Mackey Deep Energy Reduction Case Study

Chambersburg, PA

The 5th home in North America to officially meet the Thousand Home Challenge!

Wayne Mackey

Feb 1, 2012

- 33-year-old home
- All-electric
- 5,343 heating degree day (HDD) climate
- 2,500 ft^2
- 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

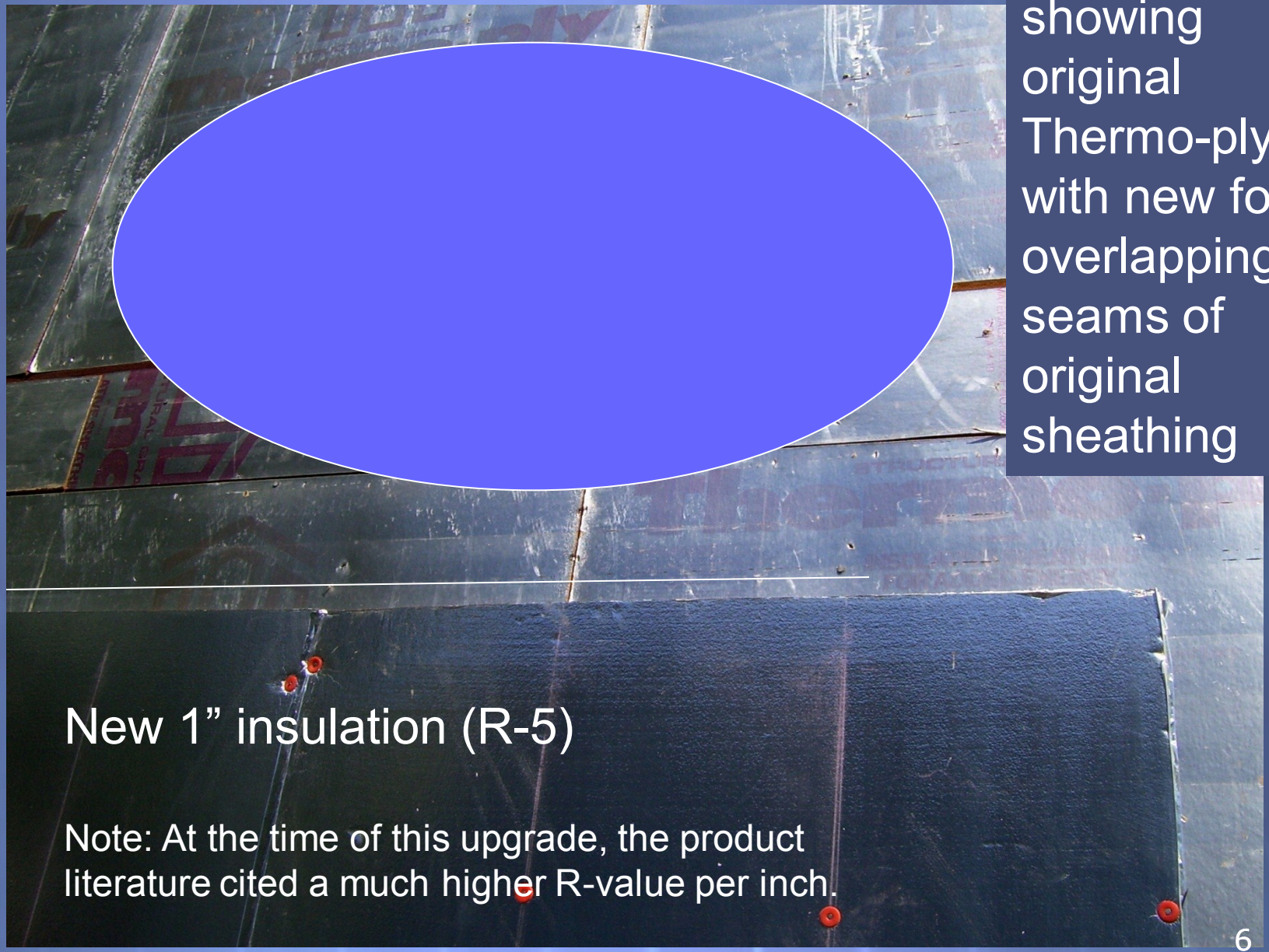
- **Severe hail storm** with damage to home + $ insurance settlement
- **Loss of large tree** in south-facing back yard + $ incentives for solar

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).

House with siding removed; ¼" Thermo-ply was original sheathing – Significant gaps at seams due to shrinkage.



Exterior wall showing original Thermo-ply with new foam overlapping seams of original sheathing

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.

Front of Home as Work Begins

(windows, exterior insulation, siding)

Lots of NW facing windows.

