Measured Performance of Side-by-side, South Texas Homes

Thermal Performance of Exterior Envelopes of Whole Buildings XI
December 9, 2010

by
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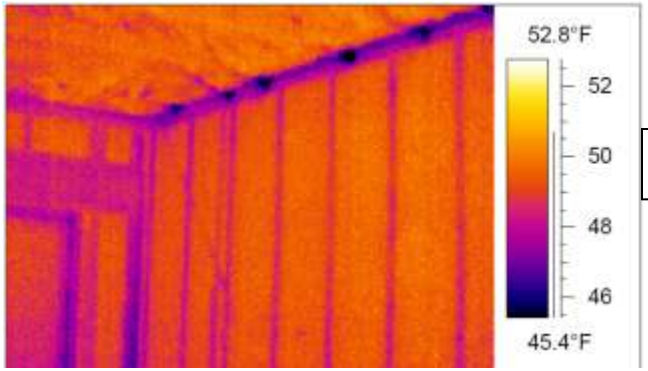
Side-by-side Homes

- 1,979 sq.ft.
- Completed March 2009
- Facing WSW

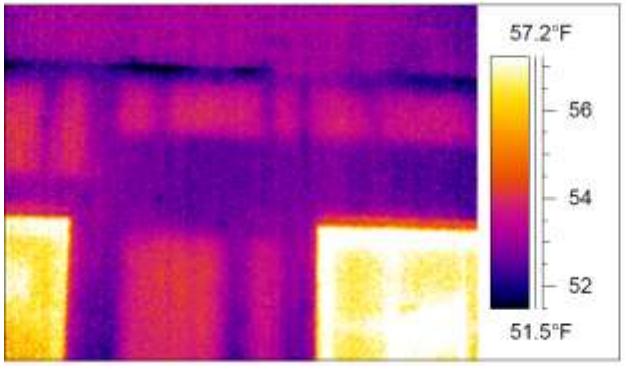
HERS Indices

- CP1 – 86
- CP2 – 54
- CP3 – 37 with 2.4kW PV

Envelope Improvements



CP2



CP3

- Roof line extension for Shading
- Sealed Attic
  - R-28 Spray Foam @ Roof Deck
- Frame walls
  - R-15 + R-3 Sheathing
- Windows
  - U-value 0.34 vs 0.53
- Enhanced Air Sealing
  - ACH50 = 1.95 for CP3
  - ACH50 = 3.64 for CP2
  - ACH50 = 5.84 for CP1
- 100% Fluorescent Lighting

HVAC Improvements

- 18 SEER A/C with 2-stage compressor (vs SEER 14
- 94 AFUE furnace or 9.5 HSPF heat pump (vs 80 AFUE
- Variable speed Fan Coil
- Manual S for coil matching for latent load
- Programmable thermostat controls T & RH
- Run-time fresh air intake
- Duct design minimizes delta P losses

