



Deep Energy Reductions

Friday, 9-10 am, October 21, 2011

CABEC's 2011: *Riding the Wave of Change*

Bahia Resort Hotel, San Diego, CA

Linda Wigington, ACI

lwigington@affordablecomfort.org

www.affordablecomfort.org www.thousandhomechallenge.org

Crisis of Obsolescence in Housing

Housing's Crisis of Obsolescence

5 Flawed Assumptions

- 1) Supply & cost of energy & water are predictable
- 2) Weather events & climate are predictable
- 3) Energy consumption is value neutral – just a commodity – no moral consequences to consumption
- 4) New construction is the solution
- 5) Our homes are our sanctuaries & sources of security

Major Challenges/Barriers

Indoor Air Quality & Infiltration

- Under- or over-ventilated
- Combustion air/makeup air
- Cigarette smoke, NO², VOCs, etc.
- Pressure effects – i.e., stack, ducts
- Attached garages
- Nasty crawl spaces & basements

In addition...

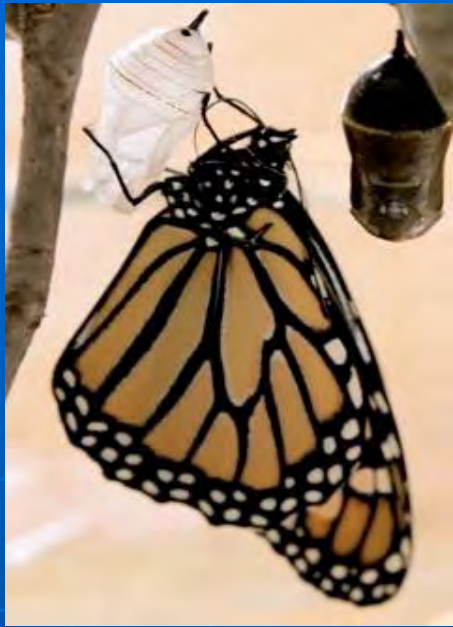
- **Lead-based paint** - biggest US health hazard to children (CDC)
- **Radon** - 20,000 US deaths/yr. (EPA)
- **Dampness** - wet basements/crawl spaces = childhood respiratory health effect of secondhand cigarette smoke (Fugler/CMHC)
- **Water use, fire & earthquake resistance** - high priorities for CA

Millions of Foreclosed Homes (not the preferred path to Deep Energy Reductions)



Crisis of Obsolescence in Housing

Minor Adjustment or
Major Transformation?



Transformation Vs.

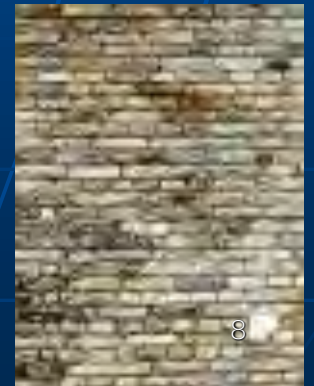
A

Caterpillar Upgrade?

- Business As Usual (BAU)
- Limited potential
- Creating barriers



www.MonarchWatch.org



Maps are Outdated

Destination

Paths

Road Signs

Business As Usual (BAU)

20%-30%
Reduction
Goal (per
house)



New Map (Beyond BAU)

- New Destinations
- New Paths



Beyond 70%
Reduction

Start

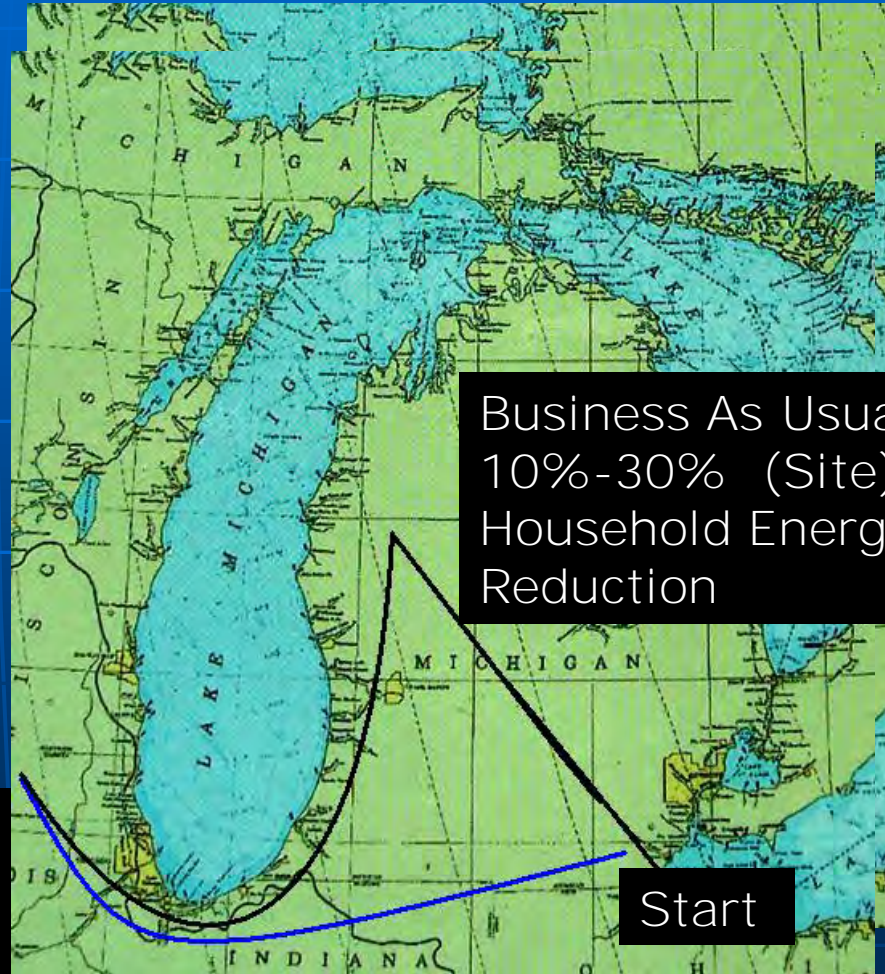


Some Paths - More Direct

- Less expensive
- Fewer barriers
- Greater synergy
- Greater impact



Beyond 70%
Household Energy
Reduction





Maps Need to Include

- Paths to Deep Energy Reductions
- Occupants/communities as resources
- Broader view of cost effectiveness
- Verified house performance
- Feedback/continual improvement

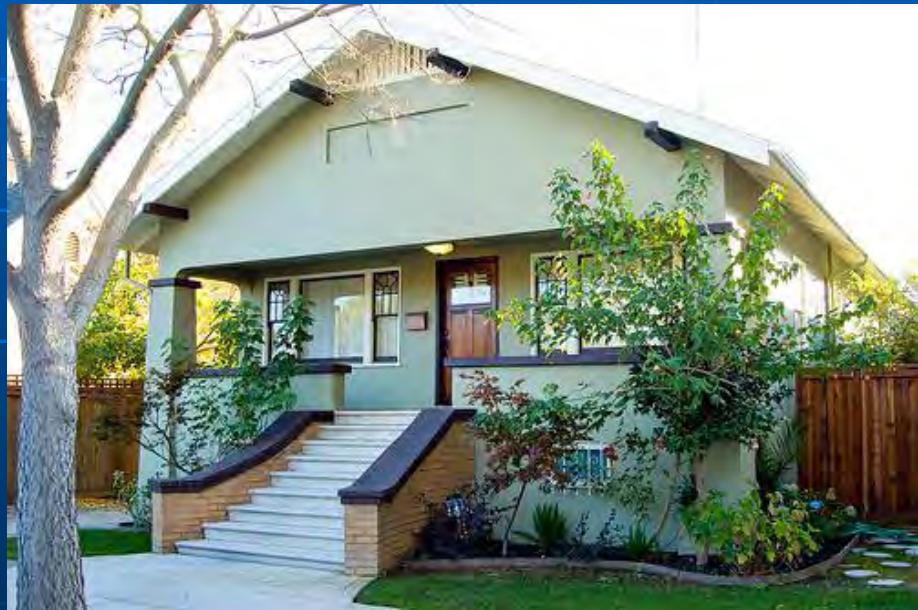
Maps Need to Include

**New Destination
New Paths
New Road Signs**



Develop Deep Reduction Packages by House Vintage

- Classic house type
- Compact form
- 100,000's of them



Whole Building Strategies

Packages of measures that collectively leap over, rather than confront, complexities (IAQ, pressure, combustion safety, durability)

Widgetize Home Performance!

Think Outside the Box

Wet?

Un-insulated?

Prone to flooding?

Radon?

Source of asthma
triggers?



Technical Packages

(comfort, energy, water, adaptability, IAQ, durability)

Streamline & Simplify...GPS

- Verified performance of system & install
- Pre-approved for financing, incentives
- Solve problems by redesign
- Minimize need for audit, pre-diagnostics
- Leverage skilled workforce w/workforce development or DIY/volunteer options
- Opportunity for community deployment

What Motivates & Supports Behavior Change & Action?



Dollars & Savings? Or Value & Meaning?

Behavioral Choices

Exploration, Not Simplification

- Process focused; household level
- Examine assumptions & boundaries
- Explore new paths to meeting needs
- Social networks, goal setting, information, feedback, aggregation, benchmarking
- Surprising results possible

Deep Energy Retrofits (Asset Performance)

Vs. Deep Energy Reductions
(Operational Performance)

Key Challenges to Deep Reductions

- Make the value proposition (not just energy or cost savings)
- Simplify the process (components)
- Address cost barriers
- Demonstrate phased approaches
- Get the signals right (partial load performance, alternative systems)
- Celebrate & recognize champions



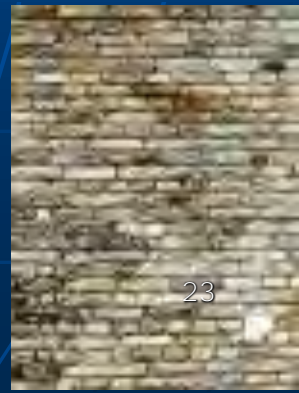
Transformation Vs.

Caterpillar Upgrade?

- Business As Usual (BAU)
- Limited potential
- Creating barriers



www.MonarchWatch.org



Maps Need to Include

**New Destination
New Paths
New Road Signs**



Issues on the Path to Deep Reductions

Water Heating

Many California Homes

1/3+ Household Energy Use

- Triple play – energy, water, & waste water
- Install better equipment
- Address plumbing design with structured plumbing!!!
- Modify end uses – products & behavior
- Good starting place – staged reduction!

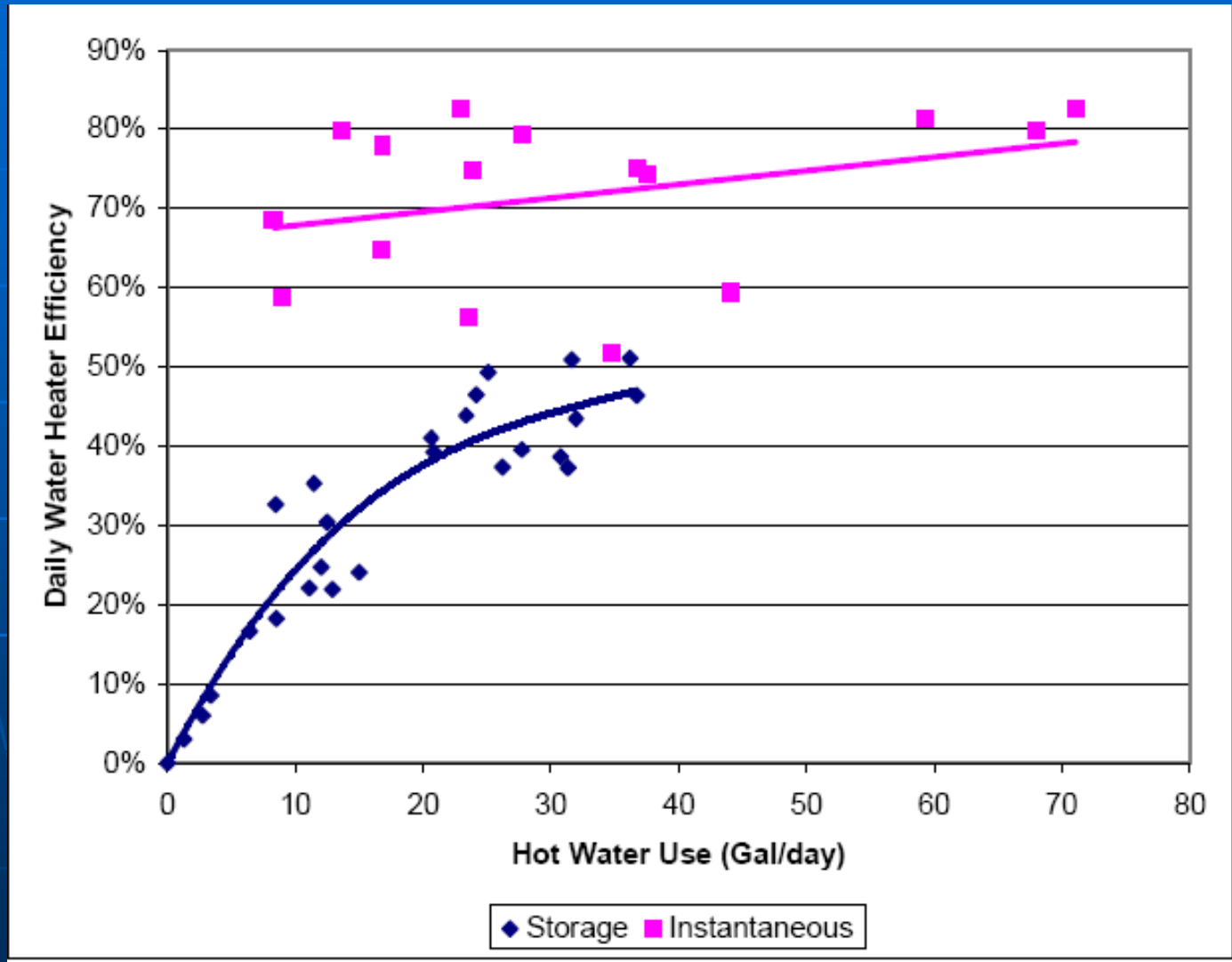
Conventional Atmospheric Gas Water Heaters

- System efficiency: 10%-40%
- System efficiency drops with lower hot water use
- Venting/combustion safety issues
- Inconsistent with tight construction
- Many better alternatives!