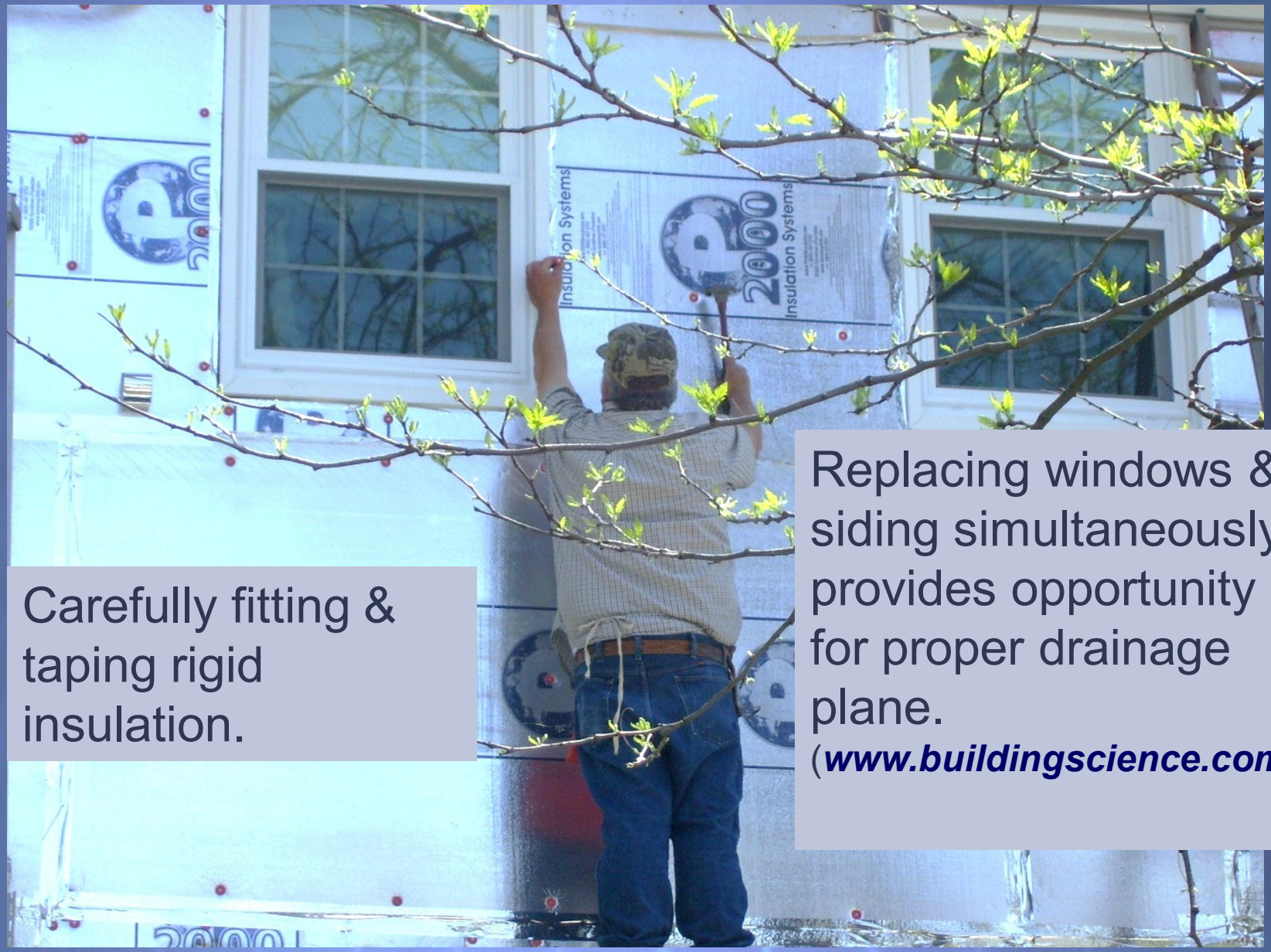
Thank goodness for summertime shade!

Original door/side lites were built in 3 sections; new insulated door – one big piece

Southwest Side

Northeast Side

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.



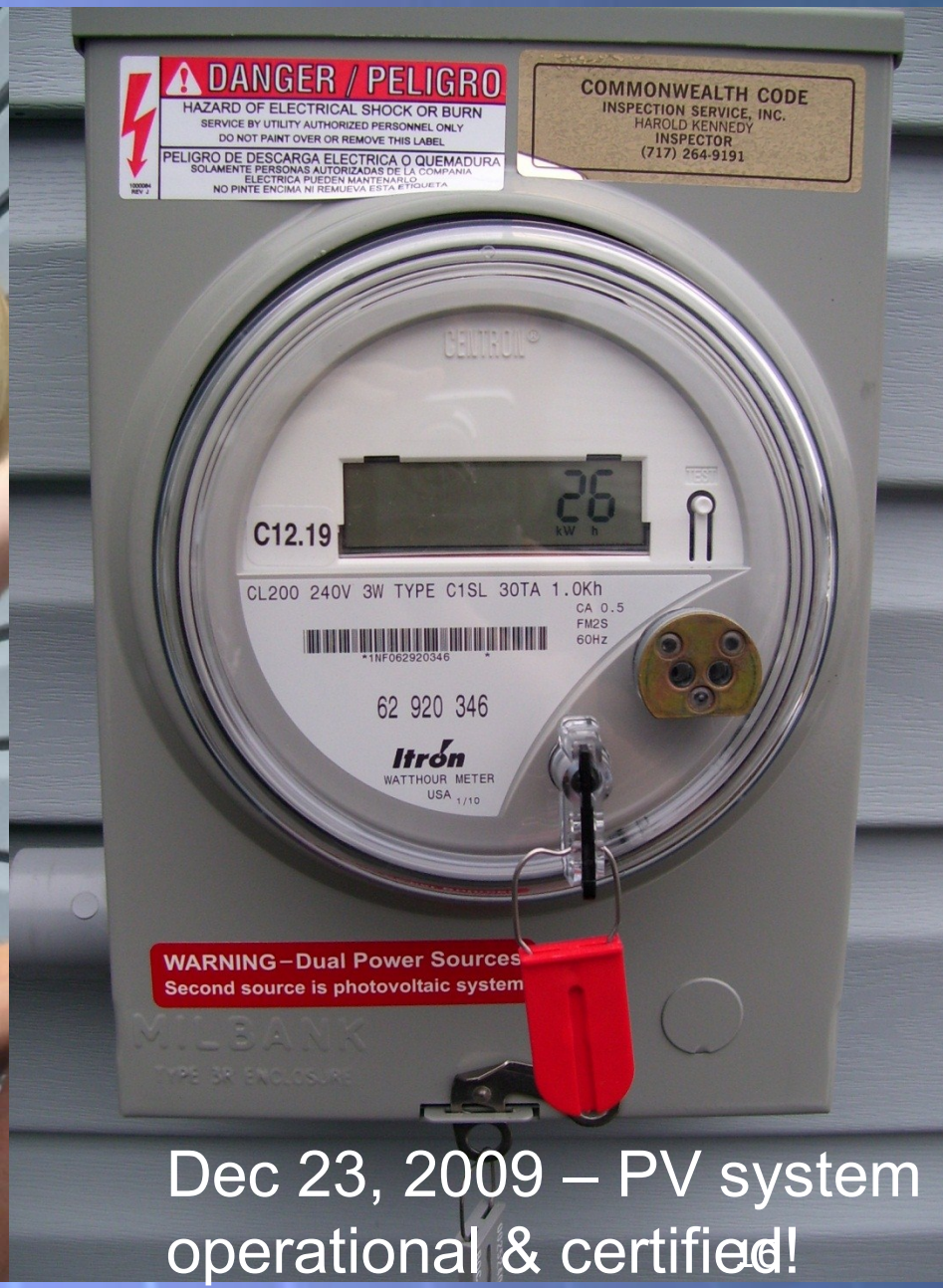
Carefully fitting & taping rigid insulation.