Combustion Safety Measures

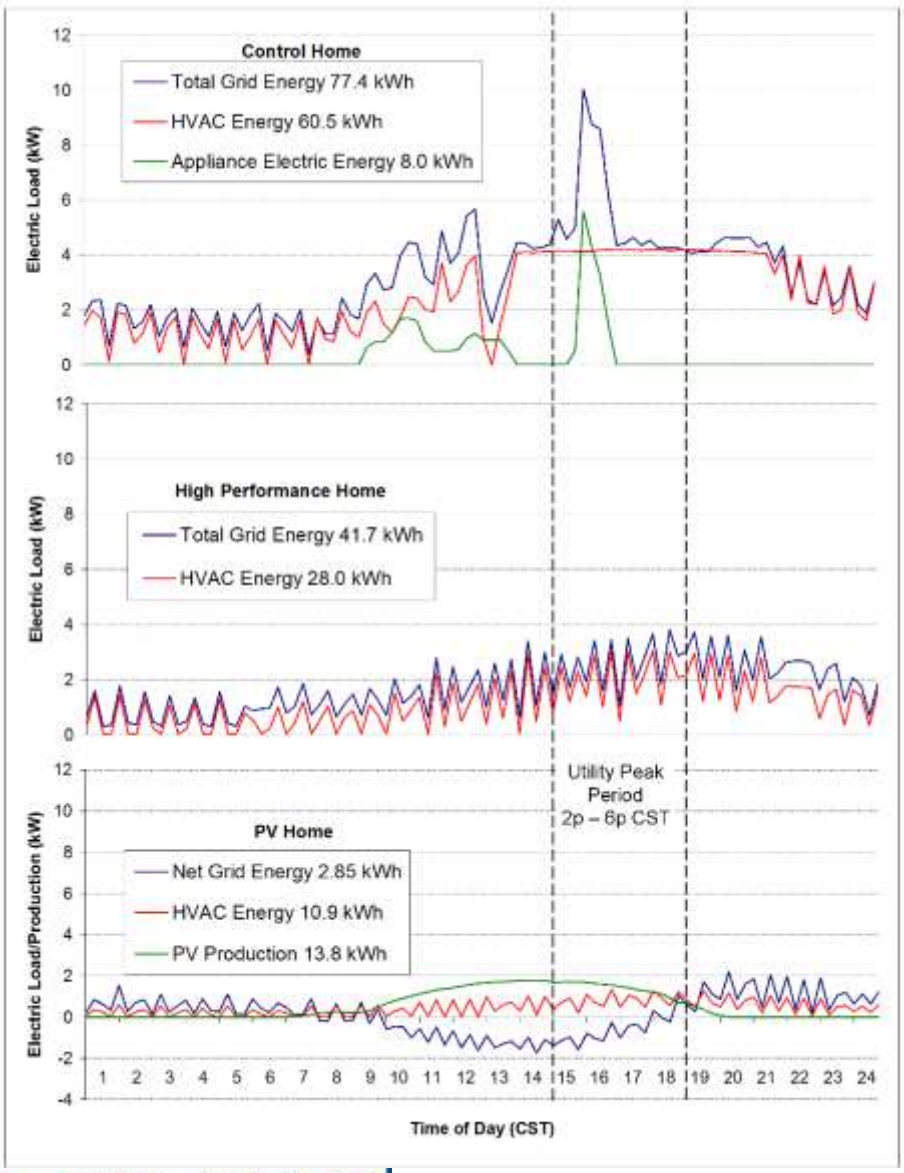
- CO Monitors near combustion equipment
- External Vents for cooktop & dryer
- Sealed combustion furnace & water heater
- Air equalization jumper ducts

Measured Electric Load on Hottest Summer Day July 8, 2009

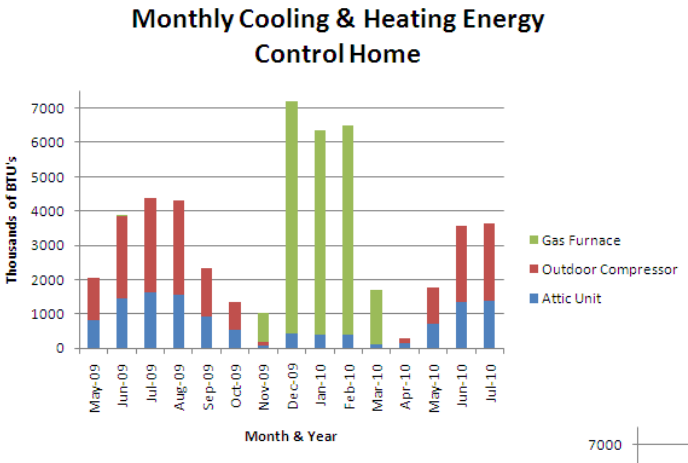
Demand management program period
May – September
3 to 7pm CDT

