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Building Smaller, Building Better: Getting to Net Zero Ready by Design

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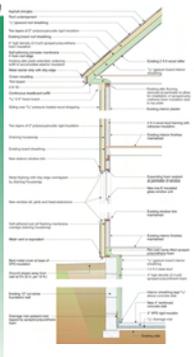
BETTER BUILDINGS BY DESIGN CONFERENCE
Burlington, VT February 12, 2009



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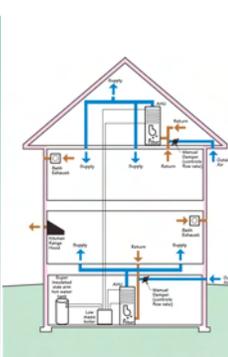
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MEASURE	PRERETROFIT	FINAL
Foundation walls (basement)	Uninsulated 12" cast stone	R-20, 4" high density (2.0 pcf) spray polyurethane foam
Slab insulation	None	R-10, 2" XPS insulating sheathing under slab
Above-grade walls	Some stug wood	R-41: blown cellulose cavity insulation and two layers of 2" polystyrene rigid on the exterior
Siding	Aluminum siding over original shingles	Cedar siding over 3/4" wood sheathing (rain-screen cavity)
Band joist areas	No insulation	Cavity filled with spray polyurethane foam
Cathedral ceilings	N/A	Two layers of 2" polystyrene rigid insulation on top of roof sheathing with 4" high density (2.0 pcf) spray polyurethane foam in the existing 2x6 wood rafter
Flat ceilings	12" loose blown stug wood	N/A
Basement windows	Single-pane wood framed	Double-glazed, Low-E, argon-filled, U=0.25, SHGC=0.30, new window sills, jamba and head extensions, expanding foam sealant at window perimeter
Above-grade windows	Single-pane wood framed with aluminum storm windows	Double-glazed, Low-E, argon-filled, U=0.25, SHGC=0.30, new window sills, jamba and head extensions, expanding foam sealant at window perimeter
Exterior doors	Solid wood stile and rail	Knap existing front door