Replacing windows & siding simultaneously provides opportunity for proper drainage plane.
(***www.buildingscience.com***)

Beginning of 5.4 KW solar photovoltaic installation (Oct 2009). Complete & operational on Dec 23, 2009

October 2009

Josh & Daniel



Dec 23, 2009 – PV system operational & certified!

355 days/year the system produces electricity. It does not need to be a sunny day.

The Mackeys paid to have the snow cleared off the PV panels once; They let the sun melt it off from then on.

March 9, 2008!

- 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)

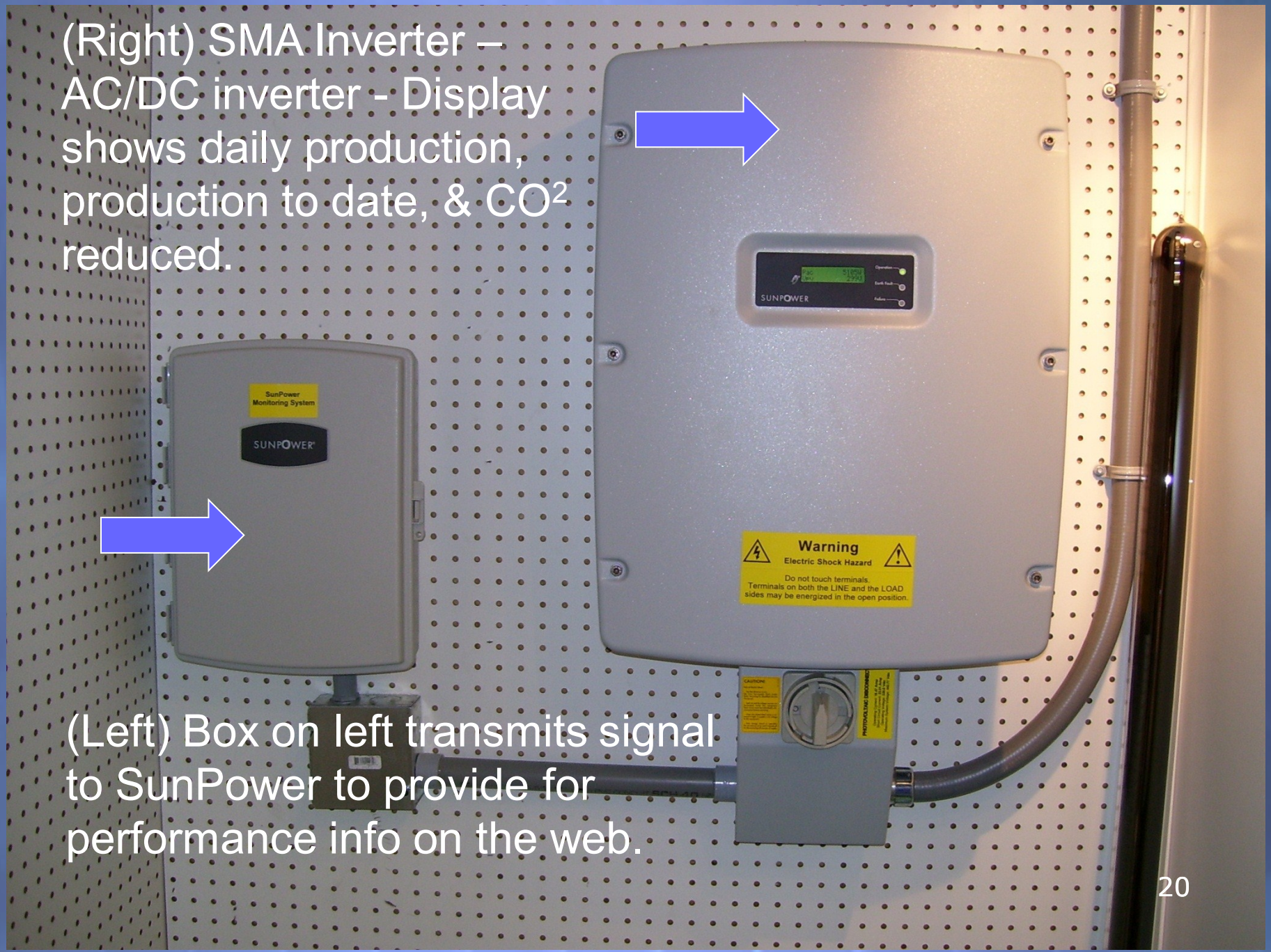
Solar Renewable Energy Credit (SREC)
- 2010 - $2,105
- 2011 - Banking them