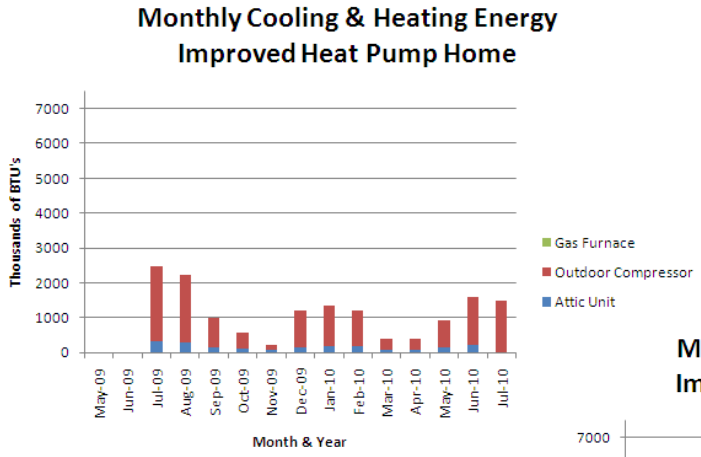
<u>Air Conditioning Peak Reduction</u>
Hi-Performance: 1.17 kW, 28%
PV Home: 2.88 kW, 68%

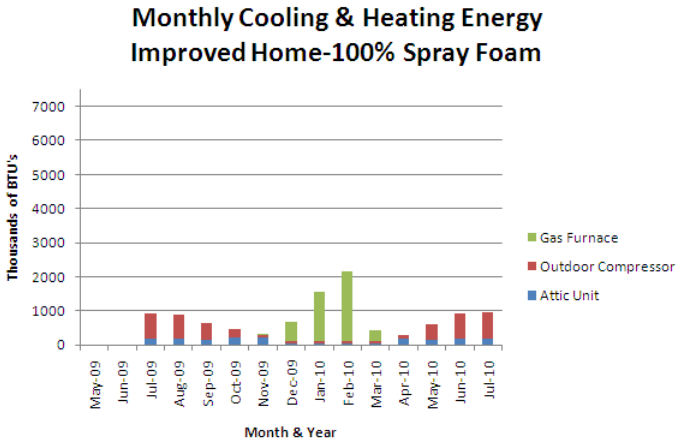
<u>Overall Peak Reduction</u>
Hi-Performance: 6 kW
PV Home: 8 kW



