

DEEP ENERGY RETROFIT MEASURES IN MASSACHUSETTS AND RHODE ISLAND *- Pilots and Beyond*



Deep Measures Verification Workshop
David Connelly Legg
September 13 and 20, 2011

Highlights

- Origins and Impetus of the DER pilots
- Offerings, tech support and outreach
- Requirements - technical and participatory
- Summary of project results
- Why guidance and incentives are needed
- Full value proposition of measures
- Cost benefit challenges and growth potential

Pilot Goals and Budget

- Assess cost effectiveness including considerations of non-energy benefits
- Gain market knowledge and strengthen cadre of DER contractors
- Deploy/test best practices for measure and building durability and sustainability
- Increase customer awareness of the window of opportunity to super-insulate



	MA	RI
Annual Budget	\$2m	\$.2M
Unit Goal 2011	~50	6
Time Frame	2009-12	2011-12

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Genesis and Future Impetus

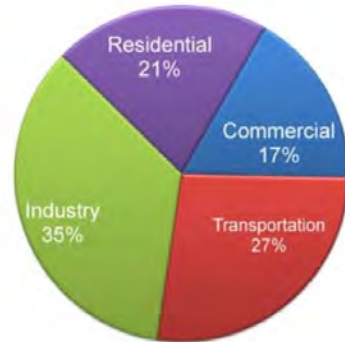


- Builds energy independence
- Consistent with clean energy legislation and climate change action
- Jobs that can't be outsourced

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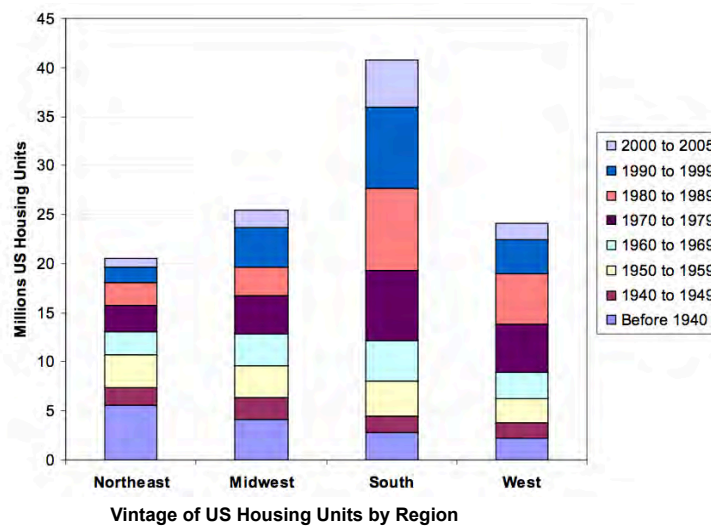
Deep Economic Impacts

- 21% of our energy is used in residential buildings
- 75% of our buildings will still be in use in 2050
- MA Energy \$ exported value \$22 billion in 2008
- DER Energy cost savings in 2020 \$84 million *



* Page 25, 26 Massachusetts Clean Energy and Climate Plan for 2020

Northeast is Cold with Old Houses



Graphic from Building Science Corporation – DER Pilot Test Plan

Climate Change –

The Ten Hottest Years on Record

2010 2005 2009 2007 1998
2002 2003 2006 2004 2001

FIGURE 4: The Changing Face of Winter



Monson tornado photo – Mike Martin of National Grid



Expect increases in severe storms and droughts. The NE region now sees 2 days per year above 100F at most, by century end this could be 20 days.

Other images; Union of Concerned Scientists, Al Gore "24 Hours of Reality" report

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Incentives and Offerings

- ◆ Incentives vary by Program Administrator
- ◆ Typically \$35,000 to \$42,000 for SF for whole house **Retrofit** package
- ◆ Partial and staged DERs encouraged
- ◆ National Grid offers Level 2 Incentives + 25% for Thousand Homes Challenge, PHI Enerfit, or NZE



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Technical Support

- Technical review of applications and plans and or HERs ratings
- Training, field assistance
- Inspections and final performance testing
- Building America and Building Science Corporation
- CET and CSG