Field Research – Water Heating

- Hot water use ~ 43 gal/household
- Water use not proportional to household size
- Many more draws/day than test assumption (86 vs. 6)
- Standard test procedure not accurate
 - tankless & conventional tank

Efficiency Vs. Water Use



Hoeschele, M., and Springer, D. "Field and Laboratory Testing of Gas Tankless Water Heater Performance ASHRAE Transactions, vol. 114, pt. 2, 453-461, 2008.

“One Thermal Engine”

Combo Space & Water Heating

- One high efficiency combustion system
- Saves space
- Lower cost than two systems (possibly)
- Fewer envelope penetrations
- Addresses orphan water heater or combustion safety issues
- Variety of options – forced air or hydronic
- Can maintain high efficiency at low loads
- Integration with solar possible

MN CEE SERC Combi Pilot

<http://srcefficiencylab.tumblr.com/>

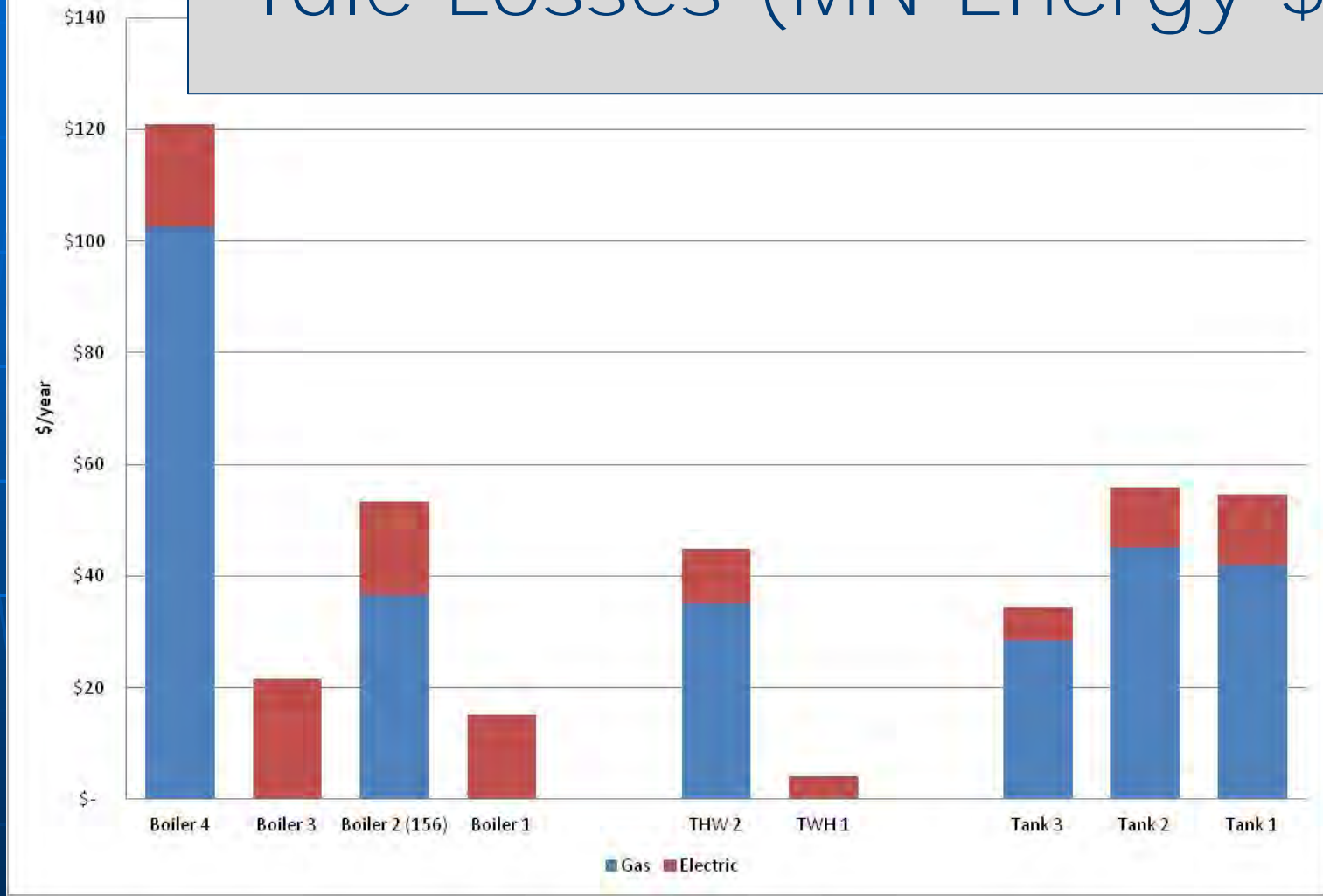
400 combi systems to be installed!

EARLY FINDINGS:

- Do not assume condensation occurs in a condensing system
- Watch out for idle losses
(huge variation: 20-1,200 Btus/hr.)!
- Need to optimize systems after installation

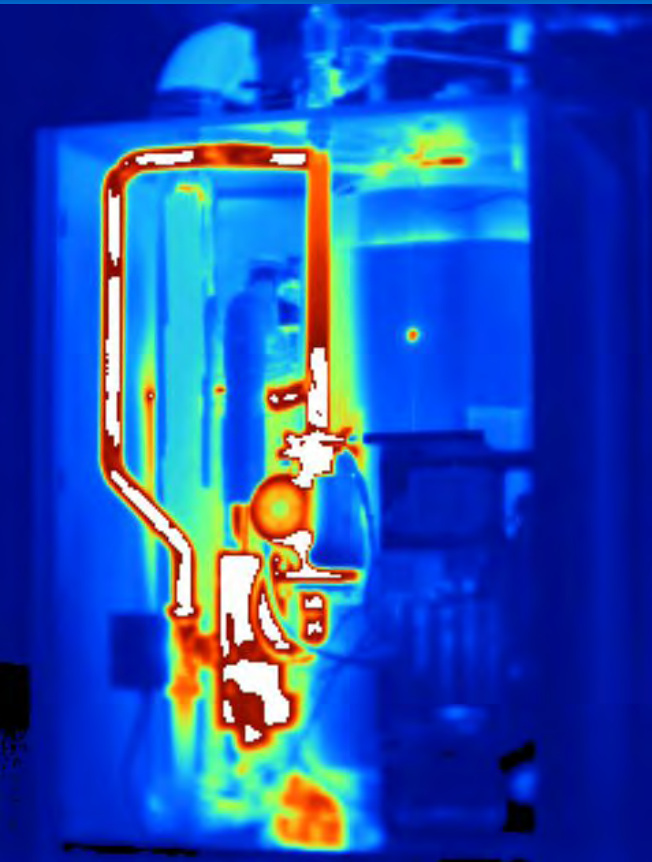


Annual Operating Costs Idle Losses (MN Energy \$)



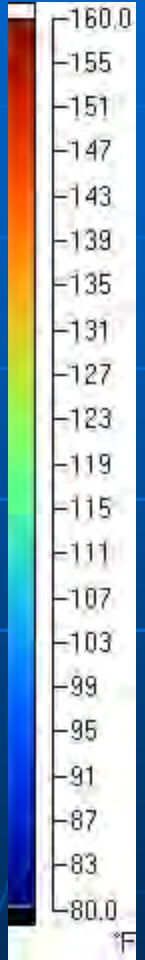
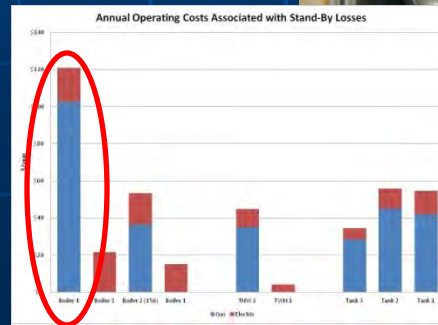
Slide Credit: Center for Energy and Environment, Minneapolis, MN

Boiler 1 – Combi Boiler with 12-gallon DHW Tank



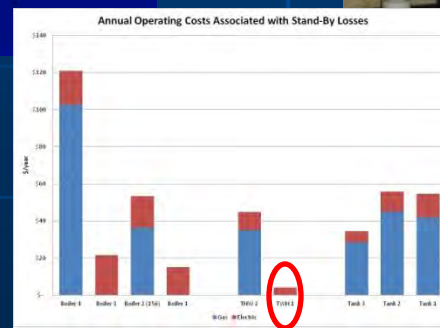
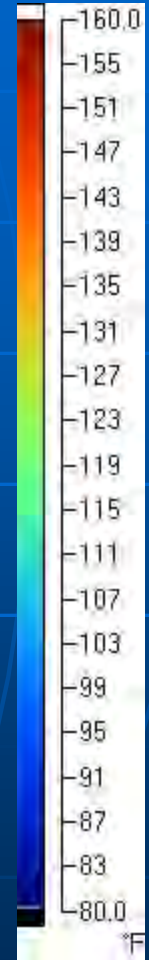
Note:

No call for heat or hot water when IR was taken.