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

Produced to Date
- 13,910 kWh

Value of Electricity
- ~$1,500

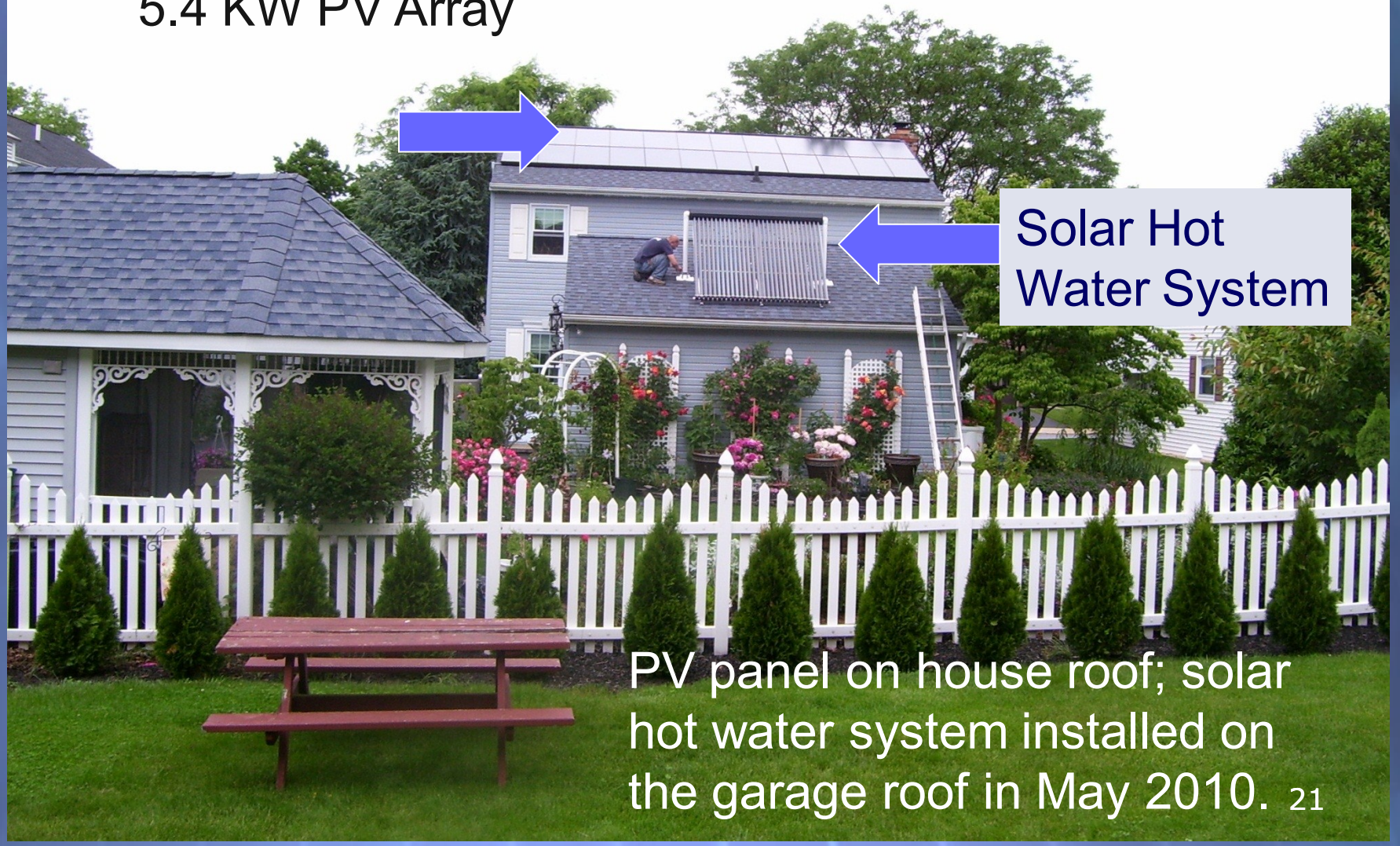
Plus
- 8,000 miles/year without buying gas



(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.

