



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

Ductless Heat Pumps: Recent Research & Applications for Low Energy Homes – Part 1 May 24, 2011 10:30-noon Pacific Time

Presented by: Mark Jerome, KAM Energy, Roseburg, Oregon
Bob Davis, Ecotope, Portland, Oregon

Respondent: Marc Rosenbaum, South Mountain Co., Inc.,
on Martha's Vineyard

Facilitated by: Linda Wigington, Affordable Comfort. Inc.

www.1000HomeChallenge.org

www.affordablecomfort.org





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www.pge.com/stockton

Learning Objectives

Attending these webinars will enable participants to:

- Understand how the technology & installation of inverter-driven ductless heat pumps (DHP) differ from conventional residential air source heat pumps
- Find out what has been learned to date through the submetering of electrically-heated homes in the Pacific Northwest that have been upgraded to include a ductless heat pump
- Examine the opportunities & limitations for installing DHPs as part of either “staged” or “all at once” deep energy reductions in Northern California, & THC/low energy homes elsewhere

Webinar Outline

- Introduction – Thousand Home Challenge
- How Are DHPs Different from Conventional?
- DHP Installation
- Field Experience
- Lessons from a Large Pacific NW Field Study
- Implications for Other Regions/Housing Stock
- Economic Considerations
- Discussion/Questions



Send your questions & comments for Thursday's webinar to:

lwigington@affordablecomfort.org

(Subject Line: DHP Webinar)

Part 2 – Thursday, May 26 same time

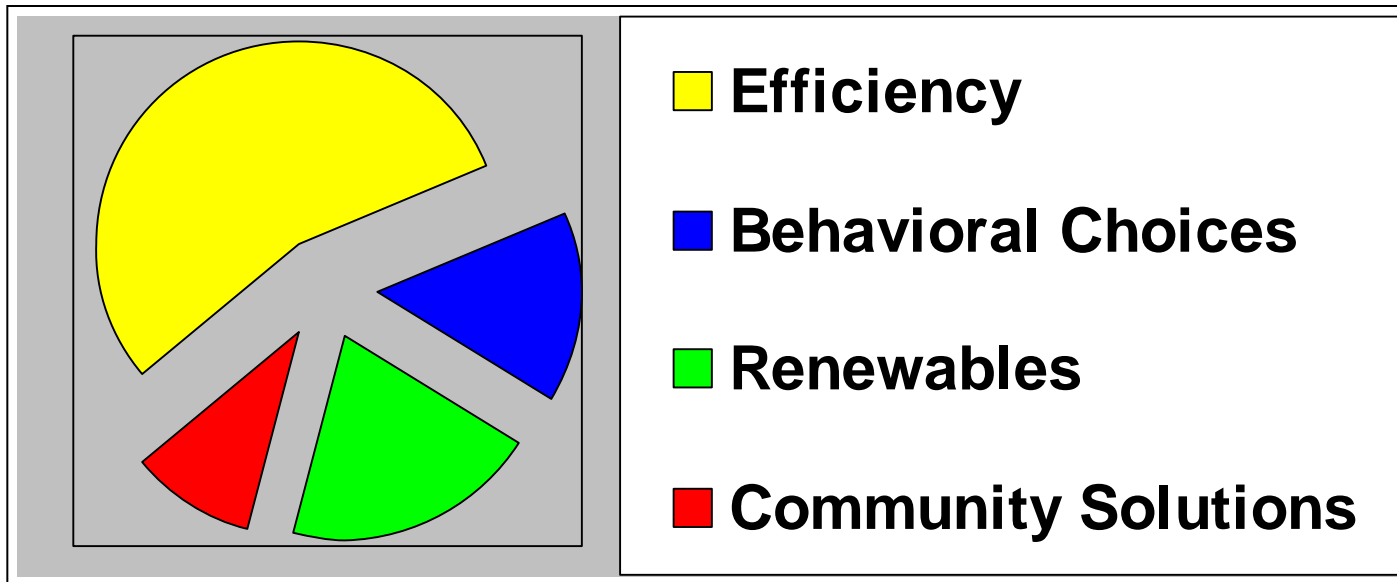
*Documents & instructions to participate will be
sent by e-mail Wednesday, May 25*



70%-90% Deep Energy Reductions

The Thousand Home Challenge:

Integrate energy efficiency with on-site renewables, behavioral & lifestyle choices, & community-based solutions





Key Metric

Transparent & Direct
Include Occupants

Net Annual Household Site Energy
wood use counts
solar & on-site renewables = credit/offset

Each household has its unique threshold of performance to meet or exceed



Thousand Home Challenge

Summary of THC Threshold Determination

OPTION A:

- 75% reduction of actual annual site energy use

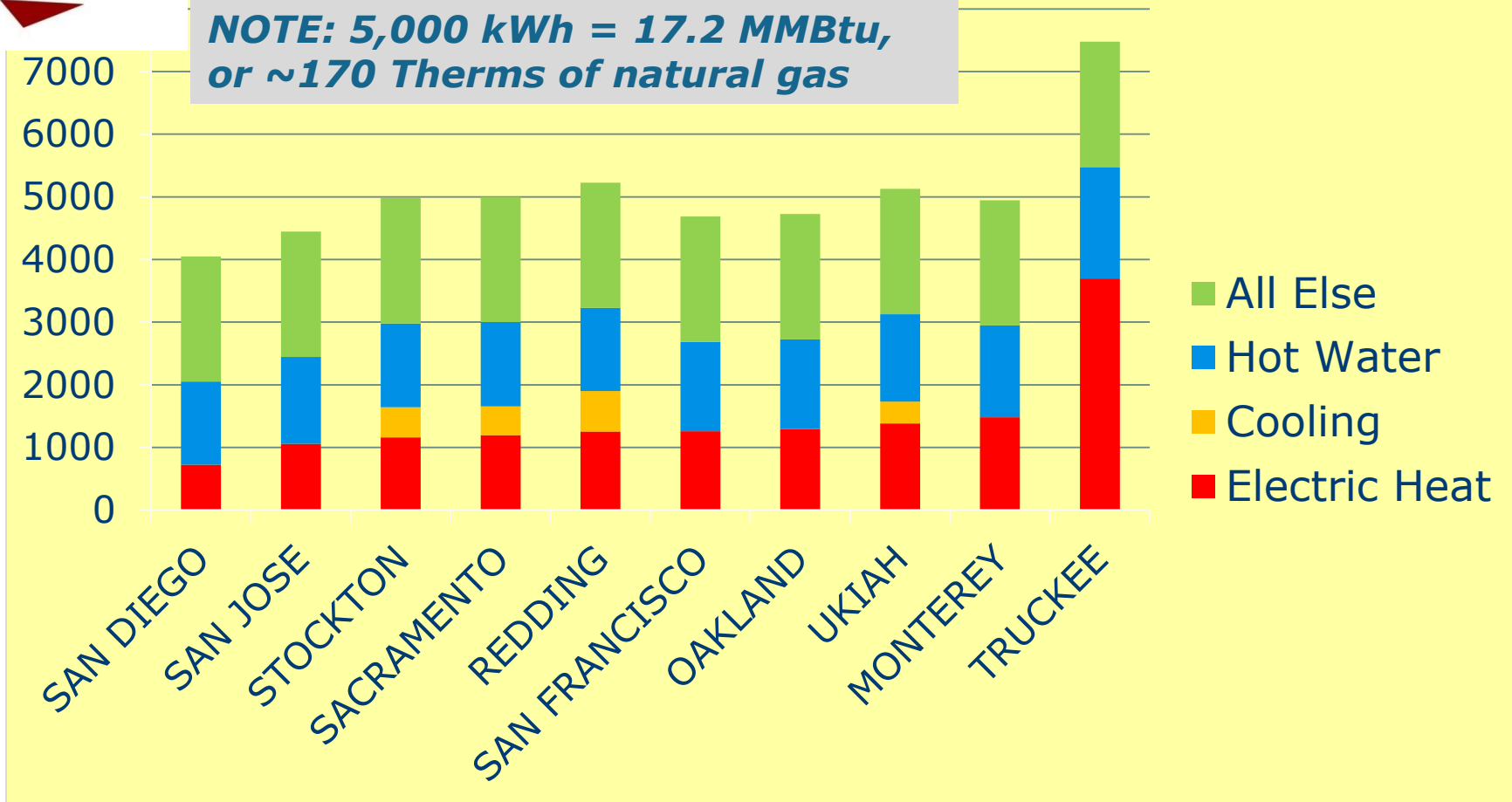
OPTION B Inputs:

- House Size (FFA), converted to surface area (5 sides)
- Climate (ZIP Code or best match weather station)
- Electric heat allowance = $\frac{1}{2}$ fossil fuel or wood heat allowance



THC Option B Household Threshold (kWh/Yr. by End-Use)

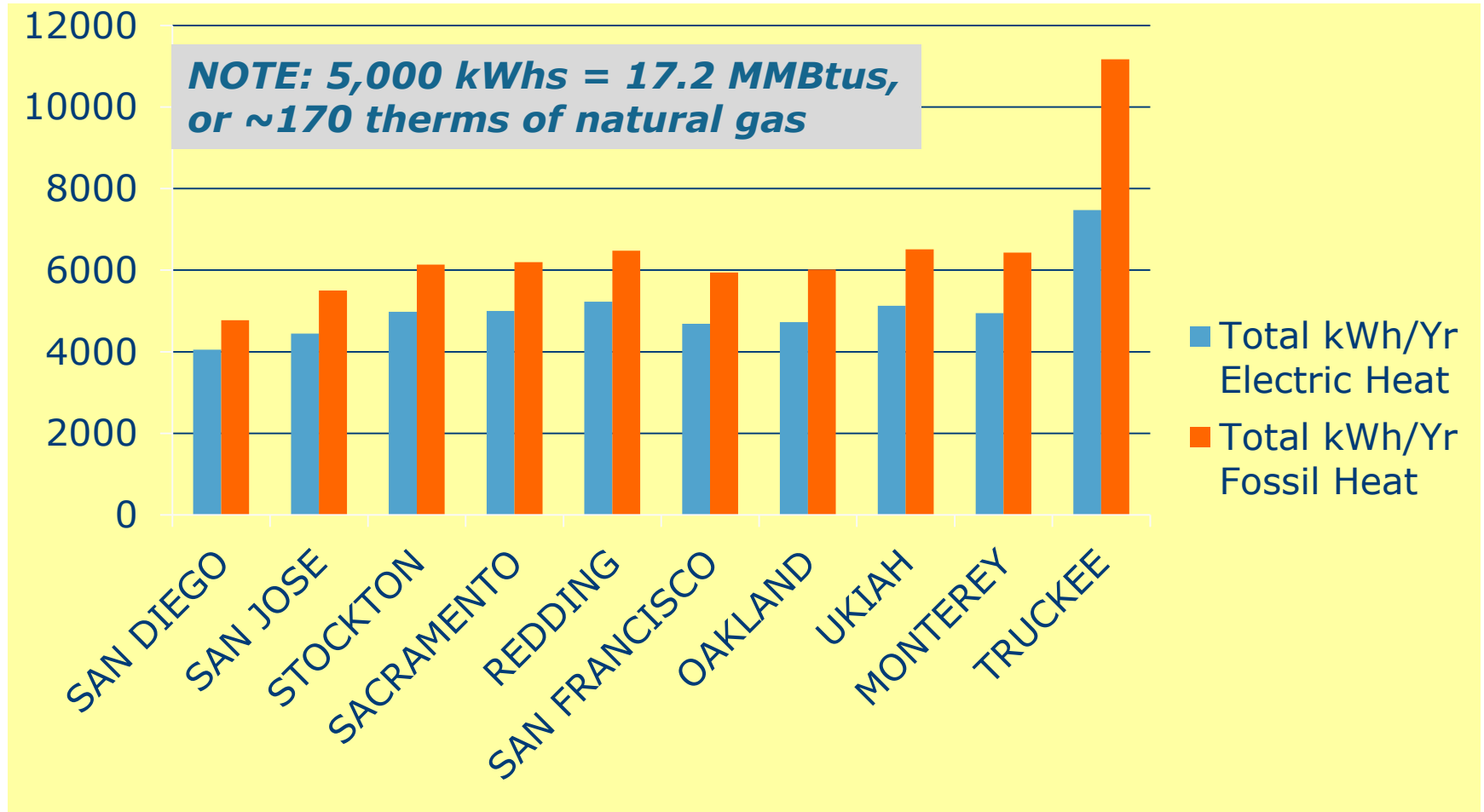
*NOTE: 5,000 kWh = 17.2 MMBtu,
or ~170 Therms of natural gas*



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



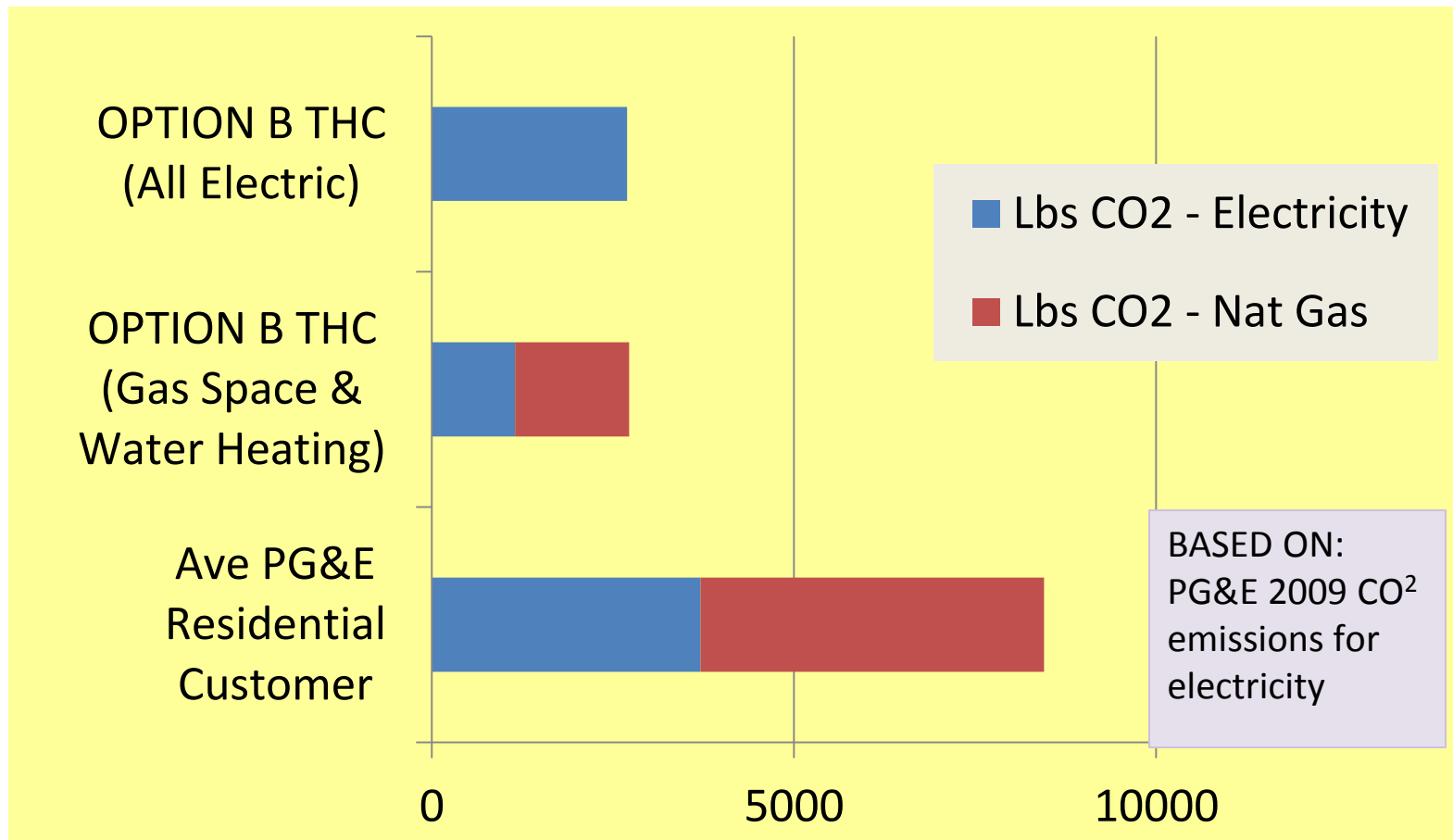
THC Option B Household Threshold (kWh/Yr. All End-Uses)



