

Southeast Elevation  
After 2005 Remodel

# The First California Home to Officially Meet the Thousand Home Challenge

Ellen & George Beeler

Live/Work Building Rehabilitation

1940 Vintage - Petaluma, CA

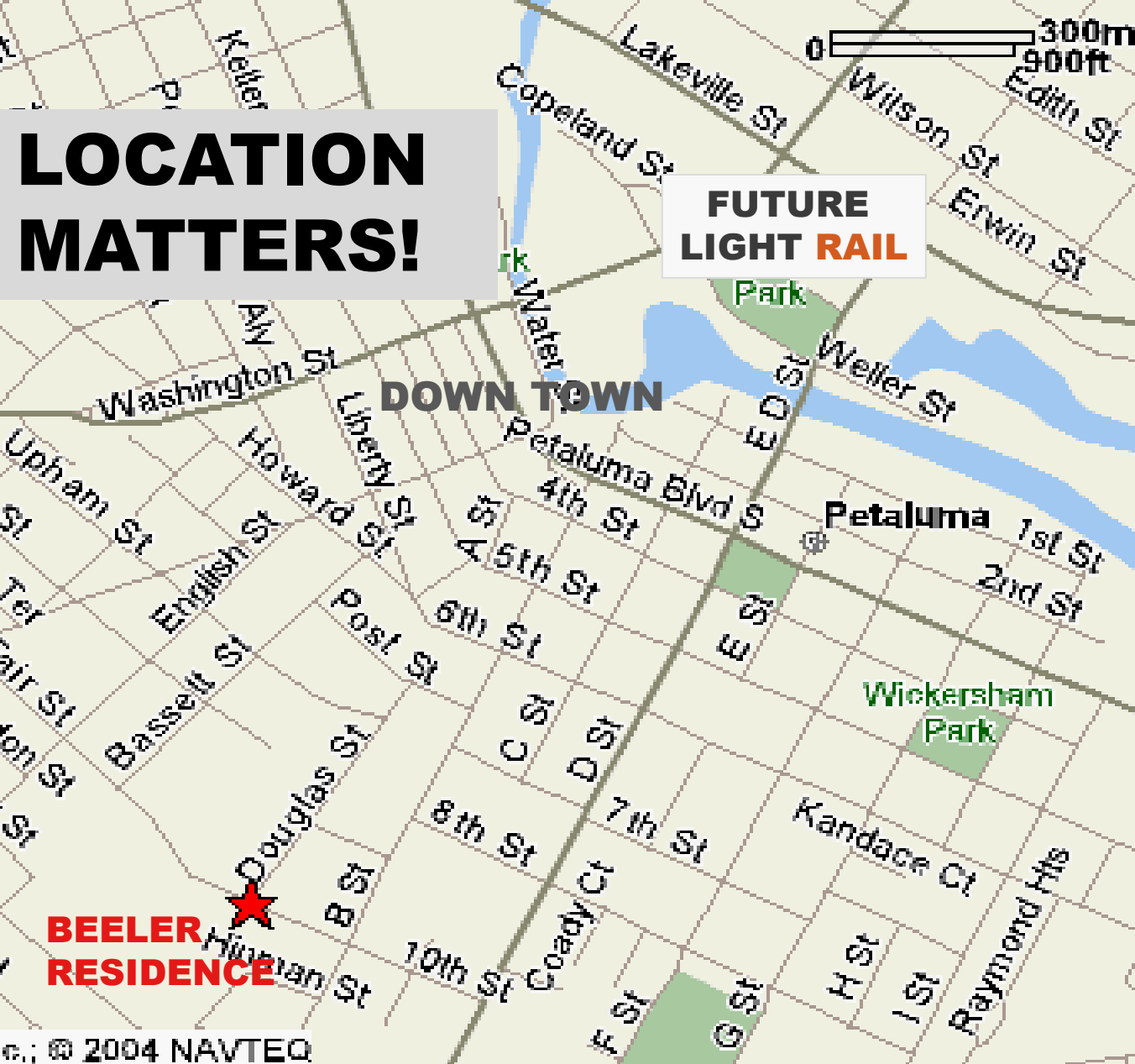
AIM ASSOCIATES

**In 1997, we decided to get serious about living a green lifestyle. We bought an existing house worthy of rehabilitation, in town to reduce use of our cars.**

**BEELER FAMILY PORTRAIT** by Emily Vincent 5/2010  
George holding Rudy and Ellen holding Iggy



# LOCATION MATTERS!



**FUTURE LIGHT RAIL**

**DOWN TOWN**

**BEELER RESIDENCE**

**Location is critical to a green lifestyle**

**Rehabilitate existing building**

**Or use infill site**

**To reduce driving, be close to:**

- Work**
- Schools**
- Friends**
- Groceries, etc.**
- Able to walk & bike**

**Utilize existing infrastructure**

**Avoid destruction of habitats**

**Avoid destruction of farm land**

© 2004 NAVTEQ

## LOCATION • ELLEN & GEORGE BEELER LIVE/WORK REMODEL

# WHERE WE BEGAN 1997

**Typical  
Neighborhood Bungalow**



**Beeler House  
Pre-purchase**



**Southwest View**

# 1998 FIRST PHASE: EXTENSIVE REMODEL

**Goal: Reduce Energy Use ~75%**



## Starting Condition

- No insulation, single-glazed windows, some moisture problems

## Actions Taken

- R-30 cellulose attic insulation
- R-13 dense pack cellulose wall insulation main floor (2x4 studs)
- R-20 dense pack cellulose wall insulation ground floor (2x6 studs)
- Low-E<sup>2</sup> glass in fiberglass frames (all but one)

# 1998 FIRST PHASE: EXTENSIVE REMODEL

**Goal: Reduce Energy Use ~75%**

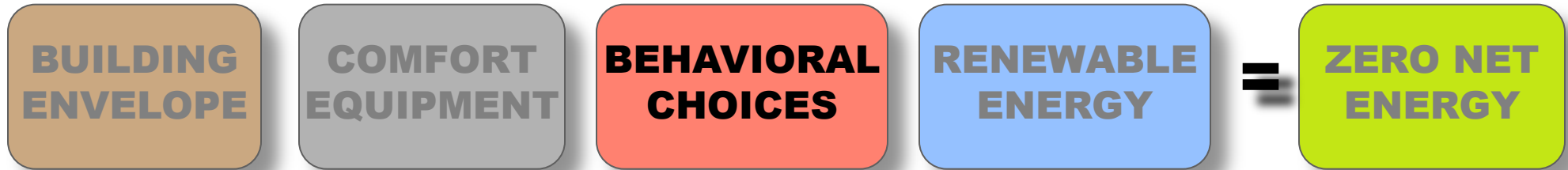


## Actions Taken

- Replaced ~60% furnace 96% condensing sealed combustion natural gas furnace
  - Two-stage burner
  - High-efficiency variable speed blower
  - Zone control
- Multi-set back thermostat
- Replaced conventional water heater with tankless gas water heater
- Energy Star appliances (top 10% of Energy Star)
- Laptop computer & LCD displays for other computers
- Nearly all fluorescent or CFL lighting
- Whole-house fan for night cooling

# **1st PHASE: 1998 PURCHASED BUILDING - EXTENSIVE REMODEL**

## **Energy Efficiency Features to Reduce Energy Use ~75%**



## **Actions Taken**

- **Pay attention to all resource use**
- **Frequently adjust thermostat**
- **Operate to maximize solar gain or passive cooling**
- **Turn off lights, computers, & entertainment devices**
- **Wait for full loads for dishwasher & clothes washer**
- **Use solar clothes dryer = clothes drying lines**

Based on standard U.S. Government tests

# ENERGYGUIDE

REFRIGERATOR-FREEZERS WITH  
AUTOMATIC DEFROST WITH TOP-MOUNTED  
FREEZER WITHOUT THROUGH-THE-DOOR  
ICE SERVICE

CAPACITY: 18.5 CUBIC FEET



MODELS: MTB1956AEA  
MTB1956AEW, MTB1956AEB

**Compare the Energy Use of this Refrigerator  
with Others Before You Buy.**

**This Model Uses**

527 KWh/Year

*-29% 1998 now avail 387 = -47%*

**Energy use (kWh/year) range of all similar models**

**Uses Least  
Energy**

533

**Uses Most  
Energy**

732

kWh/year (kilowatt-hours per year) is a measure of energy (electricity) use. Your utility company uses it to compute your bill. Only models with 18.5 to 20.4 cubic feet and the above features are used in this scale.

THE ENERGY COST OF THIS MODEL WAS NOT AVAILABLE AT THE TIME THE RANGE WAS PUBLISHED.

**Refrigerators using more energy cost more to operate.  
This model's estimated yearly operating cost is:**

**\$46**

Based on a 1996 U.S. Government national average cost of 8.67¢ per kWh for electricity. Your actual operating cost will vary depending on your local utility rates and your use of the product.

Important: Removal of this label before consumer purchase is a violation of Federal law (42 U.S.C. 8302). 077563 . 009

**Energy Star Appliances  
(I looked at ACEEE appliance  
guide to find the most efficient  
models which would be in the  
top 10% of those qualifying for  
Energy Star)**

**Paying \$100 more for the  
refrigerator saved \$1,000 when  
the PV system was installed in  
the next phase**



## **EXISTING 60-YEAR-OLD WOOD WINDOW TRIM**

**Even if repaired, wood trim needs painting & sealing almost every year**

**The original 1940 wood windows were replaced by single-glazed aluminum windows in the 1970s**



# BEST PRACTICE WINDOW INSTALLATION



Photos from **Installing and Flashing Windows** by **Rob Moody**  
<http://www.finehomebuilding.com/how-to/install-replacement-windows-and-flashing-correctly.aspx>

## **CHALLENGE:**

### **Window replacement in stucco wall**

**Existing stucco ground  
smooth & primed**

**Applied elastomeric  
sealant under the flange  
& flashing tape over the  
flange**

**Recycled plastic (HDPE)  
trim installed to cover the  
flashing tape**

# ORIGINAL WINDOWS

# NEW WINDOWS 1998



# UNFINISHED BASEMENT DURING 1998 REMODEL



Black tar on wall was previous owner's attempt at waterproofing

## **EARTHQUAKE UPGRADE**

Anchor bolts @ 4' o.c.

Metal ties from top plates to floor sheathing

1/2" plywood on exterior walls & interior bearing walls

## **ENERGY UPGRADE**

Dense pack R-20 cellulose (2x6) wall stud spaces

R-7 EPS insulation boards added to outside of concrete foundation walls

Milgard windows with fiberglass frames & Cardinal LoE<sup>2</sup>-272<sup>®</sup> glazing using argon fill



**GOOD WORKMANSHIP!**

**No settling!**

**No voids!**

**1998 - Dense pack  
cellulose insulation  
blown into exterior walls**

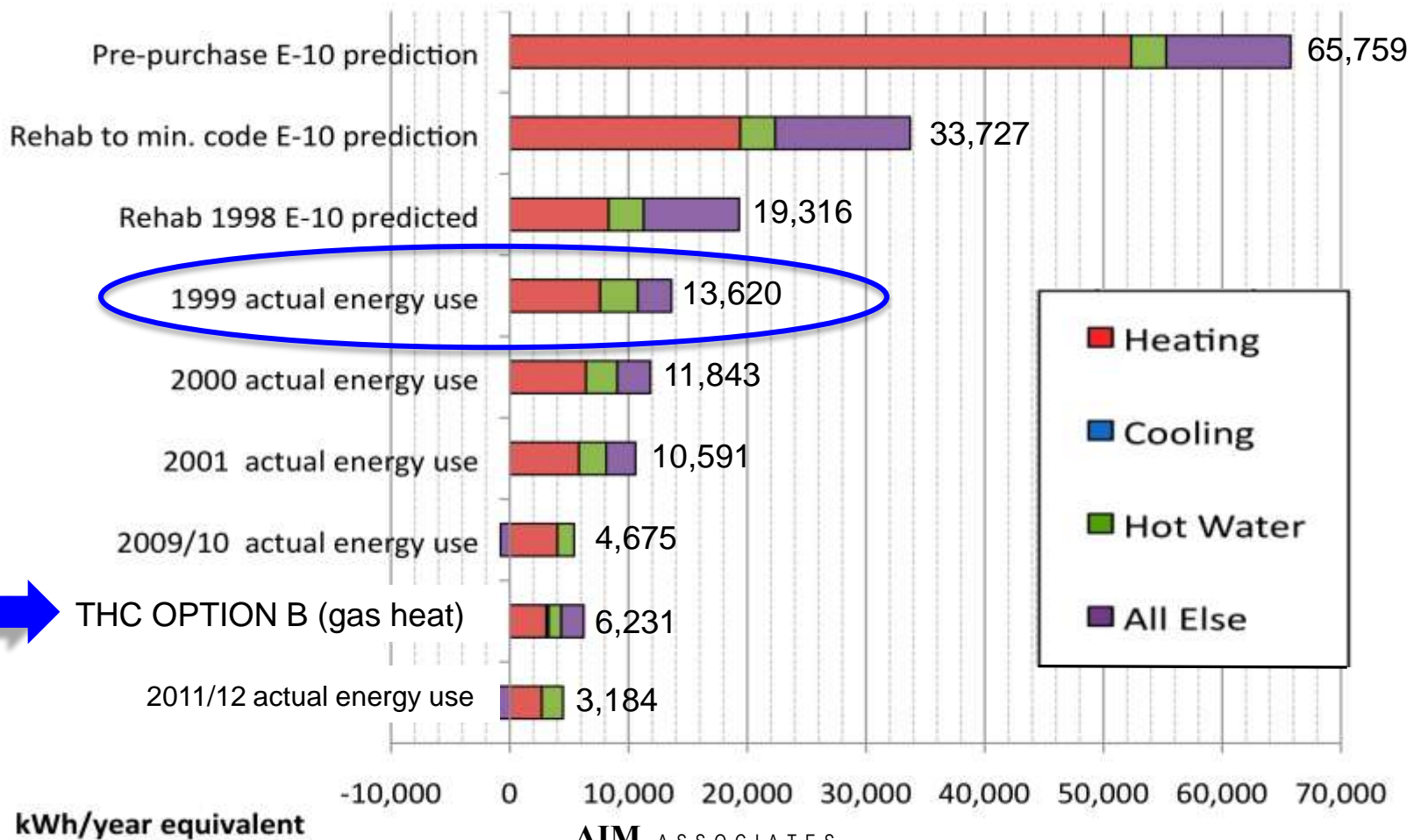
**Cellulose fills voids  
around wiring & pipes**

**2010 - Wall opened for  
additional earthquake  
strengthening**

# Thousand Home Challenge Threshold Compared with Usage/Production

(Total household energy use – site energy – kWh/y)

The energy use in 1999 was a long way from meeting the THC but it was 79% below the Energy-10 predicted use before the remodel