5.4 KW PV Array



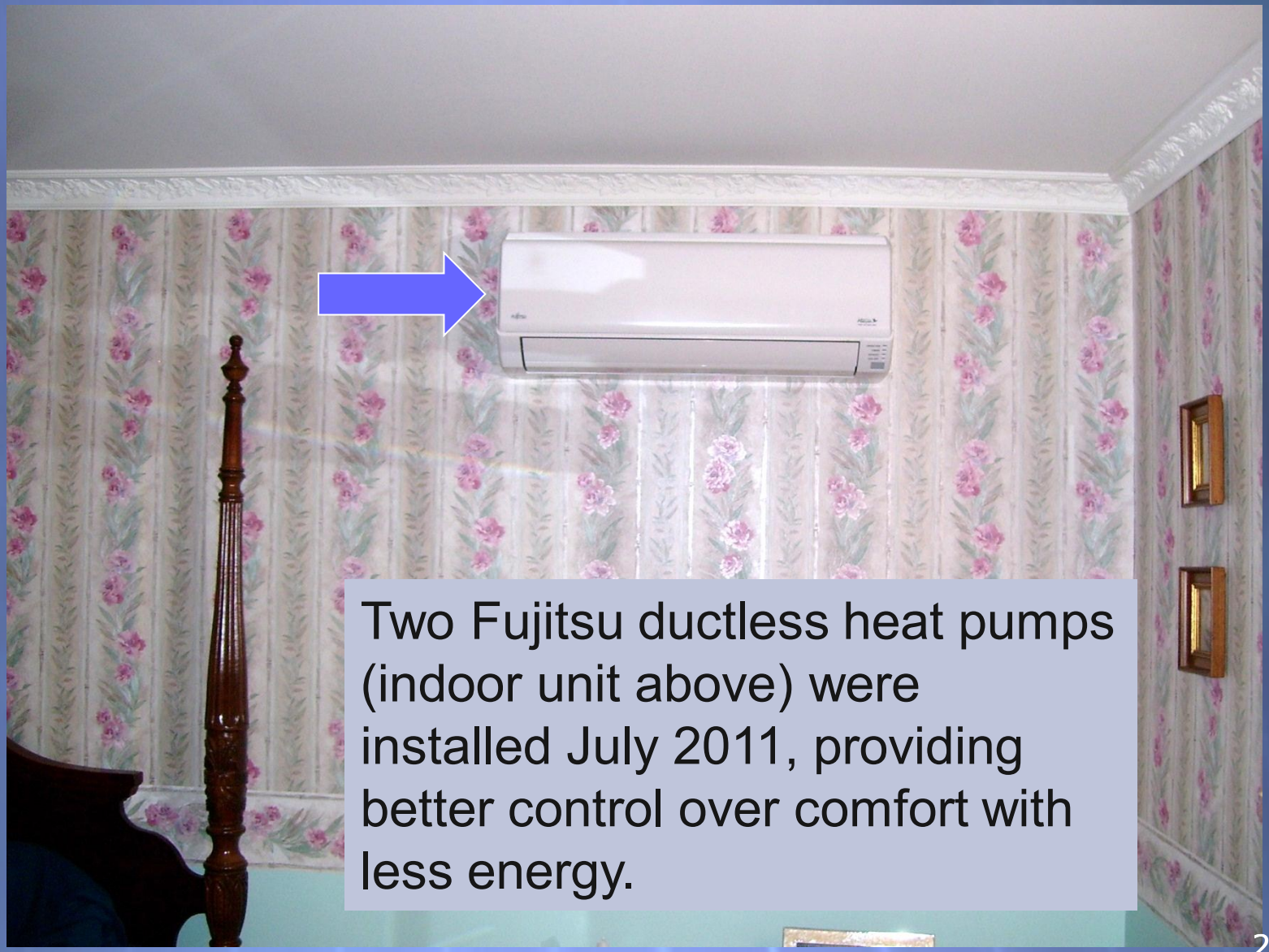
PV panel on house roof; solar hot water system installed on the garage roof in May 2010.

Solar thermal evacuated tube collector

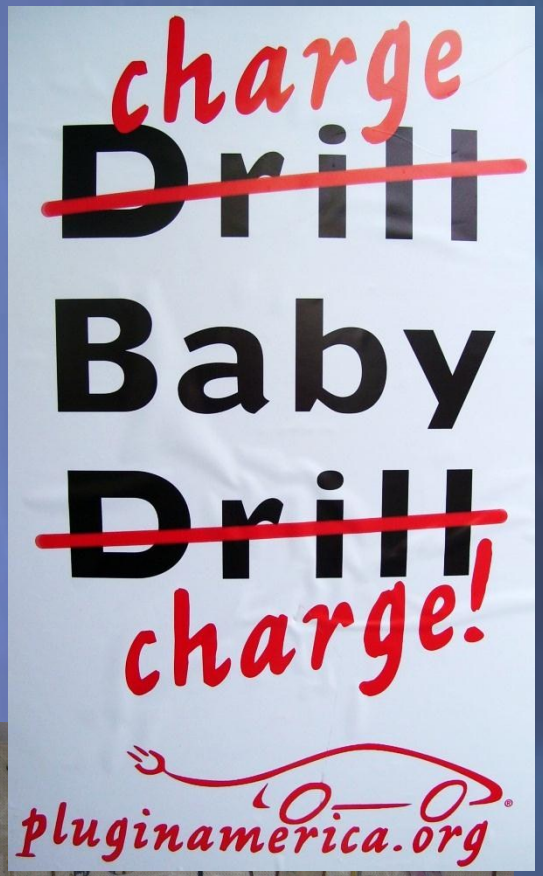
(Left) Gazebo (& potting shed) – enhances outdoor living
Trees outside fence will provide privacy screen, but will not block solar systems

Solar Thermal System for Water Heating

Black box is the motor; also displays incoming & outgoing water temperatures.