Slide Credit: Center for Energy and Environment

❖ Tankless Water Heater 1



Slide Credit:
Center for
Energy and
Environment

90+ Combustion Efficiency



Phoenix



Vertex 100



Polaris®

Heat Pump Water Heaters

Integral Units



AO Smith 80-gallon



Rheem 50-gallon



Add-on Heat Pump Water Heater

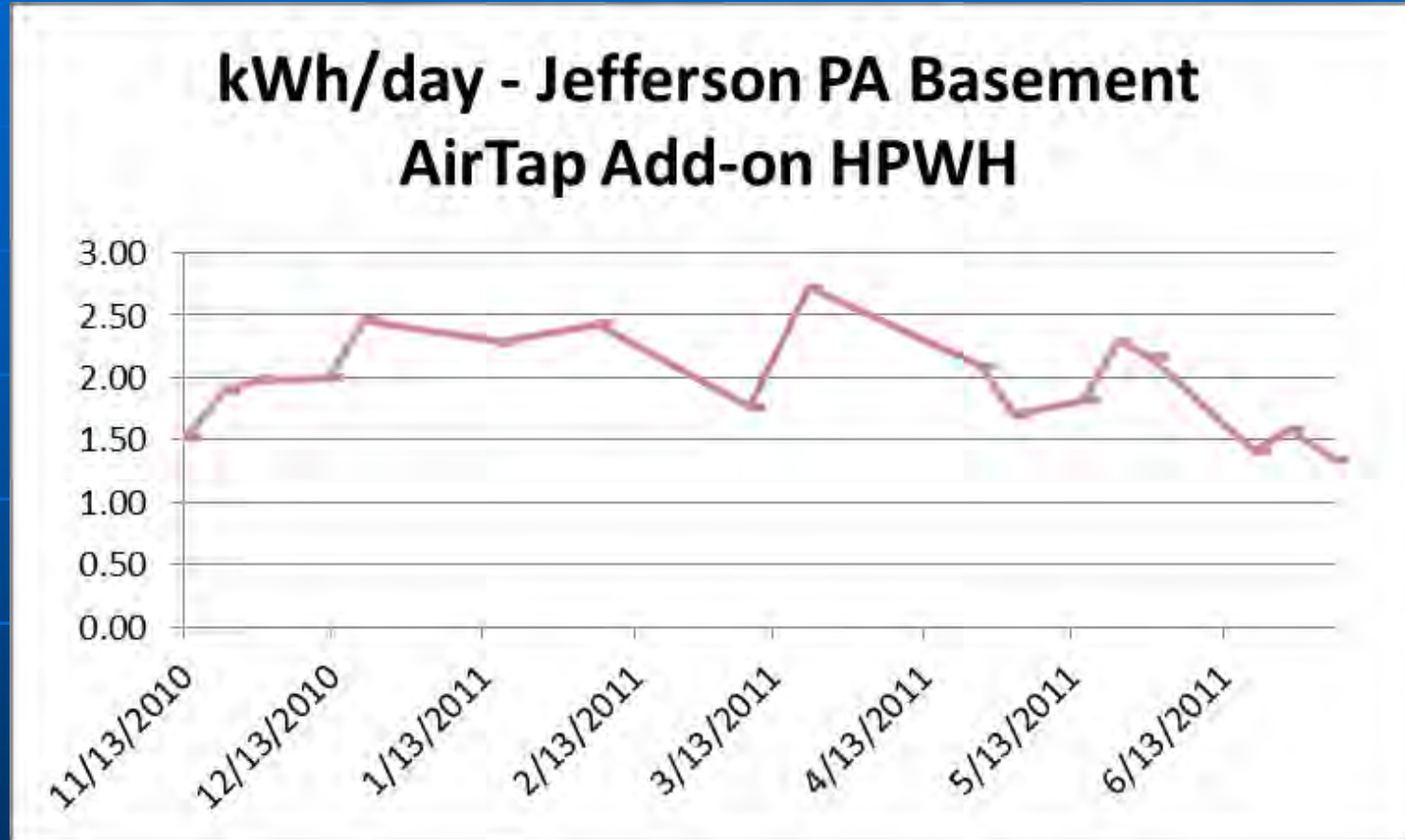
AirTap™

Concern:

*Dissimilar metals
in the tank could
lead to tank
failure*

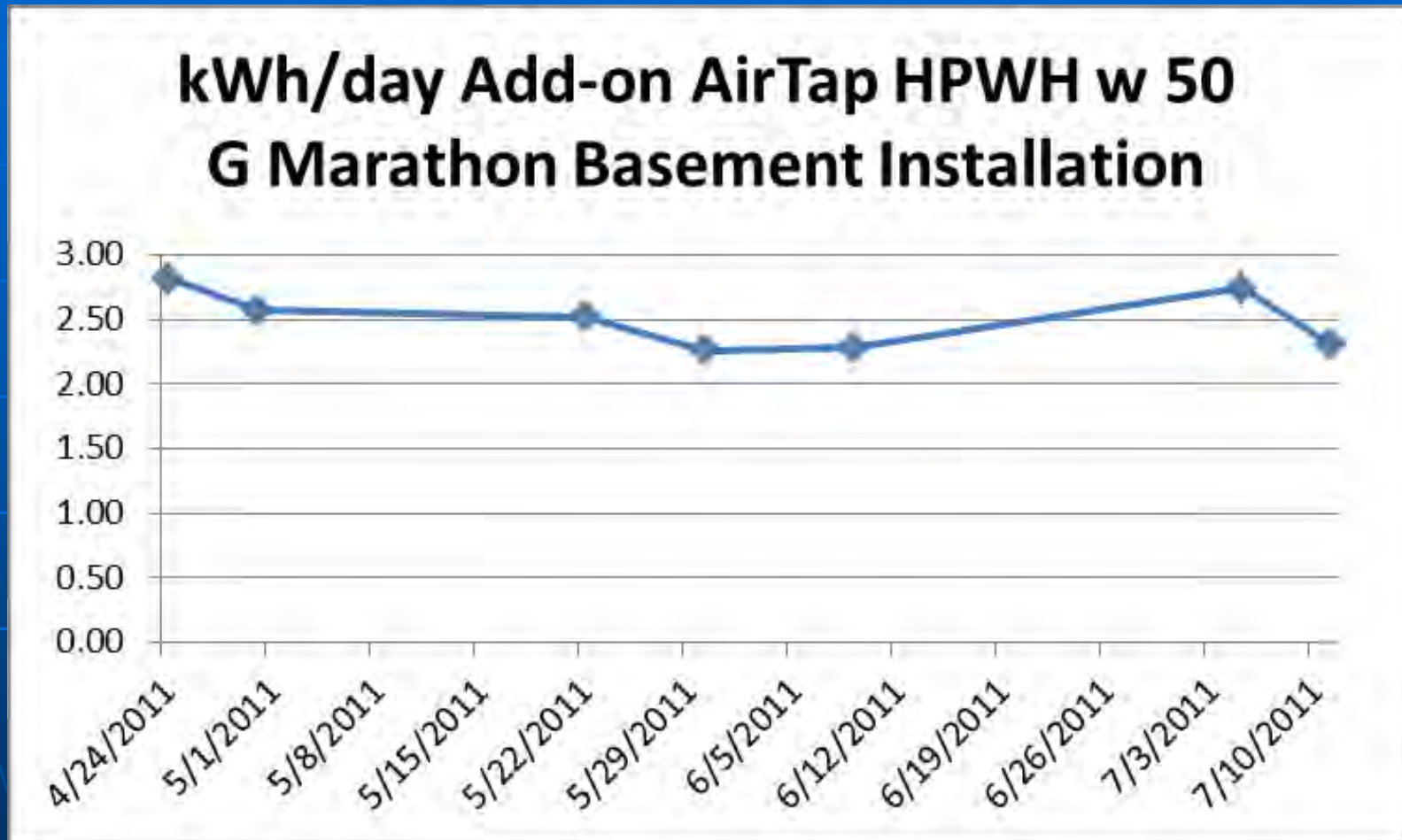


Wigington Family HPWH Field Research



Unheated basement: 48°-70°F ambient temp, single occupant, low hot water use; breaker off to electric tank resistance elements. The HPWH eliminated the need to operate a dehumidifier, since it produced condensation (up to 1 gallon/day).

Wigington Family HPWH Field Research

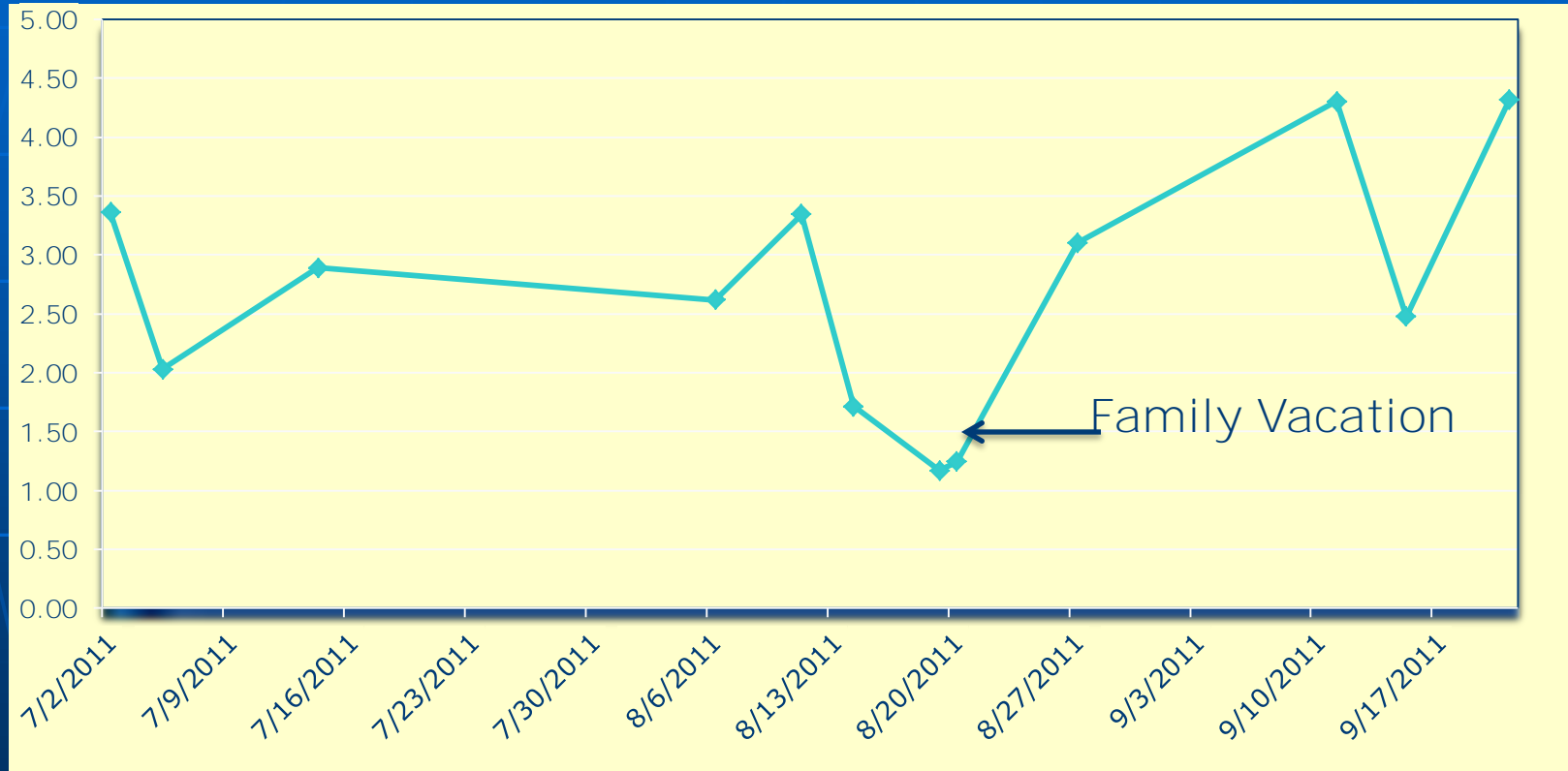


2-person household; below average hot water use; 65° to 69°F ambient temperature in basement; breaker off to electric tank resistance elements. Less condensate, drier basement than house in previous slide.

Wigington Family HPWH Field Research

kWh/day w Add-on AirTap

Installed on 80-gallon Marathon Tank



5-person household; below average hot water use; 67°-71°F ambient temperature in basement; breaker off to electric tank resistance elements; intermittently wet basement, lots of condensate – more the 1 gallon/day at times.

HPWH Synergies to Explore

- Integration with home's mechanical ventilation system (COPs of 5?)
- Desirable cooling effect/waste heat recovery from laundry or utility room
- Integration with space heating
- Dehumidification (greatest impact at RH above 70%)
- Huge issue – Occupants!

Point Source Electric Water Heating

- Complements solar hot water or heat pump water heating
- Great for low hot water loads
- Can be low initial installation cost
- Cuts distribution losses
- Small tank or inline boost at use
- Available in 110 voltage/plug-in
- Big issue – Load profile!