# SECOND PHASE - 2005 REMODEL

- Passive & active renewables
- Addition of sloped roof to accommodate them



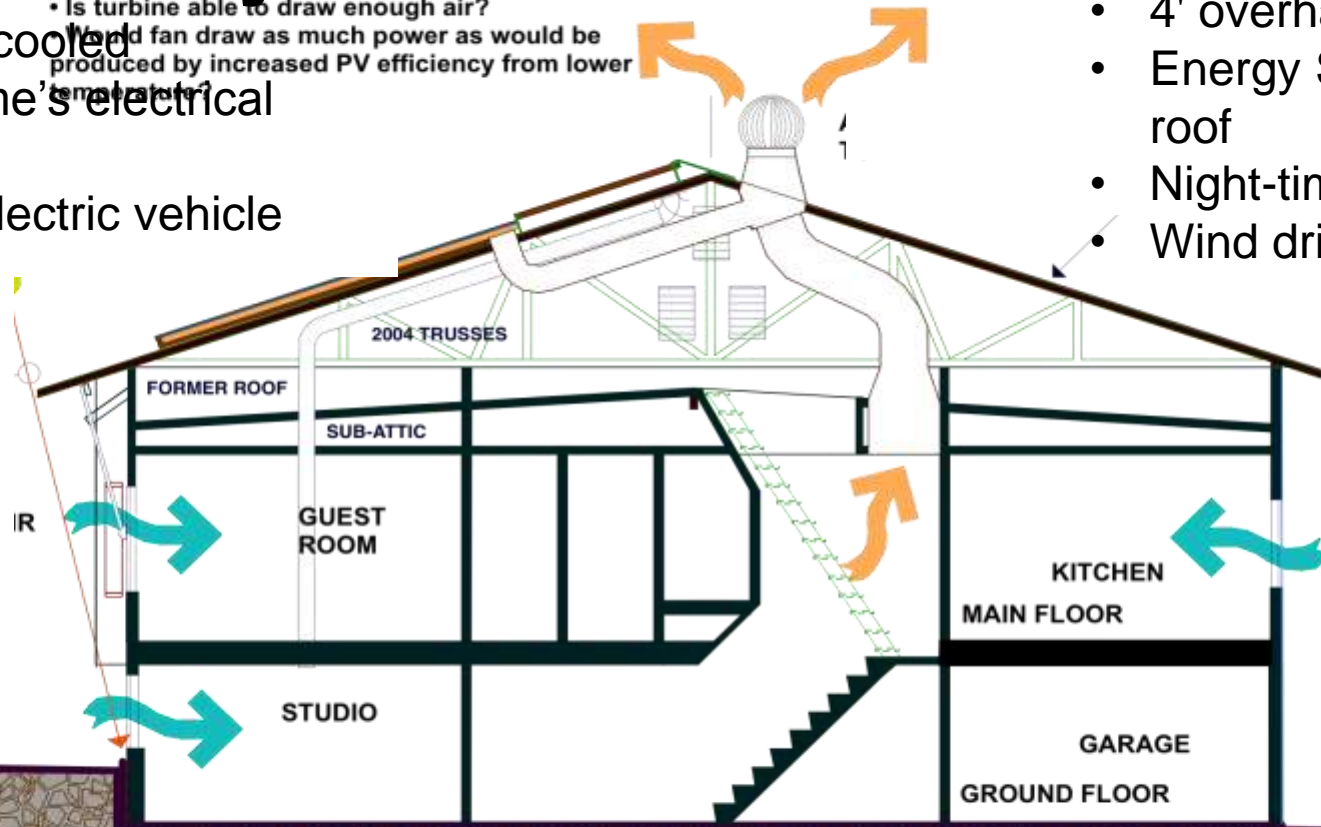
# PASSIVE COOLING WORKS!

## 2.5 kW PV Array

- Passively cooled
- Meets home's electrical needs
- Charges electric vehicle

DO YOU NEED A FAN?  
• Is turbine able to draw enough air?  
• Would fan draw as much power as would be produced by increased PV efficiency from lower temperature?

- 4' overhang
- Energy Star reflective roof
- Night-time cooling
- Wind driven turbine



**SUMMER FEATURES • BUILDING SECTION**



# ALTERNATIVE ENERGY SYSTEMS



Wind driven turbine ventilator for night cooling

- 2,000 cfm - 5 mph breeze
- Neoprene gasketed duct damper prevents unwanted air movement

200 ft<sup>2</sup> of SolarWall panels for solar heat

2.5 kW PV

- Passively cooled
- Meets home & office electrical needs
- Charges electric car & bicycle

# ATTIC DUCTS & FEATURES



14 duct to pull air under PV array

24 duct from turbine ventilator

Roof hatch for roof access

Roof trusses added in 2005

Former flat roof with urethane foam roofing (previously insulated)

Pull-down stair for convenient access





**Shade for office glass door**

**Living room window not replaced due to cost**

**R-4, three-layer honeycomb interior shade helps, but only partially effective seal at edges**



**DIRECT GAIN SOLAR HEATING  
WHEN THE SHADE IS RAISED.  
DELIGHTFUL PLACE & VIEW!**

AIM ASSOCIATES



## **PHASE 2: 2005 REMODEL**

- Goal: Zero net energy use
- Plan: Excess PV production would offset natural gas
- Action: Renewable energy & building redesign implemented
- Issue: How to define net zero energy??

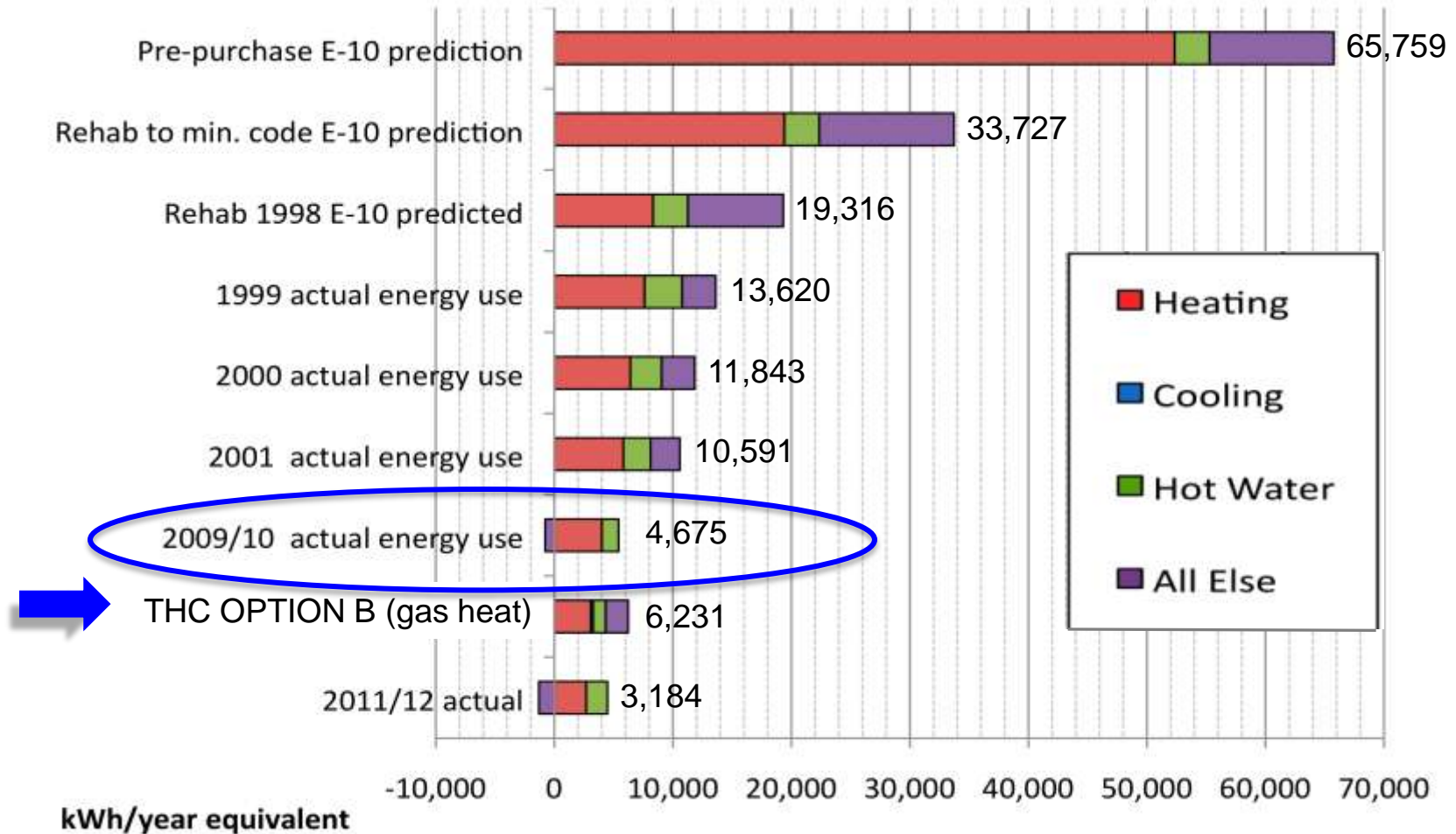
## **RENEWABLE ENERGY SUMMARY**

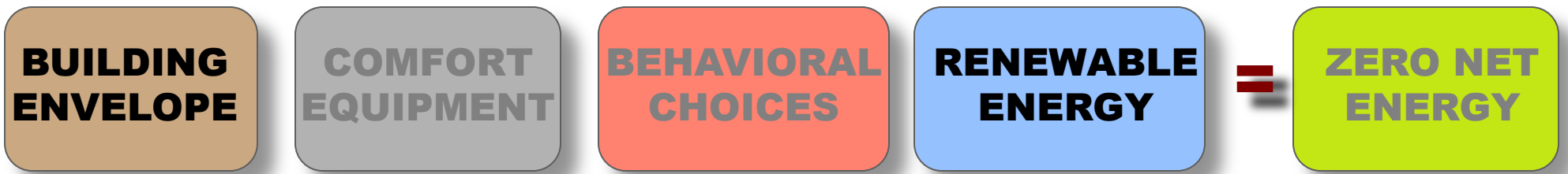
- 2.5 KW photovoltaic system
- Solar air heating to reduce natural gas use by ~20%
- Passive solar heat gain
- Wind driven turbine ventilator

## **PHASE 2 LESSONS LEARNED**

- Lasting zero net energy to offset natural gas not achieved
- Ellen's fibromyalgia required 70<sup>o</sup>F air temperature, hot baths, & long showers

# Thousand Home Challenge Threshold Compared with Usage/Production (Total household energy use – site energy – kWh/y)





## **PHASE 3 GOALS: 2010 REMODEL**

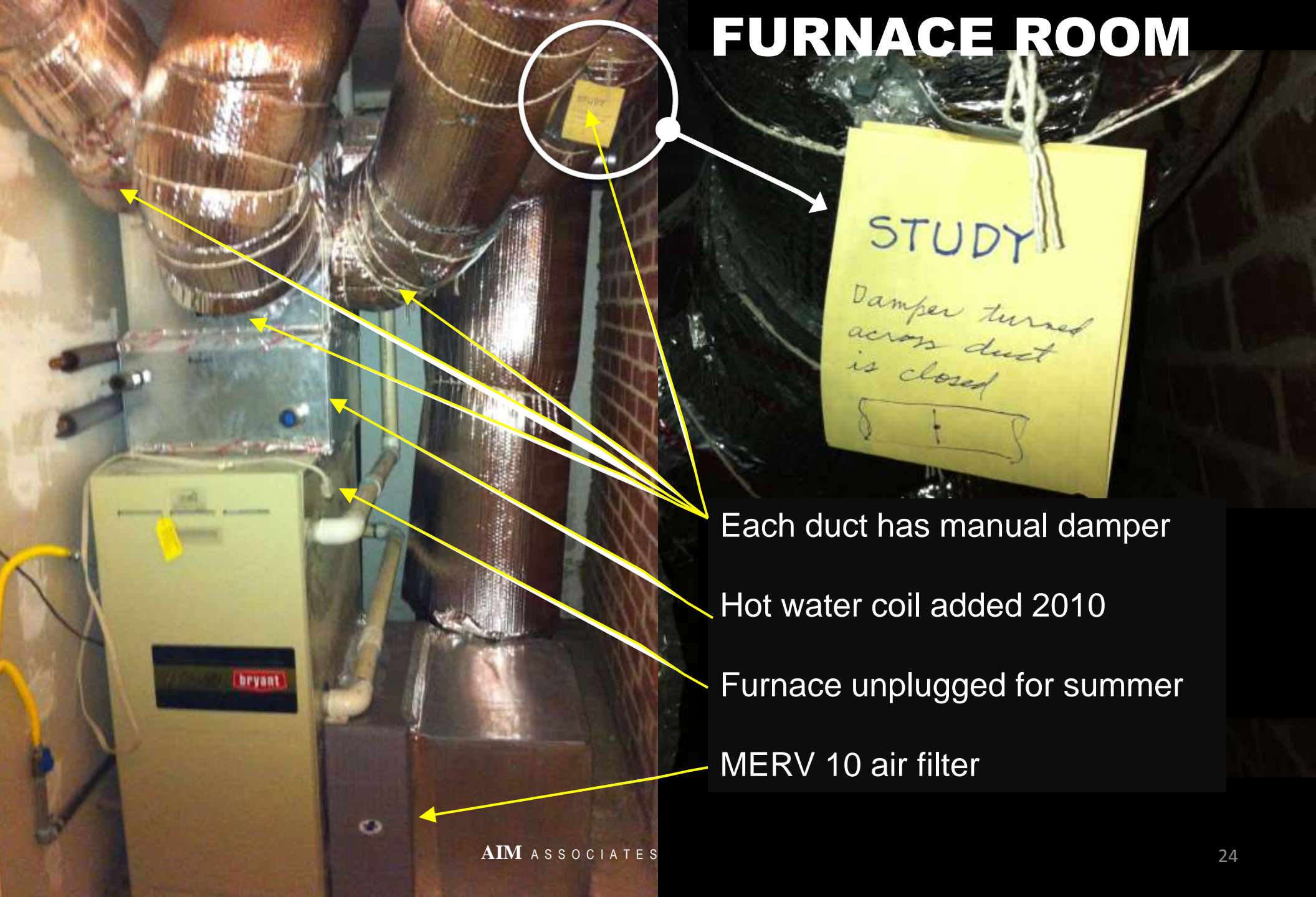
- **Improve energy efficiency with additional insulation & air sealing**
- **Create a “cocoon” room in den for enhanced comfort**
- **Add solar air heating duct to den cocoon**
- **Reinforce structure to survive major earthquakes & severe windstorms**



# DEN & KITCHEN COCOON

AIM ASSOCIATES

# FURNACE ROOM



STUDY

Damper turned  
across duct  
is closed



Each duct has manual damper

Hot water coil added 2010

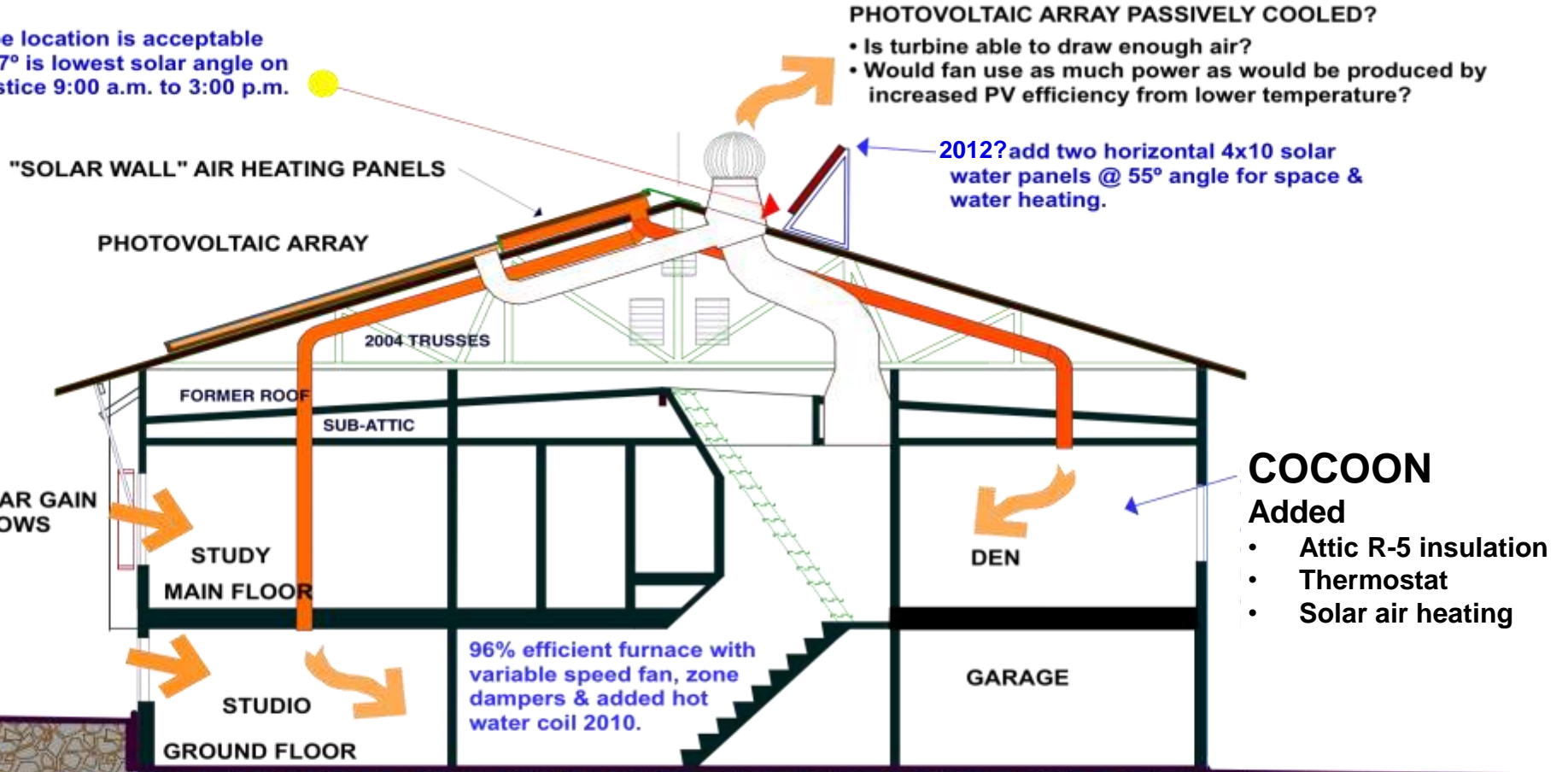
Furnace unplugged for summer

MERV 10 air filter



# DEN & KITCHEN

North slope location is acceptable because  $17^\circ$  is lowest solar angle on winter solstice 9:00 a.m. to 3:00 p.m.