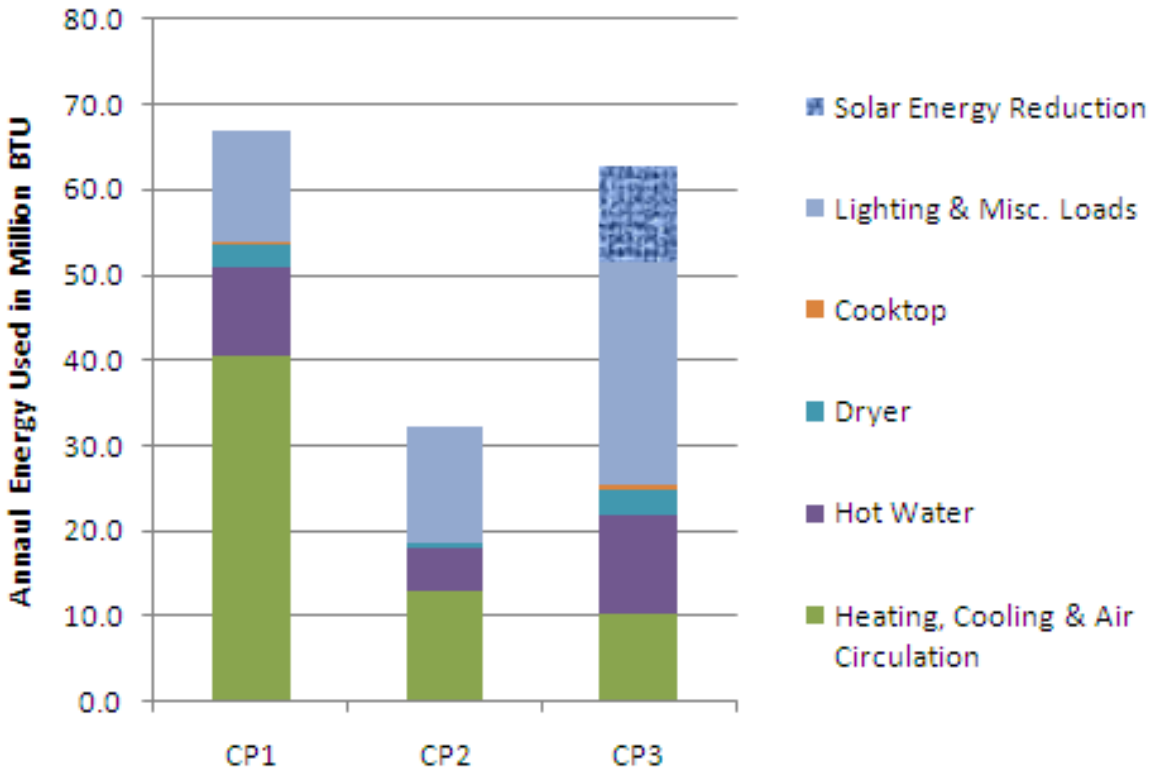
HVAC Comparisons



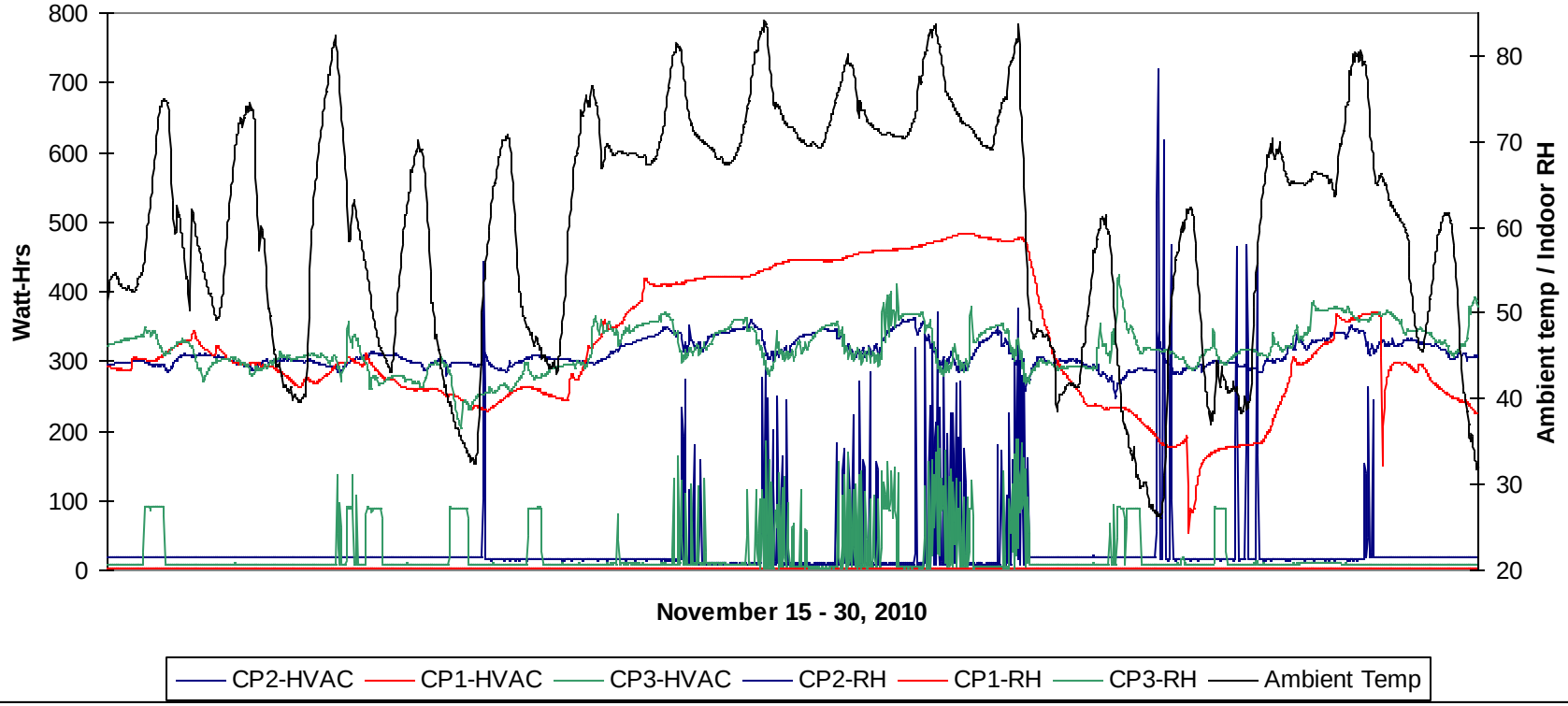


