Better Buildings Residential Network Peer Exchange Call Series:

Going Deep—What Drives Deep Energy Retrofits?

January 30, 2019

Agenda and Ground Rules

- Agenda Review and Ground Rules
- Opening Poll
- Residential Network Overview and Upcoming Call Schedule
- Featured Speakers:
  - **Rebecca Olson**, Center for Energy and Environment
  - **Brennan Less**, Lawrence Berkeley National Lab
  - **Rick Wertheim**, United Way Long Island
- Open Discussion
- Closing Poll and Announcements

Ground Rules:

1. **Sales of services and commercial messages are not appropriate** during Peer Exchange Calls.
2. Calls are a safe place for discussion; **please do not attribute information to individuals** on the call.

The views expressed by speakers are their own, and do not reflect those of the Dept. of Energy.

Better Buildings Residential Network

Join the Network

Member Benefits:

- Recognition in media and publications
- Speaking opportunities
- Updates on latest trends
- Voluntary member initiatives
- One-on-One brainstorming conversations

Commitment:

- Members only need to provide *one number*: their organization's number of residential energy upgrades per year, or equivalent.

Upcoming Calls (2nd & 4th Thursdays):

- Feb 13: Comfort – The Biggest Driver of Residential Energy Efficiency
- Feb 27: Heat Pump Water Heaters – What You Need to Know Right Now
- Mar 12: The State of Gas Energy Efficiency Programs

Peer Exchange Call summaries are posted on the Better Buildings website a few weeks after the call

For more information or to join, for no cost, email bbresidentialnetwork@ee.doe.gov, or go to energy.gov/eere/bbrn & click Join

Rebecca Olson

Center for Energy and Environment

U.S. DEPARTMENT OF ENERGY

CEE's Approach to Deeper Residential Retrofits

Rebecca Olson, Director of Residential Programs

Better Buildings Residential Network
Peer Exchange
January 30th, 2020

cee
Center for Energy and Environment

Deeper Retrofit Goals

- Complete comprehensive work scope
- Focus on cost effectiveness and health and safety
- Break down barriers to completing projects
- Use qualified and results-oriented contractors

Customer Experience

Customer Journey

Program Process

Educate and promote	Visit type selection	Schedule customer	Complete diagnosis and installs	Create reports	Review reports with customer	Recommend projects	Engage customer	Review project scope	Schedule contractor work	Ensure rebate submission	QA and reporting

Residential Retrofit Process

- Home Energy Squad
- Joint Gas and Electric Utility Program
  - Xcel Energy
  - Centerpoint Energy
- In over 8000 homes per year
  - Direct installation of gas and electric measures
  - Comprehensive Audits
- Action-oriented and customer-friendly report
  - Includes energy score and path

Contractor Relationships

- Trusted contractor network
  - 5 Insulation contractors
  - 2-3 HVAC contractors
- Negotiated pricing for Insulation scope
  - Keep costs transparent and consistent
- Deliver bids/scope of work at visit
  - Allows us to push for full scope of work
- CEE schedules work
  - Easy for customers
  - Helps us ensure work gets completed
- Quality Assurance on sample of jobs

Energy Advisor Service

Refer to trusted contractors

Answer questions, provide guidance

Connect to financing

Ensure rebate application

Case Study 1:

- 1-story (rambler)
- Built in 1950
- **Score:** from 81 to 97
- **Furnace:** 80% furnace replaced with 96% Model with programmable thermostat
- **Attic Insulation:** Added R18
- **Air Sealing:** Reduced leakage by 15%
- **Water Heater:** Power vented unit installed (safe combustion)
- Home Energy Squad installed efficient lighting
- **Total Cost: $6,000**
- **Annual Estimated Savings: $298**
- **Payback of 20 years**
- **~20% Reduction in Usage**

ENERGY FITNESS PLAN

ACHIEVED	ACTION NEEDED by priority
Walls are fully insulated	Replace your furnace with a 95% AFUE model
Windows meet minimum efficiency standards	Air seal and insulate your attic
80% AFUE heating system	
Partial attic insulation and air sealing	

HEALTH & SAFETY

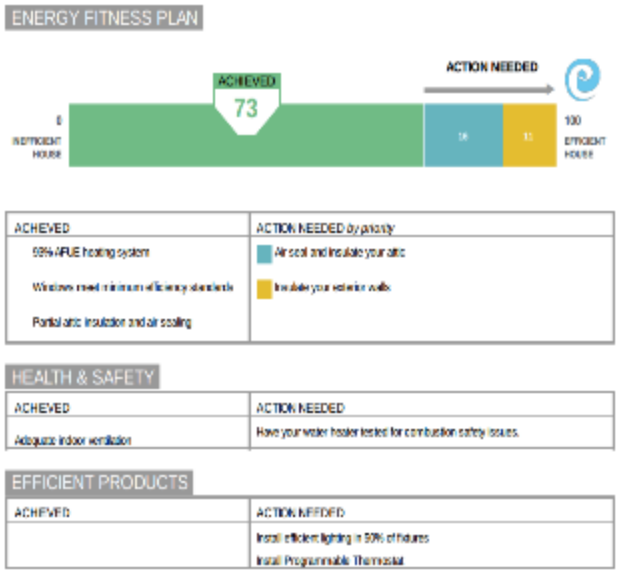
ACHIEVED	ACTION NEEDED
Adequate indoor ventilation	Have your water heater tested for combustion safety issues.