## WINTER FEATURES • BUILDING SECTION 2010

# ROCK ANCHORS AS PART OF SEISMIC RETROFIT

Strong, but short interior shear walls need massive hold-downs. These typically require large concrete foundations whose weight will hold them down

The engineer agreed to use rock anchors to save concrete



We tried this 3" diameter drill bit with a jackhammer

It took 1½ weeks to drill 12 holes



# THE RIGHT EXPERIENCE & TOOLS GOT THE JOB DONE

Kent Williams, concrete repair journeyman of Durling Concrete, determined that core drilling was the appropriate technique, even with the clay veins

The remaining 12 holes were drilled in one day!

## ATTIC SHEAR WALL

$\frac{3}{4}$ " tie rod in attic with drag anchor

Shear wall foundation to roof sheathing

Hold-down strap

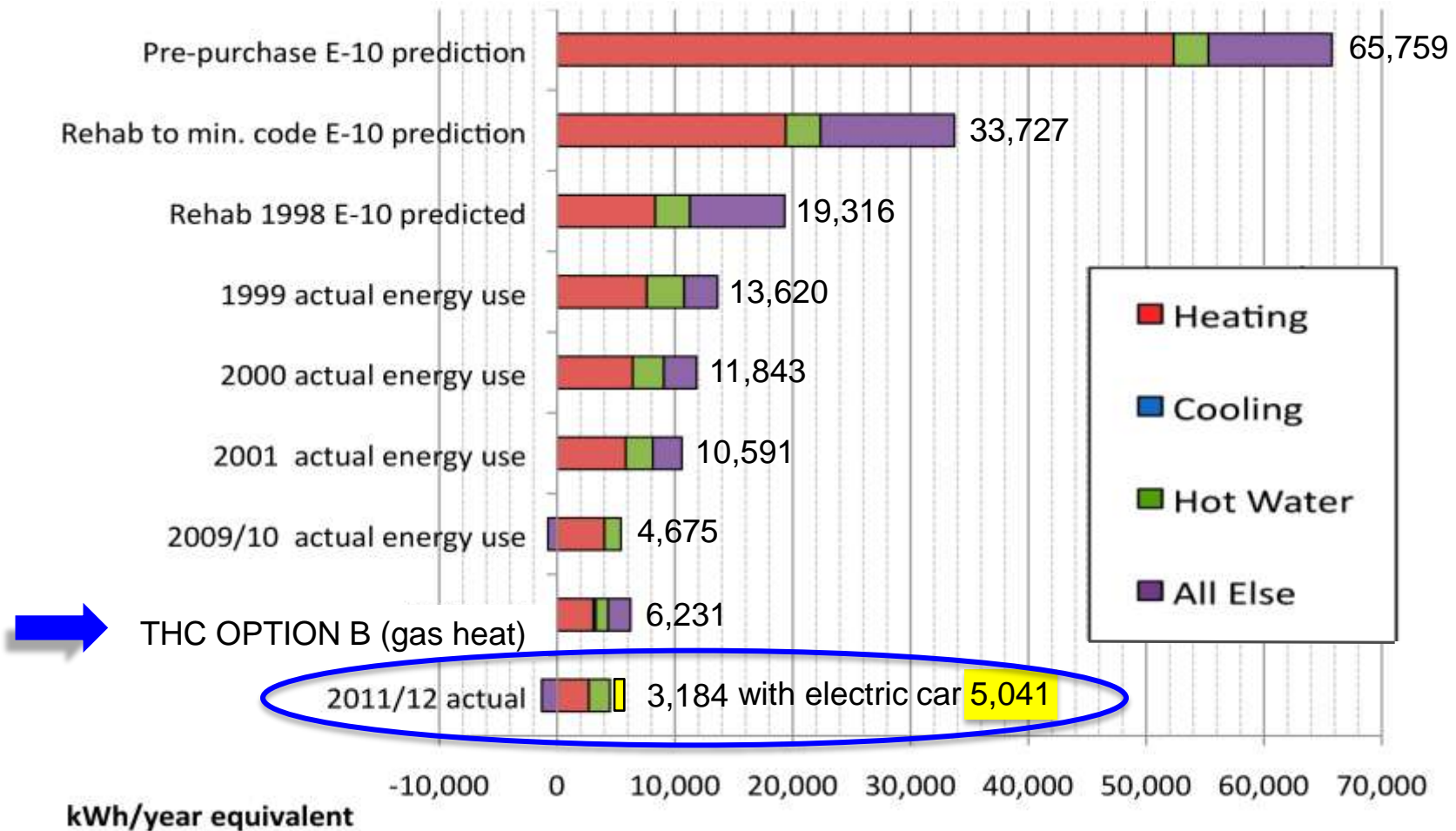
Roof truss

**JOHN HARRISON, ENGINEER, & DON FELKINS, BUILDER, REJOICE OVER FINDING PROPER TECHNIQUE FOR ROCK DRILLING**



**THIS  
VOLCANIC  
ROCK WILL  
BE IDEAL  
FOR GROUT  
ANCHORING  
THE HOLD-  
DOWNS**

# Thousand Home Challenge Threshold Compared with Usage/Production (Total household energy use – site energy – kWh/y)



# ELECTRIC CAR ENERGY USE & LIFESTYLE CO<sub>2</sub> REDUCTION

Daily reporting of distance, energy economy, & carbon reduction

CARWINGS underreports electricity used by Blink charger by x 1.79

From April 2011 to March 2012: 5,841 miles driven

1,876.33 kWh used = 3.11 miles per kWh

Zero Emission

Telematics Service  
by CARWINGS



Driving History



Route Planner



All Info. Feeds



Rankings



Eco Tree

Driving Records

My Driving Style

Electric Rate Simulation

## Driving Records



Model:

LEAF

Daily



Jan/2012



Sun Mon Tue Wed Thu Fri Sat

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Distance Traveled

77.5 miles

Average Energy Economy

6.1 miles/kWh

Electricity Consumption

12.7 kWh

Travel Time

2.5 hrs

CO<sub>2</sub> Tailpipe Emission

Reduction\*

50 lbs

MEMO

Trip to Berkeley & back with Phil. Charging station was out of order & no other available. Drove back home at 45 to 50 MPH on freeway.

Edit

# ELECTRIC CAR ENERGY USE REPORT

## Monthly reporting of energy economy compared

**Zero Emission**

Telematics Service  
by CARWINGS



Driving History



Route Planner



All Info. Feeds



Rankings



Eco Tree

Regional Rankings

World Rankings

### Regional Rankings

Your regional rank for Apr/2012 (as of April 17, 2012)



Apr/2012

#### Your Score

Ranked  
**987**

Average Energy Economy  
**5.4** miles/kWh



#### Champion's Score

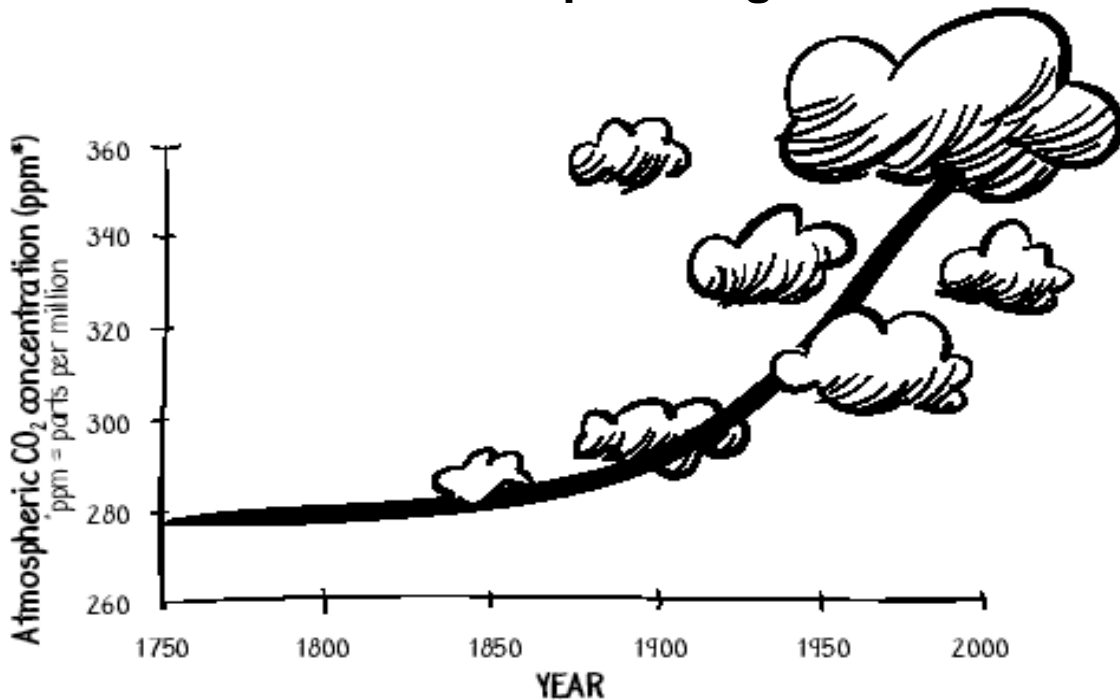
Average Energy Economy  
**23.3** miles/kWh



# LESSONS LEARNED

## What I would do differently if I knew in 1998 what I know today:

- I would have prepared a phased rehabilitation master plan (in 1998, I did not realize that global climate change was such a serious problem that my goal of 75% energy use reduction was not enough)
  - Therefore, I did not realize that this was only the first phase of a series of improvements
  - I should have set phased goals to meet our new long-term goals of:



The rise of carbon dioxide levels in the atmosphere

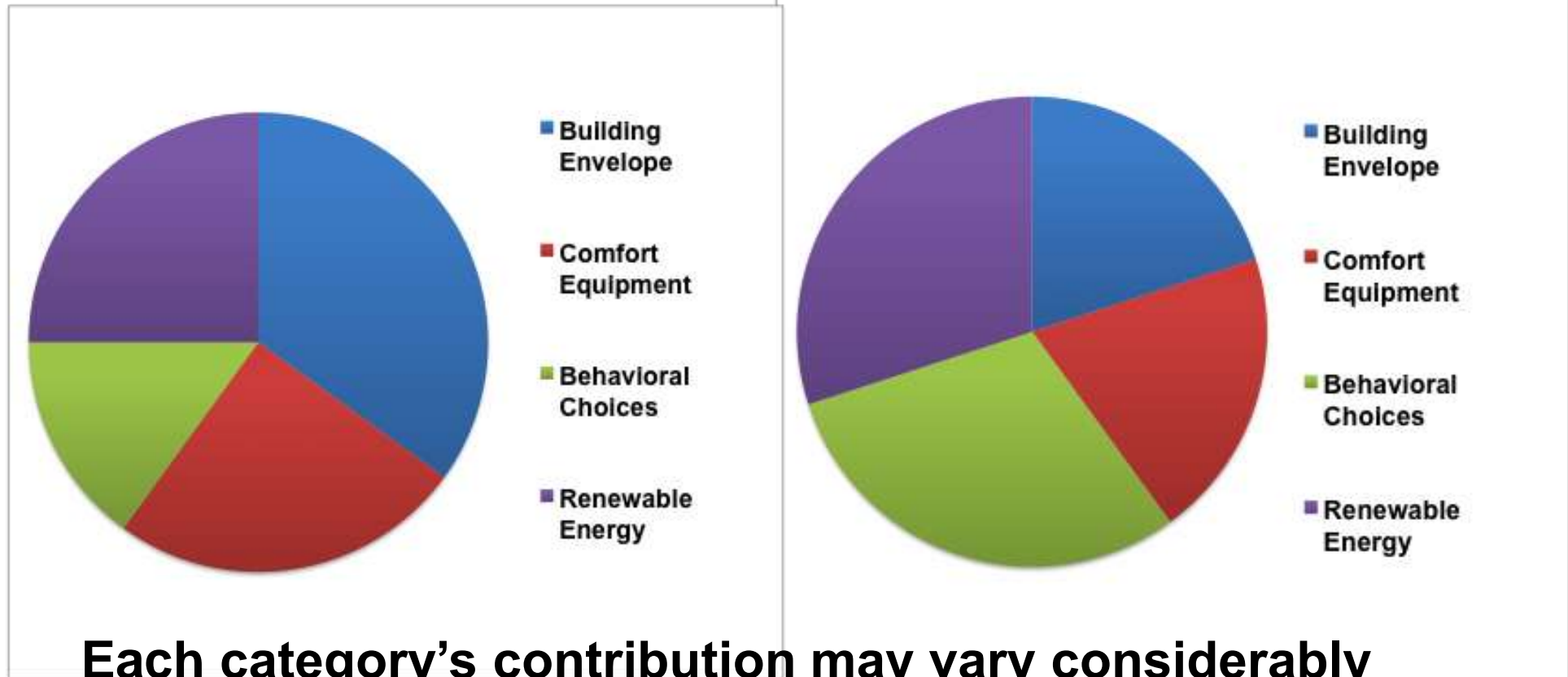
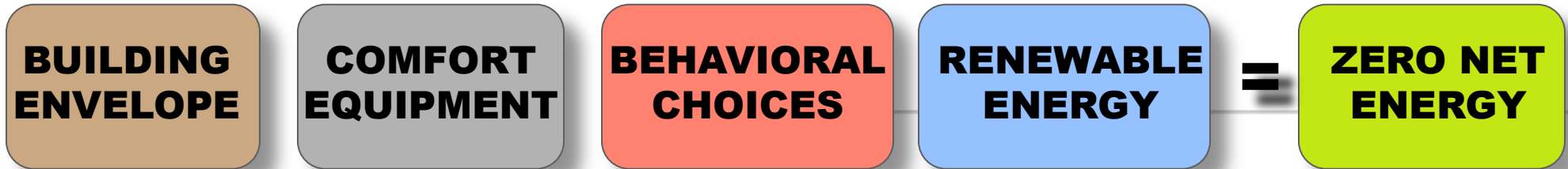
### Chapter 4: Energy, Health, and the Environment

[DISCUSSION: How green energy choices affect our health and the environment](http://www.energyforkeeps.org/preview.html) <http://www.energyforkeeps.org/preview.html>

- Zero net electrical energy
- Carbon neutral heating fuel
- Site-generated electricity to include electric car
- Improved long-term durability including above code resistance to major earthquakes & windstorms