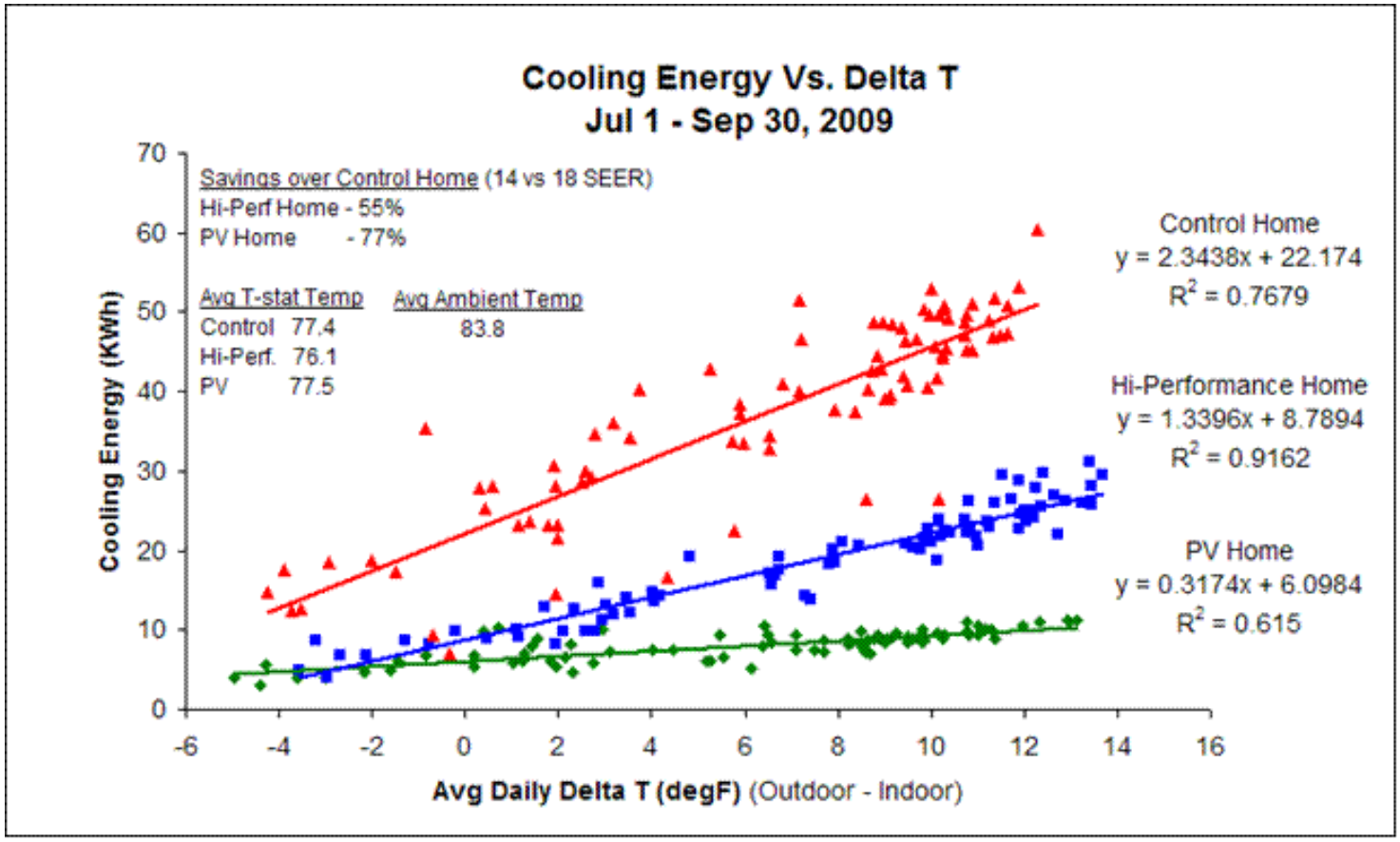


1st Year Results