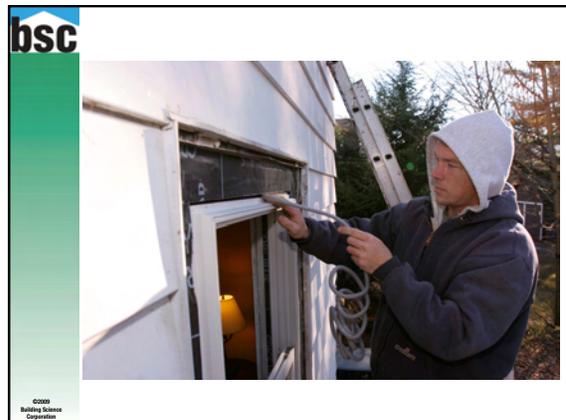
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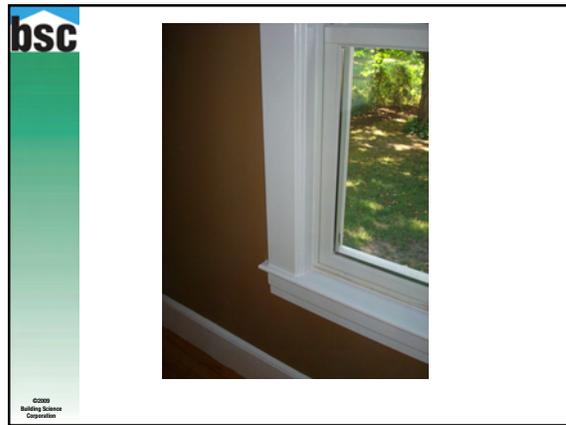
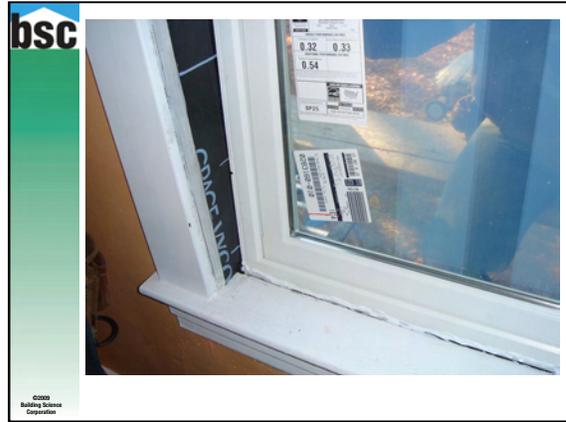
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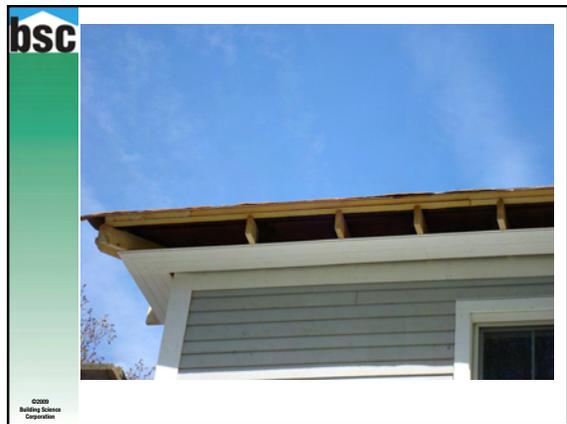
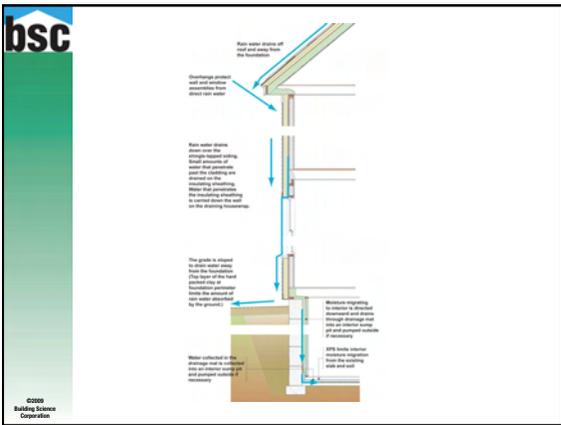
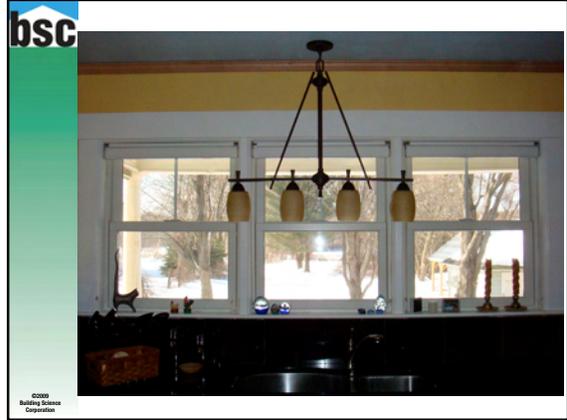


