retrofits – Details, Questions, Issues

- Helpful and nifty stuff

Deep Energy Retrofits – Details, Questions, Issues

- Slab insulation sequencing

Deep Energy Retrofits – Details, Questions, Issues

- Slab insulation sequencing

Deep Energy Retrofits – Details, Questions, Issues

- Window installation
  - 2x bucks let in to exterior foam allow for "standard practice" installation

Flanges attached to 2X frame surround

Existing interior trim retained

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Deep Energy Retrofits – Details, Questions, Issues

- Design Challenge – A River Runs Through It
  - Condition of basement very important
  - Pre-retrofit, standing (flowing) water in basement

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Deep Energy Retrofits – Details, Questions, Issues

- Design Challenge – A River Runs Through It
  - Condition of basement very important
  - Pre-retrofit, standing (flowing) water in basement

Retrofit Plan:

- Trenches, drain pipe to daylight, gravel
- 6 mil poly
- More gravel
- SPF on walls

DER project guidance:

- Insulation
- Concrete slab
- Poly in contact with concrete
- 12" high XPS at slab perimeter

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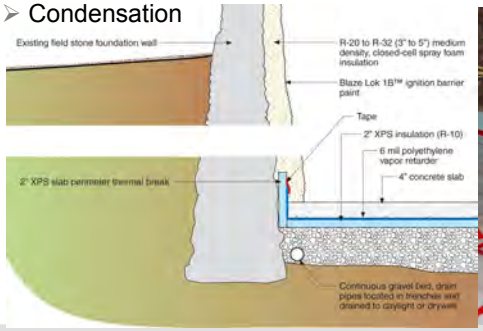
Design Challenge: A River Runs Through It

- Bulk water
- Capillary transfer
- Condensation
- Convective transfer
- Difusion



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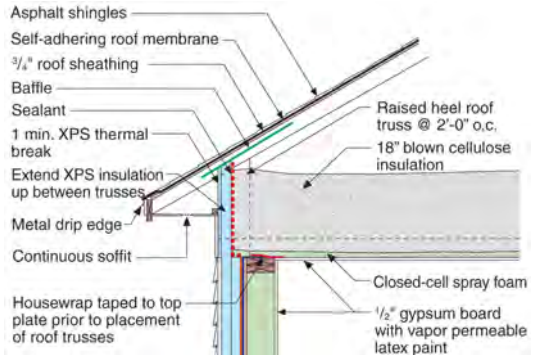
Deep Energy Retrofits – Details, Questions, Issues

- Enclosure – Roof/Attic
  - ***Water Management*** – New asphalt shingle roof
  - ***Air Control*** – Continuous 1" spray foam at attic floor and connected to wall housewrap
  - ***Vapor Control*** – 1" closed-cell spray foam and vented roof
  - ***Thermal Control*** – 18" blown in cellulose over 1" closed-cell spray foam

Critical air seal at attic floor

House wrap sealed to wall top plate

Deep Energy Retrofits – Details, Questions, Issues



Deep Energy Retrofits – Details, Questions, Issues

- Cladding attachment over semi-rigid mineral wool Insulation
  - ***It Works!***