# ROADMAP FOR ZERO NET ENERGY BUILDINGS



# **DO DIFFERENTLY IN 1998?**

## **Knowing What I Know Now**

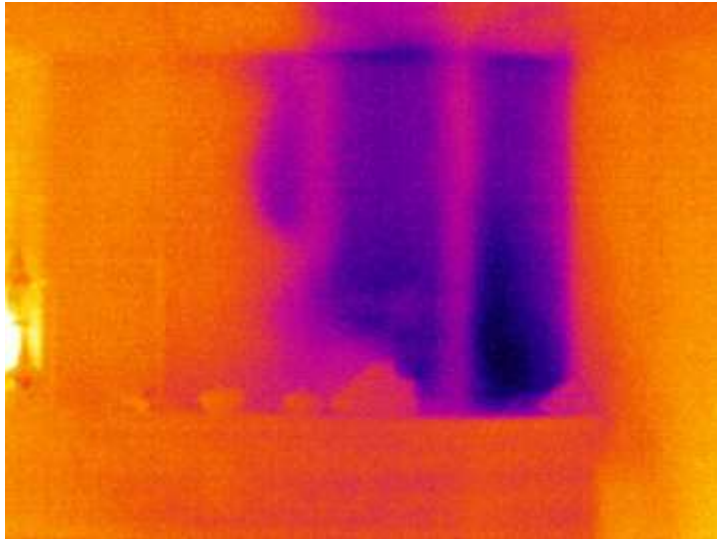
### **Consider**

- **More significant load reduction to eliminate conventional HVAC**
- **High-efficiency hot water system to provide space heating**
  - Carbon neutral fuel or HPWH w/more PV
  - Use of solar water heating (add later)

# DO DIFFERENTLY IN 1998?

## Knowing What I Know Now

In process QA with blower door, IR, & duct testing



**Air infiltration from attic at fireplace chimney interior wall**

- Identify leakage paths, e.g., coved ceiling
- Air sealing effectiveness
- Chimney-related air leakage paths
- Thermal bypasses
- Air leakage to garage
- Duct leakage
- Problem with cavity return for furnace

Consider alternative envelope improvements

Consider options with multiple benefits:

- Best access for air infiltration improvements
- Best access for structural reinforcing & adding plywood from foundation to roof

Image courtesy of Jeremy Fisher & Brennan Less, Residential Building Systems Group, LBNL

# **DO DIFFERENTLY IN 1998?**

## **If Additional Financing Was Available**

### Phase 1 Sloped Roof

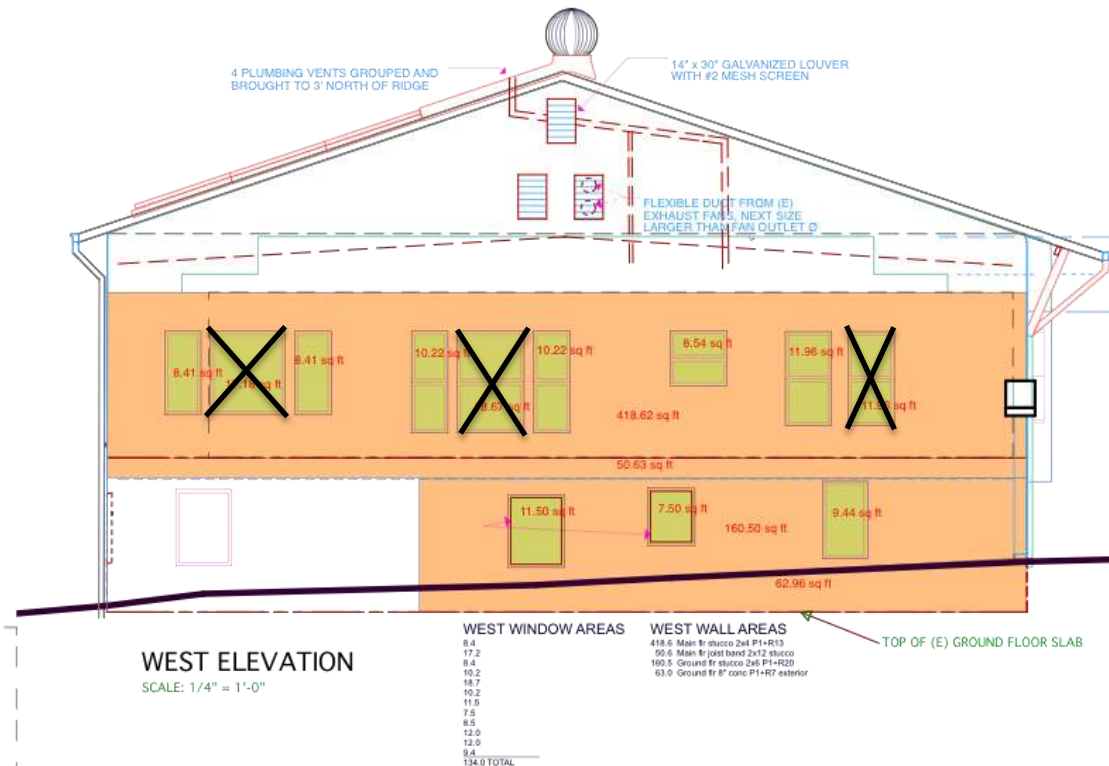
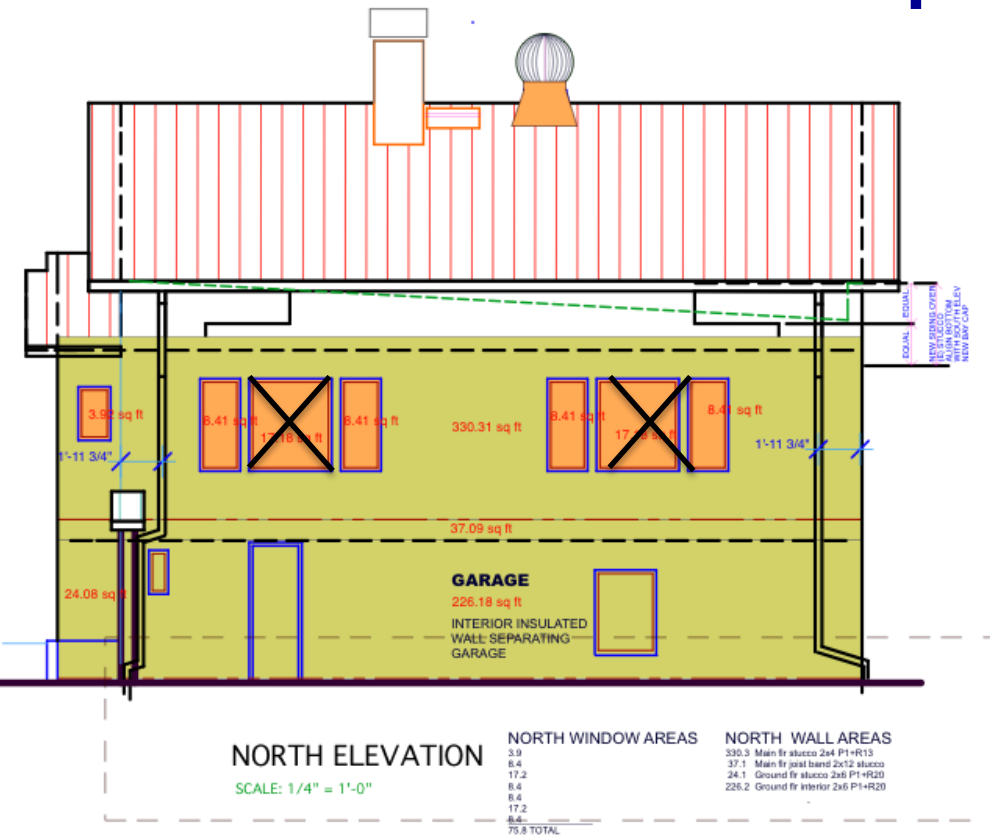
- Effective attic air infiltration work
- Better quality & R-50 attic insulation

### Consider Stucco Siding Replacement

- Strengthen exterior walls for earthquakes & windstorms (200-500 year)
- Add foundation reinforcement as necessary
- Add plywood to exterior walls sealed to provide air infiltration barrier
- Seal wall framing against air infiltration
- Better access for wall insulation (studs at wood panel & ceramic tile)
- Add 2" poly-iso insulation (R-13) for wall performance/address thermal bridging of framing

# DO DIFFERENTLY IN 1998?

## ...To Further Improve Energy Efficiency



- Reduce window areas on west & north walls
- Wait to add attic insulation until I did major air infiltration work in subattic
- Seal floor framing for air infiltration at garage

# **What I Would Change about Our Western Society If I Could**

**Mature into a world view that a  
stable climate, resources, & energy  
must be shared with all life now  
and for endless future generations  
rather than our current attitude of  
entitlement without responsibility**

# LESSONS LEARNED

## What I Am Especially Glad that I Did in Earlier Phases:

### Building Envelope Energy Improvements

- Cellulose attic insulation (lowest embodied energy)
- Dense pack cellulose wall insulation
- Better windows than code required for new buildings (fiberglass framed, Low E<sup>2</sup> argon filled)
- Achieved excellent acoustical isolation (noisy school nearby)
- Best practice window installation (tight & long-term durability)

### Durability

- Used highest quality recycled plastic (HDPE) for exterior window trim (never needs painting & looks new 12 years later)
- Replaced high maintenance flat roof with “permanent” sloped steel roof

# LESSONS LEARNED

## What I Am Especially Glad that I Did in Earlier Phases:

### Water reduction features

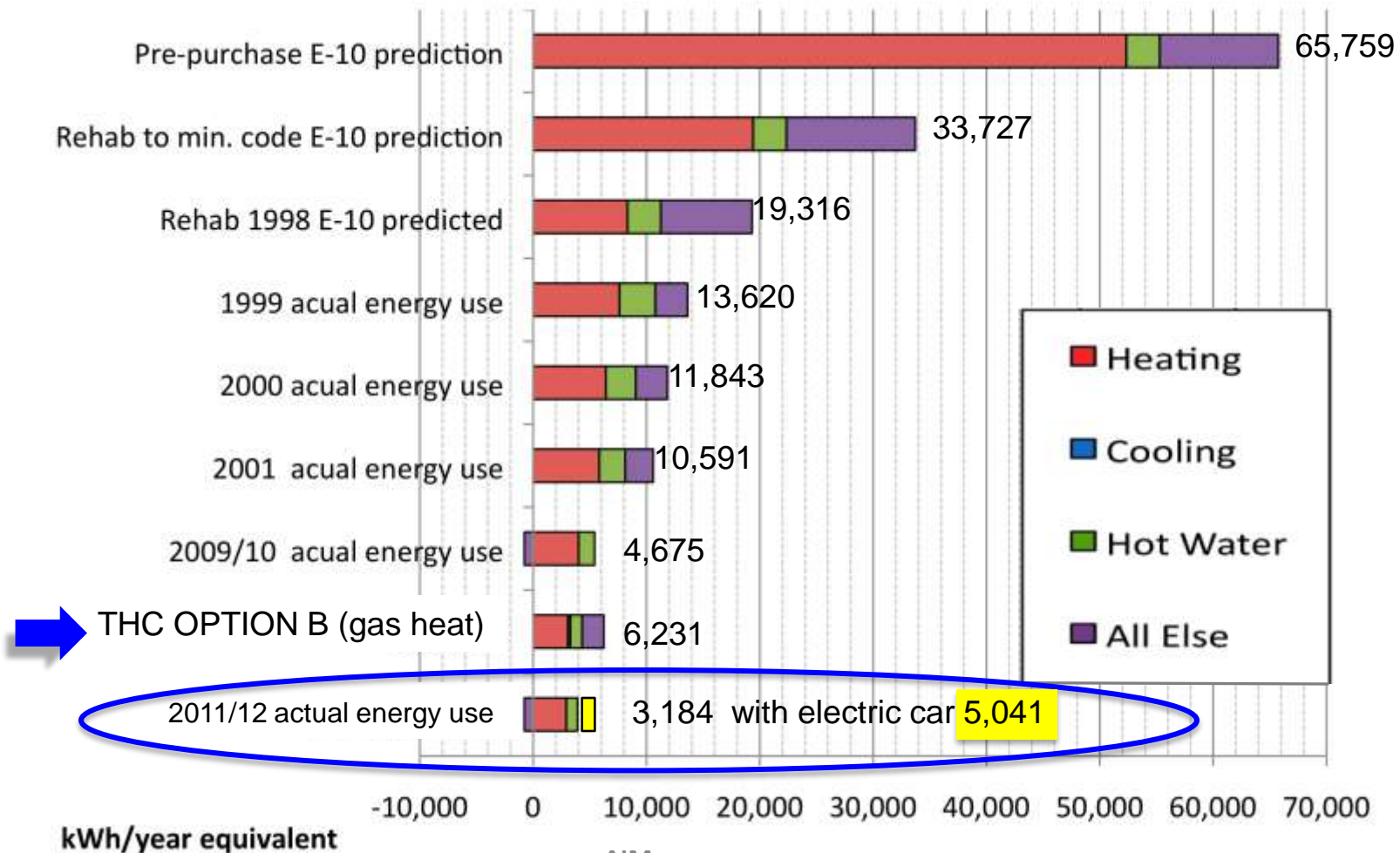
- Removed all turf & use existing shallow well for drip irrigation
  - On demand hot water circulation pump, low water fixtures
- Phase 1: 75 gallons/day(gpd); Phase 2: 50 gpd; Phase 3: 33 gpd  
*Average American water use is approx. 150 gpd*

**NIAGARA STEALTH – 0.8 gallon flush for 50% reduction!**





# Thousand Home Challenge Threshold Compared with Usage/Production (kWh/yr by use)





## **AFTER BLOWER DOOR TEST**

**A blower door test was performed after more sealing was completed & more attic insulation was installed**

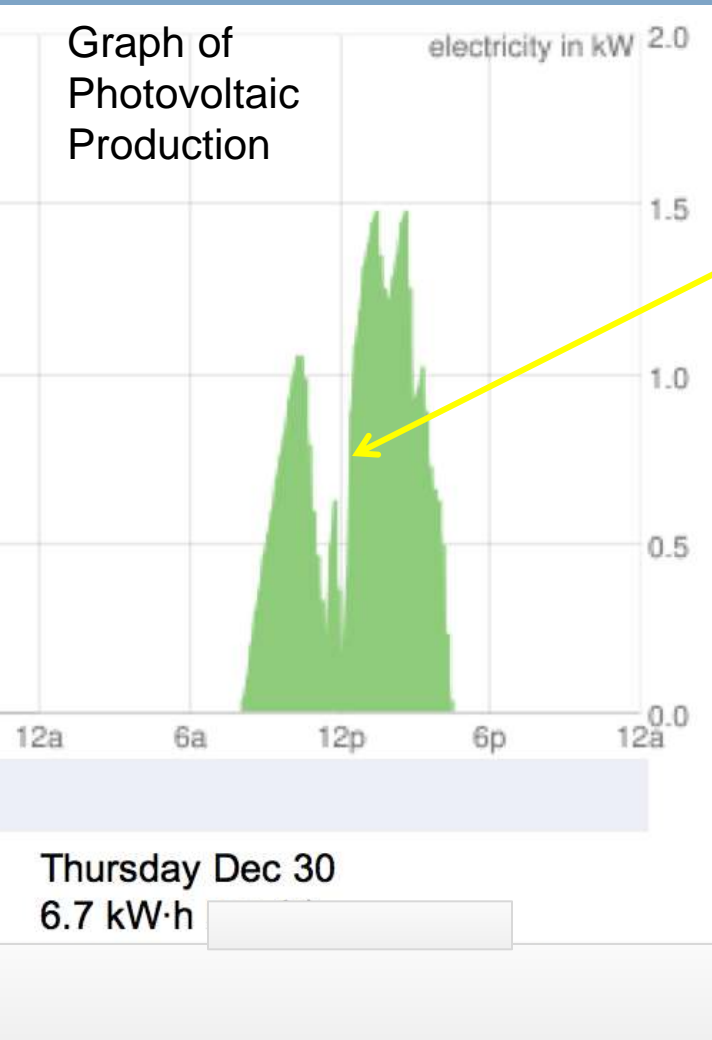
**Jeremy Fisher & Brennan Less operate a blower door to test the combined air leakage of the ground & main floors**