Water Heating Resources

Handouts – ACEEE Hot Water Forum:

<http://www.aceee.org/conferences/hwf/past>

Top notch consumer resource: Blogs, product info, links

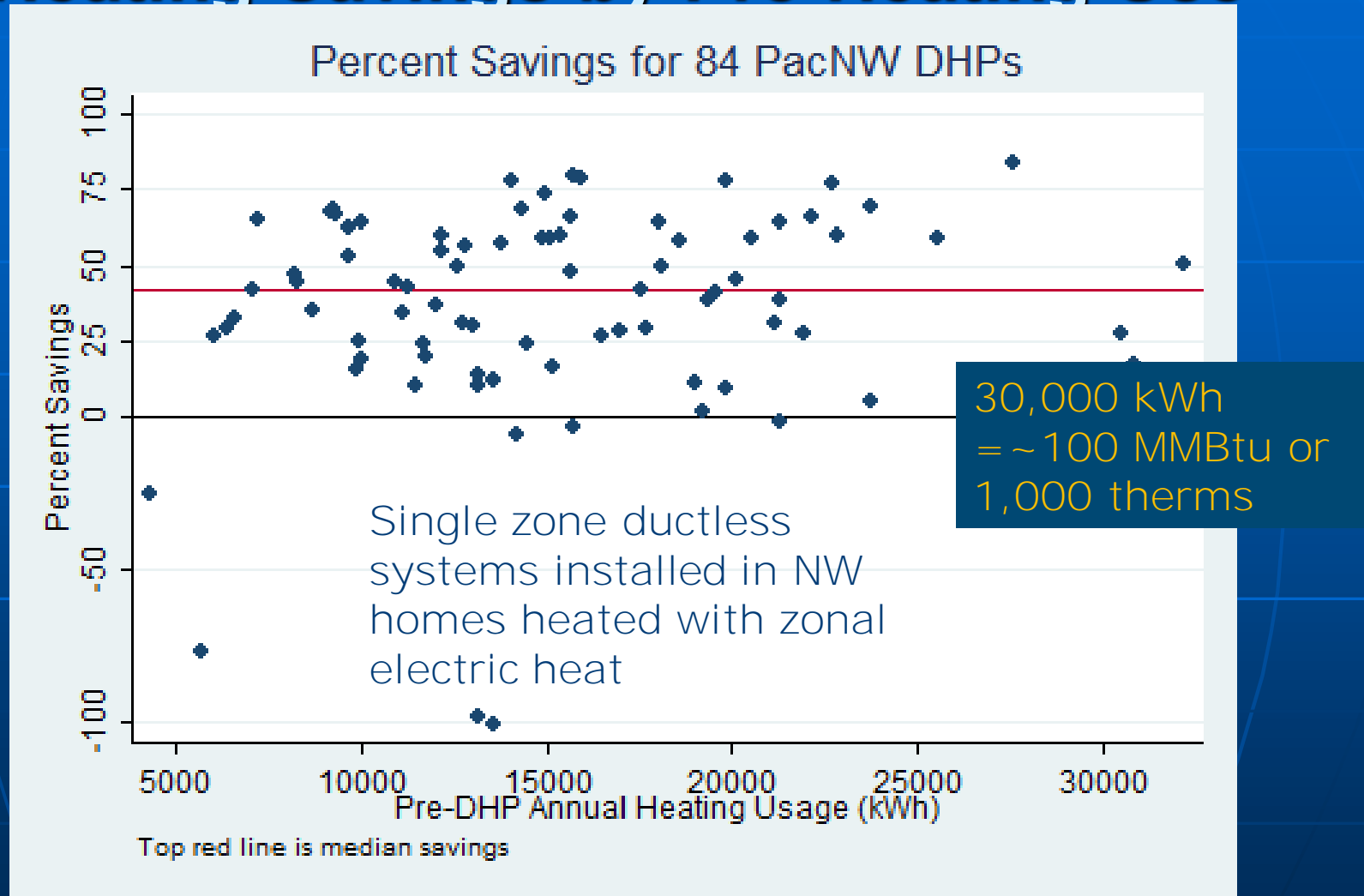
<http://www.waterheaterrescue.com/>

2-part Gary Klein webinar: Audio, PowerPoint, & resources

<http://thousandhomechallenge.com/thc-webinars-high-performance-hot-water>

Ductless Heat Pumps

% Heating Savings by Pre-Heating Use



Data from NEEA-funded research initiative
Slide credit: Bob Davis, Ecotope

Ductless Heat Pump (DHP)

Minimize distribution losses

Heat, AC, & humidity control

Integration w/central ventilation possible



NW Field Performance

Avg. 3,500 kWh reduction
(installed in homes w/electric resistance heat)



Photo Credit: Jeff Pratt

Mini-splits – Cooling Applications & Performance



Webinar

October 25, 2011

11 am-12:30 pm (Pacific Time)

Recording & slides available

Additional Resources:

May 2011 2-part webinar recordings

<http://thousandhomechallenge.com/thc-webinars-ductless-heat-pumps>

www.goingductless.com

www.nwductless.com



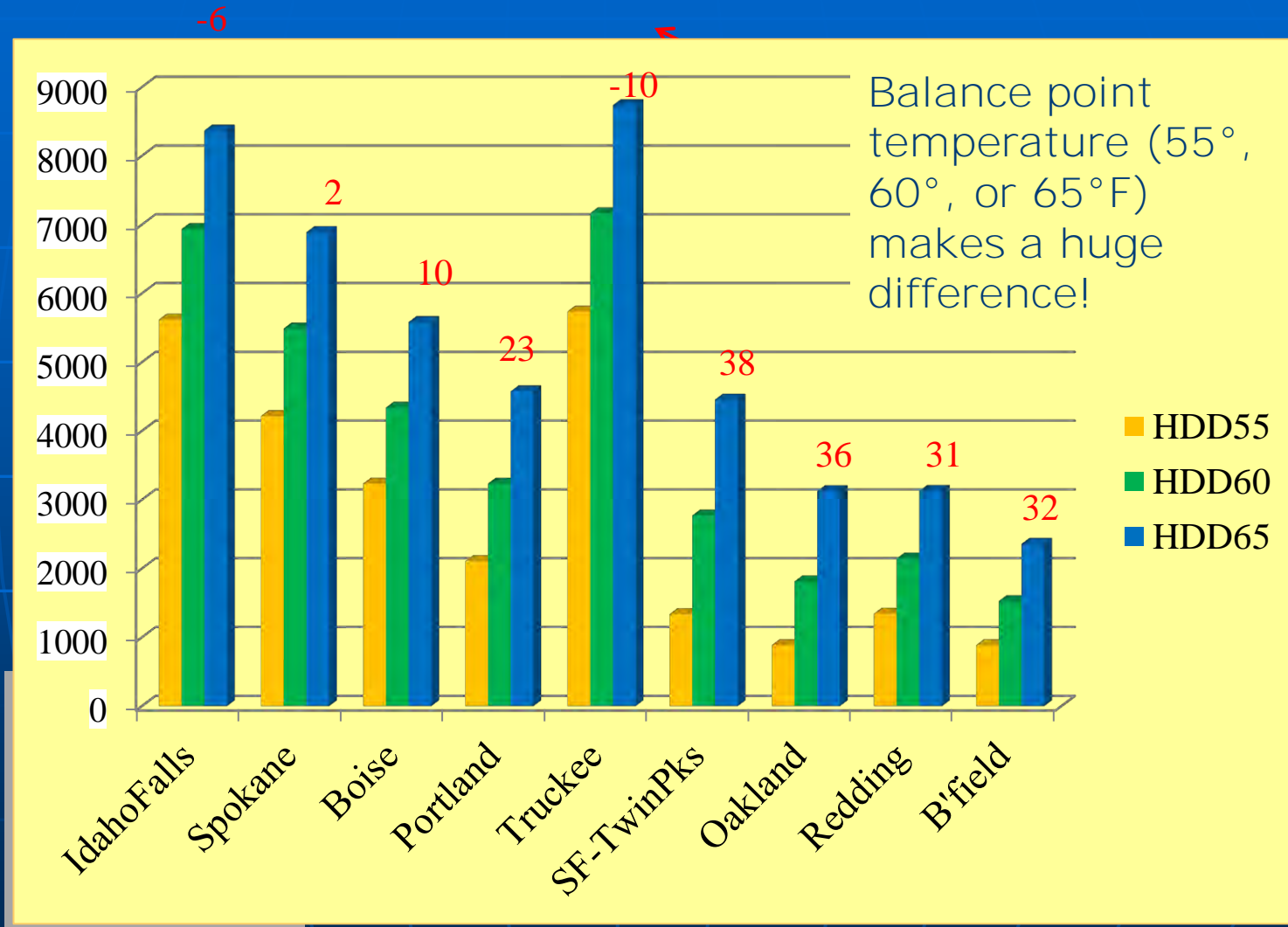
Jeff Pratt

Point Source Vs. Central Heating/Cooling System?

- Point source doesn't limit boundary choices
- Either transition or permanent solution
- Lower parasitic energy use
- Critical Needs Wx Pilot (GRI)
- Can be less expensive
- Huge issue – Occupants & house!

How much energy could
you save by moving your
home to a milder
climate?