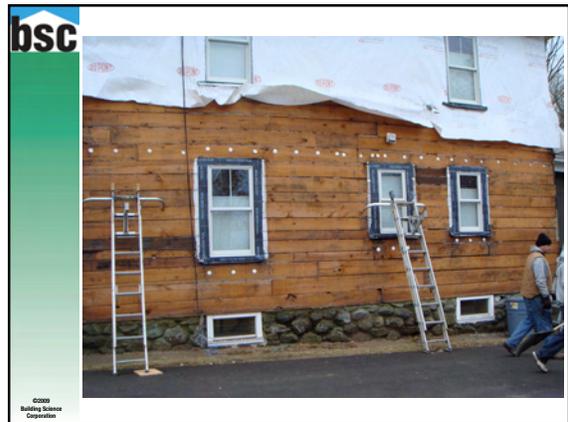
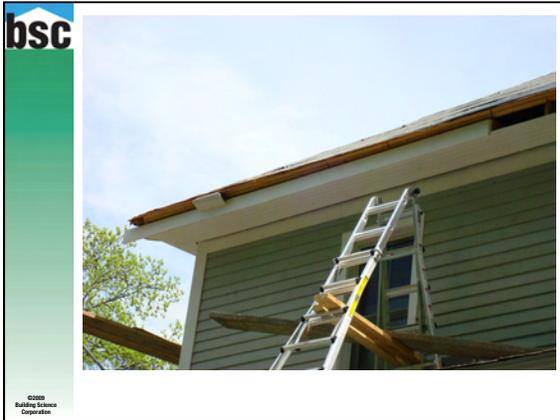
Air sealing	None	Particulate air barrier spray polyurethane foam (basement), air sealant, caulking, gaskets, weatherstripping, and door sweeps at above-grade walls. Low-expanding foam behind around windows.
Space heating	Original Oil Fired Boiler Circa 1970	50% AFUE sealed combustion low mass gas boiler in conditioned space
Cooling	Window air conditioner units	14 SEER split system in conditioned space
Thermostat	Standard - one zone	Setback - two zones
Water heating	Relatively inefficient gas tank water heater (2.0 EER)	2.0 EER energy-efficient tankless storage tank
Mechanical ventilation	None	Supply only system with outside air to meet portion of air handler, run at low speed with an ECM motor
Spot ventilation	None	Bath exhaust fan, kitchen range exhaust fan
Lighting	Standard Fluorescent	100% CFL-based compact fluorescent lighting
Refrigerator	Circa 1980	Energy Star
Dishwasher	Circa 1980	Energy Star
Clothes washer	N/A	Energy Star
Ventilation rate	Not tested (estimated ~15 ACH50)	2.3 ACH50 (bulkage area per code) in this residence (2.0 ACH50)
Door leakage (in-situ)	N/A (operator system)	None, doors tested in conditioned space
HERS Index	150+ (estimated)	49
Estimated total annual energy cost	2600 (circa 1980 with estimated)	721 (circa 2009 with present) 872 (circa 2009 with safety 50%)