**The result was 2,171 CFM50 = 5.6 ACH, which is much higher than I had hoped**

**(5.6 ACH /17.2 = 0.33 air changes per hour natural)**

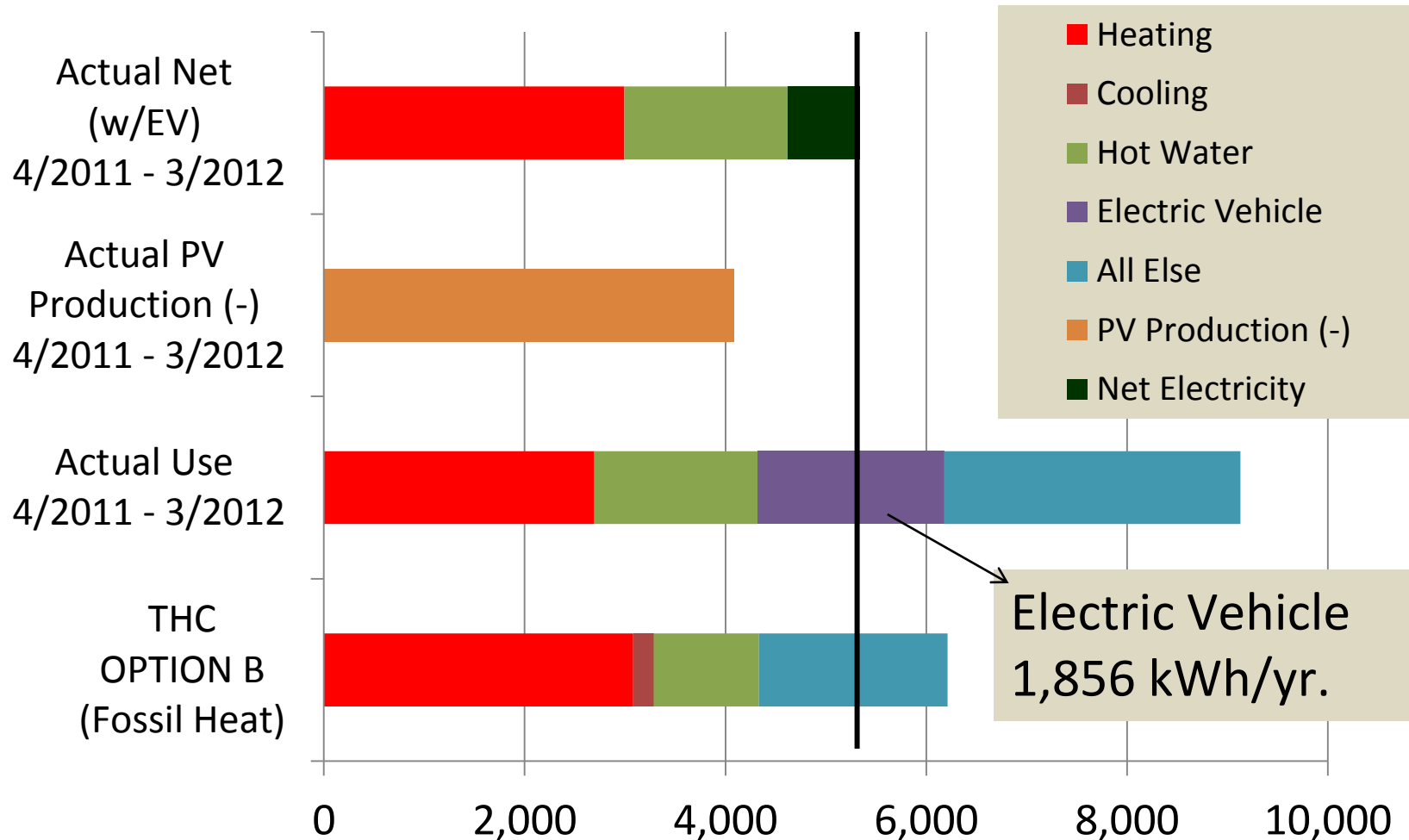
# MONITORING REVEALS PERFORMANCE PROBLEMS

Shadow from utility pole reduces output from photovoltaic system more than expected as documented on graph by Google PowerMeter from electrical circuit monitoring by Jeremy Fisher & Brennan Less



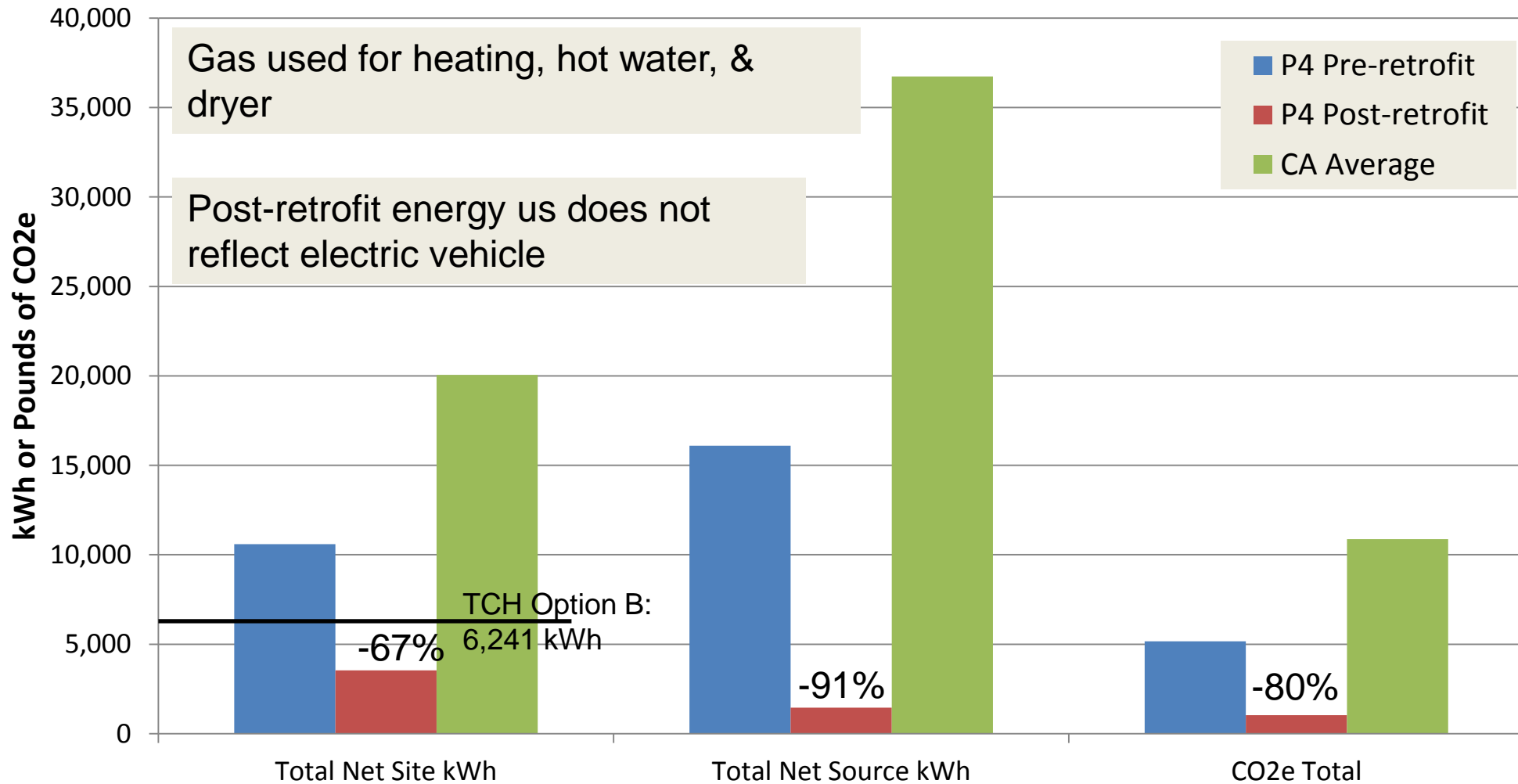
# THC OPTION B Vs. Actual Site Energy Use

(Total Energy Use/Production w/EV in kWh/year)

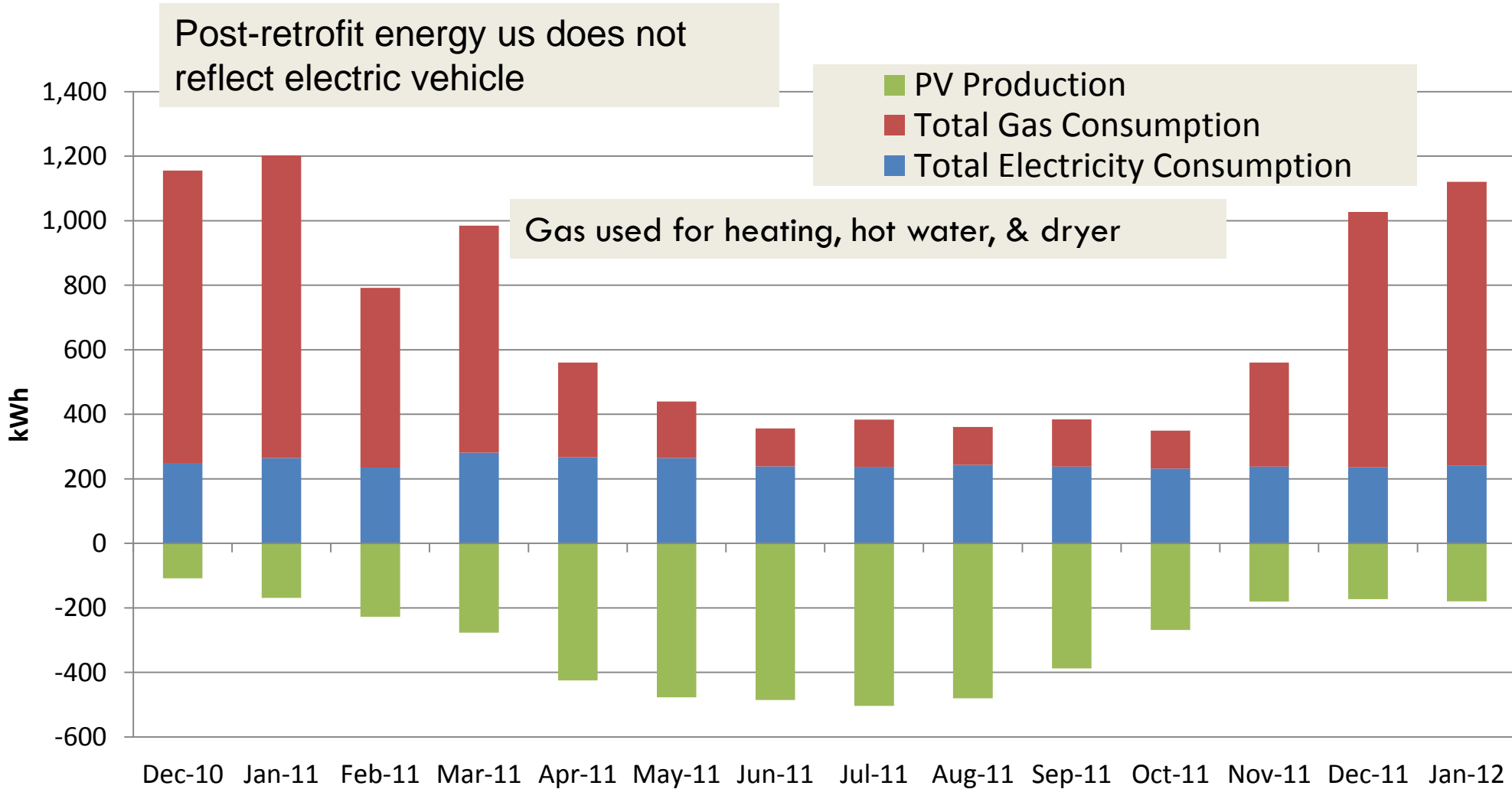


2011-12 data courtesy of Jeremy Fisher & Brennan Less, Residential Bldg. Systems Group, LBNL; THC OPTION B Assumptions: 2 occupants; 2,5010 ft<sup>2</sup> FFA; Santa Rosa (2,791 HDD Base 65); single-family detached w/gas heat

# P4 Net Energy Performance



# P4 Total Monthly Site Energy Use

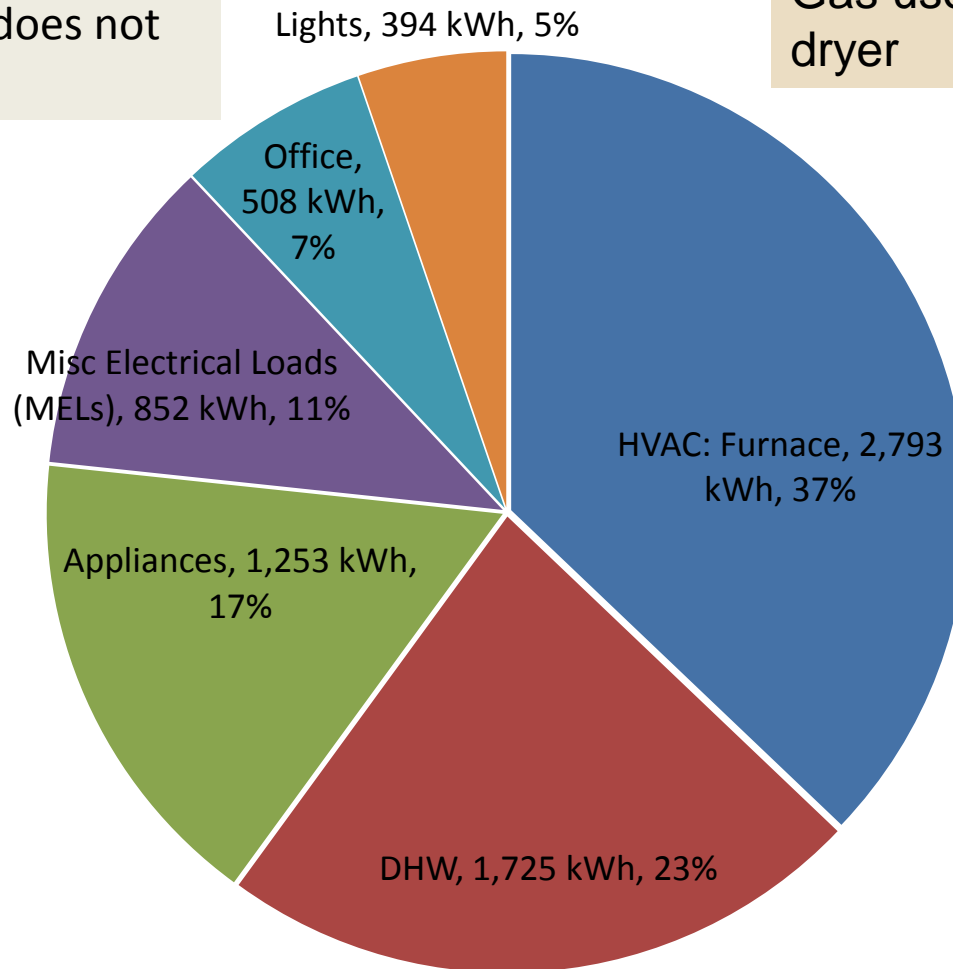


# P4 Annual Energy End Use



Post-retrofit energy use does not reflect electric vehicle

Gas used for heating, hot water & dryer



# ENERGY MONITORING WEBPAGE

## Current Power & Last 30 Day Usage



Account ▾

Monitor ▾

Control ▾

Downloads ▾

Help ▾

Welcome, p4de

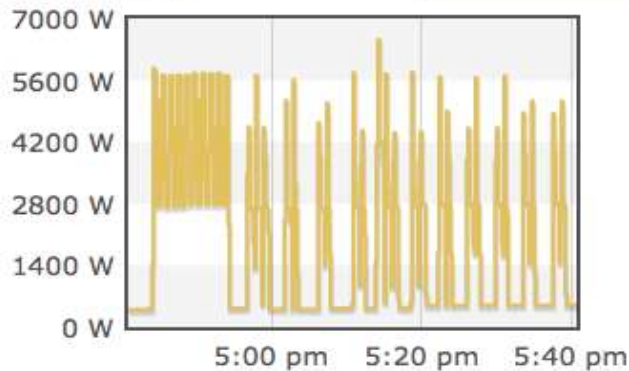
Monitor: P4 ▾

Channel: Whole House Energy ▾

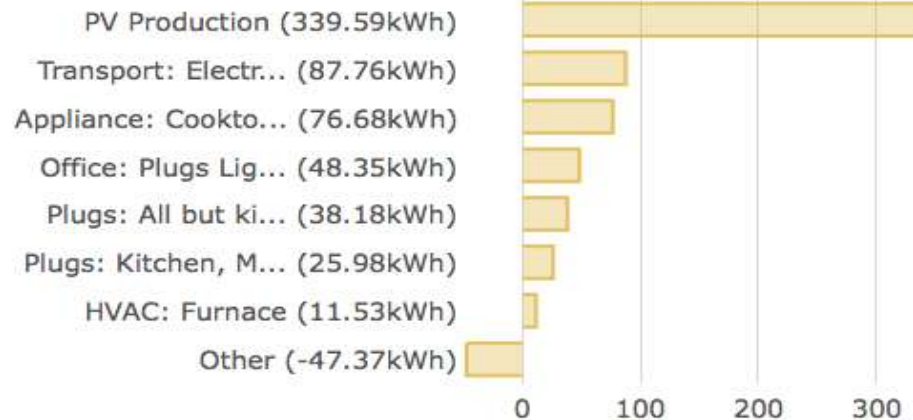
[Set as Default](#)