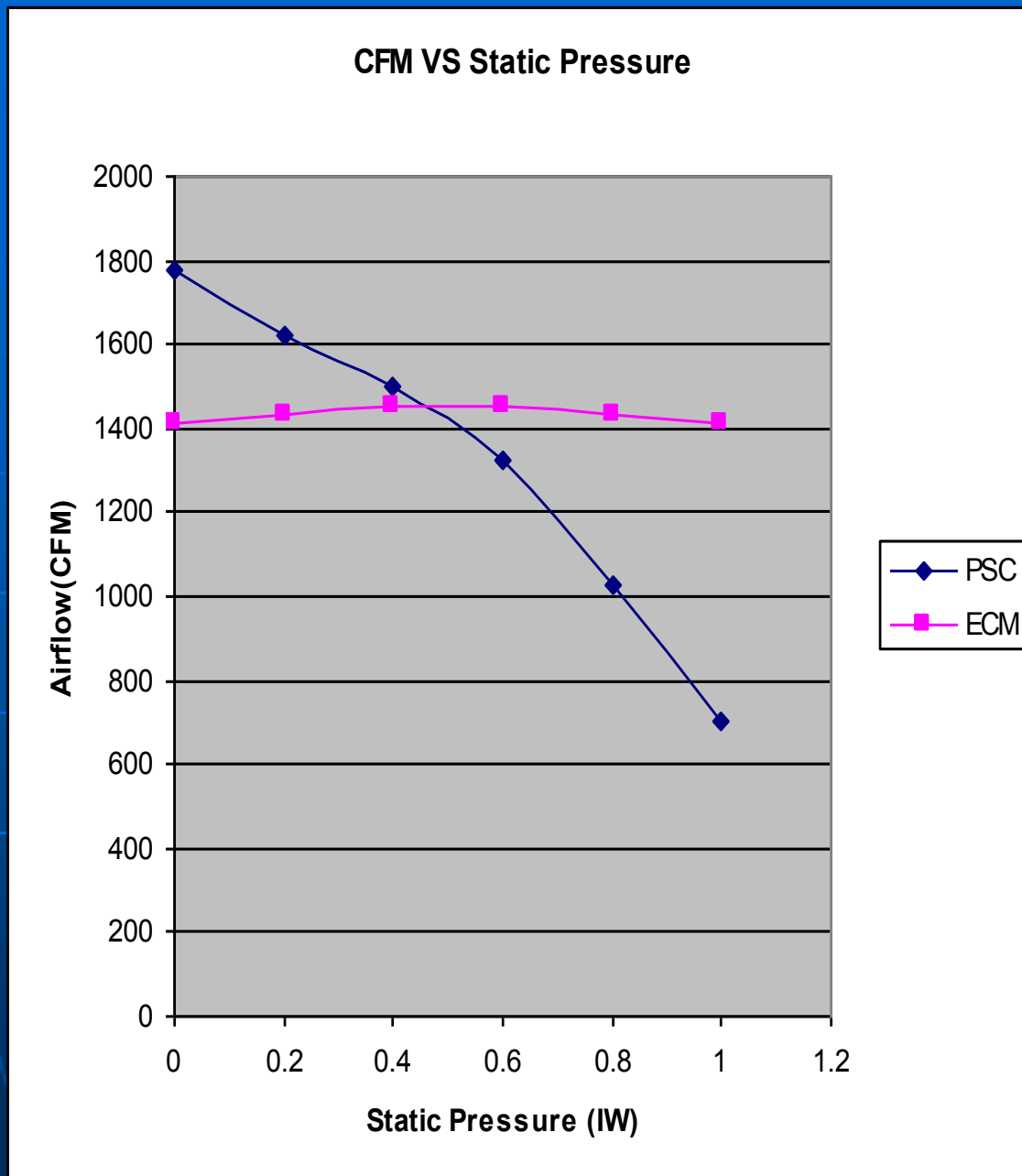
Degree Days – Just an Assumption



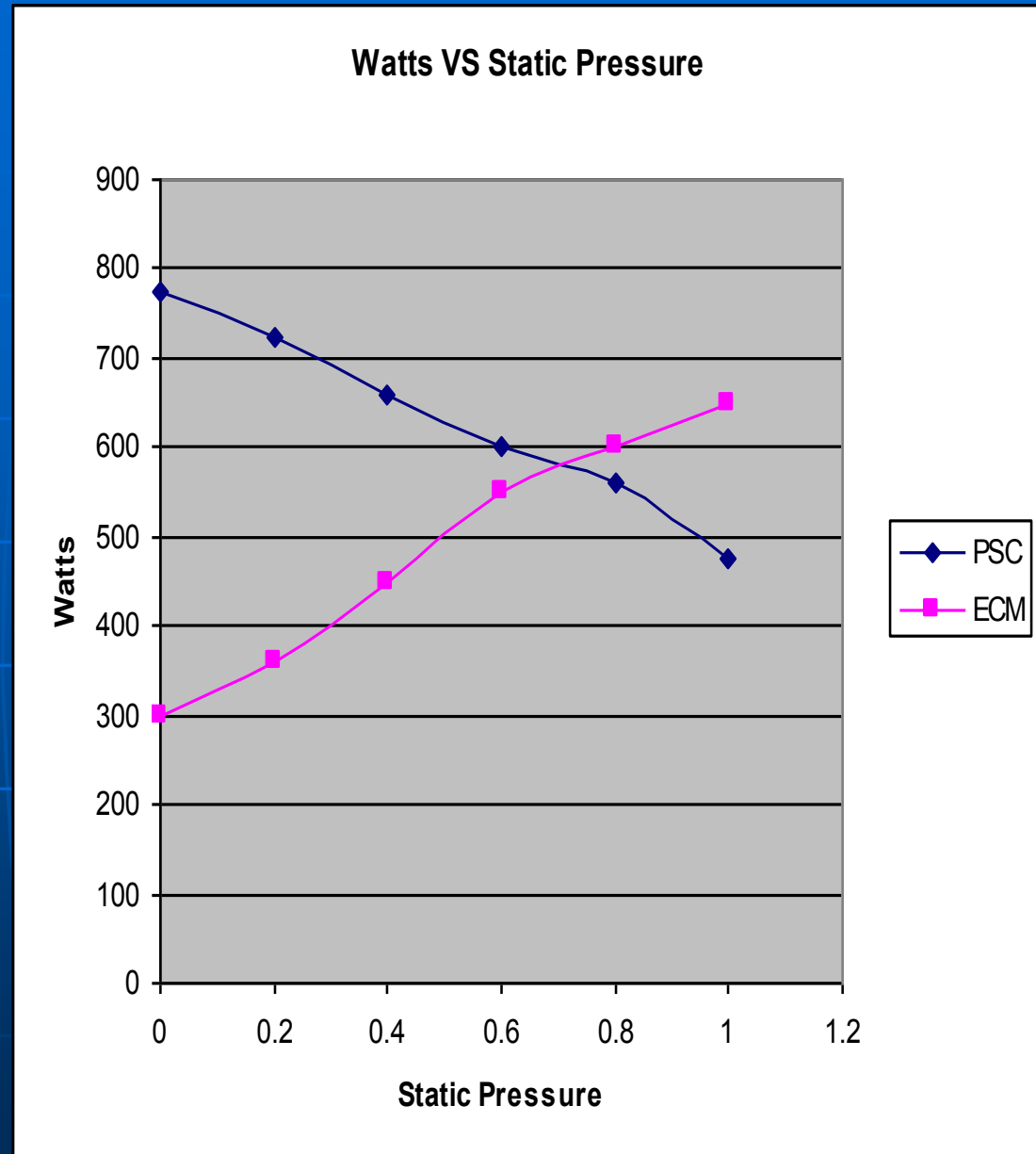
Degree days from www.degreedays.net; based on most current 12 months

CFM/Watt??

Data
We
Have
Had

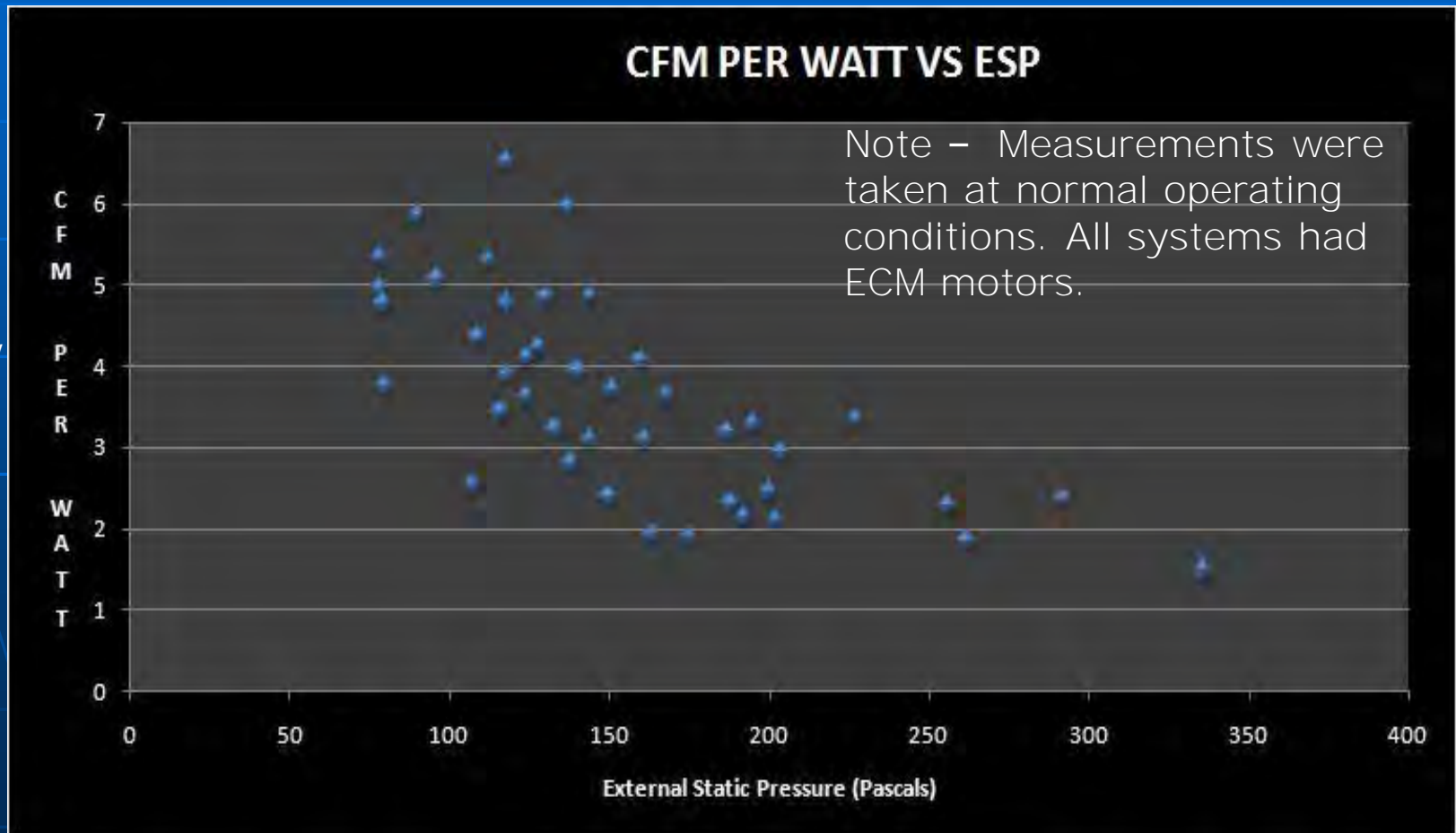


Data
We
Have
Had



Cubic Foot Per Minute/Watt Vs. External Static Pressure (ESP)

New Data



Significant Performance Variation

*Duct System Design &
Installation, Choice of Filter,
Regular Filter Replacement!*

Solutions??

- ~~Eliminate occupants~~
- ~~Mandate fail proof designs & systems~~
- Accelerate systems innovation & field testing
- Create systems to track & reward asset performance
- Create institutional incentives for routine maintenance
- Consider lease vs. ownership of systems

Most Importantly

Support & mobilize climate champions

- Occupants & homeowners
- Energy & housing professionals
- Initiatives & institutions

Why Deepest? Why Now?

Support Paradigm Change

- ❑ Demonstrate what is possible
- ❑ Clarify “On the Path” solutions

Build Capacity to Reach Climate Goals

- ❑ Technical innovation (products & systems)
- ❑ Professional capacity
- ❑ Community mobilization
- ❑ Housing & energy industry infrastructure



The Thousand Home Challenge

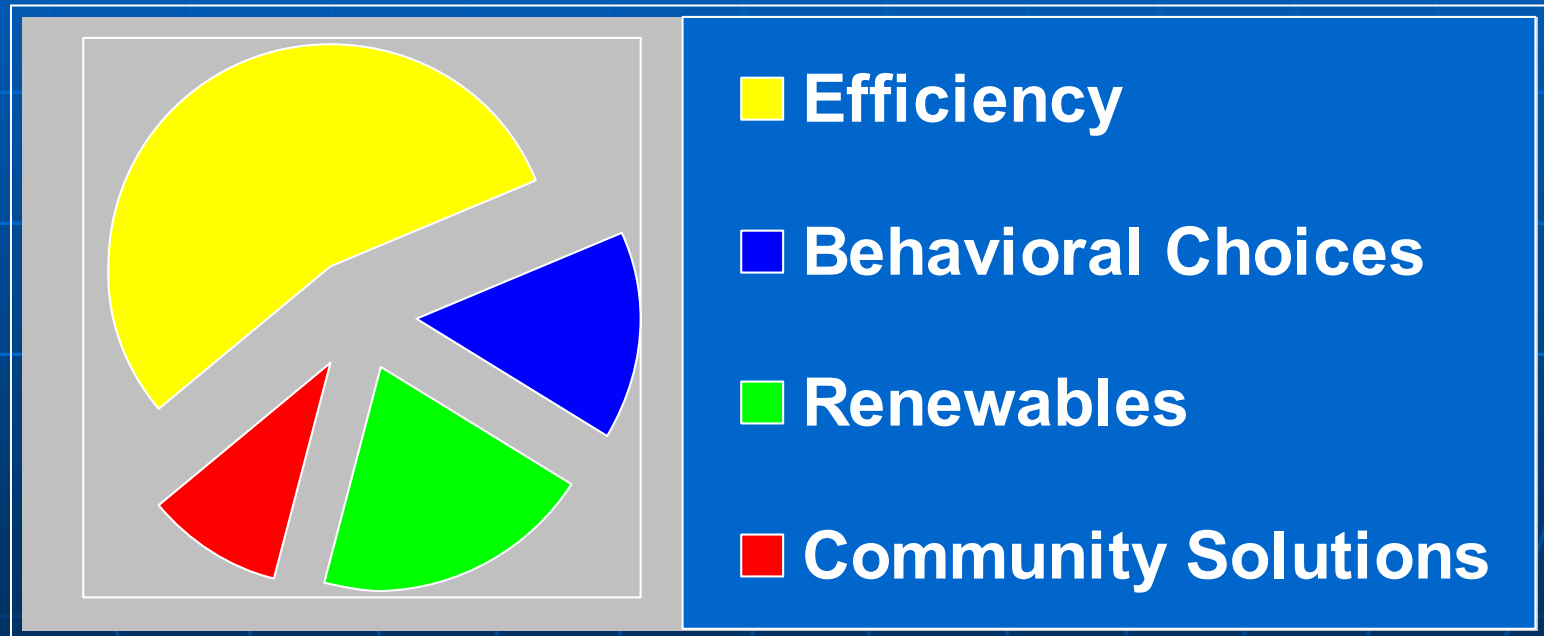
PURPOSE:

The 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.*

The Thousand Home Challenge

Access & Integrate



Key Metric

Transparent & Direct
Include Occupants

Net Annual Household Site Energy

Credit/offsets: Solar & onsite
renewables

Wood counts!