EFFICIENT PRODUCTS

ACHIEVED	ACTION NEEDED
	Install efficient lighting in 50% of fixtures
	Install Programmable Thermostat

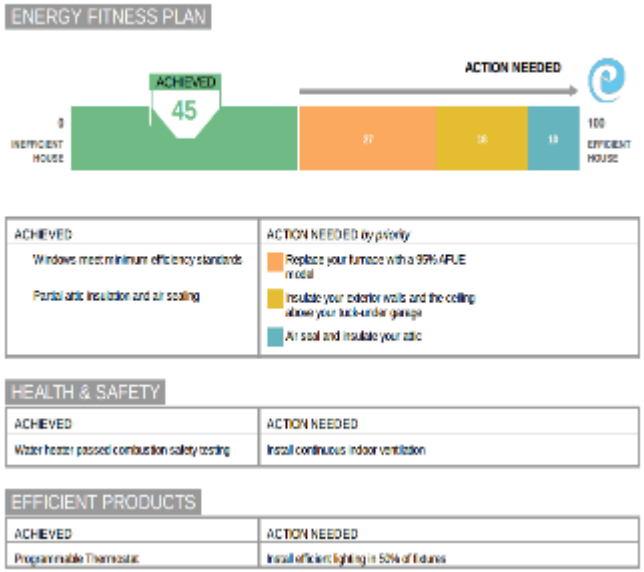
Case Study 2:

- 1.5 story
- Built in 1949
- **Score:** from 73 to100
- **Wall Insulation:** All dense packed
- **Kneewall Insulation:** Added R25
- **Attic Insulation:** Added R45 in side attics, added R29 in peak,
- **Air Sealing:** 48% leakage reduction
- **Water Heater:** Power vented unit installed (safe combustion)
- Home Energy Squad installed efficient lighting & programmable thermostat
- **Total Cost: $4,360**
- **Annual Estimated Savings: $790**
- **Payback of 5.5 years**
- **~50% savings**



Case Study 3:

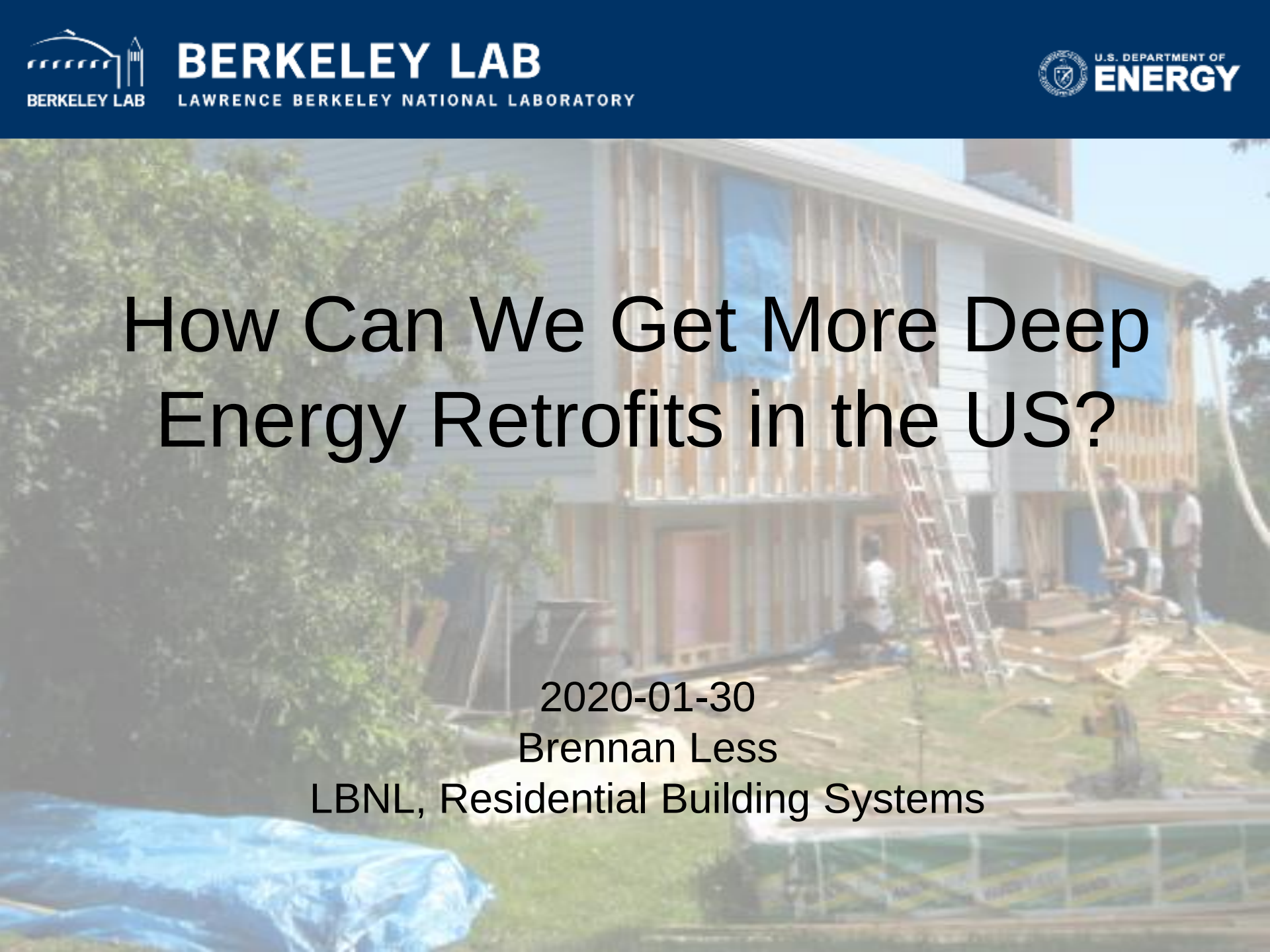
- Split-Level
- Built in 1963
- **Score:** from 45 to100
- **Furnace:** Replaced 70% furnace with 95% model with programmable thermostat
- **Attic Insulation:** Added R29
- **Air Sealing:** 36% air leakage reduction
- **Wall Insulation:** Dense packed exterior walls and tuck-under garage ceiling
- **Water Heater:** Power vented unit installed (safe combustion)
- Home Energy Squad installed efficient lighting
- **Total Cost: $8,870**
- **Annual Estimated Savings: $1,015**
- **Payback of 8.7 years**
- **~58% savings**



Center for Energy and Environment

Brennan Less
Lawrence Berkeley National Lab

U.S. DEPARTMENT OF ENERGY



BERKELEY LAB
LAWRENCE BERKELEY NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY

How Can We Get More Deep Energy Retrofits in the US?

2020-01-30

Brennan Less
LBNL, Residential Building Systems





"So many more deep residential energy retrofits are occurring than we ever hoped. Savings are high, budgets are low…We are on-track!"

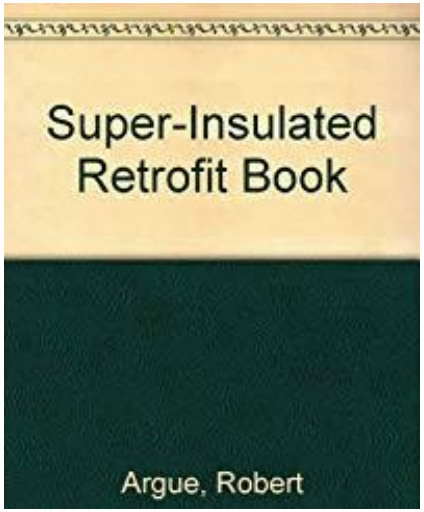




"So many more deep residential energy retrofits are occurring than we ever hoped. Savings are high, budgets are low…We are on-track!"

- No One Ever, PhD

- Every single country on the globe is struggling with this issue
- The problems are not technical (mostly)
- We've been doing this for >40 years