Energy Rating

Current Power



Last 30 Days Usage



### Energy Bill

Your next projected bill will be:

\$0

Current Bill So Far **\$0.27**

Billing Period 21 Mar 2012 - 21 Apr 2012

### Energy Usage

So Far Today	7.1 kWh	<b>\$0.0</b>
Yesterday	7.8 kWh	<b>\$0.0</b>
Last 7 Days	54.3 kWh	<b>\$0.1</b>
Last 30 Days	241.1 kWh	<b>\$0.3</b>

### Weather



**24°C**

Clear

Humidity	61%
Wind	SW 14 km/h
Updated	5:40 PM



# ENERGY MONITORING WEBPAGE



## Midday Power Use & PV Output

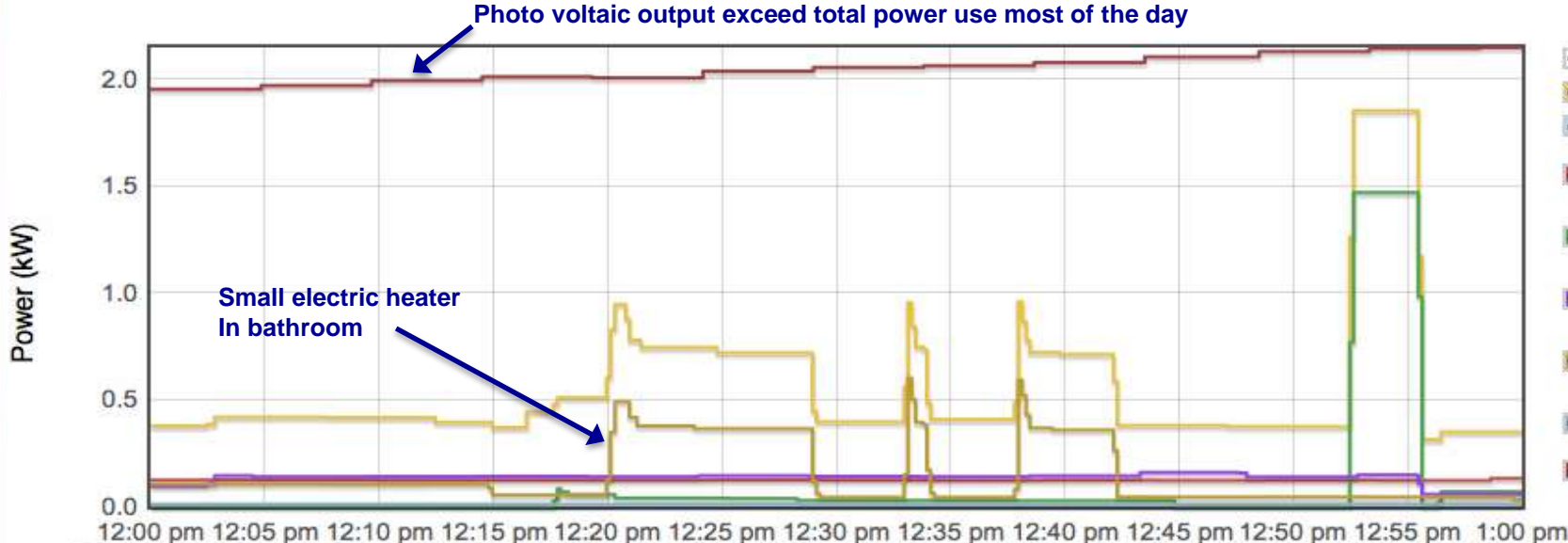
Account ▾

Monitor ▾ Control ▾ Downloads ▾ Help ▾ Welcome, p4der

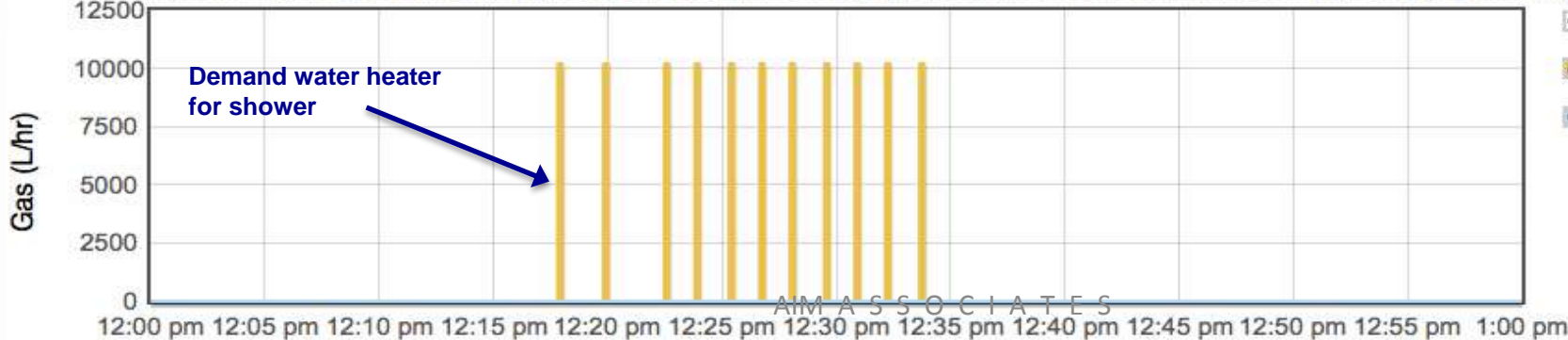
Monitor: P4 ▾

[Set as Default](#)

Time: 12:00 PM [Apr 19] ▾ Rate: winter partial peak (.11¢/kWh) ▾ Graph Text



- Select All**
- Whole House Energy
- HVAC: Furnace
- Appliance: Cooktop
- Fridge Dishwasher Fan
- Plugs: Kitchen, Micro, Study, MtgRm
- Office: Plugs Lights DSL Router
- Plugs: All but kitchen and office
- Transport: ElectricCarCharge
- PV Production



- Select All**
- Hot Water: Tankless Heater
- HVAC: Furnace Gas



# ENERGY MONITORING WEBPAGE

## Late Afternoon Power Use & PV Output

Account ▾

Monitor ▾ Control ▾ Downloads ▾ Help ▾ Welcome, p4d

Monitor: P4 ▾

[Set as Default](#)

Time: < Live ▾ > Rate: winter partial peak (.11¢/kWh) ▾ Graph Text

OVEN IS HUGE LOAD We always bake enough for 2 or 3 meals

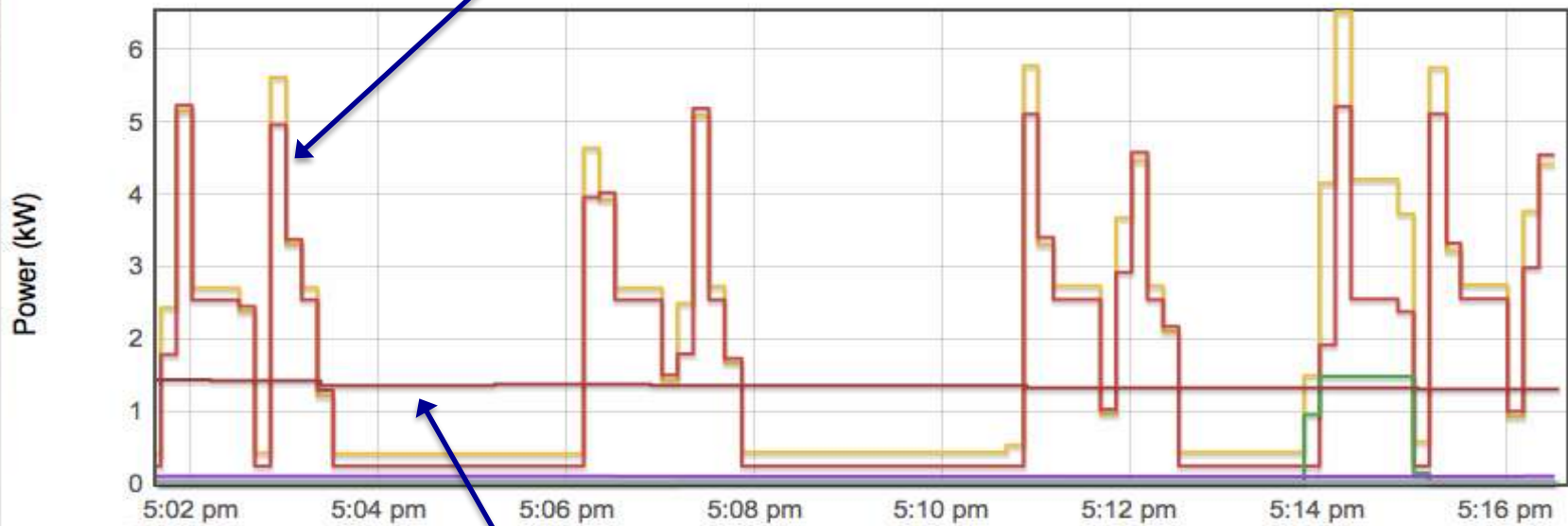
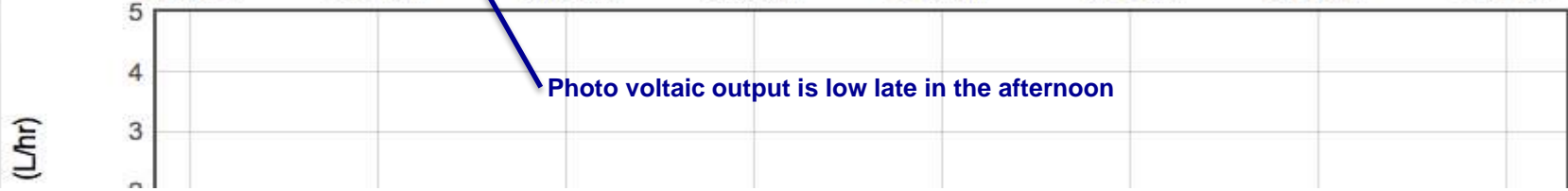
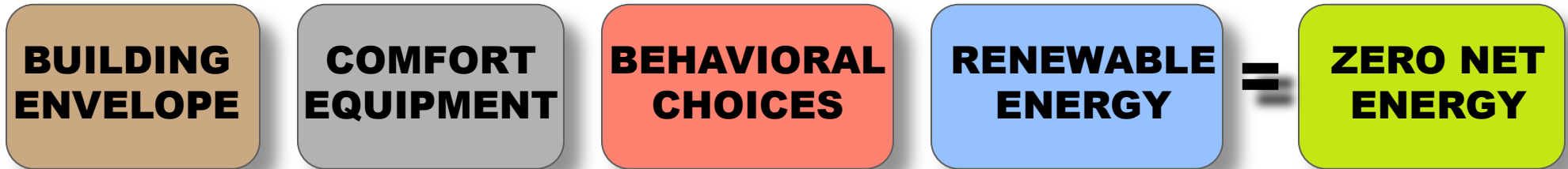


Photo voltaic output is low late in the afternoon



- Select All**
- Whole House Energy (4408W)
- HVAC: Furnace (11W)
- Appliance: Cooktop
- Fridge Dishwasher Fan (4541W)
- Plugs: Kitchen, Micro, Study, MtgRm (26W)
- Office: Plugs Lights DSL Router (101W)
- Plugs: All but kitchen and office (31W)
- Transport:
- ElectricCarCharge (4000)
- Select All**
- Hot Water: Tankless Heater (0L/hr)
- HVAC: Furnace Gas (0L/hr)

# PATHWAY FOR ZERO NET ENERGY



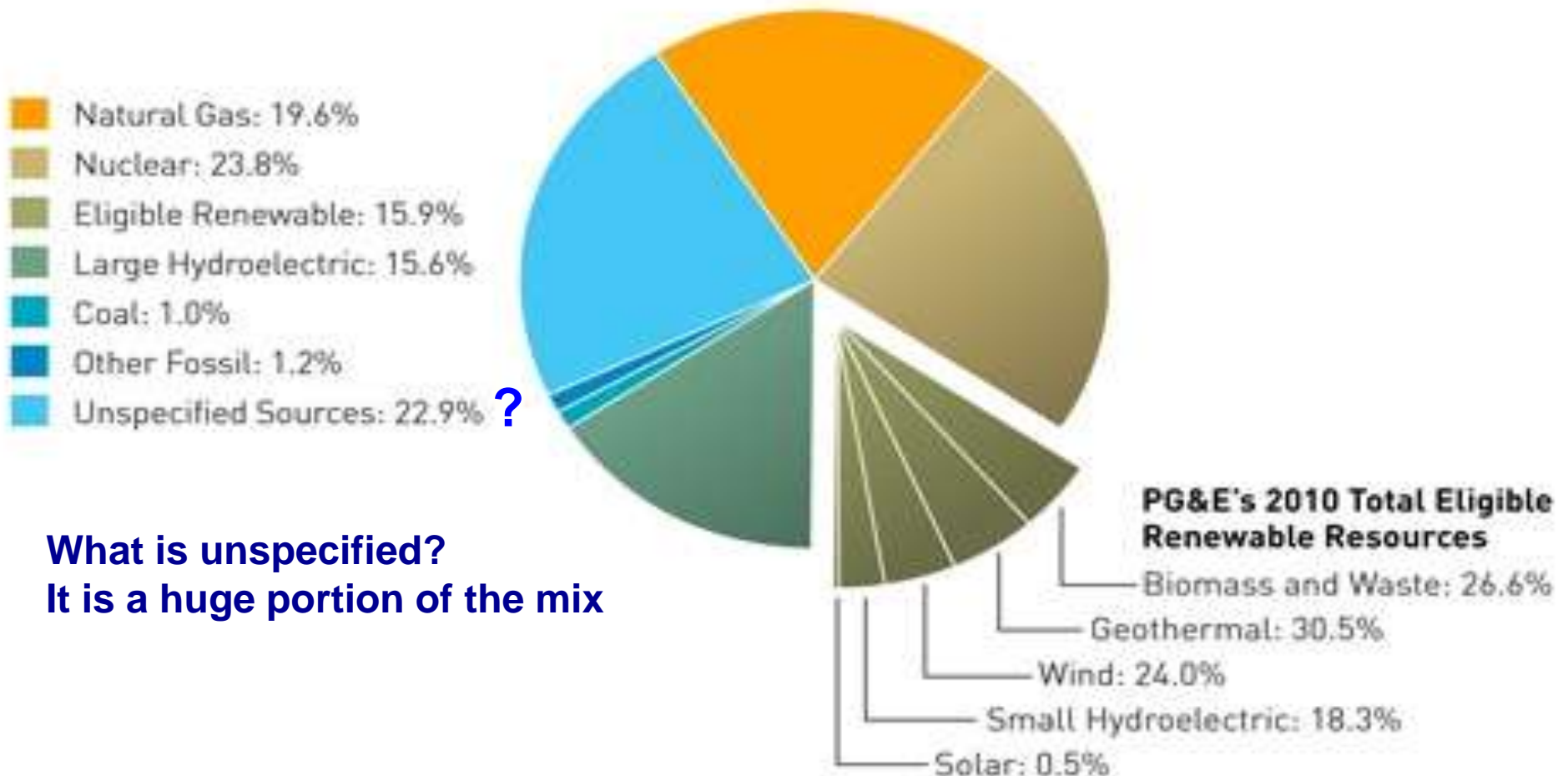
## PHASE 4 GOAL: TO ACHIEVE ZNE HEATING

- Continue monitoring
- Continue improving energy efficiency performance
- Analysis of space & water heating system upgrades
  - Solar water heating for just domestic water or combined with space heating
  - High-efficiency heat pump options with addition to photovoltaic system
    - Air to air mini-split or
    - Air to water or water to water
  - High-efficiency combined space & domestic water heater using carbon neutral heating fuel