Two Options for Qualifying

Meet or Exceed a Customized Household Energy Allowance

OPTION A

Relative, 75% reduction

OPTION B

Absolute, not relative

Thousand Home Challenge

Summary of THC Threshold Determination

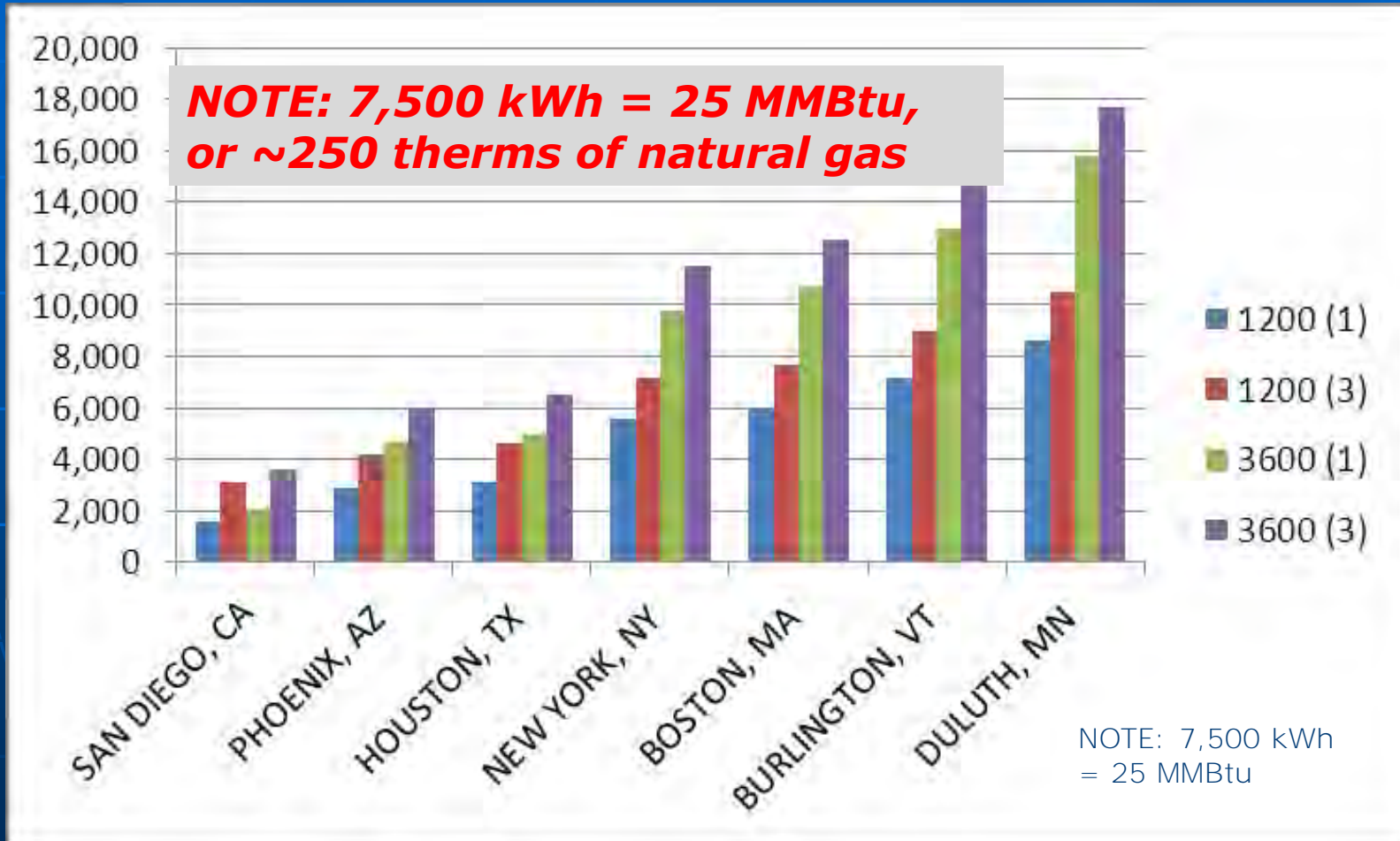
OPTION A

- 75% reduction of actual annual site energy use

OPTION B Inputs

- Climate (ZIP Code or best match weather station)
- House size (FFA), converted to surface area (5 sides)
- Number of occupants (including partial)
- Detached or attached
- Electric heat allowance = $\frac{1}{2}$ fossil fuel or wood heat allowance

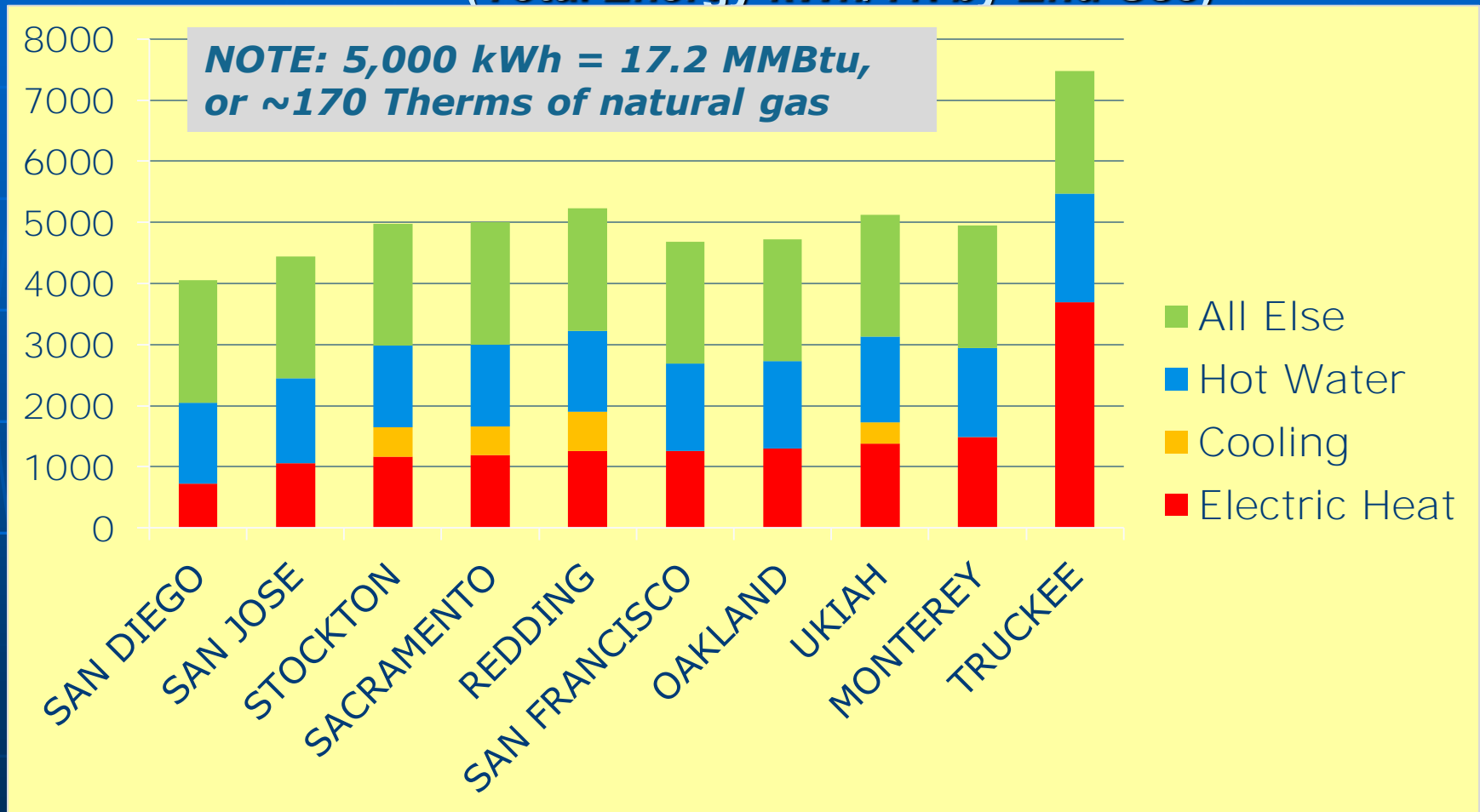
THC Option B Threshold (kWh/yr) by Ft² & Occupants (1 or 3) (rounded)



INPUTS: detached, fossil or wood heat, square feet are finished floor area (FFA), not conditioned floor area (CFA)

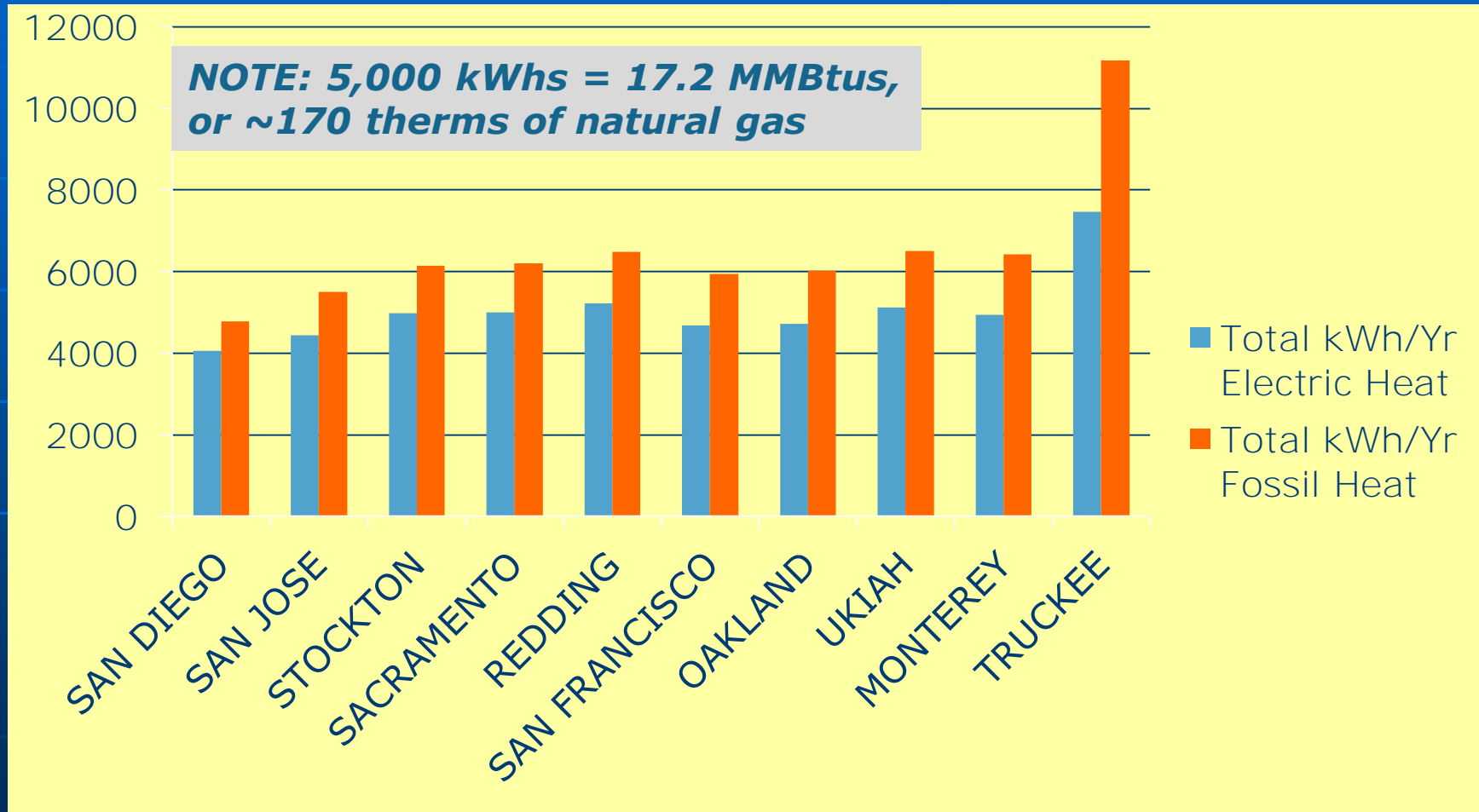
THC Option B Household Threshold

(Total Energy kWh/Yr. by End-Use)



OPTION B Inputs: Detached; 3 in household;
2,000 ft² finished floor area (FFA); electric heat