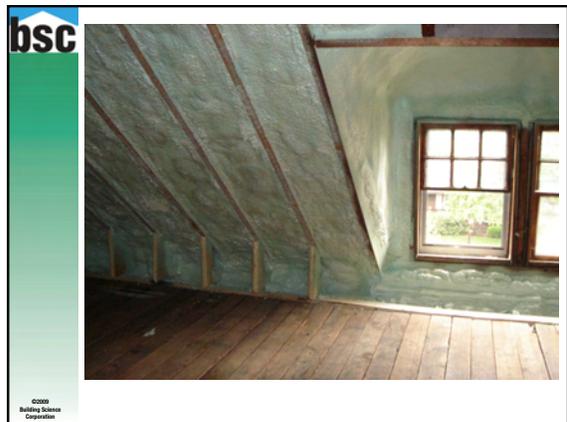
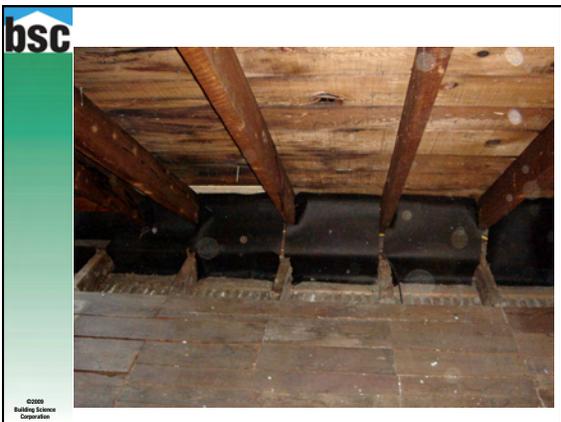
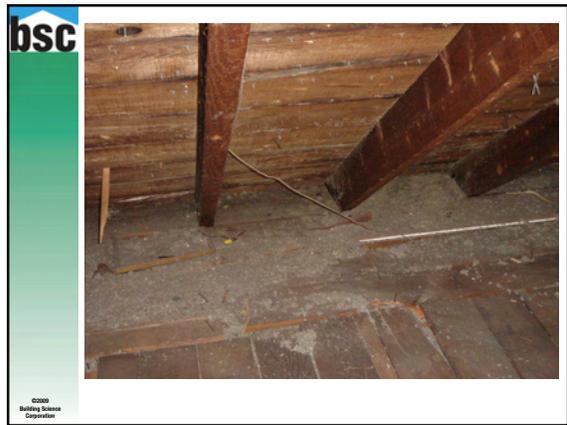
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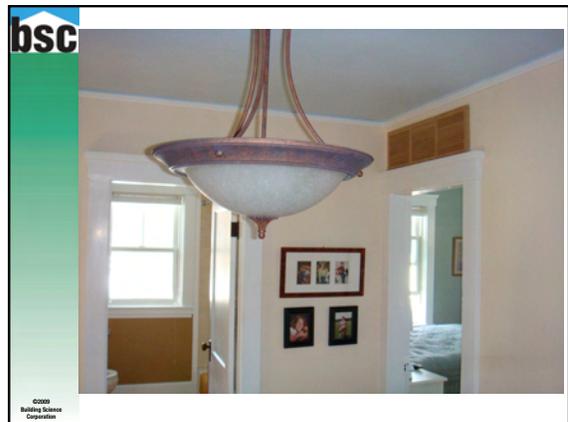
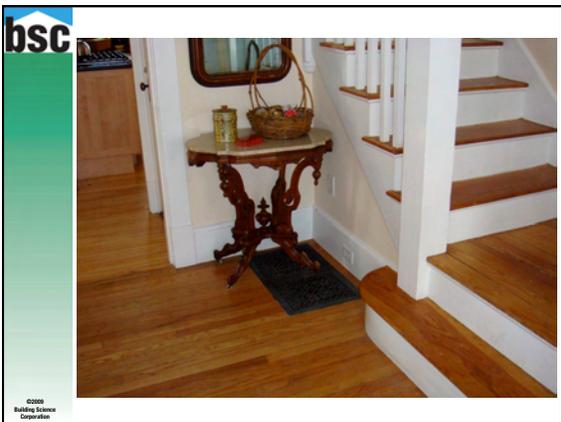
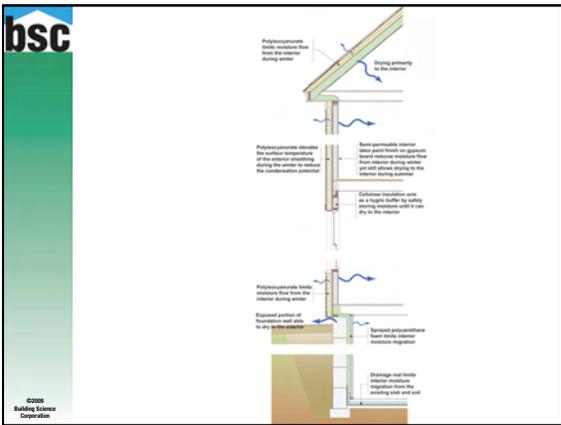
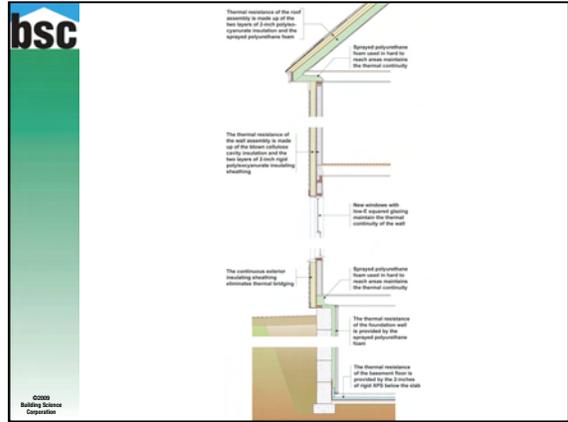