# NORTHERN CALIFORNIA ELECTRICITY IS A BETTER MIX THAN MOST OF STATES IN THE UNITED STATES

Shifting to nonpeak hours and night use saves money & natural gas but it was impossible for me to find how much CO<sub>2</sub> is saved

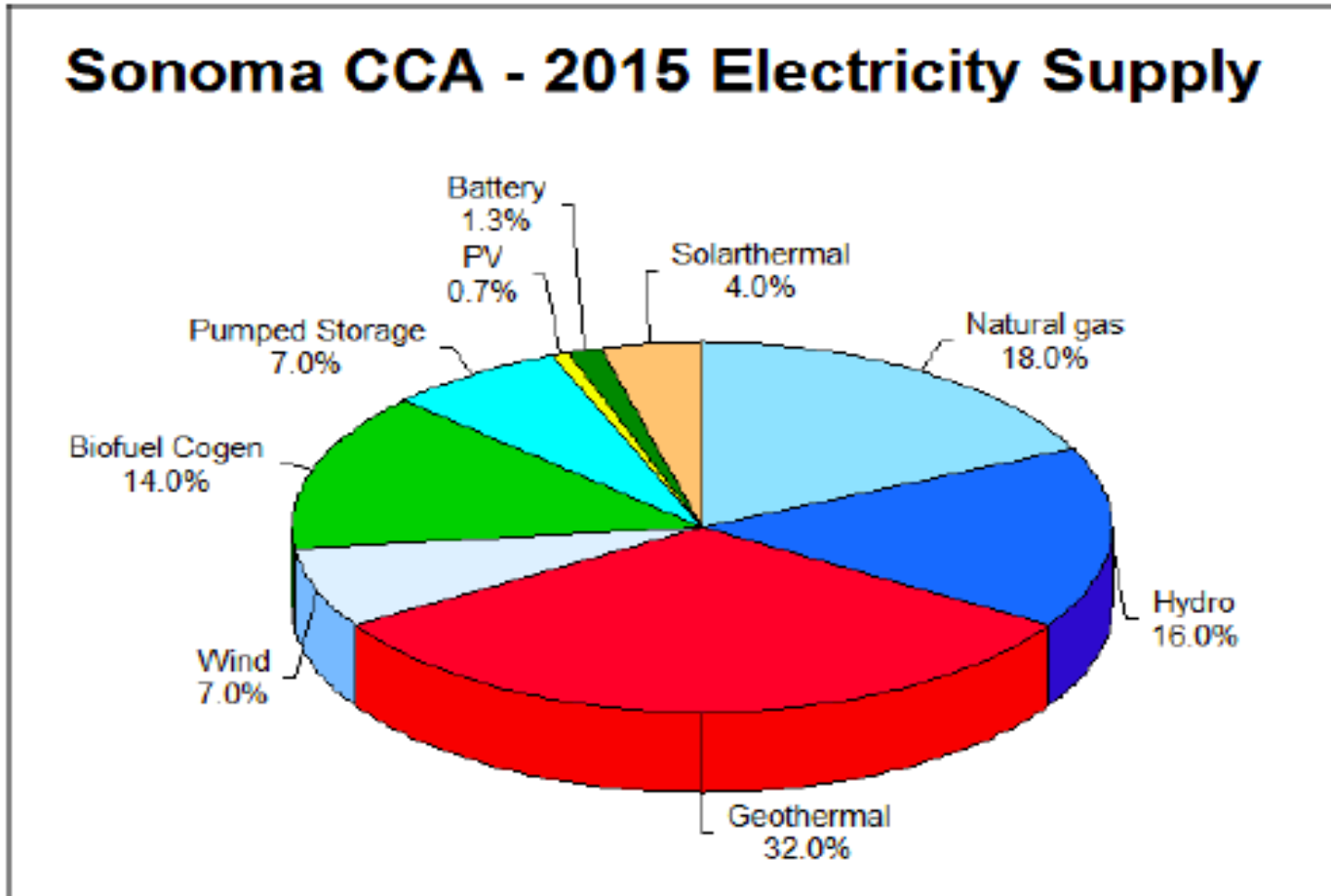
## PG&E's 2010 Electric Power Mix Delivered to Retail Customers



What is unspecified?  
It is a huge portion of the mix

# RENEWABLE SOURCE ELECTRICITY PROPOSED BY SONOMA COUNTY, COMMUNITY CLIMATE ACTION PLAN

## Community Choice Aggregation



**Energy Solutions, A Plan to Achieve, Accelerated, Scaled & Cost-Effective, Greenhouse Gas Emission Reductions, in the County's Energy Sector by 2015, Sonoma County, Community Climate Action Plan, May 2008**



## **SHARING EXPERIENCES**

**Linda, Ellen, & Judy share their experiences with changing behavior to achieve deep energy reductions**

**We talked about creative comfort - dressing to stay comfortable with low thermostat settings like people did in the “good old days” before central heating**

**Ellen has medical issues that can make low thermostat settings especially uncomfortable, so creating a comfort zone was in progress at this time**

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[www.1000HomeChallenge.com](http://www.1000HomeChallenge.com)  
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Photo by Judy Roberson

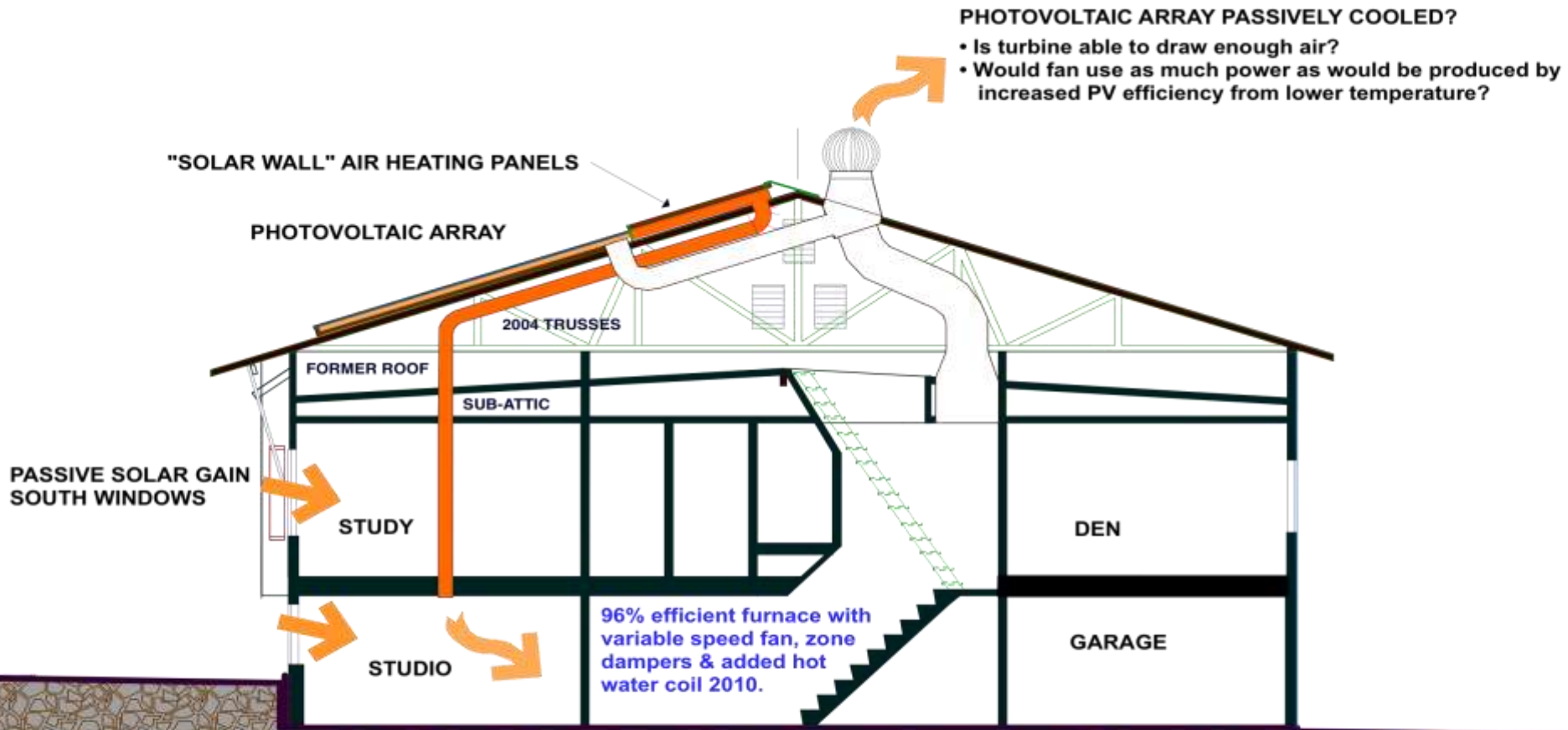
**Link to presentation** <http://thousandhomechallenge.com/spring-2012-webinar2>

**Full case study** <http://1000HomeChallenge.com/casestudy>; <http://thousandhomechallenge.com/spring-2012-webinar2>

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# Appendix





## WINTER FEATURES • BUILDING SECTION

## **ENVIRONMENTAL & RESOURCE EFFICIENCY FEATURES**

- **Selected house within walking distance of grocery store, post office, & bank**
- **100% recycling of cardboard, metal, & paper construction waste**
- **75% reuse of wood, plywood, & siding construction waste**
- **Old windows reused in friend's greenhouse**
- **Salvaged bricks used for permeable paving (brick on sand bed & sand joints)**
- **FSC-certified lumber, trusses, & plywood for new roof framing (Hayward Lumber)**
- **Finger-jointed door frames**
- **OSB basement interior sheathing & additional anchor bolts for seismic reinforcement**
- **Recycled plastic lumber window trim (Durawood of 100% HDPE) & garden planters (Epic of mixed plastic)**
- **Recycled plastic/wood composite lumber (Trex) low (18" high) retaining wall**
- **Exposed concrete as finished floor was ground to expose aggregate & sealed**
- **Water-efficient fixtures & appliances**
- **On-demand hot water circulation pump (Taco)**
- **High-efficiency, drip irrigation uses nonpotable shallow well water (Irritrol)**
- **Toilet modified for one-gallon flush (hold lever for about four seconds for a full flush)**

## **INDOOR AIR QUALITY & HEALTH FEATURES**

- Central vacuum system
- Removed all carpet & refinished hardwood floors (carpet harbors dust that is brought in on people's shoes that contains pesticides, herbicides, motor oil, etc.)
- Sealed combustion furnace with high-efficiency air filter
- Carbon drinking water filter
- Avoided insulation with formaldehyde adhesive
- Termite abatement: less toxic biological control & borate-based methods
- Solar Wall brand air heating brings in 100% outside air **to dry out basement**
- New shower pan with coved tile base for easier cleaning to avoid mold
- Existing 1970 down draft range hood (Jenn-Air) vented to outside

## **SAFETY & DURABILITY FEATURES**

- Reinforced ground floor walls to remodel, industry standards for earthquakes & windstorms
- Remodeled areas have 5/8" fire-rated gypsum board & solid core wood doors for better fire safety, acoustical separation, & improved thermal mass
- Smoke detectors in all rooms
- New electrical wiring where accessible. New GFI circuit breaker & outlets
- Connected to city water for house because poor quality of well. Use well for irrigation.

PERMACULTURE INSPIRED LANDSCAPING  
 ... ALL ORGANIC  
 REMOVED ASPHALT RV PARKING AND  
 PLANTED VEGETABLE GARDEN  
 PLANTED FRUIT & NUT STREET TREES

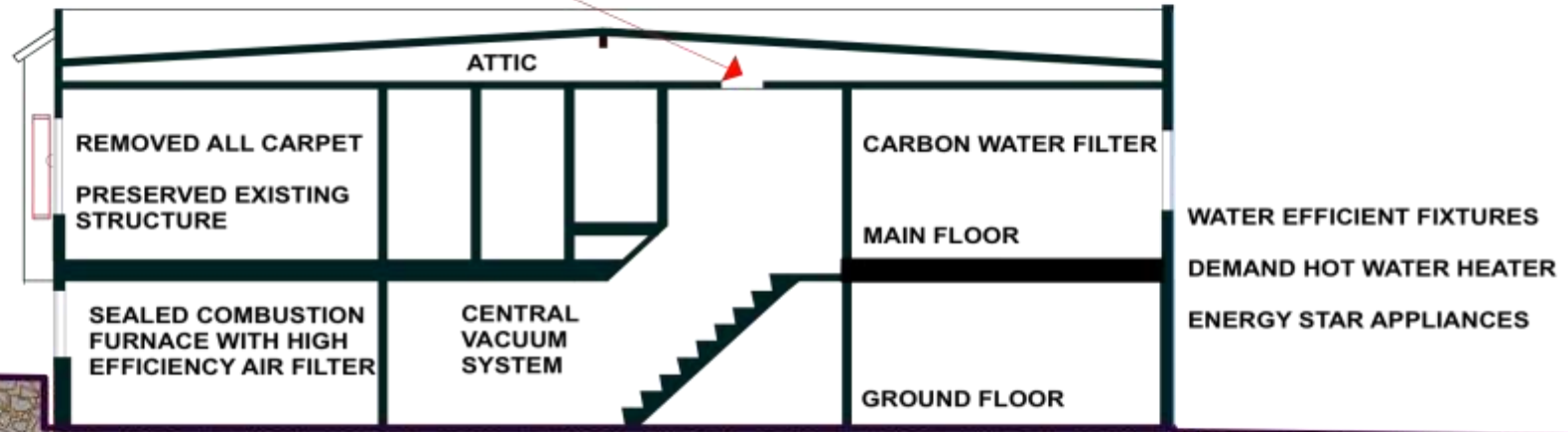
NEW LOW-E2/FIBERGLASS  
 WINDOWS FOR THERMAL  
 AND ACOUSTICAL COMFORT

WINDOW TRIM OF RECYCLED  
 PLASTIC LUMBER PROTECTS  
 FLASHING TAPE OVER  
 WINDOW FLANGES

R-13 DENSE PACK  
 CELLULOSE INSULATION  
 BLOWN INTO WALLS  
 (R-20 AT GROUND FLOOR 2X6  
 WALLS)