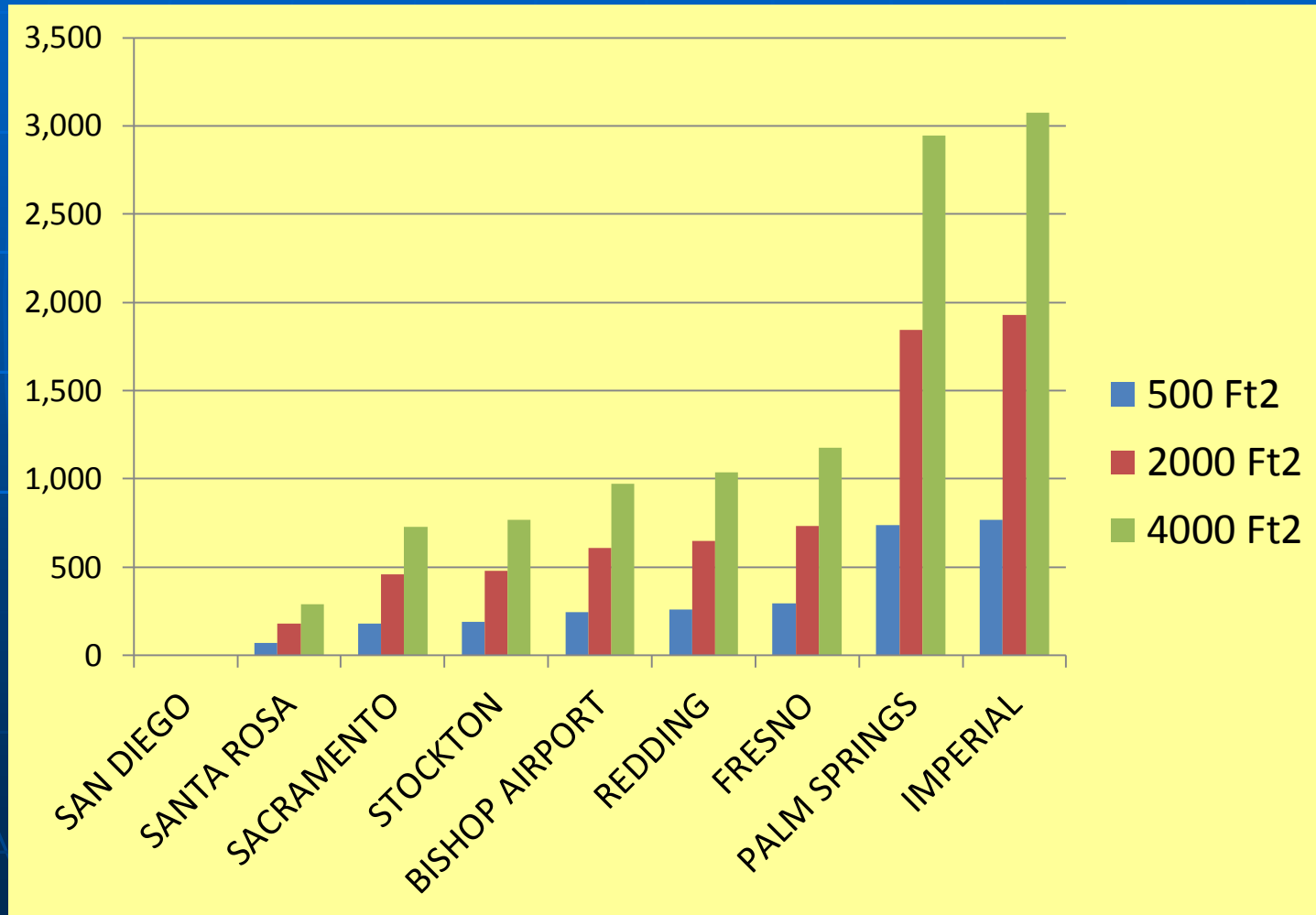
THC Option B Household Threshold (kWh/Yr. All End-Uses)



OPTION B Inputs: Detached; 3 in household; 2,000 ft² finished floor area (FFA)
NOTE: Allowance for heating portion of threshold is ½ as much for electric heat

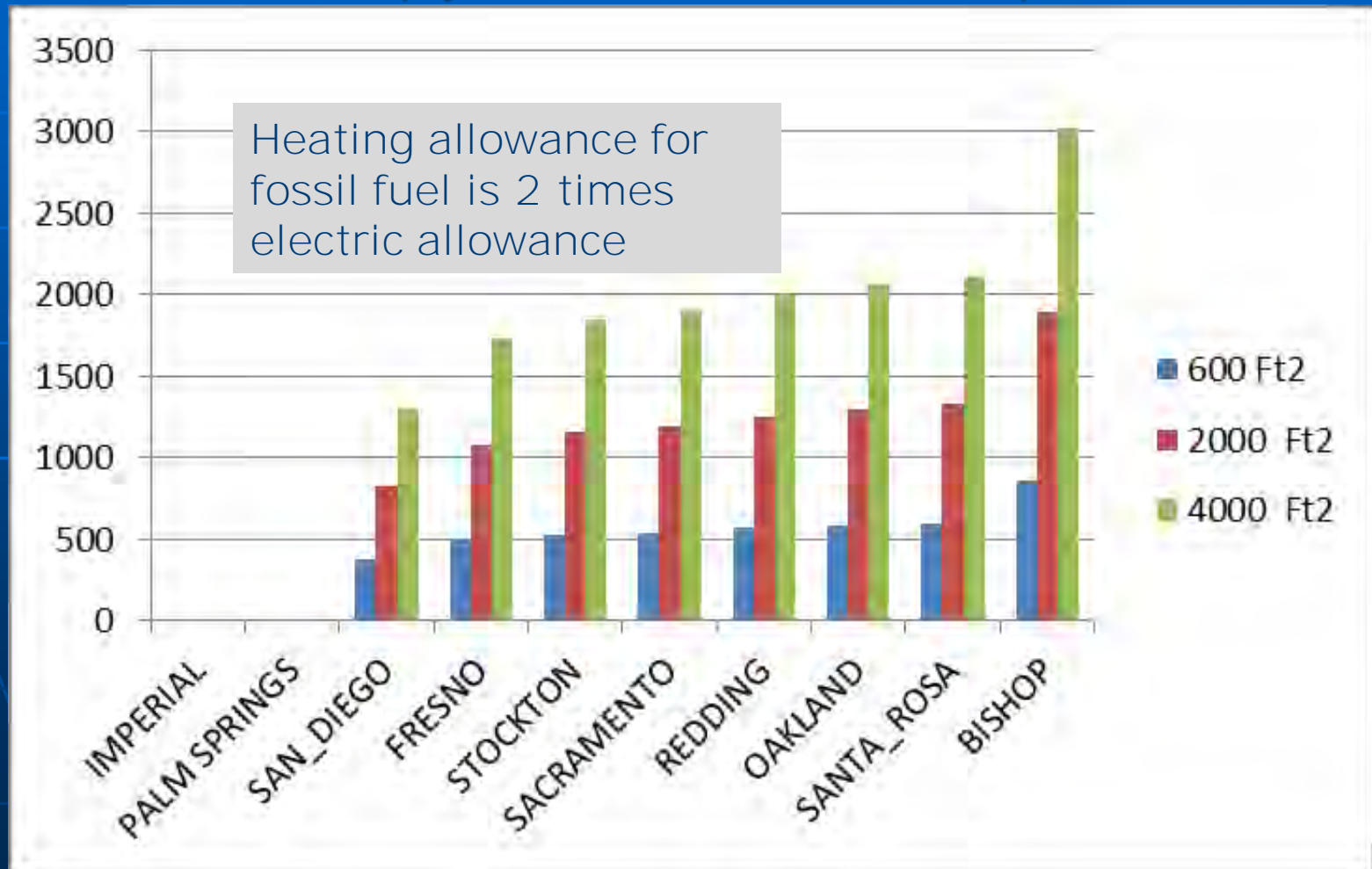
THC OPTION B Cooling Allowance (kWh/yr.)

(by location & house size)



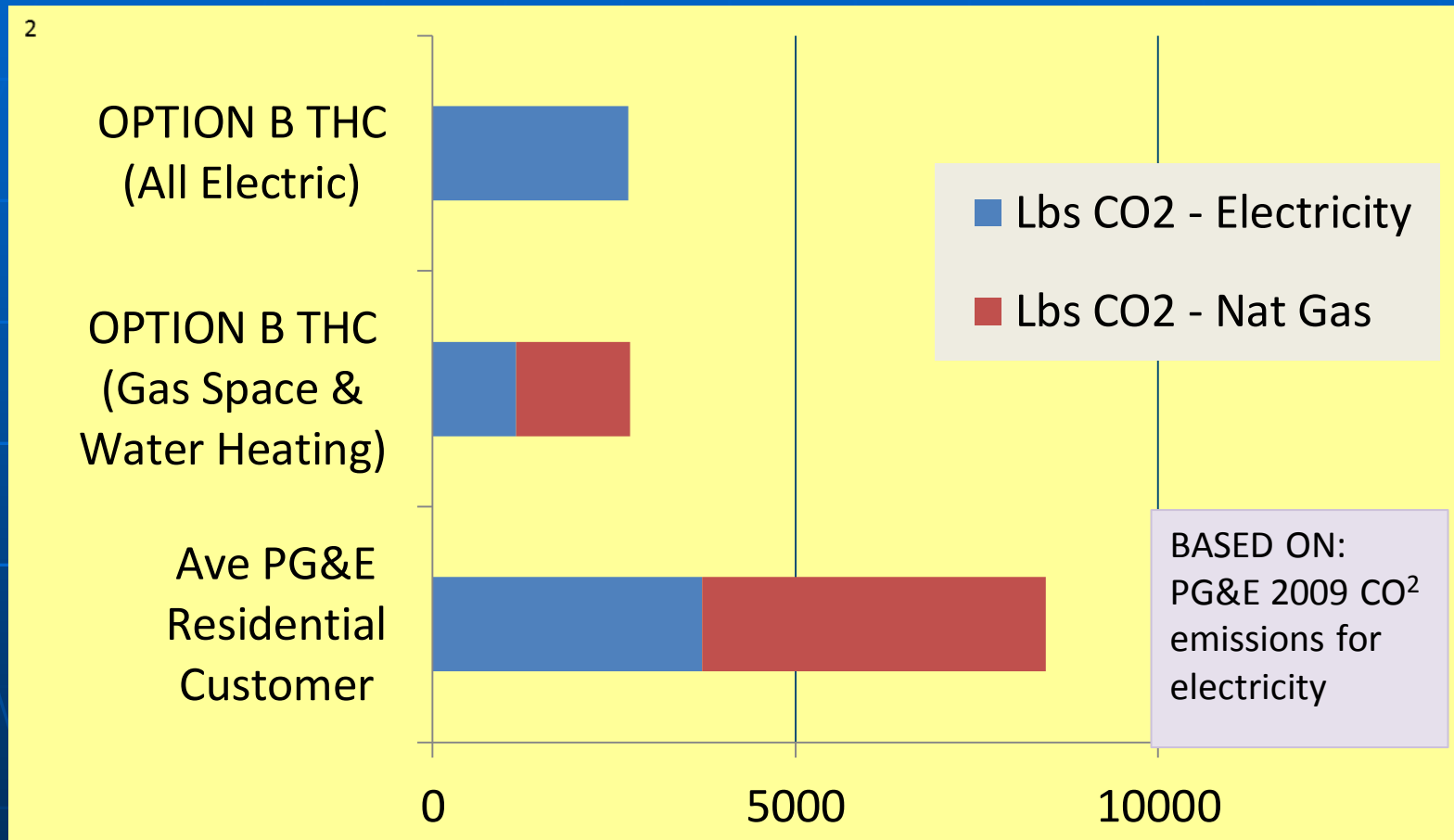
THC OPTION B Electric Heating Allowance (kWh/yr.)

(by location & house size)



Comparing CO₂ Emissions

<http://www.pge.com/mybusiness/environment/calculator/>



OPTION B Inputs: detached; 3 in household; 2,000 ft² finished floor area (FFA)
California Average Res Customer Annual Use: 405 therms; 6,456 kWh
(includes multifamily housing)

Deep Energy Retrofits (Asset Performance)

Vs. Deep Energy Reductions
(Operational Performance)

Move on to Threshold Calculator Spreadsheet

www.1000HomeChallenge.org

Excerpts from Northern California Case Studies

*NOTE: Not shown during the
presentation due to time
constraints.*

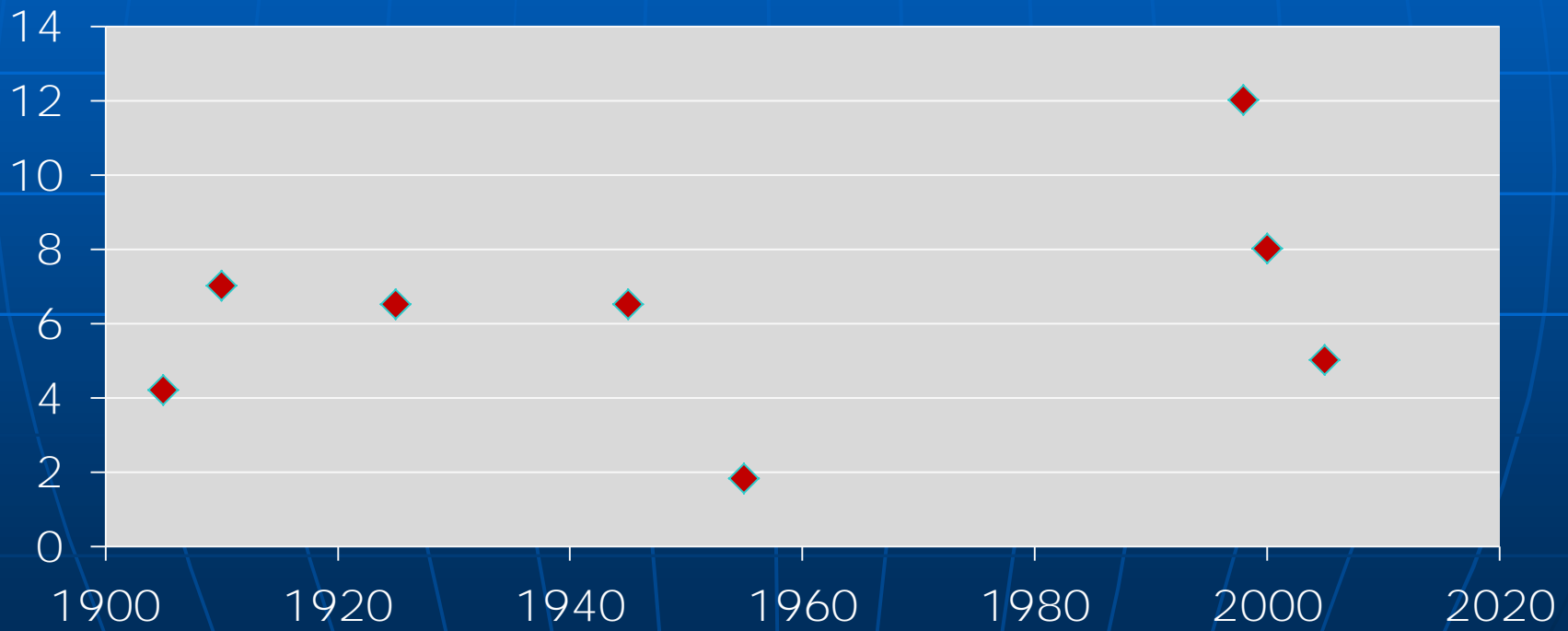
Case studies slides (with extra slides)
will be posted as a separate document.