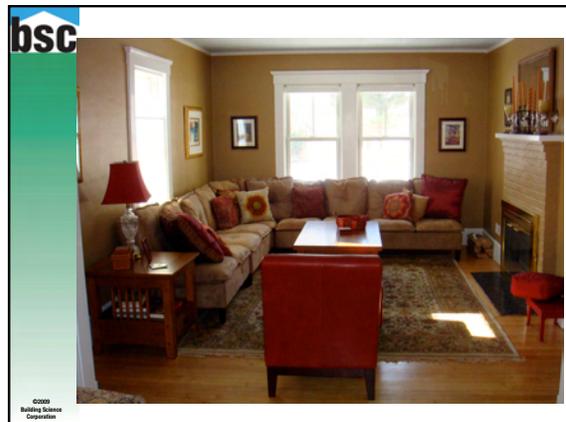
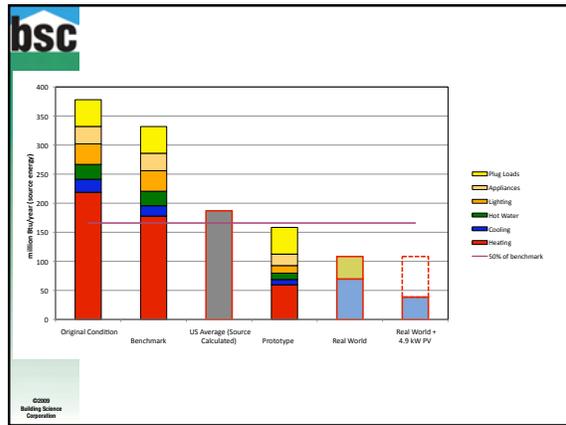
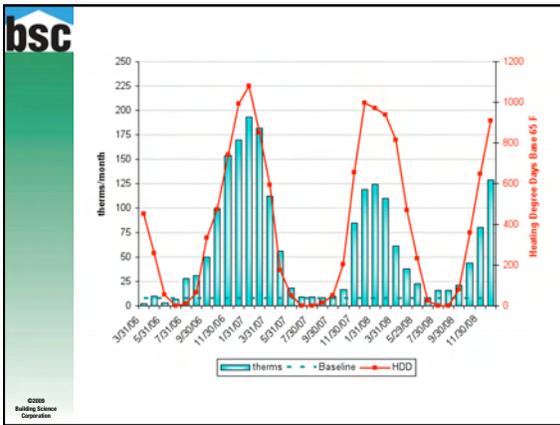
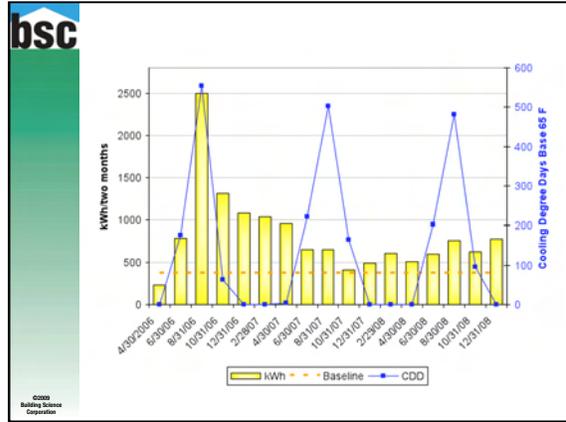
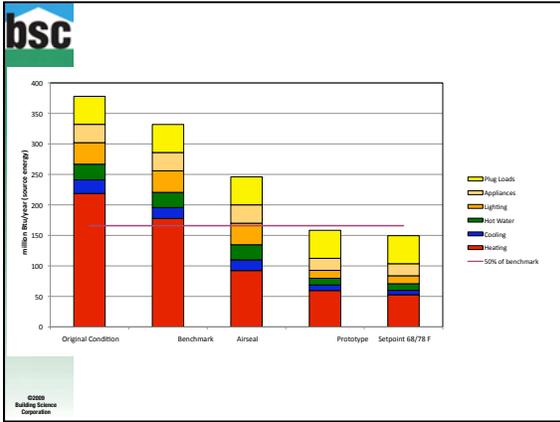