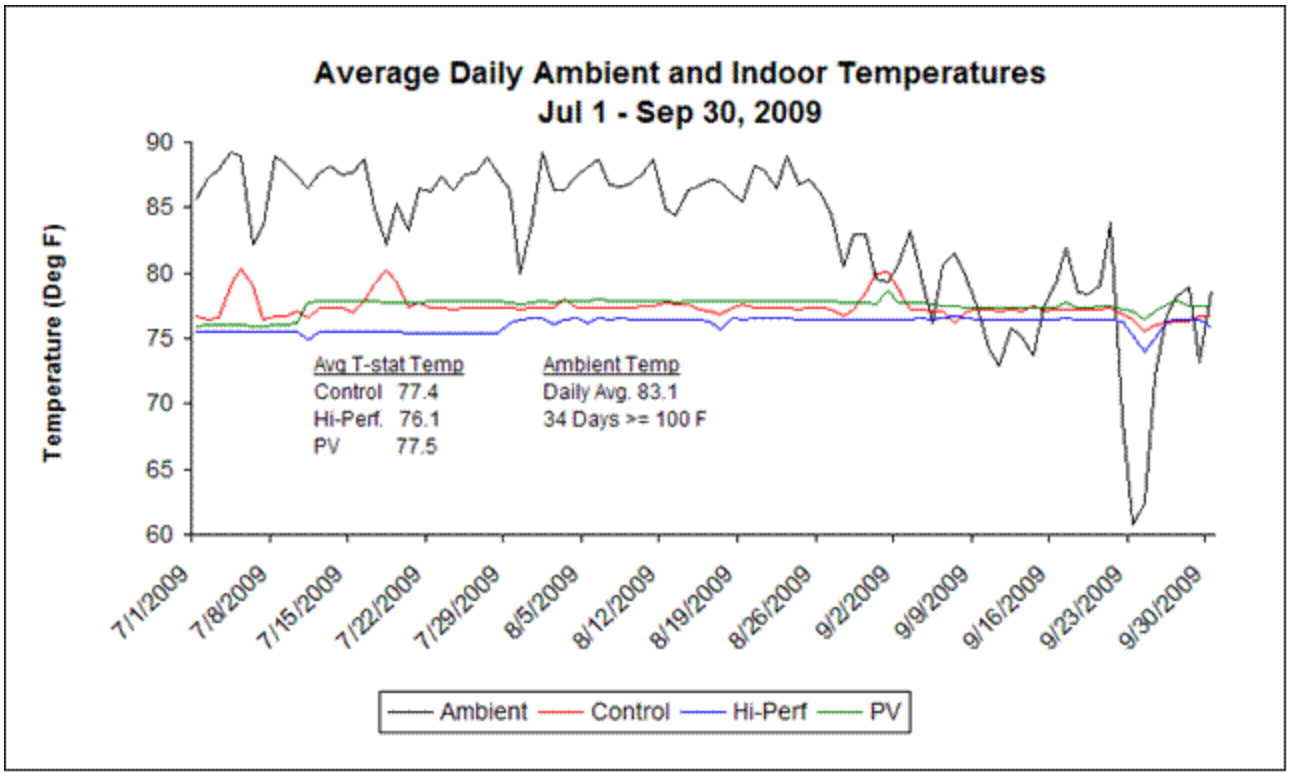
Impact of Envelope Tightness & HVAC on Indoor RH Levels