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Outreach and Marketing

- Flyer with testimonials and yard signs
- Websites MassSave.com
powerofaction.com/der/
- Referral training for auditors
- Email blasts to stakeholders
- Outreach events
- Media - newspaper, regional and national magazines, TV
- Open Houses



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Kevin O'Connor of TNH by D. Legg only by permission to announce DER Pilot will be on "This New House"

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Eligibility

- DER coincides with refurbishing or remodeling
- Heating fuel determines which PA funds project (gas is priority)
- Requirements and offerings vary by Program Administrator



- Note: Though the degree of tech support varies all PAs require or promote a rigorous approach related to EE, health and safety

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Core Measures and Screening Approach

- 50% better than current HERs
- Or HERS approaching 50
- Or Insulation - ideal: roof R60, above grade wall R40, below grade wall R20, basement floor R10
 - Windows and Doors R5
 - Air Sealing Target: 0.1 CFM50 /sq ft. surface area
- Sealed combustion or forced drafted heating and water heating systems
- Mechanical ventilation



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Project Team Prerequisites

- Must include DER listed general contractor or design professional with experience such as:
 - ENERGY STAR® HERs index ~ 60, and or remodeling with HERs < 70
 - Passive Haus Institute certification



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Project Counts ~ thru August 2011

Status - Potential	Count
complete	19
work inprogress	12
2nd ap or Contract	12
In Ap Process or High	30
Moderate	42
Low	81
Dropped Out, etc	90
Grand Total	286



- Thousand Homes Challenge candidate units 6
- Habitat and veterans units 5

RI Leads	Location
2F	N. Kingston
1	Providence
1	Newport
2F	Providence

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DER Barriers – Costs and Timing Affect Everything

- Consumers aren't typically renovating/refinishing their whole house. (e.g. finishing a basement and re-siding, new windows, roof all at the same time)
- Getting those consumers to take deep action on the whole house means they incur more super-insulating and refinishing costs. Total is often over \$100,000.
- Employing climate, energy and life cycle cost considerations with optimal building science has many benefits but presents more challenges and higher initial costs

	Min \ Unit	Max	Avg w/o Max
18 NGrid Enclosure and HVAC Costs \$000's	\$49.8	\$133	\$63.8

Market Lessons – some surprises



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DER Pilot Projects

- ◆ Amherst
- ◆ Arlington
- ◆ Auburndale
- ◆ Barnstable
- ◆ Cummington
- ◆ Easthampton
- ◆ Framingham



DER Pilot Projects





- ◆ Arlington
- ◆ Belchertown
- ◆ Belmont
- ◆ Cohasset
- ◆ Haverhill -vet
- ◆ Jamaica Plain
- ◆ Lancaster HFH
- ◆ Medford
- ◆ Millbury
- ◆ Milton
- ◆ Newton
- ◆ N Kingston, RI
- ◆ Northampton
- ◆ Quincy
- ◆ Williamstown HFH




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Belchertown – 1760’s Farmhouse



- Gut remodel project with closed cell spray foam
- Hot attic, HRV, AFUE 95 furnace
- Reduced air leakage by 95% to 458 CFM50
- Re-flashing of windows, wet basement remediation

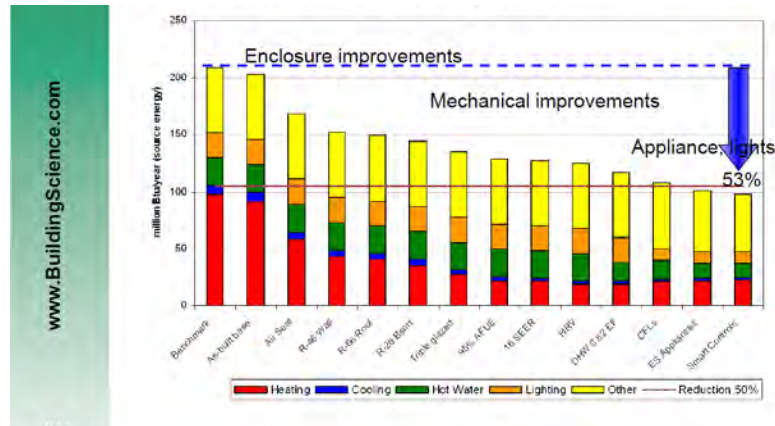


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Belchertown – 1st Case Metered Savings

Source Energy: As Built 203MBtu, Projected 99MBtu

Post 65.3 MBtu = 360 gal Propane, 2089 kWh = 68% total energy savings!