Deep Energy Reduction Lessons Learned & Implications (for current & future initiatives)

In search of trends...

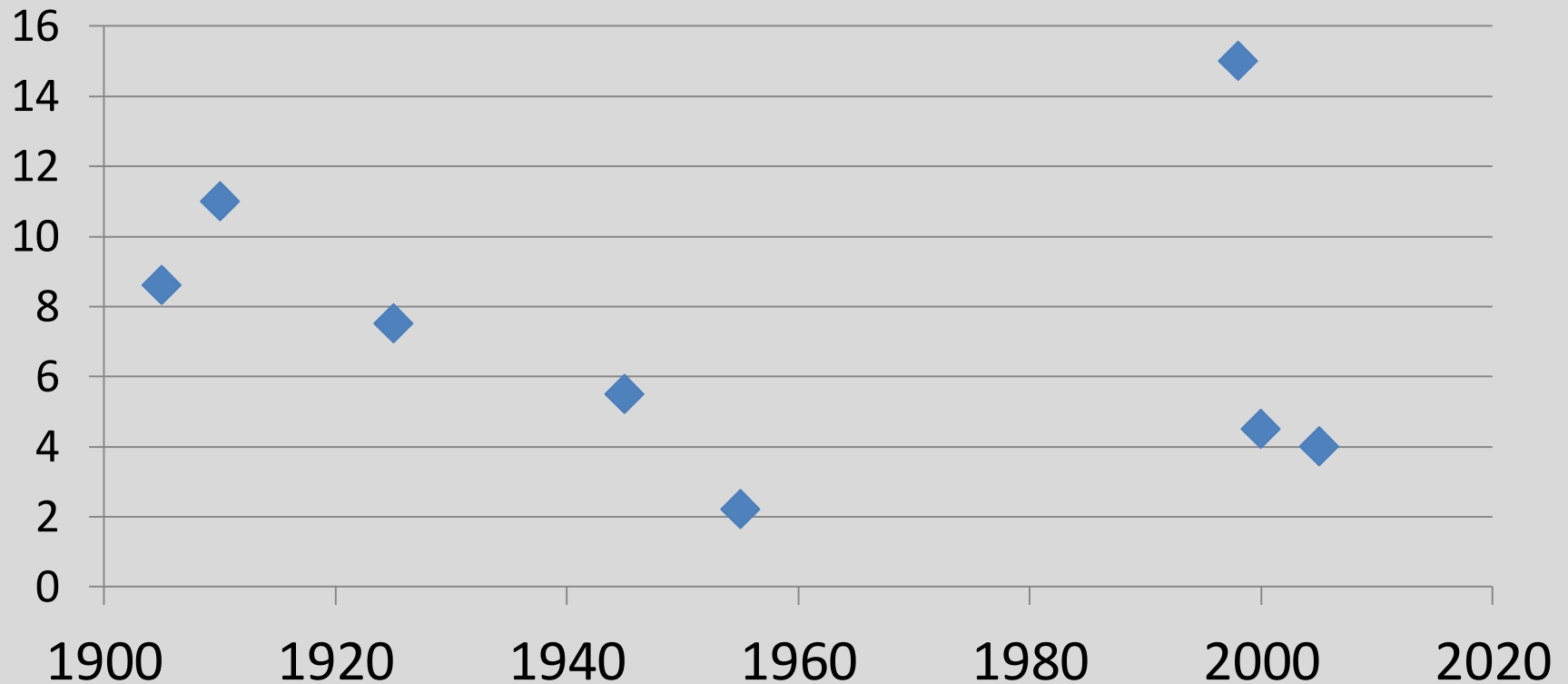
kWh (1,000's)/Yr. Reduction Vs. Year Built

(total household energy use; 8 Northern CA projects; variety of approaches: gut, home performance, efficiency with PV/solar thermal, creative)



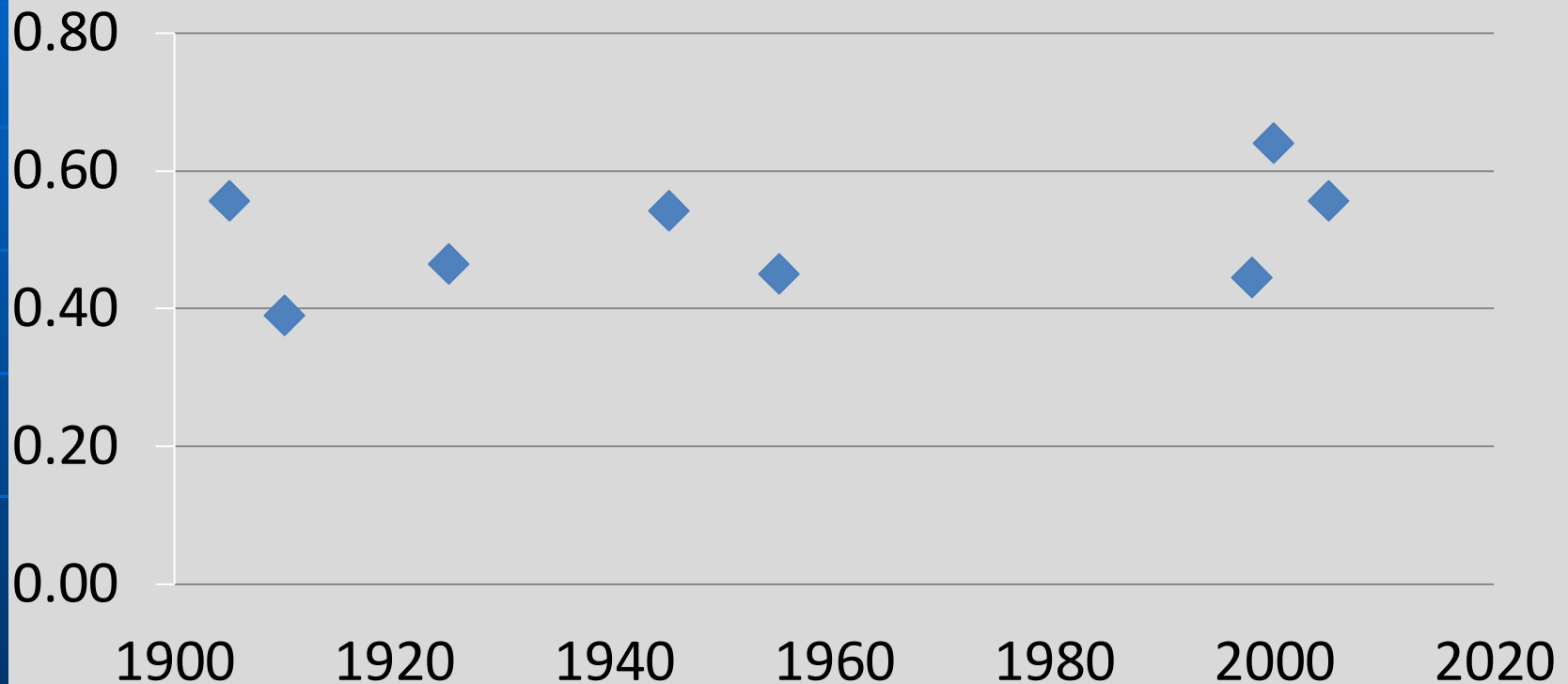
Where is the trend??

Post-kWh (1000)/Yr. Vs. Year Built (Total Household Energy Use)



Where is the trend??

Percent Reduction Vs. Year Built



What is the trend??

The Trend?

Huge energy savings potential
across all housing stock,
regardless of age!

Core Proposition 1

A performance target can be a powerful & useful determinant of energy use if it is:

- Transparent - Logical - Fair
- Easily tracked & verified
- Meaningful to the participants
- **Within participants' field of influence**

Core Proposition 2

- Rapid feedback is critical

Make new mistakes, rather than repeat old ones!

Core Proposition 3

- Need to go beyond energy reductions to make the value proposition

Integrated solutions needed!

Increased resilience

Decreased peak

Improved house durability & viability

Improved comfort & IAQ

One Vs. Seven Interventions

Energy Reduction from Deep & Shallow Retrofits



Observations - Lessons Learned

- Performance goal(s) drive the project
- It takes ***vision*** & a ***champion***
- Many paths – wide range of costs
- Durability & IAQ are non-negotiable
- Even in coldest climates, need to address water heating & electrical loads, as well as heating

Project Characteristics

- Highly educated homeowners
- Awareness led to action (e.g., Passive House Institute)
- Resources to commit (time & \$\$)
- Projects evolve
- **“No regrets” a priority**
- Ongoing commitment to go deeper

THC Homeowner Priorities

- Demonstrating environmental stewardship – both climate change & resource depletion
- Having an impact
- Contributing to knowledge
- Broader sustainable goals – food, water, transportation, resources
- Constellation of benefits

Challenges

- Finding professionals & subs who share project's frame of reference
- Previous suboptimal improvements; theory of previous investment
- Home renovations often represent missed opportunities

More Challenges

- Make the value proposition (not just energy or cost savings)
- Simplify the process (components)
- Address cost barriers
- Demonstrate phased approaches
- Get the signals right (partial load performance, alternative systems, household energy use)



Transformation Vs.

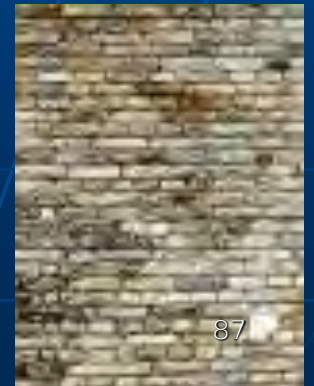
A

Caterpillar Upgrade?

- Business As Usual (BAU)
- Limited potential
- Creating barriers



www.MonarchWatch.org



**“What generation
has ever been given
such a chance
and a challenge
to transform its world?”**

Pat Murphy, Community Solutions

You Are the Champions



Redraw the Maps
Blaze the Paths
Recreate Our Future

This Thousand Home Challenge webinar series is brought to you by the Pacific Gas & Electric Company's Energy Training Center & Affordable Comfort, Inc. (ACI).

Upcoming THC Webinars

Ducted & Ductless Mini-Splits for Cooling Existing Homes

Dave Robinson – Danny Parker

Tuesday, October 25, 2011: 11 am-12:30 pm Pacific Time

Dense Pack Wall Insulation & Air Sealing for California Homes (Parts 1 & 2)

Jim Fitzgerald

Part 1, Mon., Nov. 14, 2011: 11 am-12:30 pm Pacific Time

Part 2, Thurs., Nov. 17, 2011: 11 am-12:30 pm Pacific Time

TO REGISTER: <http://thousandhomechallenge.com/news-and-events>

NOTE: Recording & presentations will be posted on THC Website



Feedback Welcome

Linda Wigington

724-852-3085

lwigington@affordablecomfort.org

www.affordablecomfort.org

www.1000HomeChallenge.org

Introduction to the Thousand Home Challenge Webinar

Tues., Nov. 8, 2011: 10-11:30 am Pacific Time

Thurs., Dec. 8, 2011: 10-11:30 am Pacific Time



Home Energy Pros THC Group

<http://homeenergypros.lbl.gov/>

ACI Conferences

Colorado ENERGY STAR Summit 2011

Denver, CO - Dec. 6-7, 2011


ACI National Home Performance Conference

Baltimore, MD - March 26-30, 2012

ACI California 2012

May 2012

JOIN THE CENTER OF THE INDUSTRY.



ACI NATIONAL
HOME PERFORMANCE
conference

March 26-30, 2012
Baltimore Convention Center