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

Comparing CO² Emissions

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



OPTION B Inputs: detached; 3 in household; 2,000 ft² finished floor area (FFA)
CA Average Res Customer Annual Use: 405 Therms; 6456 kWh



THC Option B Threshold Total Household kWh/Year

<i>3 Member Household</i>	House Size - Square Feet		
	1,200	2,400	3,600
LOS ANGELES	3,142	3,382	3,622
SAN DIEGO	4,254	5,040	5,796
SAN FRANCISCO	5,158	6,348	7,485
STOCKTON	5,281	6,578	7,816
SACRAMENTO	5,326	6,642	7,897
MONTEREY	5,530	6,889	8,185
TRUCKEE	9,170	12,201	15,076

OPTION B Inputs: detached; 3 in household; fossil or wood heat;
1,200-3,600 ft² finished floor area (FFA), not CFA or TFA



Key Questions for THC Projects

- What systems make sense for homes with low space conditioning loads (<100 therms/yr. or <3,000 kWh/yr.)?
- What systems respond well throughout the full range of operating/load conditions?
- What systems are on the path to deep reductions, providing benefits to a household both pre, & post enclosure upgrades?

On to Mark...

Mark Jerome is the owner of KAM Energy, Roseburg, Oregon, a consulting, education, and testing company focusing on HVAC performance. He has built on his experience installing hundreds of ductless heat pumps, and is now involved in training and quality assurance. Mark understands the intersection between practical field reality and the challenge of implementing programs to improve residential HVAC performance. He has been an HVAC service technician for 27 years, and continues to work part-time for Pacific Air Comfort.

kamenergy2010@gmail.com



Ductless Heat Pumps (DHP)



Mark Jerome

KAM ENERGY

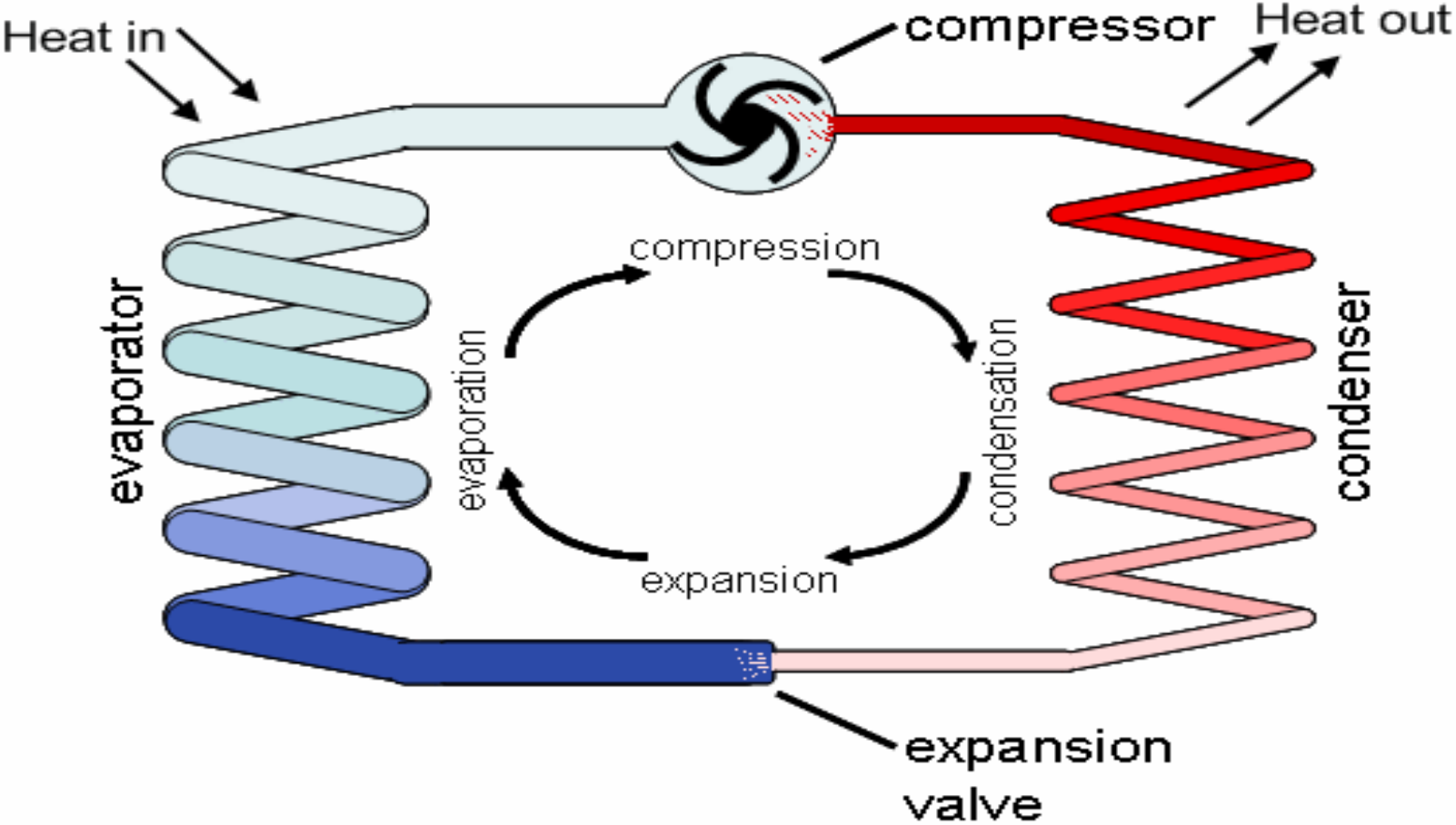
kamenergy2010@gmail.com



DHP Technology

- Worldwide – Millions of them!
- 30 years of installations
- Recent technical improvements
 - Higher efficiency
 - Broader performance
- Applications – particularly deep energy reductions

Refrigeration Cycle (Moving Heat)



My Presentation

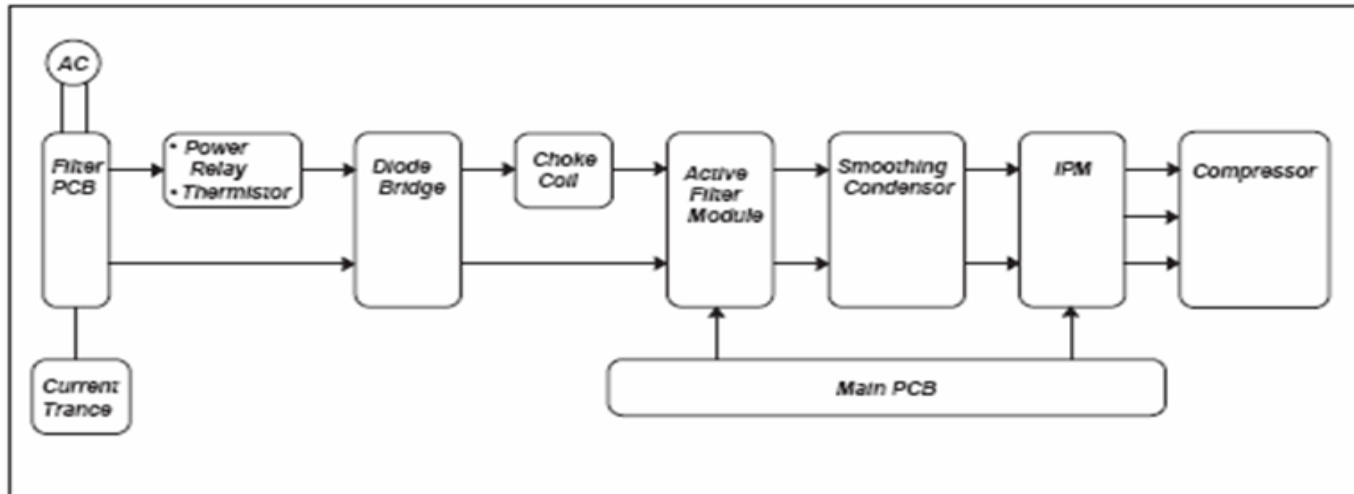
- Technology Differences Between Ductless & Conventional Ducted Heat Pumps
- DHP Installation
- Field Experience

How Are Ductless Heat Pumps Different?

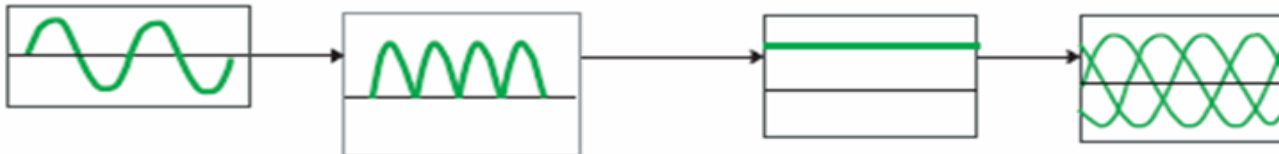
- Inverter compressors
- Expansion devices
- Defrost differences
- User interface control

DHP Compressors

Inverter Block



- VOLTAGE CONVERSION



DHP Compressor Operation

- Inverter controls DC motor speed
 - Frequency
 - Voltage
 - Precise modulation
- Compressor RPM variable (not on/off)
 - Higher efficiency
 - Capacity losses reduced
- Compressor precisely matches load
 - Reduced speed
 - Reduced input power
 - Increased system efficiency

Conventional Ducted Heat Pump Compressors

When the compressor motor starts:

- Runs at 3,600 rpm
- Needs to overcome pressure, inertia
- High inrush current (somewhat trivial)
- Draws high current
- 15 minutes until system reaches a steady state pressure condition



DHP Electronic Expansion Device



A refrigerant flow control valve driven by a four-phase pulse motor

500+ stage valve positioning ensures precise refrigerant flow

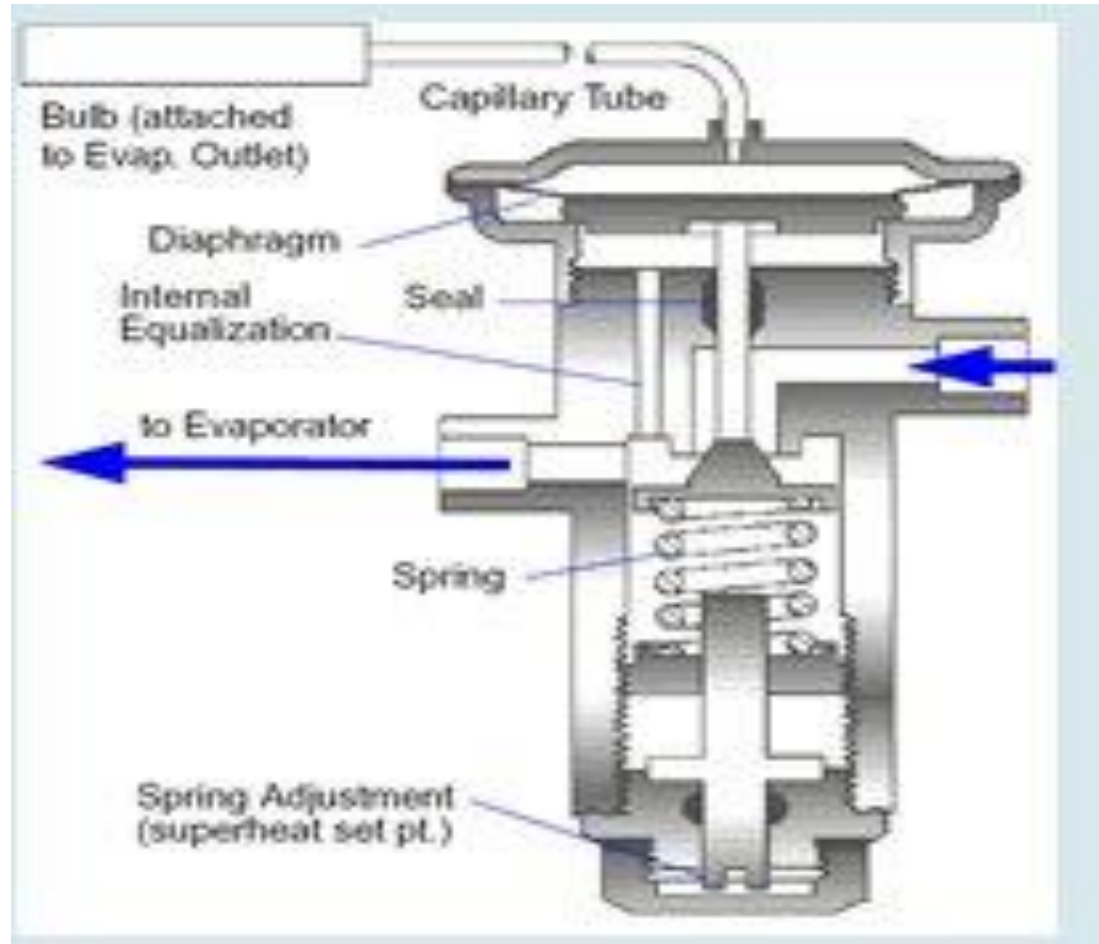
Fine refrigerant flow control provides a superior level of room temperature control & ensures less waste of energy than conventional systems