North Kingston, Rhode Island



- "This retrofit program is transforming my 1962 duplex into a super-insulated, ultra efficient twenty-first century home!"

Dave Caldwell, owner/contractor of a Deep Energy Retrofit Two-family Home in North Kingston, RI

Belmont - 1920's Two Family



- Attic conversion, renewables, 95% AFUE furnace, Renewaire ERV, HERS Index 32, **CFM50 590**.
- Thousand Homes Challenge candidate
- Completed September 2010

R-60 roof with 6" of Rigid Polyiso foam (shown above) and 6" cellulose insulation between rafters. 25

Building Tightness Comparisons

National Grid 2010 Project Town	Belmont	Milton	Millbury	Belchertown	Quincy
CFM50 Initial	5700	1695	2860	11783	5050
CFM50 FINAL	590	584	458	468	702
CFM50 % Reduced	90%	66%	84%	96%	86%
Total_Surface_Area	7468	4676	4278	3656	5772
CFM50 per SqFt Enclosure	0.08	0.12	0.11	0.13	0.12
% Compare to 0.1 CFM50\SF = Target <i>(minus exceeds target)</i>	-21%	25%	7%	28%	22%
Non Pilot DERS	Concord 4 Square	Arlington 2 Family	Bedford Farm House, Habitat	Average	
CFM50BlowerDoor Reading BSC	1511	2129	2260	1967	
Total_Surface_Area	5954	6075	5335		
CFM50 per SF Enclosure	0.25	0.35	0.42	0.34	
Compared to Target <i>(minus is better than target)</i>	150%	250%	320%	240%	

* Sources: BSC tests for the Nationalgrid pilot and ASHRAE white paper on wall assemblies in DERs by Kohta Ueno of BSC 26

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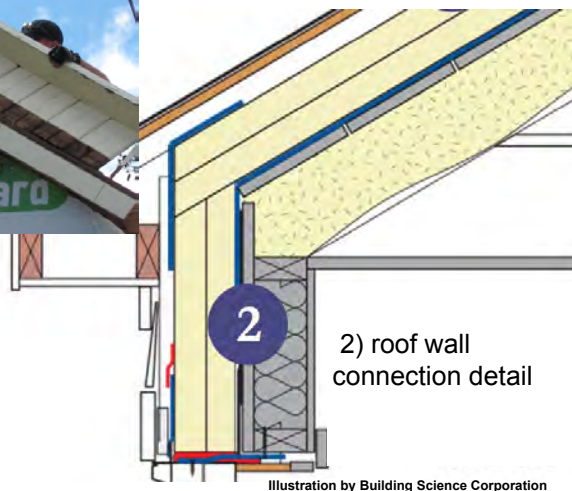
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Tight Tie Ins and Detailed Planning



1 chain saw retro

2) roof wall
connection detail

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Illustration by Building Science Corporation

Why is guidance\verification needed?

- Getting it right is tricky because once the building is super insulated - water inside and outside are a bigger problem because there's far less heat passing through the walls to dry the building out.
- **Incentives** are needed in line with guidance\verification to keep a level playing field for building performances
Pros to walk the talk – precisely because the pressure is so great to cut costs on work that is not cheap to do and has high risks if not done very well

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Why guide and verify?

- So super-insulation without advanced methods is likely to increase degradation of building assemblies



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Why guide and verify?

- Effective water management techniques are not common practice
- Should projects leading to durability problems few others will want to risk having their green dream home turn black
- Since the work is done layer by layer not typically in open attic spaces if you get it wrong it can't be fixed w/o great costs.

