• 33-year-old home
• All-electric
• 5,343 heating degree day (HDD) climate
• 2,500 ft²
• Full basement (unconditioned)
2007-08 Energy Upgrades

- New SEER-18 two-stage heat pump (Sept ’07)
- CFL or LED bulb replacements
- New high-performance kitchen appliances (Dec ’08)
- 40% energy reduction - enough to counter anticipated rate increases...
Then - The Unexpected

- Severe hail storm with damage to home + $ insurance settlement
- Loss of large tree in south-facing back yard + $ incentives for solar "equals"

- An opportunity for a much deeper reduction in energy use & CO$_2$!
Home’s energy performance was enhanced by adding insulation under the new siding & window replacement. Attic insulation was increased to R-49 (April 2009).
New 1” insulation (R-5)

Note: At the time of this upgrade, the product literature cited a much higher R-value per inch.
Richard Sword (green hat) was a craftsman, not a contractor. His attention to detail on the exterior insulation contributed to the energy performance of the Mackeys’ home.

The cost of the one-inch exterior insulation was $3,800; the full siding job cost $17,000.
11 existing thermo-pane windows & 1 door were replaced with high-performance (U.18) triple-pane windows.
Lots of NW facing windows.

*Thank goodness for summertime shade!*
Original door/side lites were built in 3 sections; new insulated door – one big piece
Front of house in progress. New 1” insulation board over old Thermo-ply. New windows on first floor; second floor not replaced yet. Siding removal, new windows, rigid insulation & new siding carefully staged – one wall at a time.
Carefully fitting & taping rigid insulation.

Replacing windows & siding simultaneously provides opportunity for proper drainage plane.

(www.buildingscience.com)
Dec 23, 2009 – PV system operational & certified!
The Mackeys paid to have the snow cleared off the PV panels once; They let the sun melt it off from then on.

355 days/year the system produces electricity. It does not need to be a sunny day.
1st time in Borough’s history that PV produced enough electricity to power a house for 24 hours.

To date, there have been 10 months when the Mackeys have exported power to grid – producing more than they use.
>10% Return on Investment (PV Installation)

**Cost of PV**
- 24,000 (after taxes & grants)

**Solar Renewable Energy Credit (SREC)**
- 2010 - $2,105
- 2011 - Banking them

**Referral bonus from PV Installer**
- 2010 - $2,000
- 2011 - $3,000

**Produced to Date**
- 13,910 kWh

**Value of Electricity**
- ~$1,500

**Plus**
- 8,000 miles/year without buying gas
(Right) SMA Inverter – AC/DC inverter – Display shows daily production, production to date, & CO$_2$ reduced.

(Left) Box on left transmits signal to SunPower to provide for performance info on the web.
PV panel on house roof; solar hot water system installed on the garage roof in May 2010.
Solar thermal evacuated tube collector
Trees outside fence will provide privacy screen, but will not block solar systems.

(Left) Gazebo (& potting shed) – enhances outdoor living.
Solar Thermal System for Water Heating

Lifetime guarantee on stainless steel tank!

Black box is the motor; also displays incoming & outgoing water temperatures.
Two Fujitsu ductless heat pumps (indoor unit above) were installed July 2011, providing better control over comfort with less energy.
New Chevy Volt purchased in Sept 2011. Additional PV panels added to provide electricity needed to drive 8,000 miles/year on free sunshine.
eMonitor™
Online results from 30 circuits – both instantaneous & over time!

Where I've used electricity in the past 30 days

- 1st floor Fujitsu: $27
- Water heater: $12
- Volt Charging: $7
- Master Bedroom TV: $5
- 1st floor TV room: $5
- Bryant SEER 18: $0
- Dishwasher: $0
- Kitchen Wall Out: $0
- Office Upstairs: $1
- Basement Rec Room: $1
- Solar Hot Water: $0
- Microwave, Garage: $1
- Range: $1
- Dryer: $2
- Raydon Vac: $3
- Washer, Downstairs: $3
- Refrigerator: $4
- 2nd floor Fujitsu: $5
Thousand Home Challenge

To lay the foundation for transforming North American homes by demonstrating the potential for greater than 70% energy reductions in 1,000 existing homes.