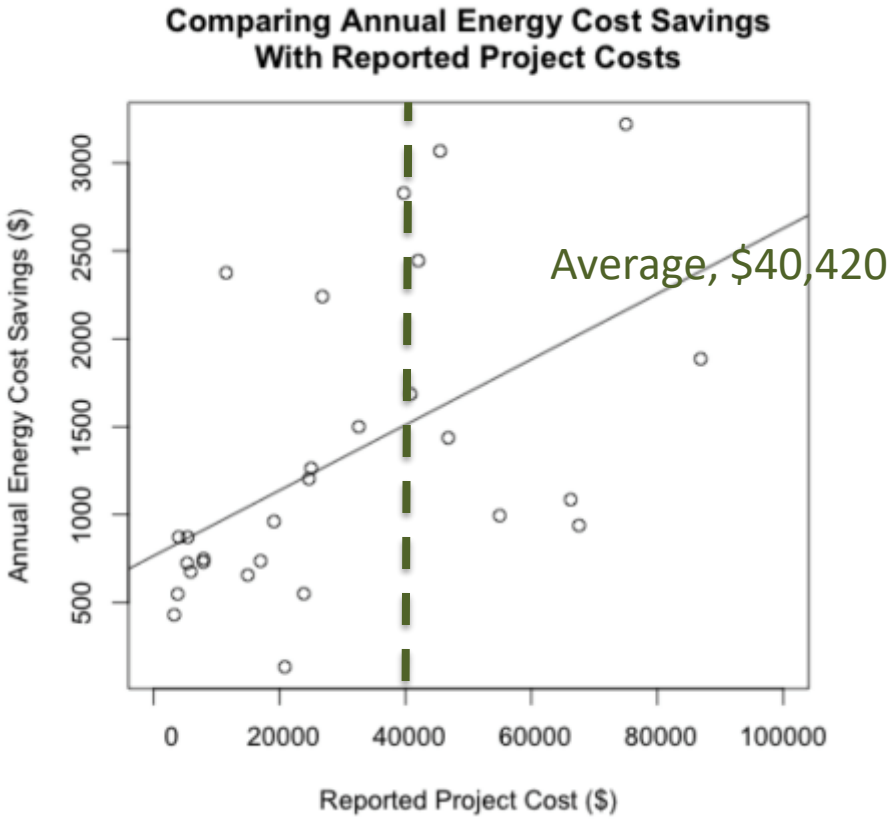
"Future DERs will need to look different than they have in (many) past demonstration projects…We are not going to be wrapping every existing home in the US with 4" of exterior insulation, air sealing them to 0.6 ACH_{50}, and custom engineering the HVAC."

-Brennan Less (that's me)

Bottlenecks and Burdens

- High project costs
- Extended project timelines
- Disruption and inconvenience
- Complexity – too many players
- Inadequate workforce
- Information burden
- Risk of new technologies and practices (procurement, contractor, inspection, etc.)
- Financing (incentives split from homeowners and financing)
- Market valuation in real estate
- Inconsistent outcomes
- Lack of incentives commensurate with costs