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Common Practice vs DER Done Right



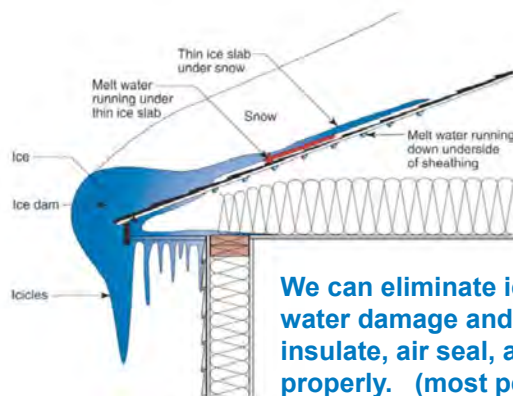
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Ice Dam Damage

- I had \$37,000 in damage to 8 different rooms/areas in my house. All of it stemming from ice dams due to this winters snow.
- My house has been demolished since the 2nd week of February and is still under construction to this day. (6/12/11). *Sue A. Sutton, MA*



Ice Dams be gone!



We can eliminate ice dams and thereby prevent water damage and improve safety if we insulate, air seal, apply ice shield and vent properly. (most people don't know you need all 4) Great info in article by Joe Lstiburek [bsi-046-dam-ice-dam/](#)

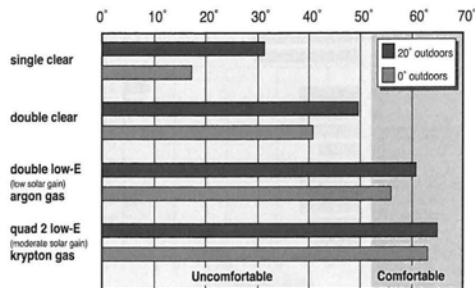
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Comfort and Quiet

- Near Zero drafts
- Even temperature
- No cool surfaces



Window Systems for High-Performance Buildings (by Dariush Arasteh)



- Before we heard busy street traffic constantly, after the DER was complete we could hear a pin drop

Inner city DER customer

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Indoor Air Quality – Healthier Indoors



Sealed combustion,
mechanical ventilation
w/ HR, spot
ventilation, reduced
mold – no cold
condensing surfaces



[Household Mold Doubles Kids' Asthma Risk](#)
Mar 4, 2005 ... Kids' asthma risk more than doubles if their homes smell of mold, says a new study.
[www.webmd.com/asthma/.../household-mold-doubles-kids-asthma-risk](#) - Cached - Similar

[Mold Allergy - Asthma and Allergy Foundation of America ...](#)
(Click on the image at right for a free PDF copy of our brochure about household mold, or call 1-800-7-ASTHMA to have a free copy sent to you by mail.) ...
[www.aafa.org/display.cfm?id=9&sub=10&cont=234](#) - Cached - Similar

[Asthma - 10 Ways to Fight Indoor Mold - Health.com](#)
Aug 1, 2009 ... Mold is among the most hazardous household substances for people with allergies and asthma.
[www.health.com > Home > Health AZ](#) - Cached - Similar

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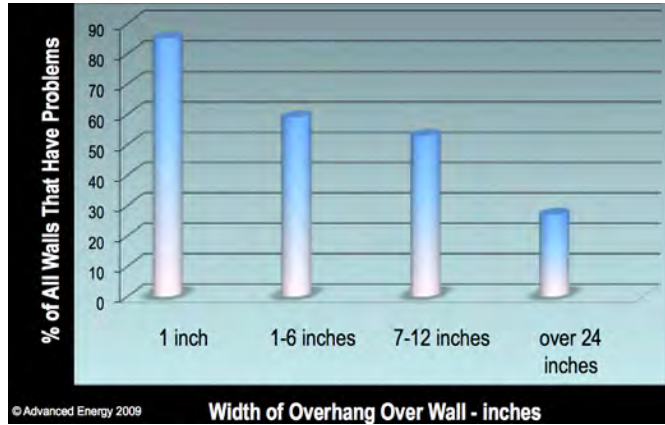
Overhangs



Improve appearance, home
value and water management

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Overhangs – with outboard roof SI



Improve appearance, home value and water management


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	Min \ Unit	Max	Avg w/o Max
Benefit to Cost Ratio	\$49.8	\$133.5	\$63.8