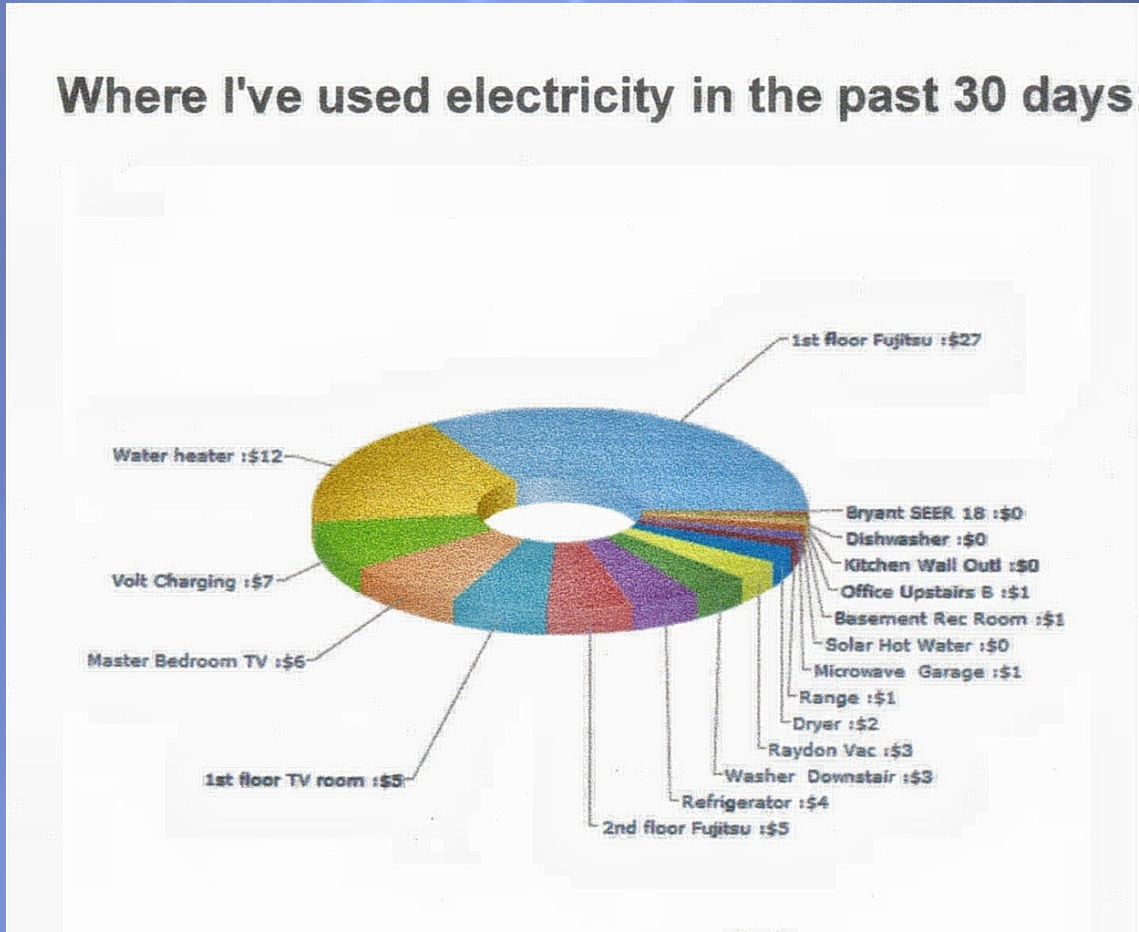
Two Fujitsu ductless heat pumps (indoor unit above) were installed July 2011, providing better control over comfort with less energy.



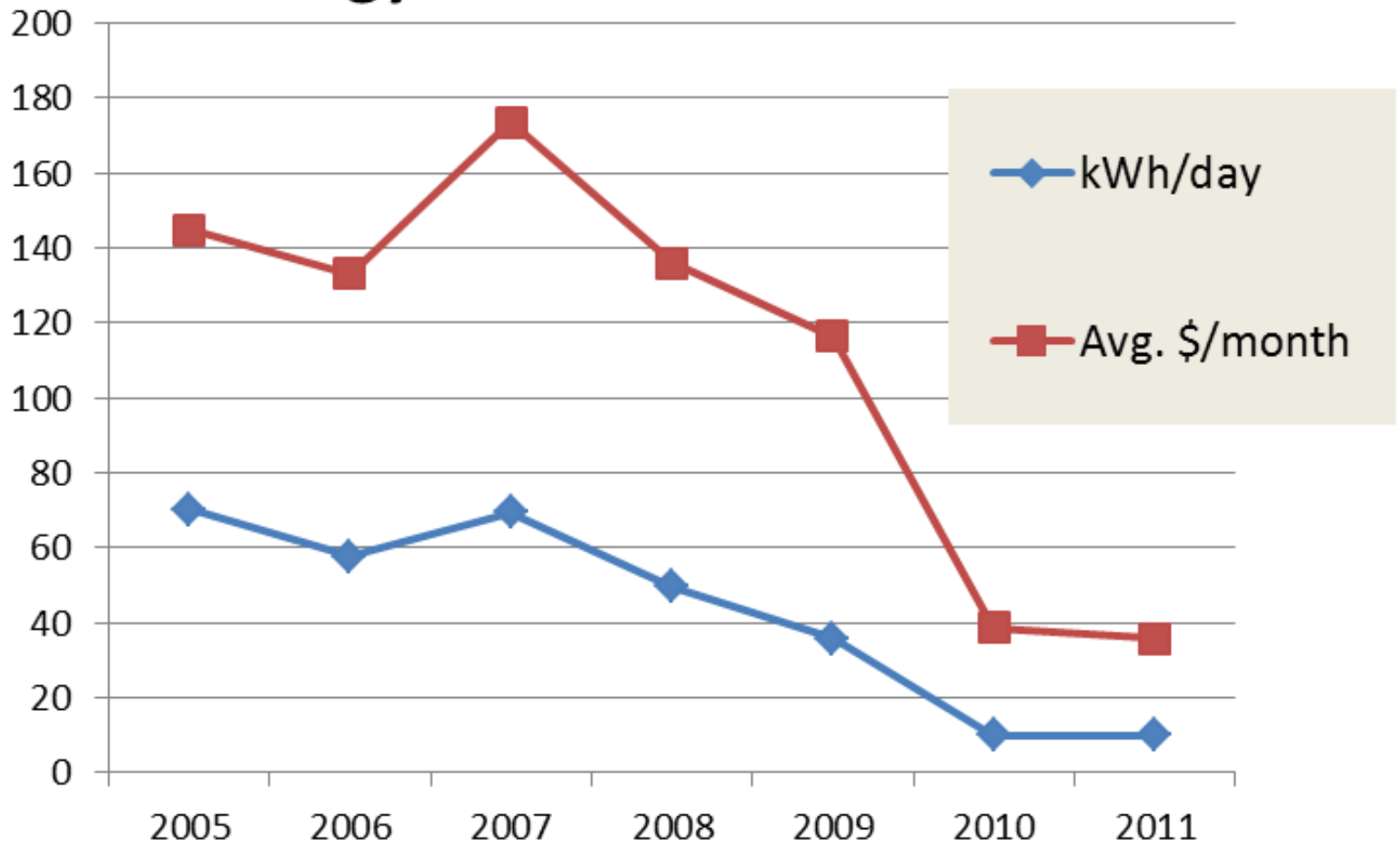
New Chevy Volt purchased in Sept 2011. Additional PV panels added to provide electricity needed to drive 8,000 miles/year on free sunshine.