Conventional Ducted Heat Pump Thermostatic Expansion Valve

TXV is a strictly
mechanical device

Spring-loaded

Works independent of
the thermostat, motor,
temperatures, &
compressor operation



Defrost Cycle Comparison

DHP

- Initiated by sensors in the outdoor unit
- Indoor & outdoor fan motors are shut off, & the indoor damper is closed
- Ramps the compressor up when going into/coming out of defrost. No electric resistance heat
- No noise

Conventional Ducted Heat Pump

- Initiated by sensors in the outdoor unit
- Outdoor fan motor is shut off - indoor fan motor runs
- Electric resistance heat activated to temper the indoor air (20% energy penalty)
- Compressor noise

DHP User Interface

Functions:

- air clean
- coil dry
- set/swing
- sleep timer
- clock adjust

Optional wired programmable thermostat available

Indoor temperature sensor is in the indoor unit, **not** in the remote control



Conventional Ducted Heat Pump Thermostat

Wall-mounted

Provides whole house
temperature control

No warm outdoor
temperature lockout for
electric resistance heat
(aux heat), without an
optional sensor

Cycles heat pump on & off
to maintain temperature
control



Summary: Technology Differences

DHP

- Inverter compressor for energy efficient operation
- Electronic expansion valve for precise refrigerant flow
- Superior defrost control with less energy consumption
- Remote control user interface
- Zonal heat (may not provide adequate comfort to entire house)
- Relatively low output per unit (~15,000 Btu/hr)
- May not carry peak heating/cooling load

Conventional Ducted Heat Pump

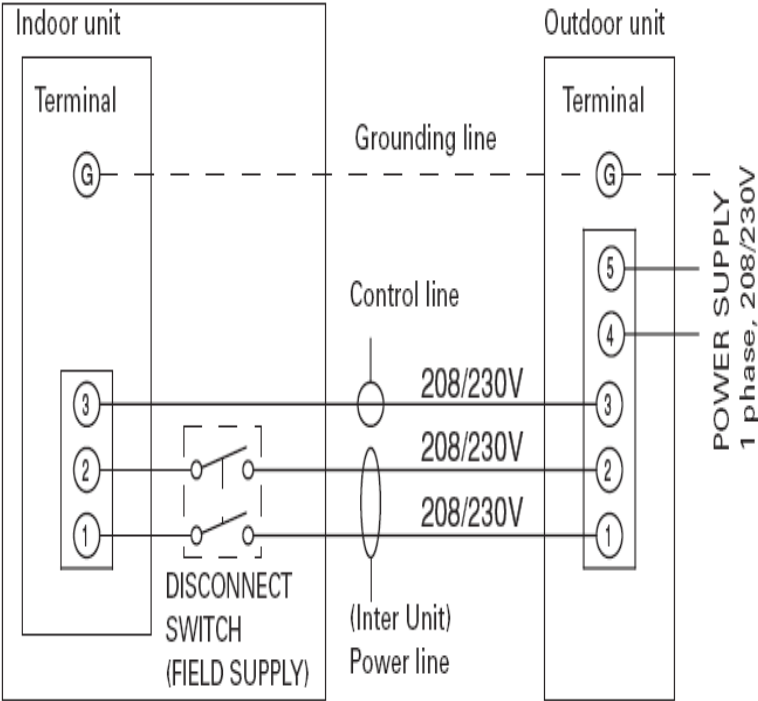
- Compressor motor runs at one speed, so not as efficient
- Less precise thermostatic expansion valve
- Defrost cycle uses electric resistance heating
- Controller cycles unit to maintain temperature
- Entire home comfort
- Large capacity (with electric resistance heat)
- Sole space conditioning system

Installation Differences

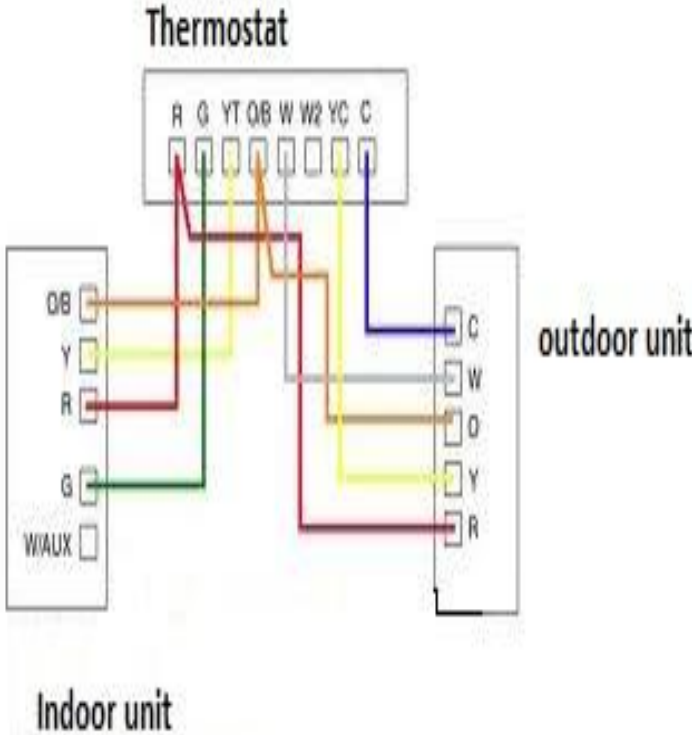
- Wiring
- Refrigerant tubing installation & best practices
- Condensation drain
- Installation tools
- Commissioning

DHP Wiring Differences

DHP



Ducted heat pump

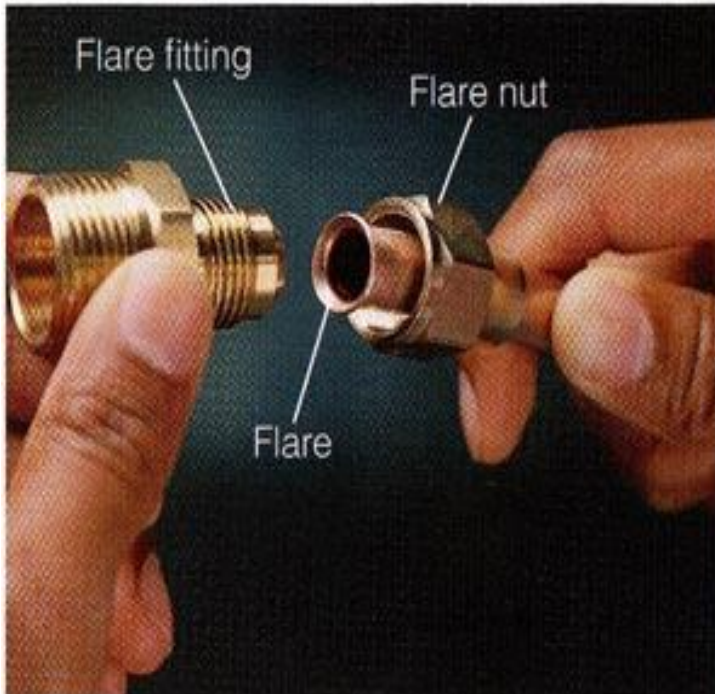


Easier installation

Refrigerant Tubing Installation Differences

DHP

No brazing leaves a clean refrigerant system



Conventional Ducted Heat Pump

Can leave scale from oxidation unless properly purged with nitrogen, which can plug expansion valves



Best Practices (For All Heat Pumps)

Proper Evacuation



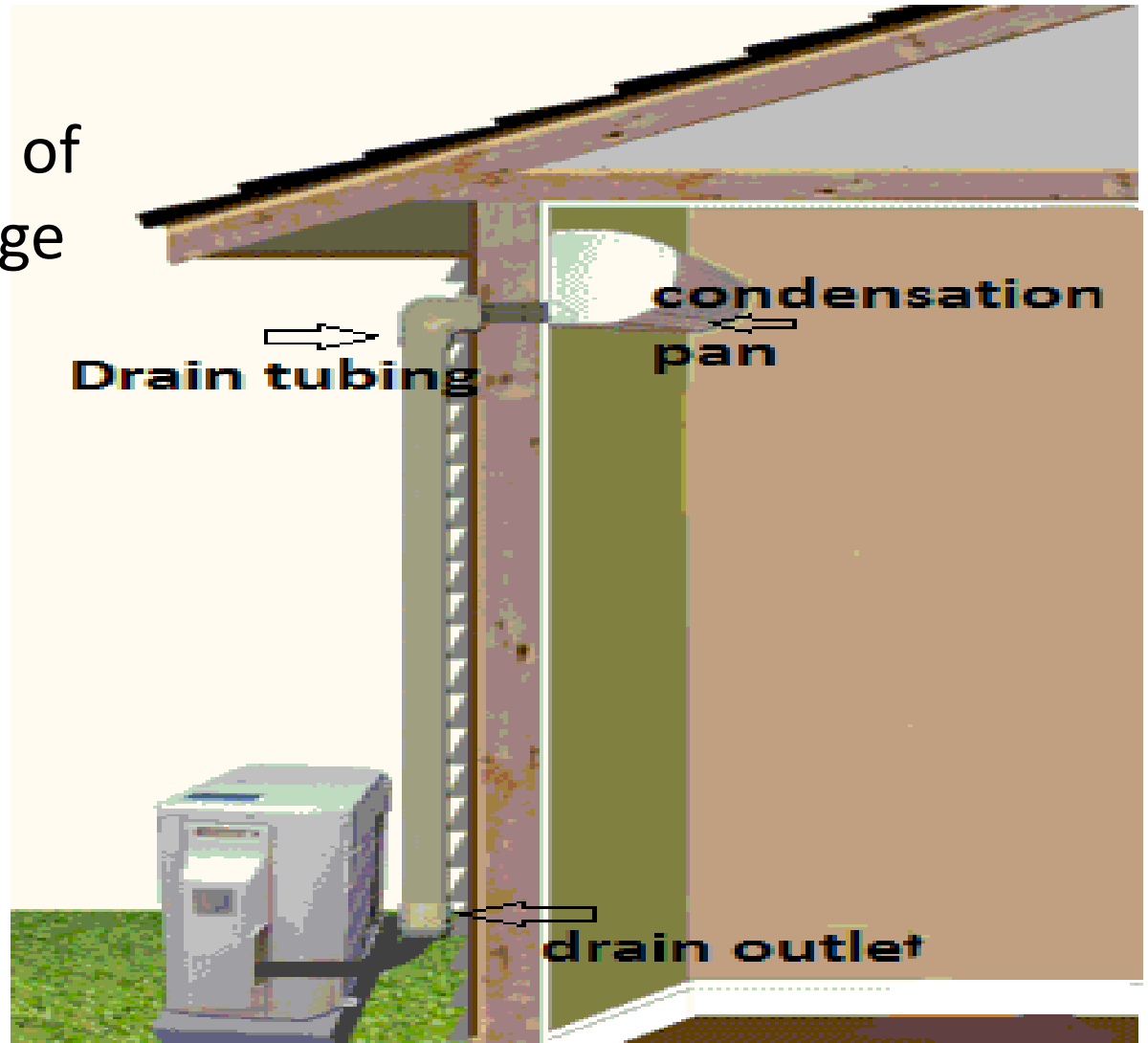
Nitrogen Pressure Check



Condensate Drainage for DHPs

Precise installation of condensate drainage needed

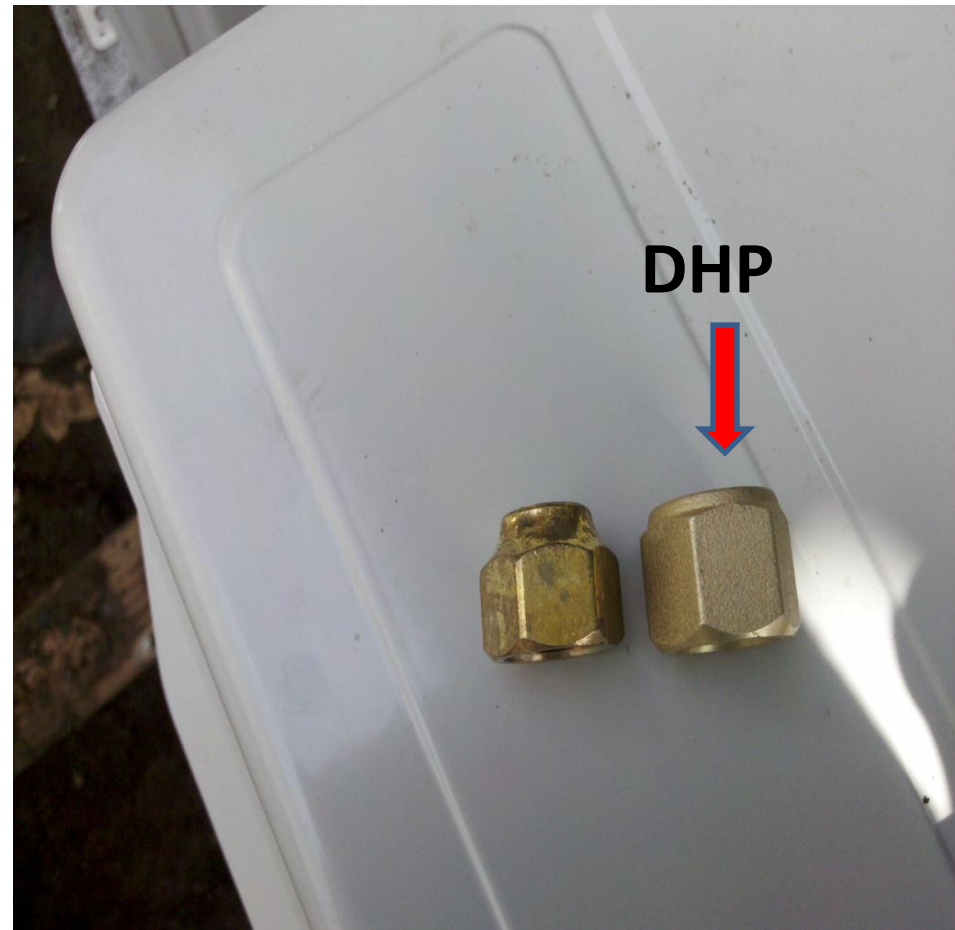
Placement of condensate could cause moisture problems in & around homes



Common DHP Installation Mistake

Flare nuts provided with copper tubing do not provide adequate seal!

Use flare nuts that come with the DHP



Required Tools for DHPs



Micron gauge



R410a refrigerant gauges



Tubing cutter



Torque wrench



Refrigerant tank



Vacuum pump



Tubing flaring tool

Tools for Ducted Systems



Micron gauge



R410a refrigerant gauges



Tubing cutter



Refrigerant tank



Vacuum pump



Oxy-acetylene torch

Commissioning

Conventional Ducted Heat Pumps

- Refrigerant gauges to ensure proper refrigerant levels
- Airflow measuring tools like flow hoods or the True Flow plate
- Thermometers
- Amp/volt meters
- And a substantial amount of paperwork!