Cost Burden



Many cold climate projects have reported > $100,000

At best, a DER costs as much as a kitchen remodel…

But then you don't have a new kitchen

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Time Burden

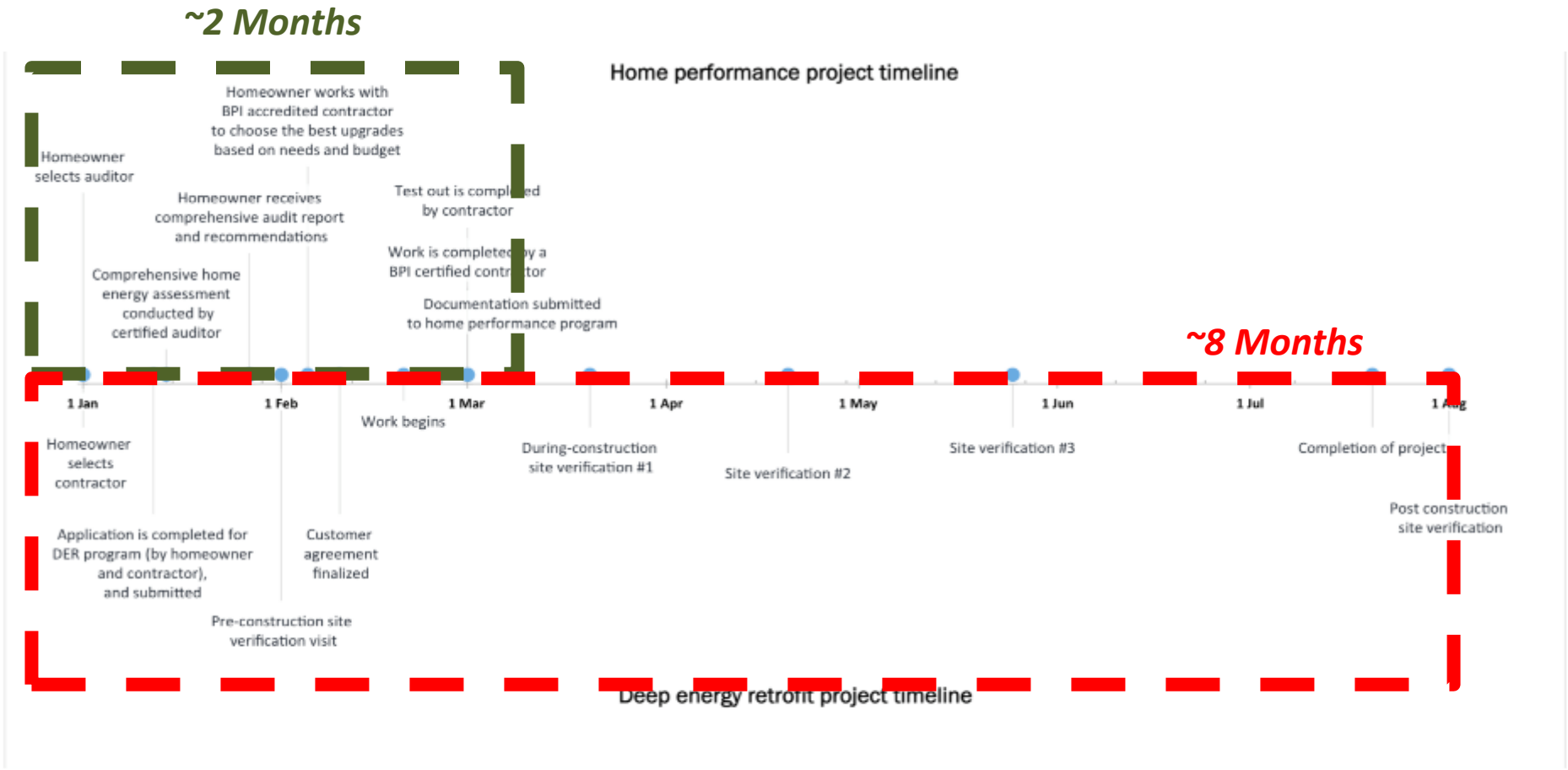
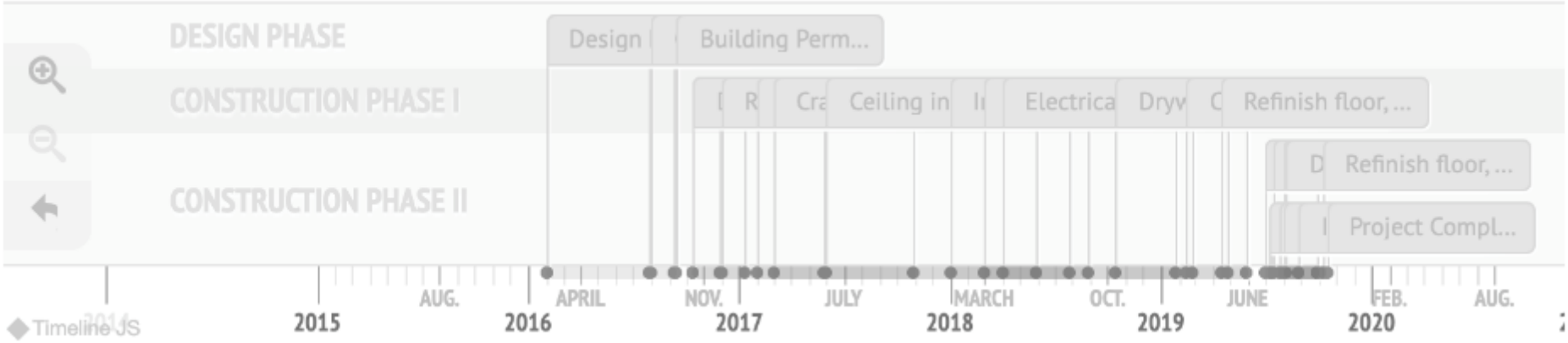


Figure 11. Home performance and deep energy retrofit program timelines. *Source*: EPA 2011, Neuhauser 2012.