eMonitor™

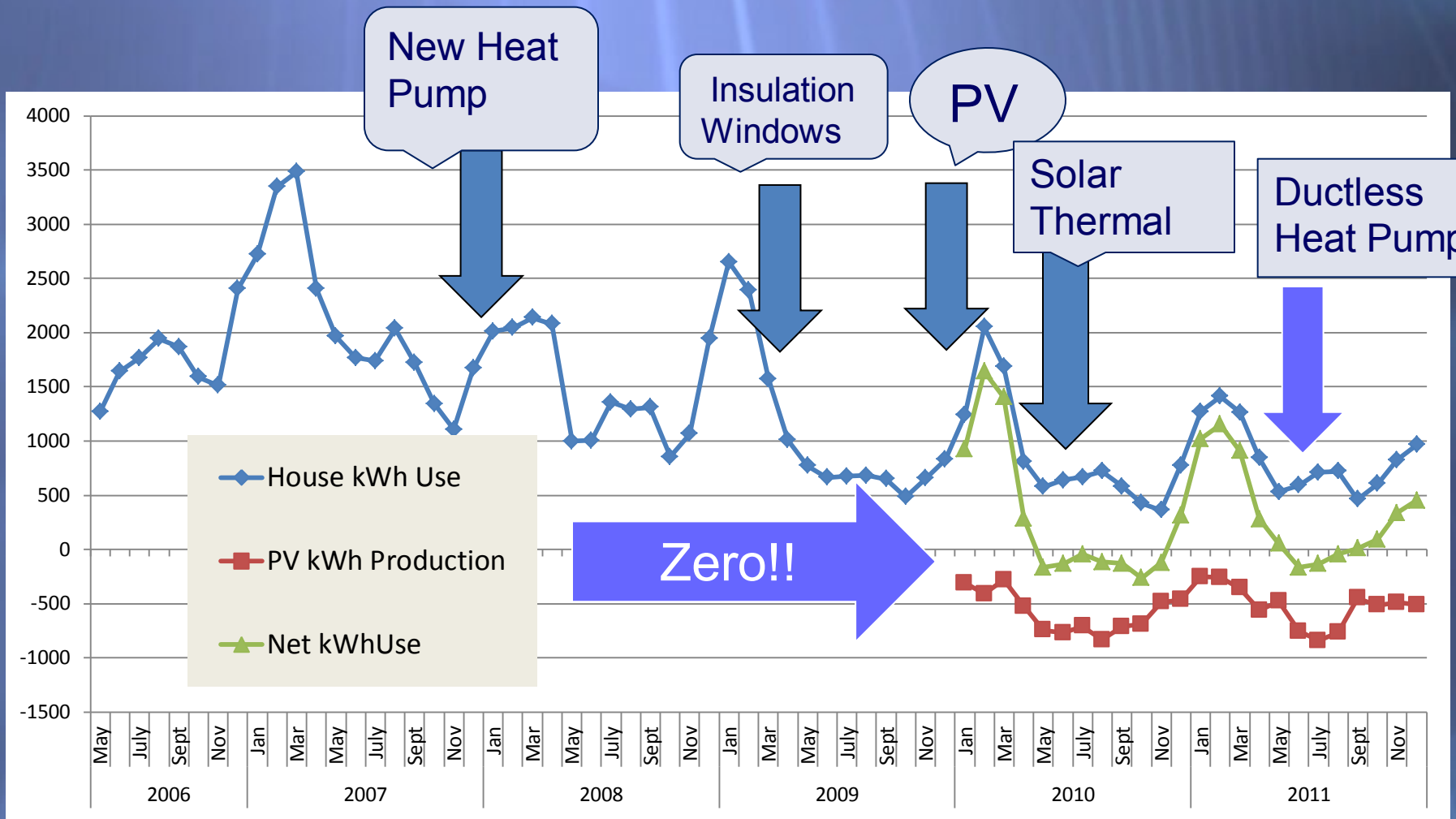
Online results from 30 circuits – both instantaneous & over time!



Mackey Home
Energy Use & Cost Over Time



Monthly Energy Use Over Time (kWh)



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.