DHP Commissioning

- Proper installation: proper flare nuts, pressure checking, & evacuation
- Verify:
 - Voltage to the outdoor unit
 - Good batteries are in the remote
 - Unit provides heat once the time delay has been satisfied (3 minutes if the power has been off)
- Refrigerant gauges should only be used to verifying that refrigerant is present in the system or if there is a problem with the refrigeration system

Installation Summary

DHP

- Ease of wiring installation
- Condensation drain from indoor unit (living space)
- One power cable from the electrical panel
- Clean refrigerant tubing installation
- Similar tools slightly less expensive
- Ease of commissioning

Conventional Ducted Heat Pump

- Complex control voltage wiring
- Condensation drain not often inside living space
- Two power cables from electrical panel
- Potential of contaminating the tubing by brazing
- Explosive/flammable gases
- Complicated commissioning

Field Experience

- Required training sessions
- Service & maintenance
- Customer interactions
- Price points
- Multiple indoor head units
- Ducted ductless systems
- Lessons learned

DHP Required Trainings

- Each manufacturer has a training specific for their ductless heat pumps, ~4-8 hours
- In the Pacific Northwest, utilities providing incentives require attendance at a best practices webinar & contractor orientation webinar

Servicing & Maintenance

- All HVAC systems should be maintained by a certified technician
- Refrigerant gauges should not be used to verify refrigerant levels on DHP units
- There are usually 1 or 2 washable filters & sometimes a unique filter specific to the manufacturer (odor-eliminating, electrostatic, etc.)

Customer Interactions

Homeowner education is key to ensure satisfaction

- Operation of the remote control
- How to clean the filter
- How often it should be serviced
- Realistic expectations regarding output & distribution compared to past experience
- Awareness of interactions with other space conditioning systems

Price Points

(Pacific Northwest Experience)

- Typical installation prices \$3,000 - \$5,000 (single head ductless heat pump) depending on difficulty, area, & contractor, with most in the \$3,500 - \$4,000 range
- Multiple head installations are usually \$1,000 per additional indoor head

Multiple Indoor Head Systems

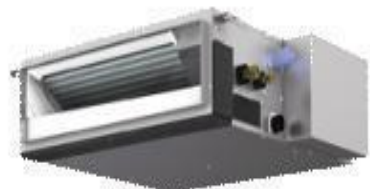
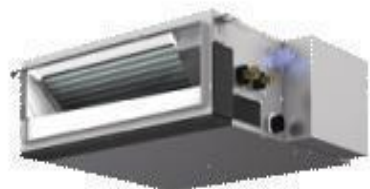
Multiple indoor units could serve homes with multiple floors or floor plans that are spread out over a large area. These units have yet to be monitored to determine energy savings, but have proven to be an effective comfort device in several sites in the Pacific Northwest.



Ducted (Ductless) Heat Pumps

These units have air handlers that allow for a very small amount of ducts.

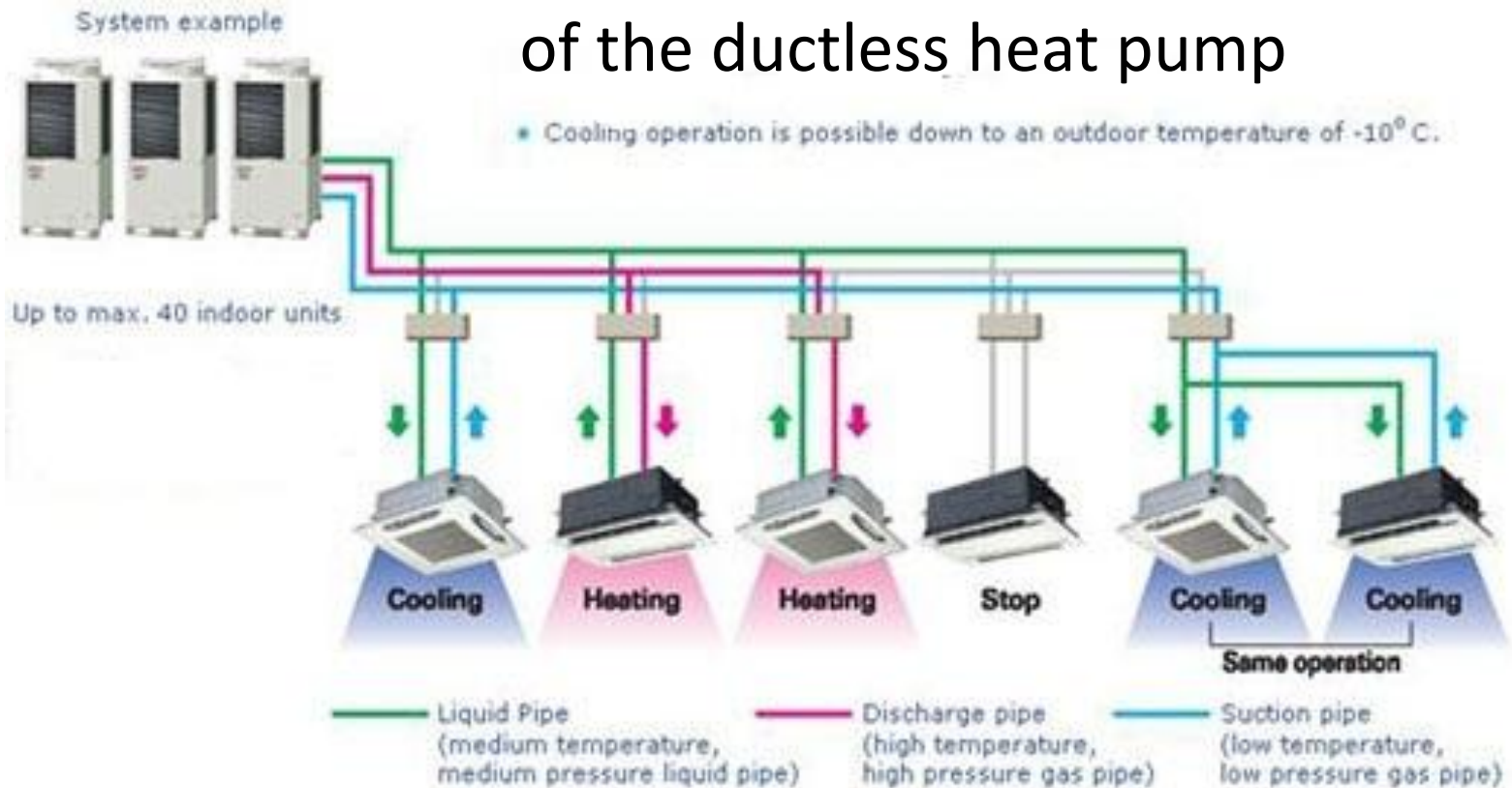
Conventional duct sizing will cause problems that could reduce energy savings & will certainly compromise comfort.



VRF Systems

Variable Refrigerant Flow

This is the commercial version of the ductless heat pump



Lessons Learned

Successes & challenges from the field

Pros & Cons

PROS

- Provide air conditioning in homes without ductwork
- Reduce use of expensive fuel or inefficient space conditioning system
- Complement another non-ducted heating system
- Create comfort zone in home's core
- Use in addition to or in lieu of central system
- Sole system in high performance or low load/small home

CONS

- Appearance & presence in living space (objectionable to some)
- Condensate drain needed at indoor head
- May not meet space conditioning or distribution needs of moderate use homes

Well Installed DHPs

Lead to sales from satisfied homeowners



Poor Installation



2 Units Rather Than Multiple Head Units ?



Field Experience Summary

- Contractor training & maintenance are needed
- Pros & Cons driven by house type & installation
- Informed customers are key to acceptance & success
- Prices are often less expensive than alternatives

Final Thoughts

- Inverter technology & the control strategy of ductless heat pumps have many energy saving applications in new & existing homes
- Proper application & installation are the keys to the successful future of DHPs

NW Ductless Heat Pump Project



Bob Davis is a researcher and consultant at Ecotope in Portland, Oregon. For the past 20 years he has measured field performance of homes and small businesses. Bob is the field manager of two, year-long projects which are evaluating installed performance of ductless heat pumps (DHPs) in existing Pacific Northwest homes. These projects include 150 sites with DHPs installed from the Pacific Ocean to the Rockies. Bob's work includes design of instrumentation systems, construction of field protocols, oversight of installation crews, and field data management.

bdavis@ecotope.com

www.ecotope.com

Ductless Heat Pumps: Lessons From a Large Pacific NW Field Study



Bob Davis, Ecotope, bdavis@ecotope.com

Presentation Topics

- Pacific NW study design/location/hardware
- Pacific NW savings results
- Efficiency results (field/lab/very cold weather)
- Customer satisfaction
- DHP economics
 - Operating costs vs. other fuels
 - Life cycle/total resource costs in different locales

Study Overview

GOAL: To determine heating season offset from a ductless heat pump installed in the main living area of an electrically-heated home (zonal [baseboard] heat)

- Metered 95 ductless heat pump installations in 3 states (OR, WA, ID)
- Began in April 2009
- Approx. 2 million homes, apartments, & small businesses in Pacific NW have zonal electric resistance heat

NOTES:

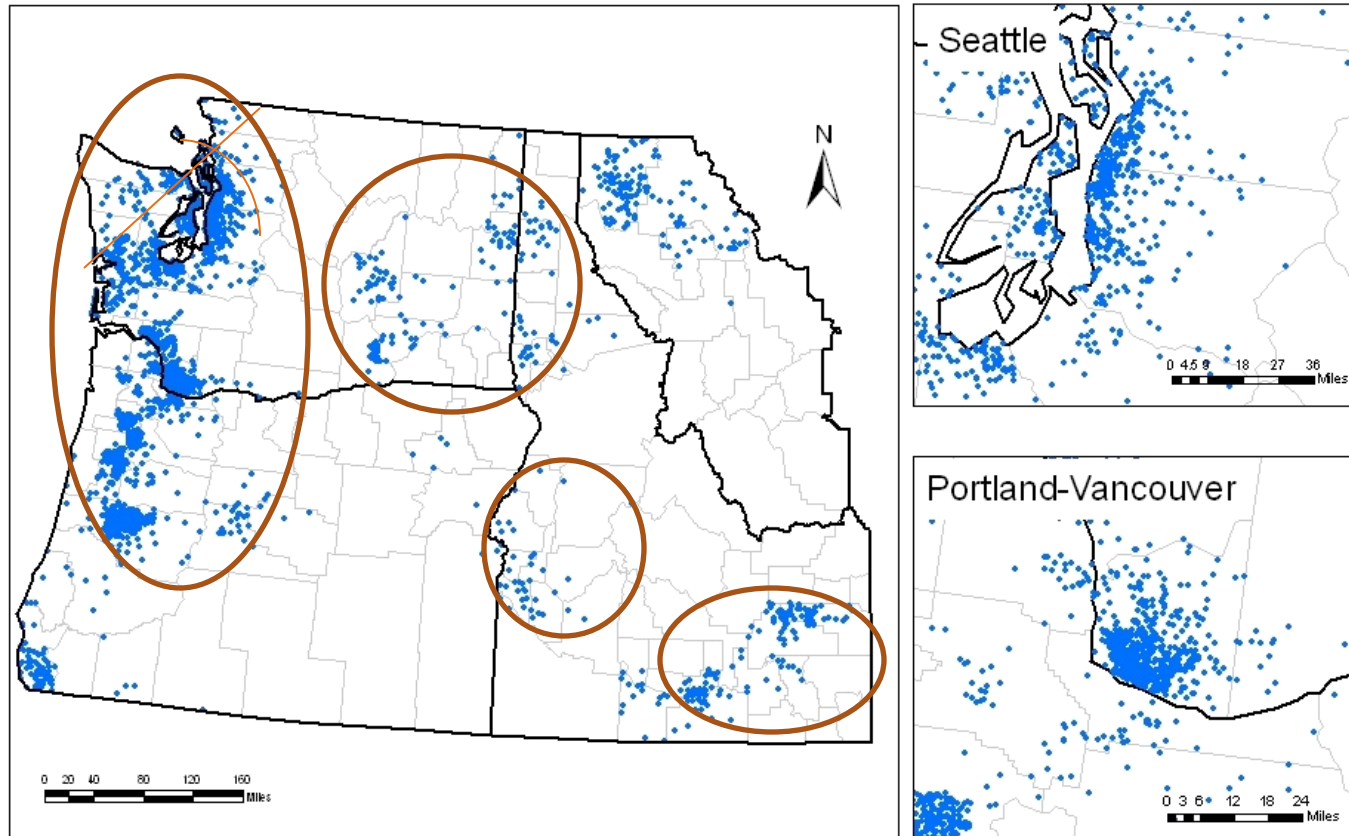
Avg. Pacific NW electric cost well below \$0.10/kWh!