Linda Wigington, ACI
lwigington@affordablecomfort.org, 724-852-3085
www.thousandhomechallenge.org; www.affordablecomfort.org;

Home Energy Pros THC Group
http://homeenergypros.lbl.gov/
Meeting the Thousand Home Challenge

- This home’s customized threshold to meet or exceed is 6488 kWh/yr. (Threshold Allowance OPTION B)
- Meeting the 1000 Home Challenge requires documentation of one year of consumption/production verifying actual net site energy use is less than 6488 kWh.
- Full PV generation counts as a credit.

OPTION B Assumptions: 2,500 ft² finished floor area (FFA); Harrisburg Capital weather station – 5,343 HDD; 2 occupants; & 100% electric heat

NOTE: THC OPTION A (75% reduction from immediate previous use) was not used because actions were taken over several years.
Beat 1000 Home Threshold by 3,500 kWh!

Mackey Household Annual Energy Use (kWh)
Pre & Post Compared to Threshold Allowance

PRE-USE (2007)
25,308

THC THRESHOLD
Option B, Electric Heat
6,488

POST - (No PV)
May 2010 - April 2011
9,645

POST - NET kWh (With PV Credit - 6332 kWh)
May 2010 - April 2011
2,696

Over 82% reduction from 2007 energy use!
Do Differently?

- Buy American
- Have energy audit with BPI-certified professional first (e.g., air seal attic prior to insulating)
It Takes a Team!

- Travis Arsparger, Climate Control, Fayetteville, PA (www.climatecontrolpa.com)
- West Shore Windows and Doors, Mechanicsburg, PA (www.westshorewindows.com)
- Advanced Solar Industries (ASI), Lancaster County, PA
- Rosenberry Electric, Chambersburg, PA
- Bill Mooney, Appalachian Energy of Gettysburg, PA (AppalachianEnergySystems@comcast.net)
- Wade Martin, Waynesboro, PA (Radon mitigation)
- Jon Kautz, Carlisle, Energy Smart Home Improvement, Boiling Springs, PA
- J.K. Mechanical, Lancaster County, PA (eMonitor)
- PA Code Inspection Services
- The Borough of Chambersburg Master Electricians & Plumbing Inspections

Special thanks to the late Richard Sword, a true craftsman
Products & Systems Used

- Bryant Evolution Series heat pump – www.bryant.com
- Park Avenue Windows – www.parkavenuewindows.com/
- SunPower USA (PV) – www.Sunpower-usa.com
- eMonitor™ – www.powerhousedynamics.com/

¹The inclusion of products & manufacturers on this list should not be interpreted as an endorsement.
Access to Resources

- Affordable Comfort, Inc. (ACI) – www.affordablecomfort.org
- Building Science Corp. – www.buildingscience.com
- Consumer Reports – www.ConsumerReports.org
- DSIRE (Data Base of State Incentives for Renewable Energy) – www.dsireusa.org
- Efficiency First – www.efficiencyfirst.org
- Energy Star Most Efficient! www.energystar.gov/index.cfm?c=most_efficient.me_index
- PA Home Energy – www.pahomeenergy.com
- Top Ten – www.toptenusa.org/
- RMI (Rocky Mountain Institute) – www.rmi.org
Bottom Line

- **Significant drop in CO\textsuperscript{2} emissions\textsuperscript{1}**
- **Stimulate local economy:** paying contractors & supporting local business
- **Great improvement** – house & comfort
- **Impressive return on my investment**
- **Greater resilience** – hedge against uncertainty

\textsuperscript{1}www.epa.gov/climatechange/emissions/ind_calculator.html
This project demonstrates that it is possible NOW to significantly reduce our dependence on nonrenewable energy sources, create millions of green jobs, and protect future generations from the devastating consequences of global climate change.

I am committed to the goal of achieving this by our nation’s 250th birthday celebration, July 4, 2028 so we once again serve as a beacon of light and hope to the rest of the world.

Wayne Mackey
Surprises? 

Oops – radon! (Fixed)

Missed opportunities – Why didn’t more folks improve homes—energy efficiency & resilience with insurance $

We tend to take energy for granted

Really big reductions possible

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