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http://homeenergypros.lbl.gov/

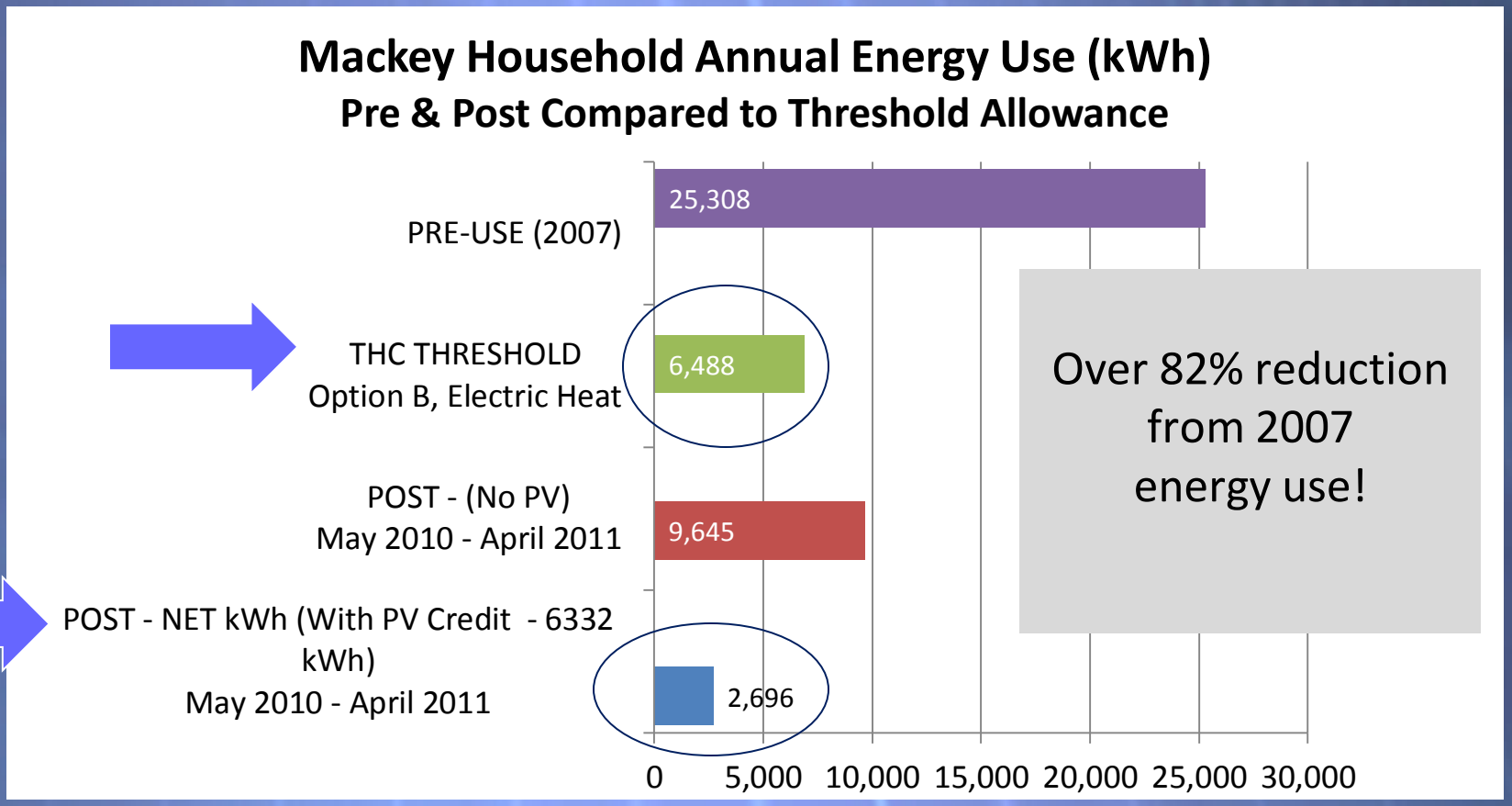
Meeting the Thousand Home Challenge

- 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 ft^2 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!



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 Arnsparger, 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[1]

- Bryant Evolution Series heat pump – www.bryant.com
- Park Avenue Windows – www.parkavenuewindows.com/
- SunPower USA (PV) – www.Sunpower-usa.com
- Heat Transfer Products, Solar Thermal Hot Water System – www.htproducts.com/solar.html
- Fujitsu Ductless Heat Pump – www.fujitsugeneral.com/
- Chevy Volt – www.chevrolet.com/volt-electric-car/
- eMonitor™ – www.powerhousedynamics.com/

[1]The inclusion of products & manufacturers on this list should not be interpreted as an endorsement.

Access to Resources

- Affordable Comfort, Inc. (ACI) – www.affordablecomfort.org
- Better Business Bureau – www.bbb.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
- EPA Energy Star – www.energystar.gov
- Keystone Help – www.keystonehelp.com
- NREL (National Renewal Energy Laboratory) – www.nrel.gov
- PA Home Energy – www.pahomeenergy.com
- Thousand Home Challenge – www.ThousandHomeChallenge.org
- Top Ten – www.toptenusa.org/
- RMI (Rocky Mountain Institute) – www.rmi.org

Bottom Line

- **Significant drop in CO^2 emissions[1]**
  2005: **27, 797 lbs.** 2011: **3,762 lbs.**
- **Stimulate local economy:** paying contractors & supporting local business
- Great **improvement - house & comfort**
- Impressive **return on my investment**
- **Greater resilience** – hedge against uncertainty

[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

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