Some savings erosion due to new AC usage

Study Home Details

- Median house size in study about 1,800 ft²
- Average insulation values
 - R-30 ceiling, R-11 wall, Class 65 window
 - R-19 crawl space; west side sites with basements typically not insulated; east side sites usually are
 - Average air leakage rate of about 10 ACH₅₀ (about 0.45 ACH_{nat})
- Pre-ductless heating loads range from 5,000-20,000 kWh/yr. (170-500 therms/yr.)
- Cooling loads range from 0-1,500 kWh/yr.; average about 200 kWh/yr. for sites with AC

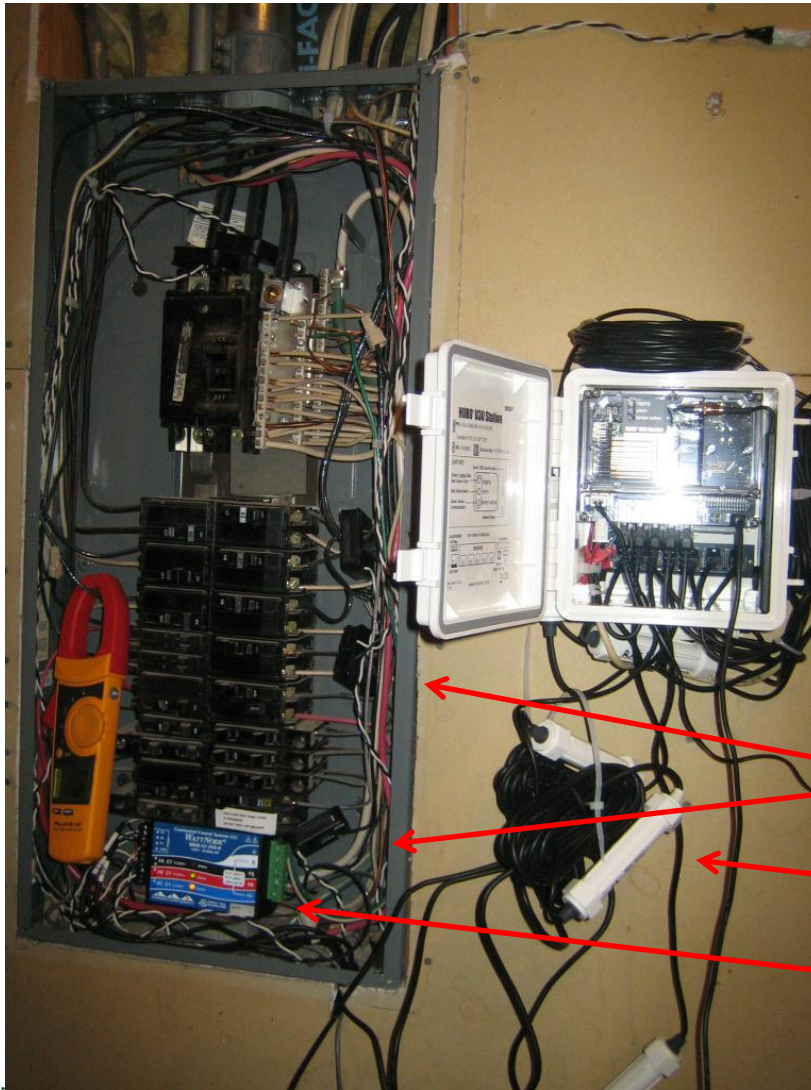
DHP Pilot Project Installations



**Ductless Heat Pump Installations (n=3899),
October 1, 2008 - December 31, 2009**

• 1 dot = 1 installation
□ County

Quad* Meter Rig



*Service entry (true power)
Hot water
Ductless heat pump (DHP)
(true power)
Electric resistance heat (ER)

← Onset U30 with integral cell antenna

← Current transformers

← Pulse counter

← Watt-hour transducer

COP Rig

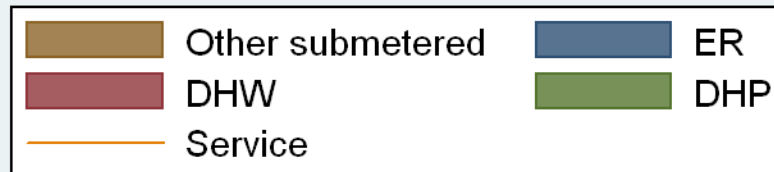
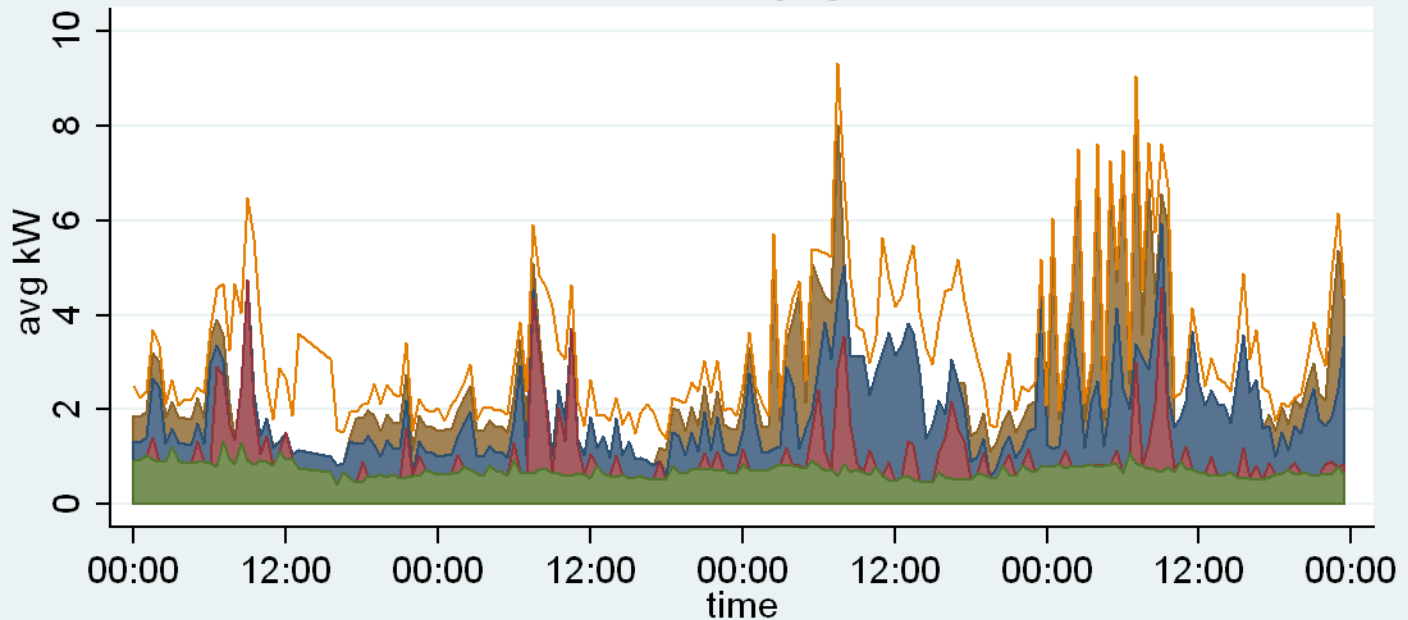


Data Handling

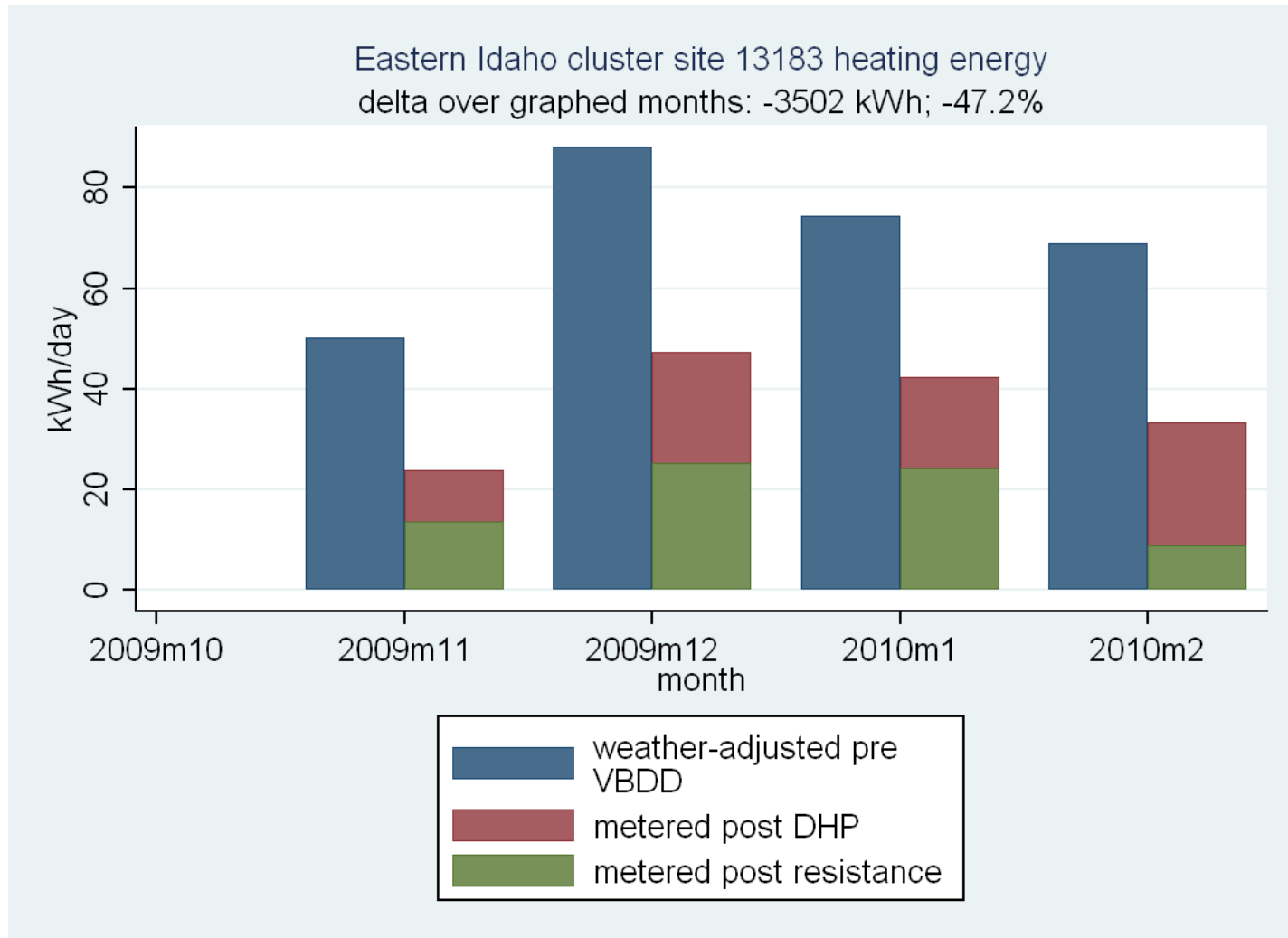
- 5 second samples/5 minute avgs into datalogger
- Cell phone antenna with 4x/day uploads to web-based server
- Daily accumulation in Ecotope system via use of executable stata™ files
- Daily error-checking (also in stata™; log files delivered daily via e-mail)
- Weekly error-checking (cumulative log) on COP sites, datalogger battery voltage

Quad-Metering Summary

usage over 96 hours starting January 26, 2010 00:00
site 13183 (2451473) Idaho Falls, ID
30 min averaging used