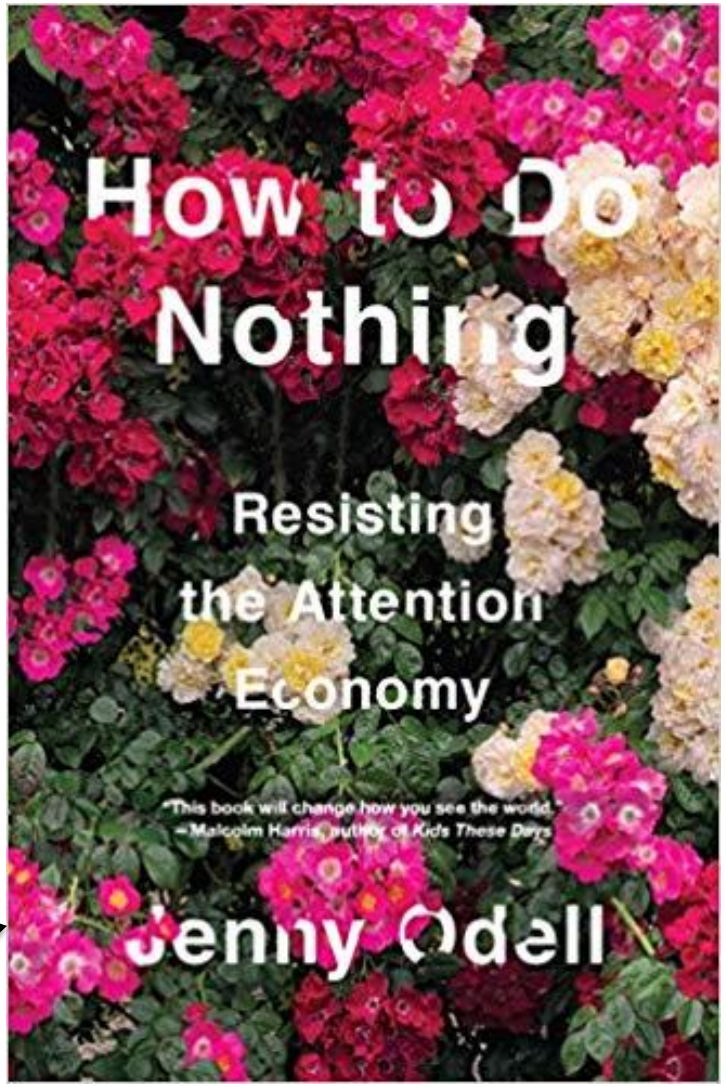
Time Burden, Continued



Frugal Happy DIY DER timeline


"People say nothing's impossible,
but I do nothing everyday."
-Winnie the Pooh

Recommended by Barack Obama!



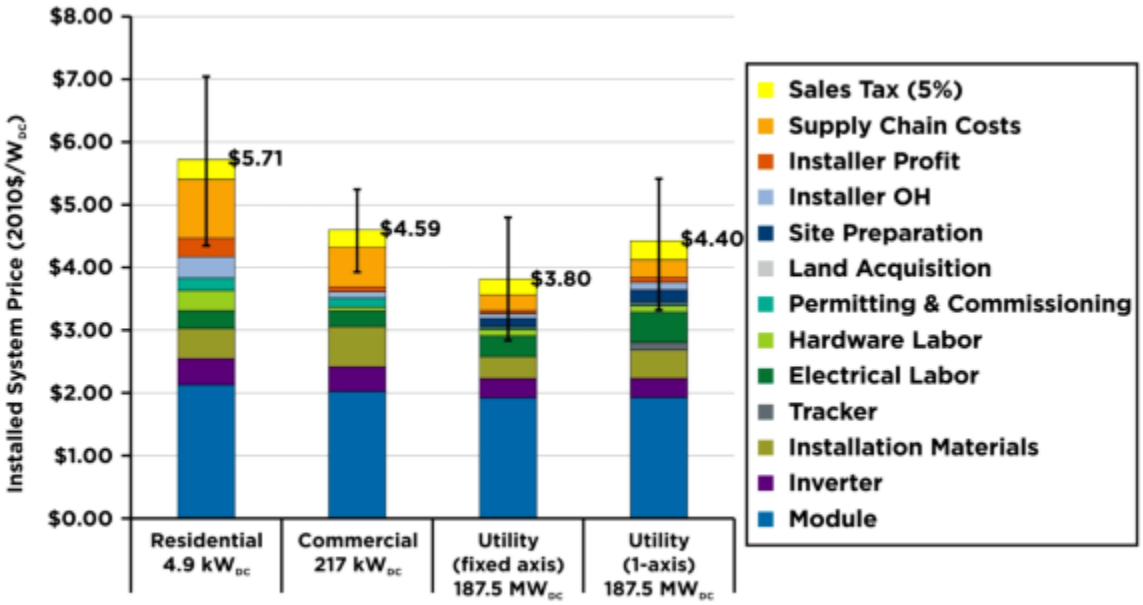
Options and Ideas Moving Forward

Options and Ideas Moving Forward

- Need to comprehensively address the actual barriers to wide-spread implementation of DERs
  - Make them easier, faster, more convenient, less disruptive, flexible, etc.
  - One Stop Shop program designs
  - Trigger Point program strategies
    - Time of Sale, Renovation or Energy Rate change
  - Over-time retrofits, with planning and implementation support
  - Standardized packages and approaches, NOT optimized
    - Marginal value of contractor familiarity, reliability and serviceability will outpace any marginal cost-performance benefit
    - Need to find sweet spot between Standardized and Individualized

DOE RBI Funding of DER Cost-Stacks and Research Prioritization

- Modeled on successful SunShot program by DOE
  - 75% reduction in installed PV costs
- DER work will inform targeted DER research strategy in upcoming years



Source: Goodrich et al. (2012)

DOE RBI Funding of DER Cost-Stacks and Research Prioritization

- Tasks
  - **Literature review** of US and international DER programs, market assessments
  - Develop **reproducible cost-stack methodology** to guide future research funding
  - **Create baseline cost-stacks** for present-day Deep Retrofits in the US
  - **Survey of DER contractors** and associated professionals to identify research opportunities
- May include time burdens along with costs