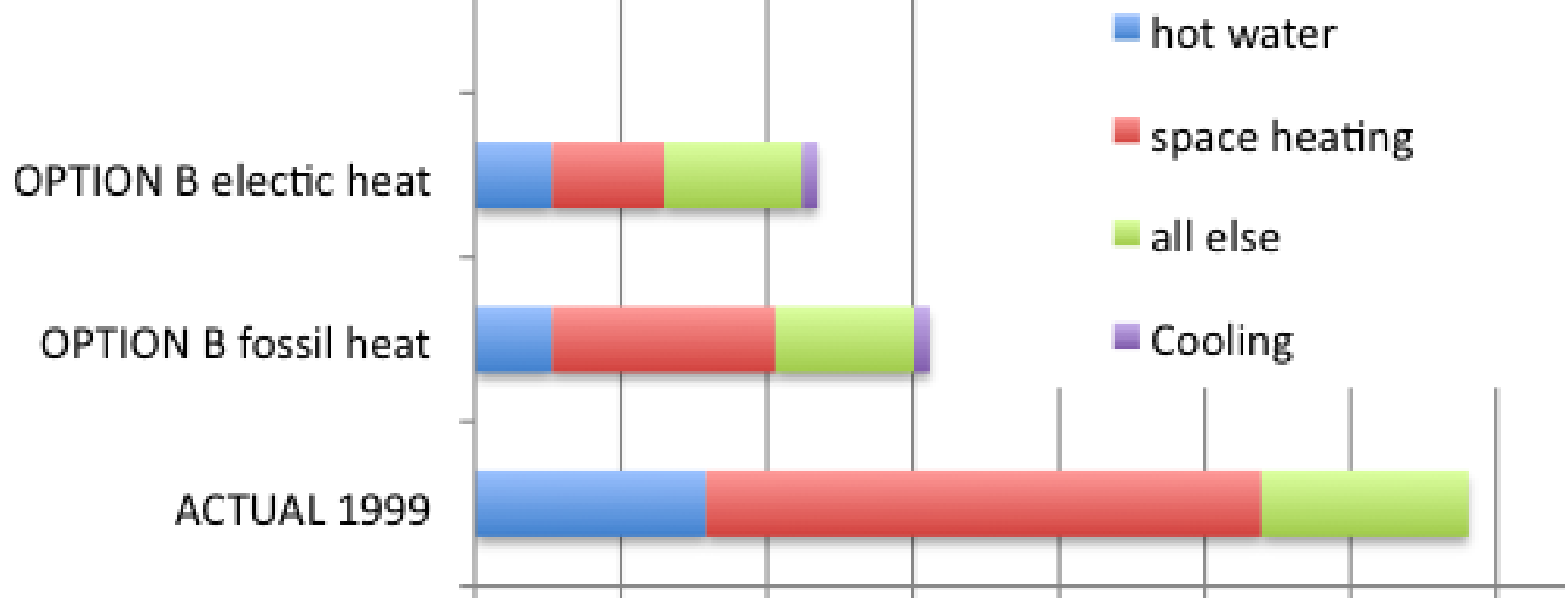
EXISTING ARMSTRONG FOAMED URETHANE ROOFING COST  
 PREVIOUS OWNER AS MUCH AS A 4-PLY 20-YEAR ROOF BUT  
 ONLY CAME WITH A 5-YEAR WARRANTY

CELLULOSE INSULATION BLOWN INTO ATTIC  
 R-38 INTENDED BUT DIFFICULT WORKING CONDITIONS ONLY  
 ACHIEVED APPROXIMATELY R-30  
 SMALL ACCESS PANEL WAS ONLY ATTIC ACCESS

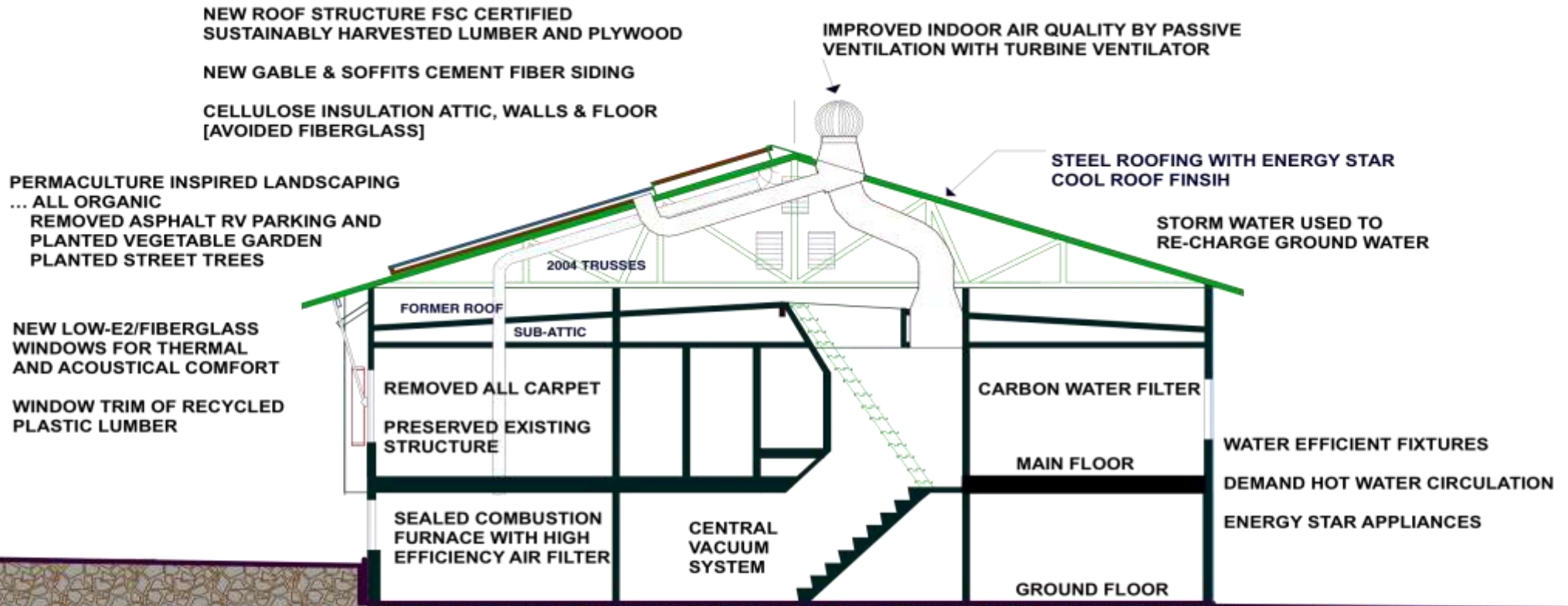


## BUILDING SECTION 1998 REHABILITATION

# Magnified View of Annual Use First Phase 1999 and THC Threshold of Performance (converted to kWh year)



**The energy use in 1999 was a long way from meeting the THC but it was 79% below the Energy-10 predicted use before the remodel**



**GREEN, INDOOR AIR QUALITY, COMFORT, & HEALTH FEATURES**

## **RESOURCE EFFICIENCY**

- FSC Certified sustainably harvested lumber & plywood
- Steel roofing because:
  - Recycled content
  - Never needs to be replaced if it is repainted about every 30 years
  - Ideal for future rainwater harvesting
  - Provide partial shielding of house from electromagnetic fields of adjacent power lines
- Storm water used to charge ground water
- Partial gray system for irrigation
- Cement fiber siding for new roof gables, etc.
- Lumber & siding waste:
  - Salvaged 75%
  - Used for birdhouses
- Best practices detailing for longevity & low maintenance

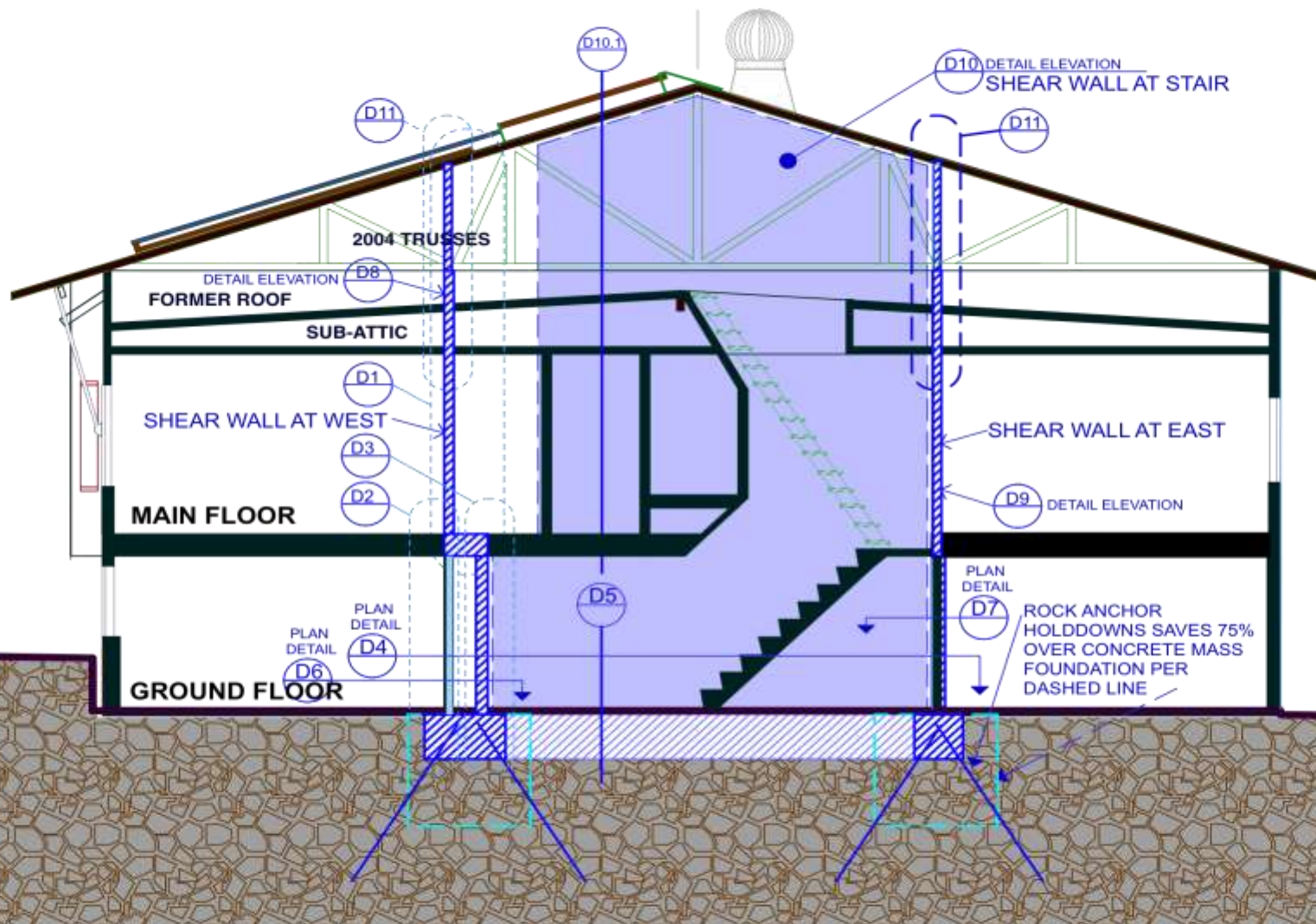
## **ADDITIONAL ENERGY EFFICIENCY FEATURES**

- Add roof overhang over south facing windows for summer cooling
- No mechanical cooling needed
- LED house number

# **IMPROVE EARTHQUAKE & WIND RESISTANCE**

- **Previous phases have dramatically improved earthquake & wind resistance following industry standards**
- **However, what most people do not realize is that, even with new buildings built to code, the goal is only for the occupants to get out safely, not to preserve the building**
- **The loss of a building's embodied resources during a natural disaster can usually be prevented with relatively little extra structural cost when the work is done during remodels adjacent to the structure**
- **Unfortunately, no green building program that I am aware of is addressing this issue**
- **This phase will reinforce the existing structure to approximate code requirements for essential buildings, like schools, for "maximum expected" earthquakes & windstorms**
- **This means that the building should be repairable after the "big one." Lateral strength of the building is improved with interior shear walls built on new concrete foundations with "rock anchors" and extending up to & connecting with the underside of the existing roof sheathing**
- **This is a good investment because now we feel that we do not need earthquake insurance which is expensive & has very high deductibles**





**BUILDING SECTION**

**SEISMIC RETROFIT**

## **RESOURCE EFFICIENCY & DURABILITY**

- **The concrete used was reduced by about 75% by using drilled rock anchors instead of mass footings at holddowns (5.5 C.Y vs. 25 C.Y.)**
- **The soil was tested and found to be slightly corrosive, so the rock anchors were hot dip galvanized and protected by thicker than usual grout**
- **Concrete has 50% of Portland cement replaced with fly ash. This is not unusual for the greenest of buildings but, in this case, it is also for the exposed replacement slab areas, which is unusual & required very careful wet curing performed by the owner/architect**
- **The ultimate strength of the wood & plywood shear wall connections & mudsill connections to concrete footings was significantly improved by using construction adhesive**
- **A properly reinforced access panel opening & pre-placed water supply replacement piping anticipate plumbing repairs that could damage the shear wall**
- **Construction quality for the unusual structural detailing was ensured by an interested & diligent construction team as well as frequent site visits by the structural engineer & the architect**
- **The 40-year-old kitchen range had been repaired three times, but parts are now difficult to find. The Dacor replacement range was selected because of its high performance, durability, & repairability, & the fact that it is made in California**
- **“New” office lavatory & etched glass door are from a local salvage yard**

# **RESOURCE EFFICIENCY & DURABILITY (CONT'D)**

**Water efficiency is improved by:**

- **0.8-gallon flush Niagara Stealth™ toilet, with innovative technology that uses water pressure to create a vacuum in the waste pipe so that it pulls & pushes at the same time so it works even better than a power assist but without the noise**
- **New kitchen sink & bathroom faucets with separate valves for hot & cold because the way most people use single lever faucets is to push straight back, causing both hot & cold to flow even when they want only cold water**
- **Grey water diverter valve installed below shower & tub so that the system may be installed when the city reduces its restrictions**

**Construction demolition debris was recycled to the full extent locally available**

- **Small wood scraps & sawdust were composted**

## **OPPORTUNITIES LOST**

- **The existing cellulose insulation that needed to be removed for working access could have been saved, but it got mixed in with demolition debris & had to be thrown away**
- **Using Zip Poles™ & Zippers™ would have saved a lot of plastic sheeting & finish repair damage from hanging dust protection plastic film with tape**

## **HEALTH OF OCCUPANTS & BUILDERS**

- **The shear wall mudsills are borax pressure treated, which is a new nontoxic option**
  - **It is also more durable because the treatment penetrates the full thickness of the wood**
  - **As a result, drilled anchor holes & cut ends are not decay weak points**
- **All shear wall plywood is fastened with nails & construction adhesive. The very low VOC adhesive used is about 10x better than California requirements & 3x better than LEED requirements**
- **The furnace is being upgraded from a 1” air filter to a 4” MERV 10**
- **The areas not being worked on, registers, & opened ducts, were dust protected**
- **A much more effective range hood is added to the kitchen**
  - **It is top-capture & side-exhaust rather than the former down draft**
  - **It has a silencer for noise reduction & a variable speed control for much better energy efficiency**
- **The new kitchen sink has sloped stainless steel drain boards to avoid water pooling under the dish drain**
- **Opportunities lost:**
  - **Workers were diligent about wearing dust masks at first, until the head carpenter who insisted upon them left for another project**
  - **Unfortunately, hard hats were worn only by the sole union trained carpenter on the job, the structural engineer, & the architect**

# PLANNING FOR AN ELECTRIC CAR

We are going to buy an electric car, so we want to use our excess PV production to charge the car

- Then we will not be able to count that amount of our excess PV as a carbon offset for our natural gas use
- However, our priority is to reduce our full lifestyle carbon footprint

We recently installed a time of use meter (5-20-2010) so that our excess summer peak time PV electricity credit (\$0.301) will have about a 5x multiplier for our off-peak, night charging of the car (\$0.058 summer & \$0.066 winter night rates)

- Our Nissan Leaf electric car is predicted to average 4.167 miles per kilowatt hour (kWh)
- We have a credit of 612 kWh summer peak excess power x 30.1¢ credit / 6.2 ave. night charging rate = 2,971 kWh x 4.167 miles per kilowatt hour = 12,380 miles
- 12,380 miles is significantly more than the 9,743 miles/yr. we drove last year