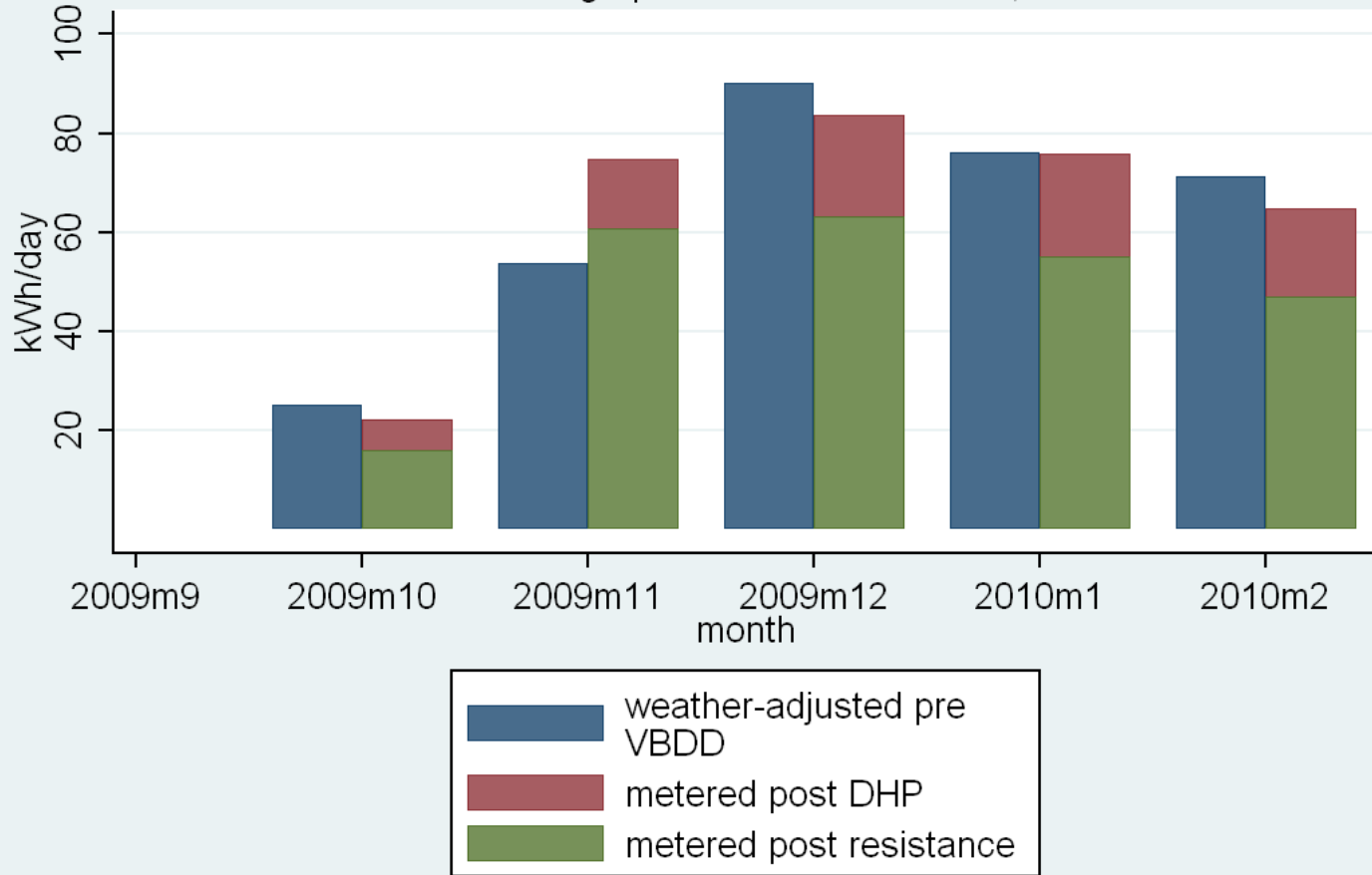


High Savings Site

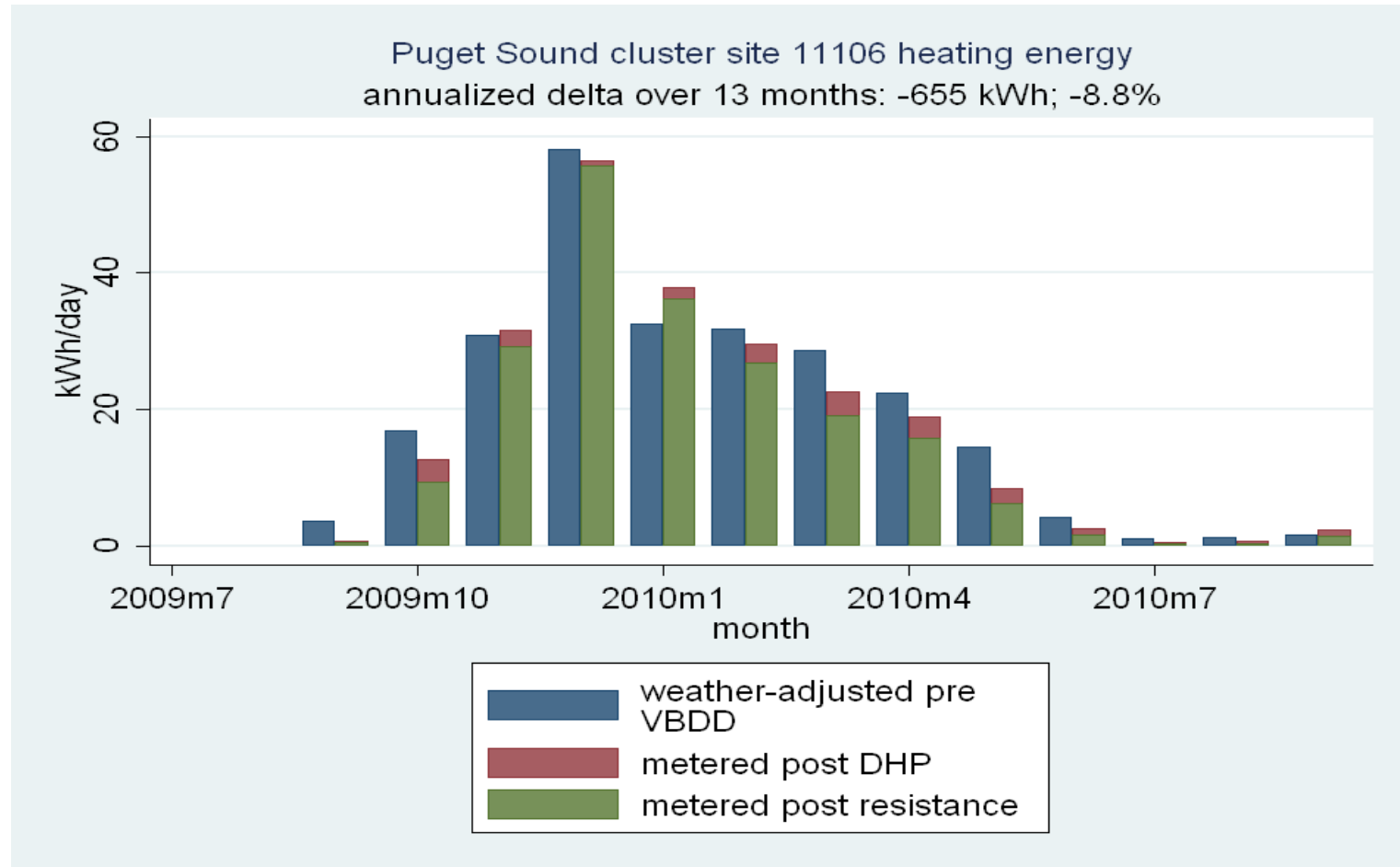


Ambiguous Savings

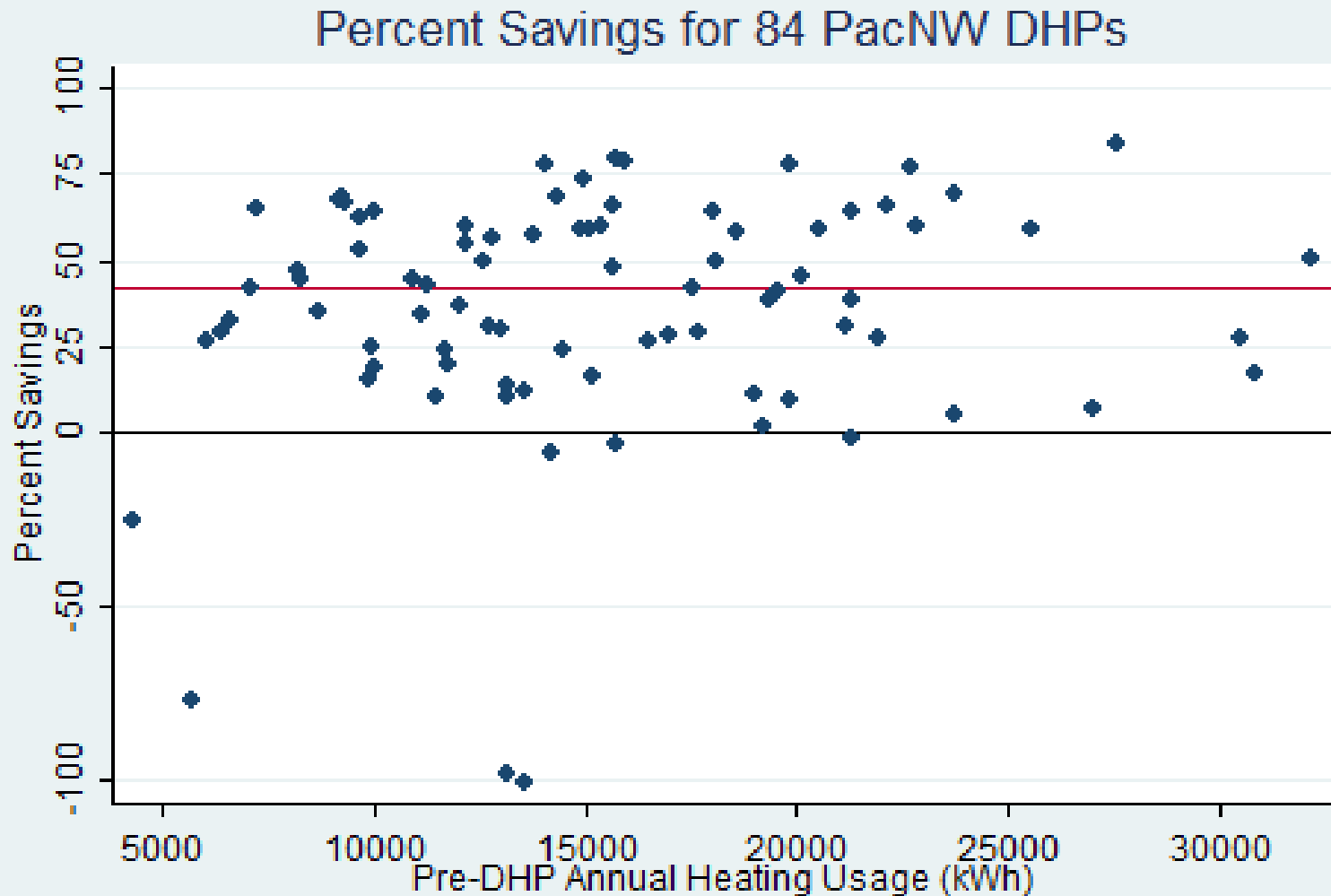
Eastern Idaho cluster site 11446 heating energy
delta over graphed months: 250 kWh; 3%



No DHP Impact



Percent Savings by Pre-Heating Use



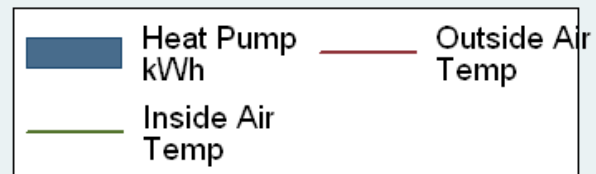
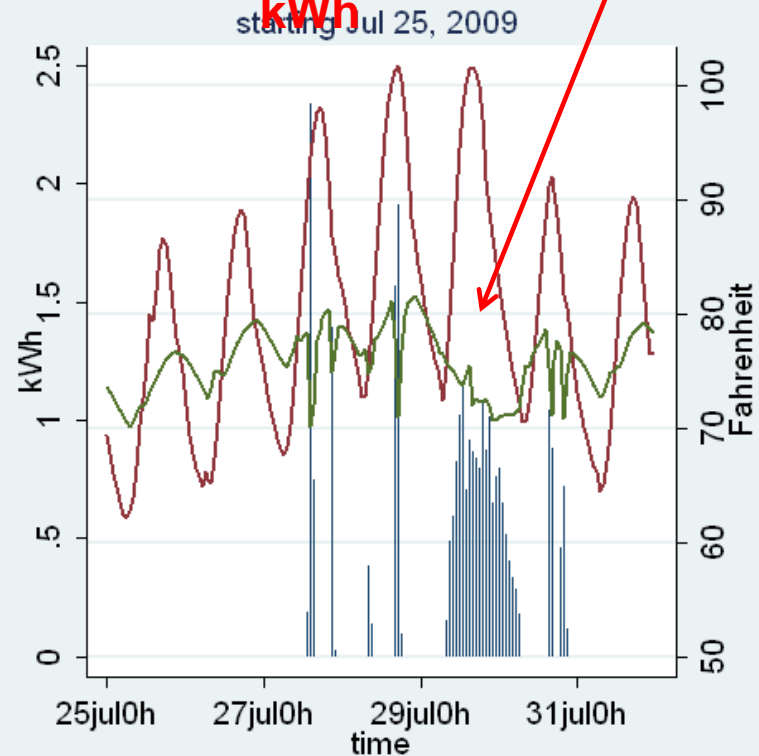
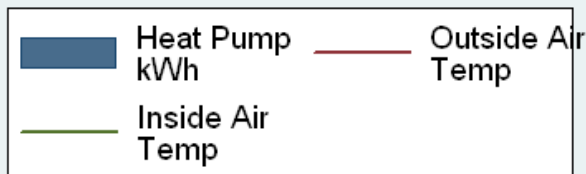
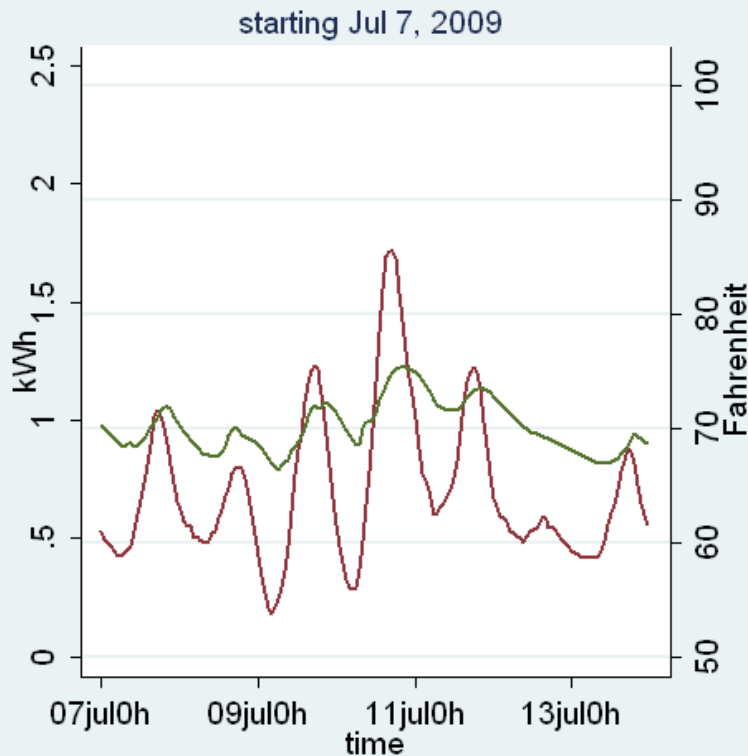
30,000 kWh = ~100 MMBtu or 1,000 therms

Cooling Usage Profile 1

hourly DHP usage over two 7-day intervals

logger id 2329708

Total 7-day Usage ~ 7 kWh



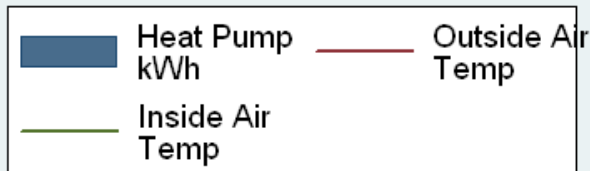
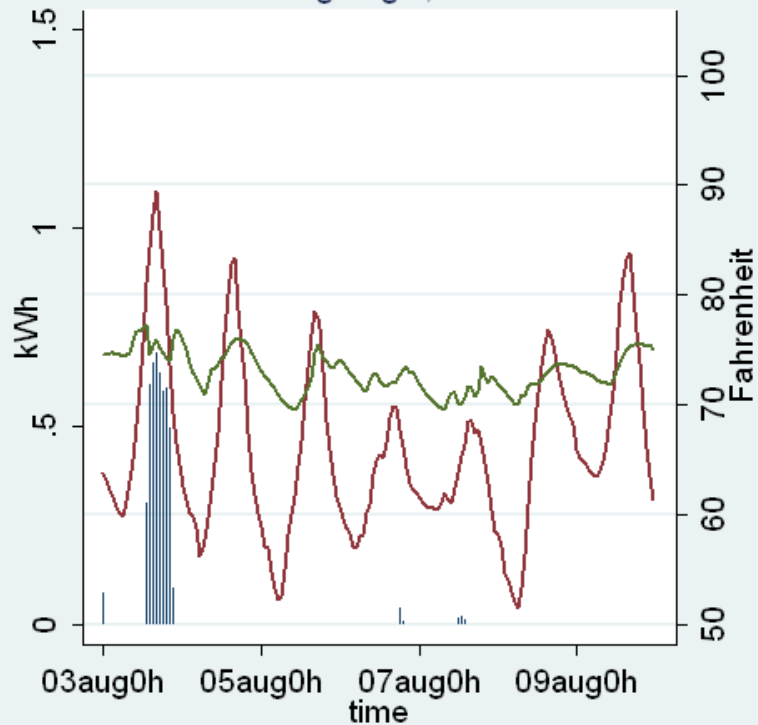
Cooling Usage Profile 2

hourly DHP usage over two 7-day intervals

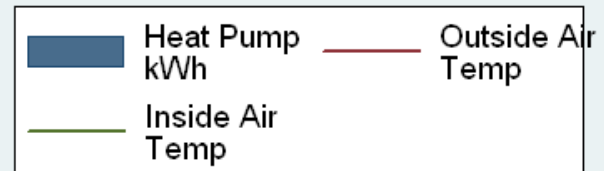
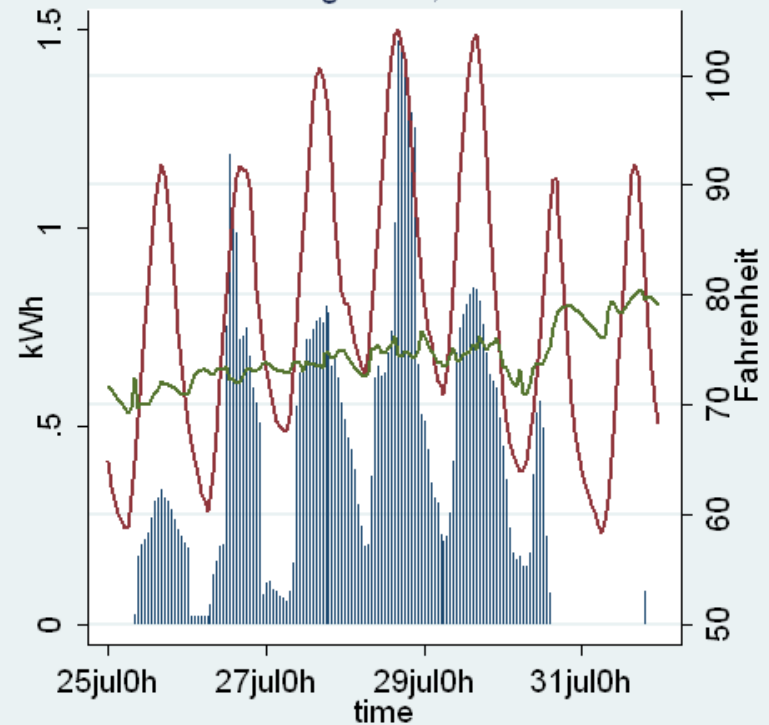
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Total 7-day usage ~ 26 kWh