DOE RBI Funding of DER Cost-Stacks and Research Prioritization

- To help support DER R&D at the Federal level
- Please provide your valuable input:

- Brennan Less
  - bdless@lbl.gov
- Iain Walker
  - iswalker@lbl.gov

Options and Ideas Moving Forward, Contd

- Different types of DERs with more Consumer Benefits
  - Minimum disruption retrofit
  - Low risk retrofit
  - Smart home retrofit
  - Resilient retrofits (power outage resilience, etc.)
  - Contractor-friendly retrofit - designed around familiarity, durability, longevity
    - Current Code retrofit
  - Grid responsive retrofits
  - Water, carbon …
- Role of PV, electrification, car charging, thermal/battery storage
  - How can we still get most (but not all) of the thermal comfort, IAQ/health, durability and other co-benefits?

European Panelized Approaches

- Energiesprong – Panelized retrofits
- Complete reskinning – best for uniformly shaped buildings
  - Integrate walls, windows, HVAC
  - Questions remain about moisture considerations
- Integrate financing, planning, contracting, etc. Simplify for owners/occupants. Make it one decision. ONE STOP SHOP.

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- Panelized retrofit activity in US
  - RMI REALIZE initiative
  - NYSERDA RetrofitNY, 10-years, $30 million
  - California, $7.2 million to operationalize a market facilitation platform to deliver Energiesprong-type projects.

THANK YOU

- **Let us know if you want to contribute to current DOE Cost-Stack Assessment and Contractor Survey**

- Brennan Less
  - bdless@lbl.gov
- Iain Walker
  - iswalker@lbl.gov

- Residential Building Systems Group
- Indoor Environment Group

Rick Wertheim

United Way Long Island

U.S. DEPARTMENT OF ENERGY

United Way of Long Island

Deep Energy Retrofit

From the Outside – Circa 1890's Colonial

Rick Wertheim **Senior VP Housing & Green Initiatives**

Organizational Mission

United Way of Long Island

"Develop Healthy, Durable Energy Efficient Housing for the Special Needs and affordable Housing Sector on Long Island, New York."

Performance

United Way of Long Island

Comfort and Health

Basic Project Parameters

United Way of Long Island

1. Take an older home that uses a lot of energy and is drafty and uncomfortable and convert it into a “High Performance” Energy Efficient home with low operational costs
2. Augment existing oil fired steam boiler with cast iron radiators with new state of the art Air Source Heat Pumps
3. Produce significant Building Envelope improvements
4. ALL without disturbing the interior of the home or disruption of occupancy

Existing conditions

United Way of Long Island

1. House was originally Masonry Stucco over lathe on plank skip sheathing with NO insulation and Plaster interior walls
2. Prior owner had “resided” the home with Vinyl Siding and fanfold “insulation” and re-roofed the home to attempt comfort solutions
3. Next attempt was to change out existing windows with more efficient Vinyl Replacement Windows
4. Owner after raising a family was unable to remain in the home due to his fixed income and outrageous operational costs.
5. House purchased by United Way for the Deep Energy Retrofit

Grand Winner

U.S. Dept. of Energy

“Housing Innovation Award”

Affordable Housing Category

Take our New Construction Methodology…

Apply it to a Deep Energy Retrofit!

United Way of Long Island

Plan for Retrofit

United Way of Long Island

1. “Gut” the home from the outside to achieve building envelope improvements
2. Leave existing vinyl replacement windows, as they were replaced recently
3. Plan a PV solar Array for south facing renewable energy
4. Leave existing steam boiler and cast iron radiators for historical aesthetics and back-up heat
5. Install 2 separate Air Source Heat Pumps – medium static, ducted.
6. LEAVE the interior alone. Re-Paint and floor refinishing only improvements done inside

Wall Retrofit – Priority One

United Way of Long Island

1. Remove Vinyl Siding
2. Chip away all of the Masonry Stucco
3. Repair any sheathing defects
4. Drill and Dense Pack with Cellulose (R-12.6)
5. “Outsulate” and provide new continuous air barrier and WRB with Zip R-Sheathing and attached 1.5” foam. (R- 6.6)
6. LEAVE the interior alone. Re-Paint and floor refinishing only improvements done inside
7. New siding to be PVC clapboard and PVC trim
8. Total R Value Wall = R-20

Shell

Remove exisiting siding

Shell

United Way of Long Island

Expose Stucco

Shell

United Way of Long Island

Expose Stucco

Shell

Expose Stucco

Rear

Shell

Repair Defects

Rot at corner

United Way of Long Island

Shell

United Way of Long Island

Prepare for Dense Pack

Shell

United Way of Long Island

Prepare for Dense Pack

Drilling holes

taping holes to keep out weather until cavity is filled

Shell

United Way of Long Island

Prepare for Dense Pack

Rear

Shell

United Way of Long Island

Install Zip R-Sheathing

Shell

United Way of Long Island

Install Zip R-Sheathing

Shell

United Way of Long Island

Install Zip R-Sheathing

Rear

Starting to tape seams

Shell

Install Zip R-Sheathing

Details

Water table

Windows

United Way of Long Island

Shell

United Way of Long Island

Siding

Shell

United Way of Long Island

Siding

Done

Shell

United Way of Long Island

Siding

Done

Mechanical System–
Heat Pump for large home?