- Cost-effectiveness concerns –Total Resource Cost test doesn't include the full range of DER benefits
- Measure life is > 28 or 30 year max in current BCR models

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Looking Deeper Under the Regulatory Hood

- * “methods that are used to evaluate programs for cost effectiveness should be reviewed to ensure that deep retrofits can be implemented to the maximum possible extent....”
- ..adoption begins at low levels and grows slowly until it reaches 10 percent of normal maintenance projects by 2020.”
 - * Page 25, 26 Massachusetts Clean Energy and Climate Plan for 2020
- DER Non Energy Benefits study underway
- “Developing alliances in support of regulatory changes needed to support a long-term focus on programs like DER”

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Deep Envelope Measure Expansion

- More tech support and funding for:
 - Enhanced side attic treatments
 - Super-insulation at time of re-siding and re-roofing
 - Advanced triple glazed windows
 - Hybridized approaches to weatherization, building on techniques being perfected and researched in DER pilots

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Floor Knee-wall Transition – side attic




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Hot Attics

Hot Roof Pilot 2009 - NGrid\CSG	
Install Sites	20
Considered Sites	39
Sq Ft Foam Average	1490
Est MMBtu Savings	16
Leakage reduced by 975 CFM50 avg.	1869

OC PolyU spray foam in sites code acceptable for ventilation free attic, w/ vapor barrier sealant



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Hot Roofs



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Highly insulating windows and doors

Existing 2 yr old DH - add Harvey **low E Tight Storms**

EcoShield casement 700 Series.

Triple Glaze Argon/krypton, eliminate 2 windows (R21 to R40)

Pardigm U-0.20, trpl, argon, LoE

Paradigm 8312, Krypton Blend, **R-5 w/ foam filled jambs**

Serious 925 series, 2X Krypton plus film- casement

Serious 525 (5L glass) fiberglass with 1 low SHG film

Paradigm Premium, Double Hung, low E Krypton gas,

Intus Eforte low-e, double argon with **R-7**

UniLux IsoStar + Four Seasons Sunrooms skylight R7



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Full Value Proposition Focus

- Plan, specify and verify for full value over time
- Symbiotic energy and non-energy benefits including durability and lower maintenance
- Foster climate optimal efficiency – economic growth
- Promote occupant health, safety, IAQ, aesthetics, amenities and comfort



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Thank You!



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1st Rule Do No Harm

6) Health, Safety, and Durability Issues Project Name: Jeffrey Oliver First A4
 Complete sections A, B and C below

Section (6A) Identification of Health, Safety, and Durability Issues
 DIRECTIONS: In the Stage 1 Application, please complete Column B with "yes", "no", "high priority" or "TBD" (to be determined).

Category	
Combustion Safety	Combustion products from vented furnace or water heater spilling due to inadequate draft or house depressurization (NOTE: Natural draft gas & oil combustion appliances are not acceptable see DER Guidelines)
Combustion Safety	Combustion products (NOX / CO / water vapor) from gas range / cook stove in living space
Combustion Safety	Combustion products from fireplace or woodstove due to house depressurization
Indoor Env Quality	Inadequate source control (exhaust) of moisture & odors
Indoor Env Quality	Inadequate indoor-outdoor air exchange, dilution of contaminants
Indoor Env Quality	Inadequate distribution of indoor and fresh air
Indoor Env Quality	VOCs from building materials, interior finishes
Indoor Env Quality	VOCs and/or SVOCs from consumer products
Indoor Env Quality	Unit-to-unit cross contamination of indoor air pollutants (tobacco smoke, cooking odors, etc.) (Attached dwelling)
Indoor Env Quality	Contaminants from attached garage entering living spaces
Indoor Env Quality	Radon and other soil gases entering living spaces
Indoor Env Quality	Lead health risk from paint
Indoor Env Quality	Lead health risk from outdoor contamination (indoor dust)
Indoor Env Quality	Exposure to asbestos (from zonalite loose-fill insulation, HVAC system, popcorn ceilings, etc.)
Code Issue	Hazard due to unsafe or inadequate electrical system
Code Issue	Structural problem due to not substantiated or substandard construction

Super Insulation with Re-roof



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