starting Aug 3, 2009

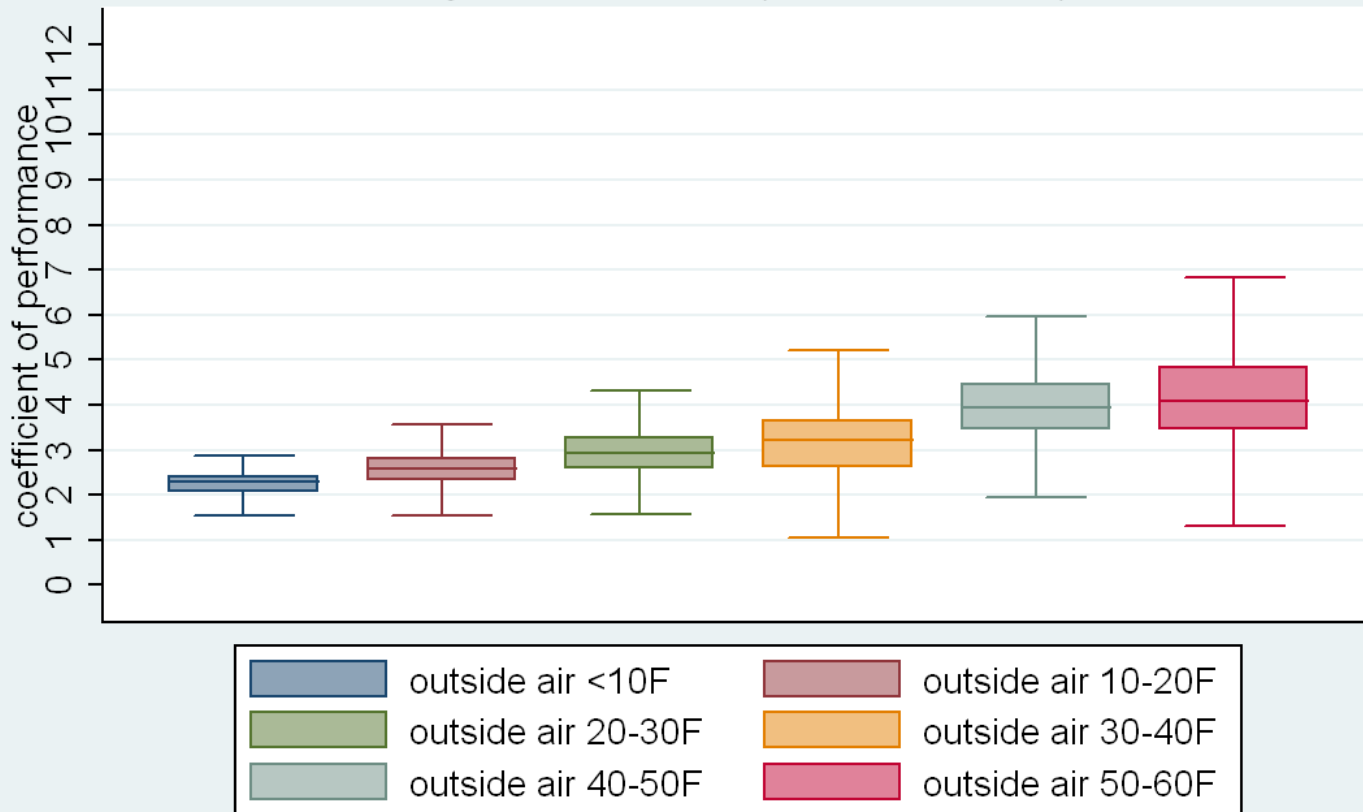


starting Jul 25, 2009



Aggregated COP Measurements

COP with different outside air temperatures (pruned data)
Fujitsu AOU12RLS (data from 3 sites)



excludes outside values

2009-2010 Heating Season to Date

(2007-2008 Base)

Cluster	kWh Saved	N
Willamette	4,605	25
Puget Sound	3,498	25
Spokane Area	1,783	9
Boise/Twin Falls	3,362	15
Eastern Idaho	3,655	10

Heating Savings as % of 2007-2008 Base

Cluster	% Saved	N
Willamette	51.0	25
Puget Sound	41.9	25
Spokane Area	16.7	9
Boise/Twin Falls	22.3	15
Eastern Idaho	26.7	10

Savings Notes

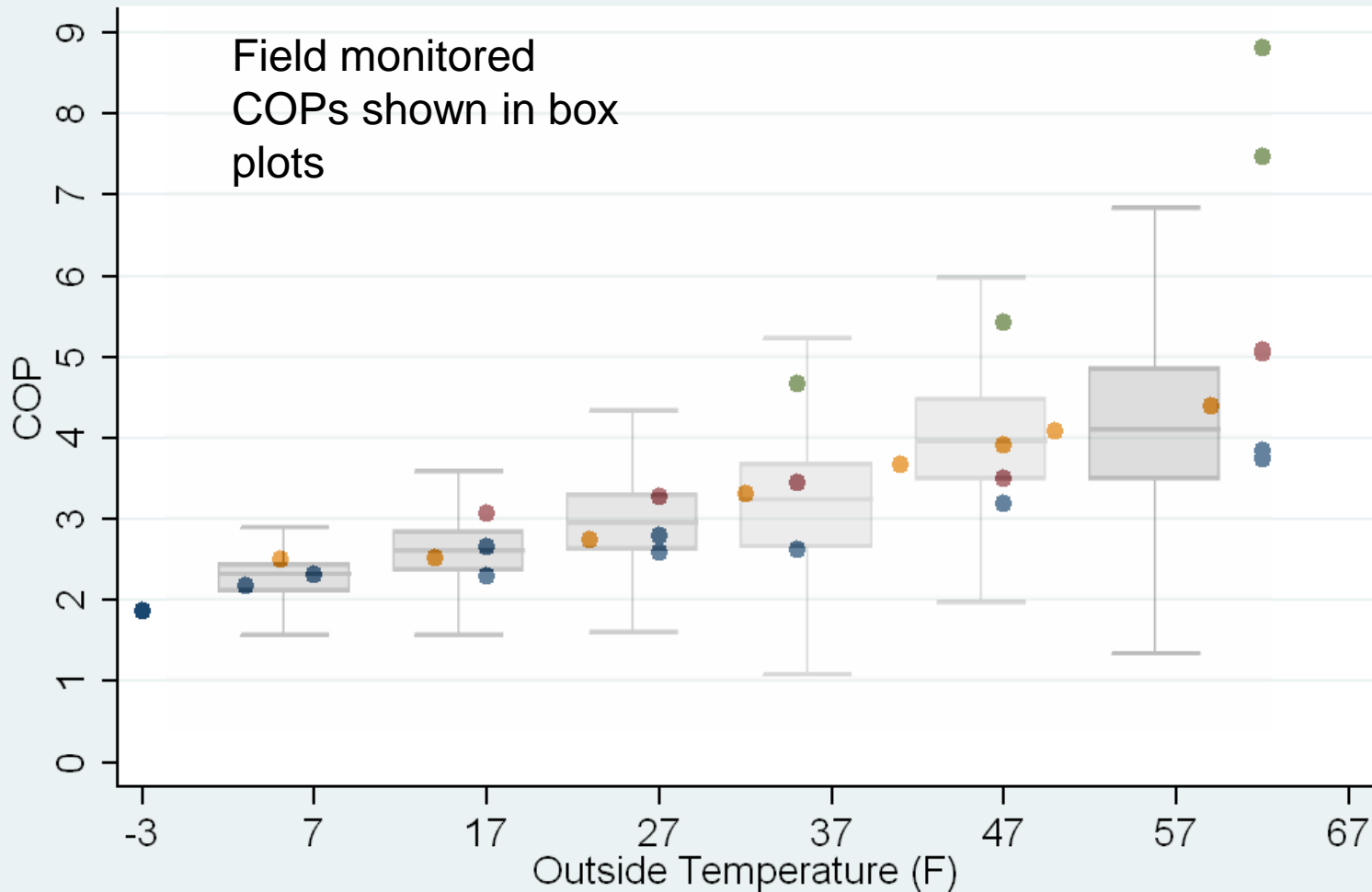
- 3,000-4,000 kWh savings/year very robust (as long as homes use only electricity for heating)
- Open floor plans/moderate to better insulation help
- Cooling offset very small at most NW sites (most sites needing cooling already used some, typically 120V window units)

Efficiency Results

- Lab tests
- Field tests (*in situ* COP rig)

COP Lab & Field Data Comparison

Model: 12RLS Fujitsu



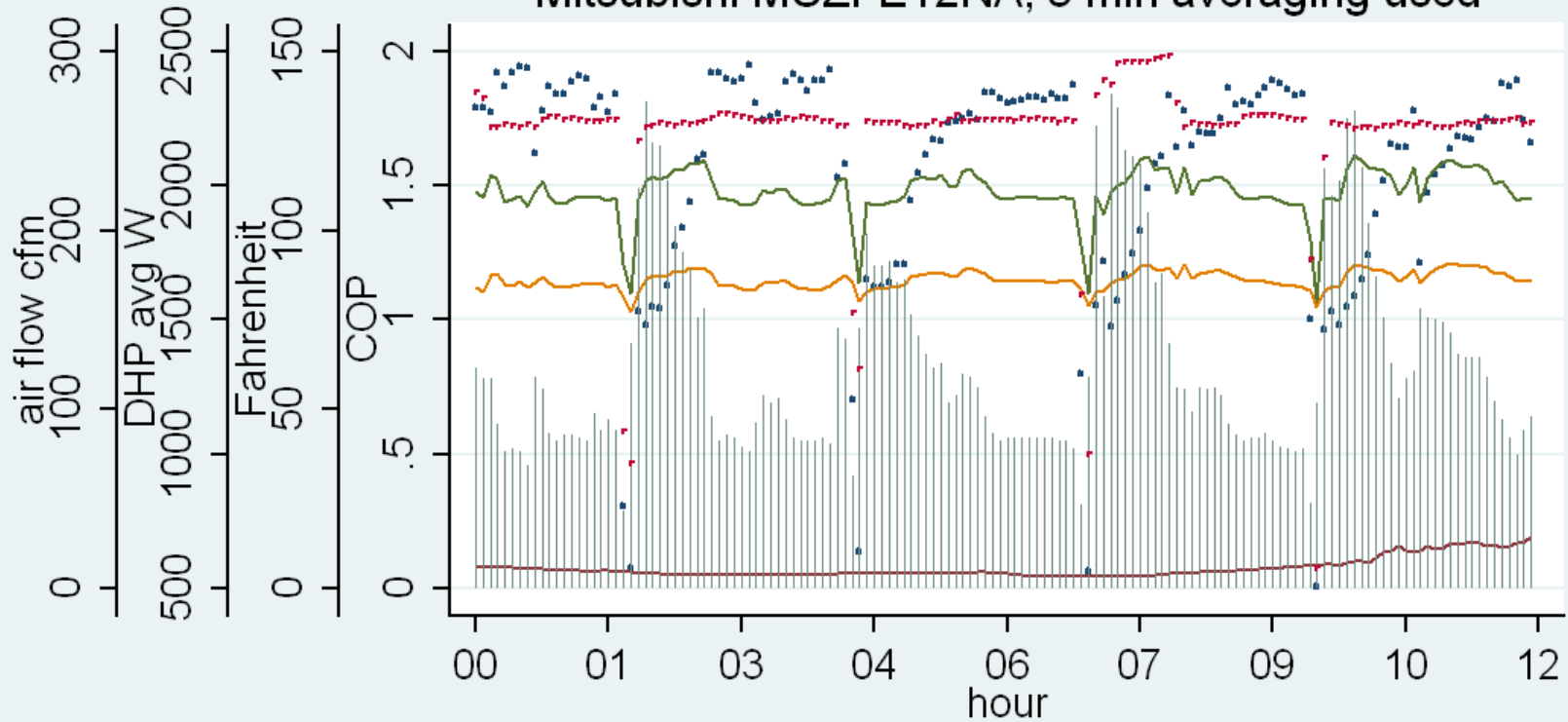
Results: HSPF/SEER Ratings

- Rating point results do not definitively demonstrate higher or lower performance than the catalog data
- Possible (likely) explanations for differences:
 - Calculations for both HSPF and SEER dominated by intermediate speed points which were difficult to replicate
 - “Intermediate” speeds in lab likely higher than those used by manufacturer which leads to lower measured performance
 - Some “wobble” room allowed in testing conditions
 - Minor ambiguities in Std 210/240 calculation procedure

Equipment Model		12RLS	FE12NA*
Heating HSPF by Zone	I	15.2	10.3
	II	14.6	10
	III	13.8	9.6
	IV	11.8 [12]	9 [10.6]
	V	8	7.9
Heating Cyclic Degradation Coefficient		0.28	0.45
Cooling SEER		20.3 [25]	15.5 [23]
Cooling Cyclic Degradation Coefficient		0.43	--
*All HSPF values calculated using simulated H1 ₁ test			
[bracketed] number indicates catalog value			