United Way of Long Island

Will this Work?

Factors that have Changed recently with Heat Pumps

United Way of Long Island

Performance has SIGNIFICANTLY improved

Panasonic *"EXTERIOS"* Cold climate model data…

Panasonic

Wall Mount Heat Pumps									
Model No.			XE9SKUA		XE12SKUA		XE15SKUA		
Unit Model No.			Indoor Unit CS-XE9SKUA	Outdoor Unit CU-XE9SKUA	Indoor Unit CS-XE12SKUA	Outdoor Unit CU-XE12SKUA	Indoor Unit CS-XE15SKUA	Outdoor Unit CU-XE15SKUA	
Performance & Electrical Ratings									
Capacity	Cooling	Btu/h	8,700 (2,800–12,000)		11,500 (2,800–14,000)		15,000 (3,300–19,000)		
	Heating	Btu/h	10,900 (3,000–18,000) (10,600 at 17°F)		13,600 (3,000–23,000) (13,500 at 17°F)		18,000 (3,300–24,000) (16,500 at 17°F)		
Moisture Removal	High	Pints/H	1.3		2.3		2.70		
Dry Air Flow	High	CFM	470		520		550		
SEER	Cooling		30.6		26.2		22.10		
EER	Cooling		17.05		14.7		12.50		
HSPF	Heating		14.0		12.5		12.00		
Power Supply	V, Phase, Hz		230/208V, 1PH, 60Hz		230/208V, 1PH, 60Hz		230/208V, 1PH, 60Hz		
Running Amps	Cooling	A	2.4 / 2.7		3.7 / 4.1		5.7 / 6.3		
	Heating	A	3.1 / 3.5		4.4 / 4.9		5.9 / 6.7		
Power Input	Cooling	W	510 (150–850)		780 (150–1,050)		1.20k (250–1.90k)		
	Heating	W	670 (150–1,650)		950 (150–2,100)		1.30k (200–2.65k)		
Back-up Heater		W	80		80		80		
Fuse or Circuit Breaker Capacity		A	15		20		25		

Factors that have Changed recently with Heat Pumps

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More Manufacturers

Some Models creating HEAT at -15 deg. F

Panasonic heating & cooling solutions

LG Life's Good

MITSUBISHI ELECTRIC

BOSCH

DAIKIN

FUJITSU

Halcyon HFI Hybrid Flex Inverter

Factors that have Changed recently with Heat Pumps

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More Configurations

Ductless

Factors that have Changed recently with Heat Pumps

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Ducted

Finished Installation - Attic

United Way of Long Island

Ducted with flex

Finished Installation - Attic

United Way of Long Island

Ducted with flex

4- 10” ports

Open Cell SPF Foam- Attic

United Way of Long Island

"Hot Roof"

Brings attic into conditioned space

10" = R-34

High Performance Details added

United Way of Long Island

Energy Recovering Ventilator

Lighting Controls

LED lighting

High Performance Details to be added

PV Solar will get deep energy retrofit project to “Near Zero”

PV Solar

High Performance Details added

Heat Pump Hot Water Heater

Summary

United Way of Long Island

- Deep Energy Retrofits costs *SHOULD* be assessed by Life Cycle Cost savings vs. First Costs
- This project has produced over 40% energy savings based upon improvements over original condition of home
- Comfort and health have been improved SIGNIFICANTLY
- New detailing will lower ongoing operational and maintenance costs for a not for profit housing agency to house and run health and human services for clients
- These improvements are sustainable and buffer the agency from energy spikes

Available Programs to guide you

United Way of Long Island

United Way of Long Island

Thank you

Questions: rwertheim@unitedwayli.org

Invest in what matters. Changing lives where you live.

Explore the Residential Program Solution Center

Resources to help improve your program and reach energy efficiency targets:

- Handbooks - explain *why* and *how* to implement specific stages of a program.
- Quick Answers - provide answers and resources for common questions.
- Proven Practices posts - include lessons learned, examples, and helpful tips from successful programs.
- Technology Solutions NEW! - present resources on advanced technologies, **HVAC** & **Heat Pump Water Heaters**, including installation guidance, marketing strategies, & potential savings.

https://rpsc.energy.gov

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