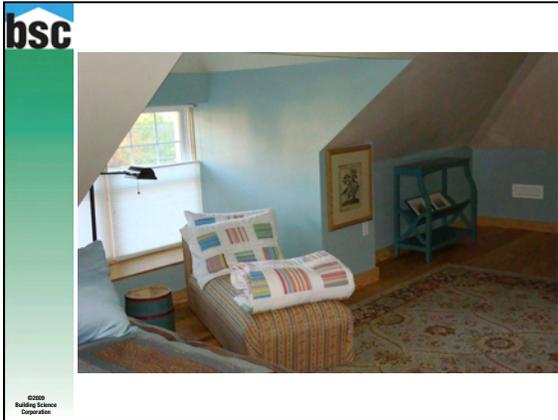












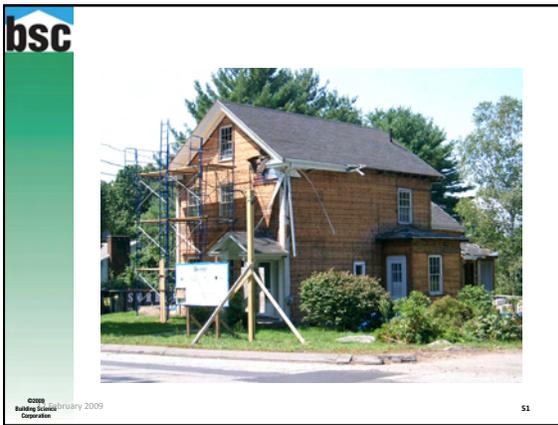
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Retrofit of Existing Farmhouse into a 2 Story Single Family Home with 3 Bedrooms and 2.5 Baths

The Farmhouse is located in a Cold Climate, Climate Zone 5A (5596 HDD, 5358 CDH)

Existing Farmhouse

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Design Highlights

- High-Performance Building Enclosure Retrofit
- High Efficiency Heating and Hot Water Systems
- Central-Fan-Integrated Ventilation
- New Bedroom and Barrier-Free Full Bath on First Floor
- Affordable Housing Developer
- Volunteer and Student Labor

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Retrofit Challenges to High Performance

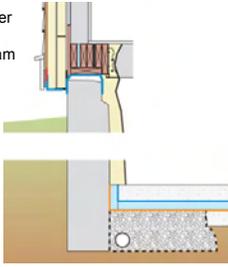
- Water Management and Air Barrier Continuity with Thick Insulating Sheathing (*Outsulation!*)
 - Transition air barrier down and in at foundation wall while maintaining water management (down and out!)
 - Roof-Wall interface
- Structural Attachment through Insulating Sheathing
- Windows and Doors
- Room for Mechanical Distribution
- Structural Remediation

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Basement Details

- Capillary Break installed under new sill beam
- 2"-3" High Density Spray Foam (~R13 – R19.5) applied to Rubble Stone Foundation
- Intumescent Paint fire protection for spray foam
- R-10 XPS under New Slab




Perimeter Drain

Basement Wall Section

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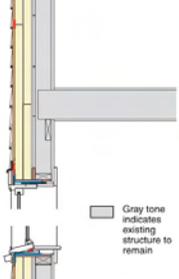
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Wall Details

- 4" Cellulose in Walls (R-14)
- 2" – 4" Foil-Faced Polyiso Insulating Sheathing (R-13 to R-26)
 - Joints staggered horizontally and vertically
 - All joints taped and sealed
- Wood furring strips, vinyl siding

High Performance Windows

- U = 0.31, SHGC = 0.32
- Double pane, vinyl-framed, low-e, argon fill



Typical Wall Section

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Window Installation



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Roof Details

- High Density Spray Foam Air Seal at Roof Perimeter
- Spray Foam Flash Coat 1"-2" (~R6-12) to underside of Roof Sheathing and at Gable Walls
- Cellulose Netted and Blown 2"-4" (~R7-14) between Roof Rafters and Gable Framing
- 4" (R26) Foil-Face Polyiso Insulating Sheathing, in (2) Layers
 - Joints staggered horizontally and vertically
 - All joints taped and sealed
- Nail base, Ice and Water Membrane, Asphalt Shingles



Basement Wall Section

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Mechanical Details

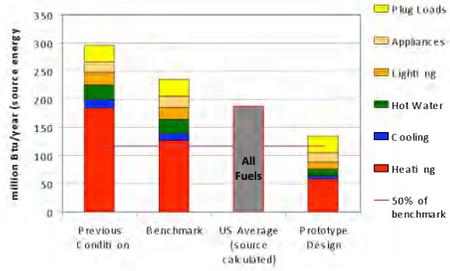
- 93% AFUE Furnace
- Ducts in Conditioned Space
- Ducts Sealed Exceptionally Tight
- Instantaneous Hot Water Heater EF = 0.82
- Energy Star Appliances
- Full CFL Package



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Projected Energy Use



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