Field Data Plot, Outdoor Air Temp 5-15° F

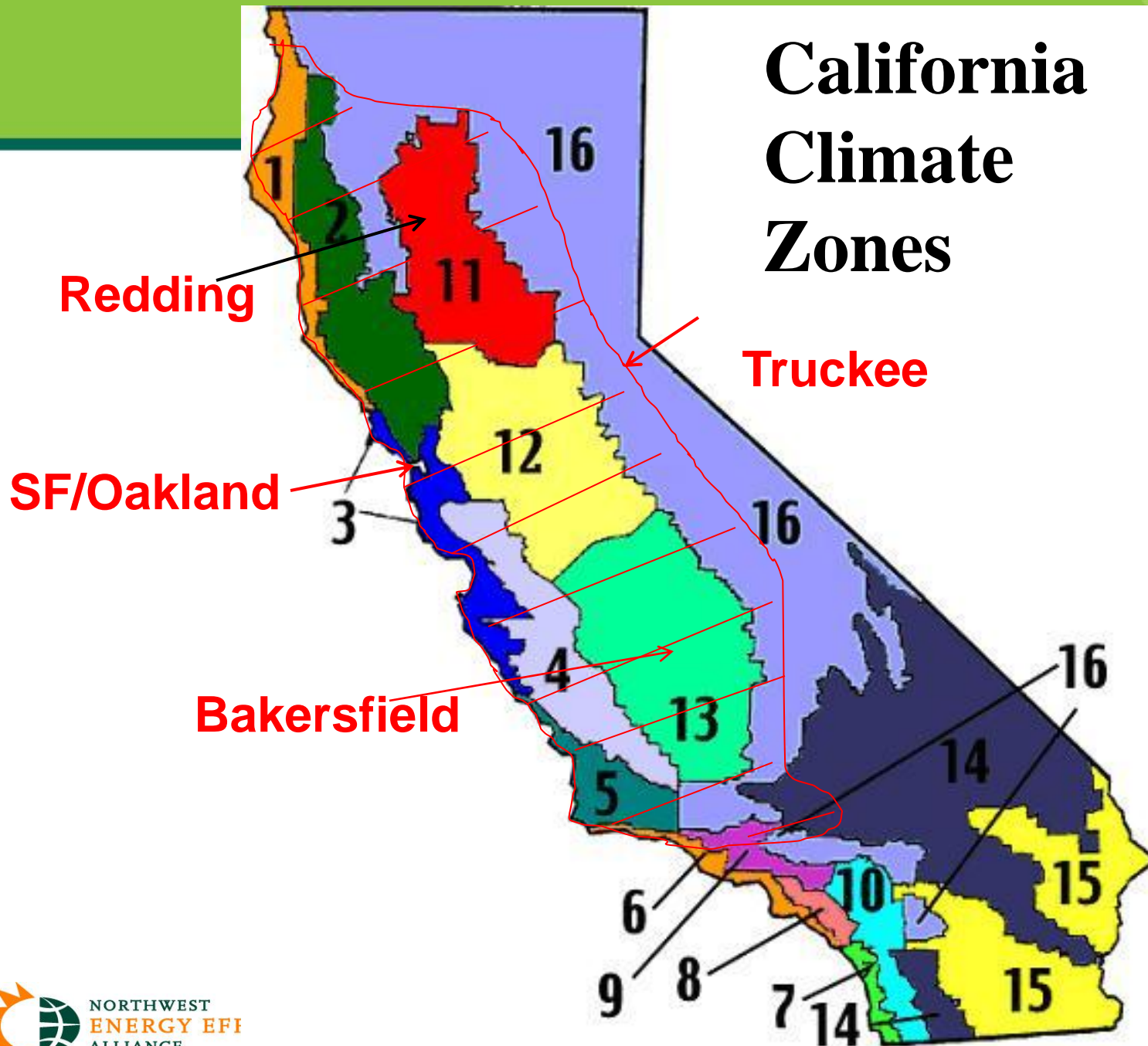
DHP data for 12 hrs from Feb 18, 2011 0:00
site 20003 (9678353) Great Falls, MT
Mitsubishi MUZFE12NA, 5 min averaging used



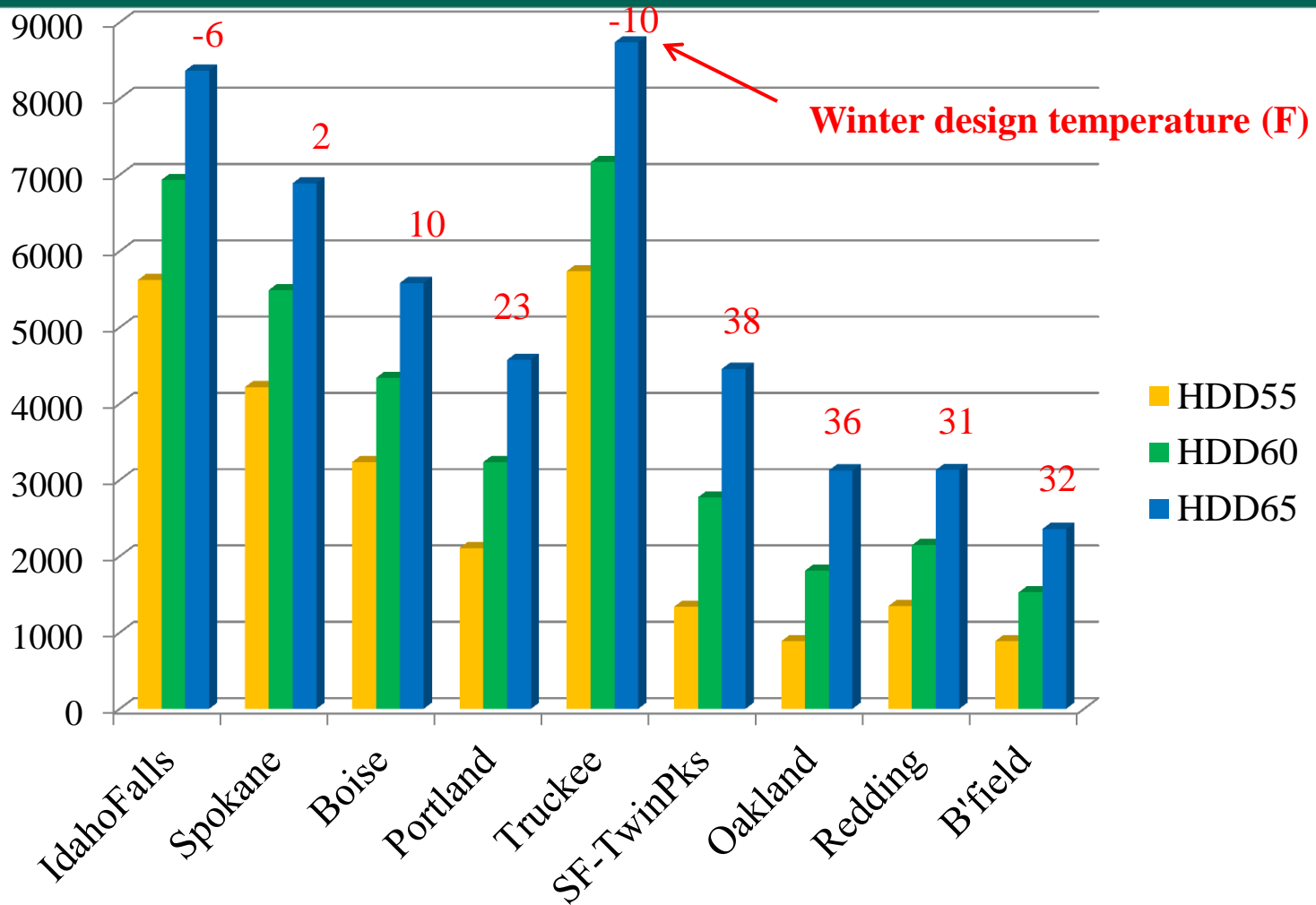
High Consumer Satisfaction

- More than 75% of new DHP owners report being very satisfied with appearance, sound level, heating comfort/coverage, cooling comfort, maintenance, and cost of operating system
- Remaining challenges:
 - ongoing maintenance
 - remote control confusion
 - coverage (for those who expected a whole-house solution or who have difficult floor plans)

California Climate Zones



Pacific NW & California Heating Conditions



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

Cooling Loads

NORTHWEST

Most Pacific NW: <300 kWh/year

Portland: ~ 200 kWh/yr (if AC is present at all)

Boise: ~ 600 CDD₇₄
(Average cooling ~1,500 kWh/yr.)

CALIFORNIA

Bakersfield: 1,350 CDD₇₄

Redding: 1,150 CDD₇₄

(Some homes could use >3,000 kWh/yr.)

San Francisco: none

Oakland: ~100 CDD₇₄

Solar management makes a big difference (anywhere)

Operating Cost – Heating Options

*PG&E rates vary from \$0.10-0.40 depending on rate schedule and time of day

<i>Heating System Type</i>	<i>Unit</i>	<i>BTUs per Unit</i>	<i>Cost per Unit</i>	<i>Unit Cost/Million Btus</i>	<i>System Efficiency</i>	<i>Dist. Effic.</i>	<i>Com-bined Effic</i>	<i>Cost per Million Btus</i>
Natural Gas Furnace	Therm	100,000	\$1.20	\$12.00	80%	80%	64%	\$18.75
Natural Gas High Eff. Furnace	Therm	100,000	\$1.20	\$12.00	92%	80%	74%	\$16.30
Natural Gas Stove/Fireplace	Therm	100,000	\$1.10	\$11.00	80%	100%	80%	\$13.75
Electric Resist. Heat	kWh	3,413	\$0.20*	\$58.60	100%	100%	100%	\$58.60
Heat Pump	kWh	3,413	\$0.20*	\$58.60	225%	72%	162%	\$36.17
Ductless Heat Pump	kWh	3,413	\$0.20*	\$58.60	300%	100%	300%	\$19.53
Fuel Oil Furnace	Gallon	138,000	\$4.00	\$28.99	80%	80%	64%	\$45.29
Propane Stove/Fireplace	Gallon	92,000	\$4.00	\$43.48	80%	100%	80%	\$54.35
Wood	Cord	12,000,000	\$225	\$18.75	60%	100%	60%	\$31.25
Pellets (wood)	Ton	16,000,000	\$220	\$13.75	70%	100%	70%	\$19.64

Savings Factors (1)

- Heating is dominant load in many parts of the west, so most DHP savings are for heating
- Not all models are designed to deliver below 30° F outside (more important in Truckee than in Oakland)
- Counting on “making bank” due to published high SEER can be a misplaced priority
- ***Consumer decisions are a huge determinant in savings***

Savings Factors (2)

- DHP most cost-effective if only single head/outdoor unit (current cost in NW about \$3,500 for this install)
- Once multiple heads/outdoor units installed, life cycle economics less favorable (even with no duct losses)

Consumer Payback

Cost/unit	Fuel	Savings/Yr. (kWh)		
		1,500	3,500	5,000
\$0.10	Electricity	23.3 yrs.	10.0 yrs.	7.0 yrs.
\$0.20	Electricity	11.7 yrs.	5.0 yrs.	3.5 yrs.
\$1.00	Natural gas	68.4 yrs.	29.3 yrs.	20.5 yrs.
\$4.00	Propane	15.7 yrs.	6.7 yrs.	4.7 yrs.

Single indoor unit paired with single outdoor unit

Installed cost: \$3,500

Utility Cost/Benefit

(calculated for electricity only)

- 3,500 kWh savings in Pacific NW = conservation resource which passes Total Resource Cost (TRC) test comfortably¹
- 1,500 kWh savings in CA = resource which *almost* passes TRC test

¹ 15-year measure life, 3.5% discount rate, 1% fuel escalation, 10% adder for O&M, marginal elec. cost of 100 mills in Pacific NW & 160 mills in CA

Peak Savings

- Peak DHP **cooling** power will be about 1.5-2 kW for 1 to 1.5 ton units vs. 3-4 kW for standard central AC or heat pump (3-4 tons)
- In **heating**, peak usage for DHP is 10x smaller than electricity-backed heat pump
- Single-head DHP might keep 500 ft² comfortable on peak day (*less, with high solar gain [**cooling**] or very cold/poorly insulated [**heating**] – or more, low load home with good natural distribution*)

Summary of Economics

- If installing for economic reasons, understand how many ft² can be conditioned and what existing fuel is offset
- Multiple unit installation economics will not be much different from installing a new central system (about \$3,000/zone)
- Adding DHP for cooling in a limited cooling climate is very expensive

Performance Summary

- System output in heating mode exceeds rated capacity
- DHPs could provide high efficiency & usage reduction for small homes, zonal heating/cooling applications, or highly motivated occupants
- Significant percent savings potential if used in tandem with existing space conditioning systems (assuming informed/motivated occupants)
- Relatively low DHP system output could limit application where quick recovery from steep thermostat setback is desired
- NW experience should be applied to housing stock with central heating/cooling systems only with careful consideration of system synergy (dueling thermostats)

Additional Resources

From the Pacific Northwest

DHP Consumer Website:

- www.goingductless.com

DHP Project Website: www.nwductless.com

- Available for download at: nwductless.com > Contractors > Resources

Evaluation Reports:

- http://www.bpa.gov/energy/n/doc/BPA-Report_Ductless-Heat-Pump-June2009.pdf

Home Energy Calculator Comparing Sources (Interactive)

Bob Davis

- <http://thousandhomechallenge.com/resources>

Comments & Observations from Marc

Marc Rosenbaum, P.E., is a long-time student of making great buildings. He uses an integrated systems design approach to help people create buildings and communities which connect us to the natural world, and support both personal and planetary health. Marc is a Passive House consultant and trainer. Much of his recent work has been deep energy retrofits and zero net energy buildings in New England using minisplit heat pumps. He is the director of engineering for South Mountain Co., Inc., on Martha's Vineyard.

Marc's Blog

<http://thrivingonlowcarbon.typepad.com/>





Send your questions & comments for Thursday's webinar to:

lwigington@affordablecomfort.org

(Subject Line: DHP Webinar: Question for ____)

Stay tuned:

Part 2 – Thursday, May 26 same time

*Documents & instructions to participate will be sent
by e-mail Wednesday, May 25*

Some Discussion Issues

- In addition to cost/MMBtu, what factors drive the decision to recommend/install?
- What are niche markets or house characteristics that could be good applications for DHP in N CA?
- What is the capacity of the single-head systems?
- How do you make selection decisions re: sizing & system choice (e.g. single vs. multi-head)?
- What is the experience w/equipment reliability & responsiveness of manufacturer technical support?
- What are the research questions that need to be addressed to better understand DHP potential in CA heating, cooling, & mixed climates?

PG&E's 2011 Classes

Related to Deep Energy Reductions in Existing Homes

For a complete schedule -- www.pge.com/energyclasses



*Pacific Gas and
Electric Company®*

Go Ductless California, Try Mini-Splits! *Dick Rome*

May 27 (9 a.m.-3 p.m.) Stockton

Planning a Zero Energy New or Existing Home in CA *Danny Parker*

July 19 San Jose July 21 Upper Lake (9 a.m.-4:30 p.m.)

Check schedule in August for upcoming fall sessions:

Go Ductless California, Try Mini-Splits! *Dick Rome*

Deep Energy Reductions - The Thousand Home Challenge

Linda. Wigington

Energy-Wise Renovation of Foreclosed Homes *Dave Robinson*

Plus many others!





ACI Resources



Information about the Thousand Home Challenge:

www.ThousandHomeChallenge.org

Introduction to the Thousand Home Challenge Webinar:

May 31, 2011 8:30 - 10 a.m. (Pacific Time)

Repeated: June 14, 2011 8:30 - 10 a.m. (Pacific Time)

Contact: Linda Wigington lwigington@affordablecomfort.org

Past handouts & upcoming ACI events:

www.affordablecomfort.org

ACI Home Energy Trainer Conference 2011 Charlotte, NC – Nov. 1-2, 2011

ACI National Home Performance Conference 2012