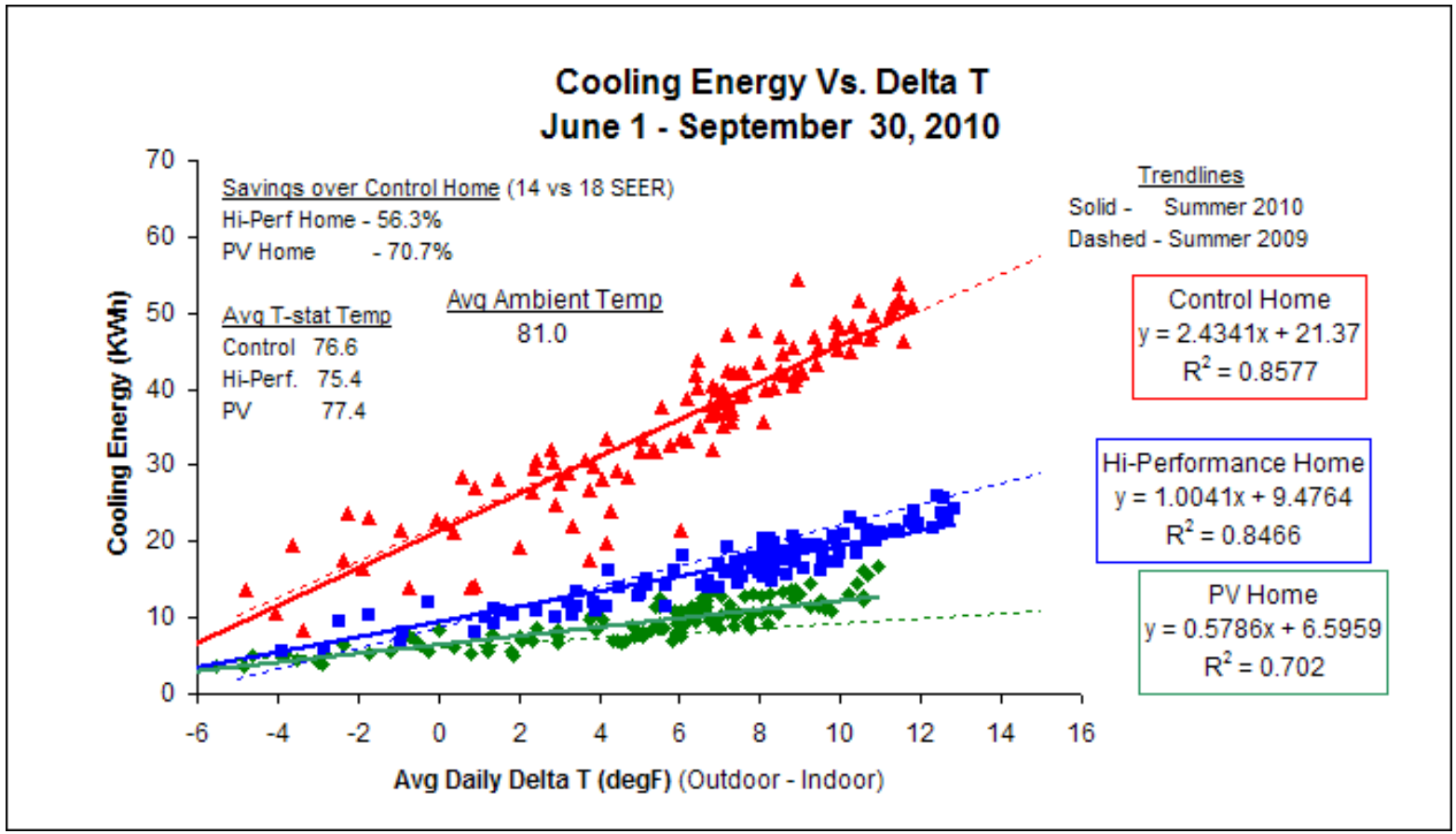


4 Days removed from 92 day data set due to:

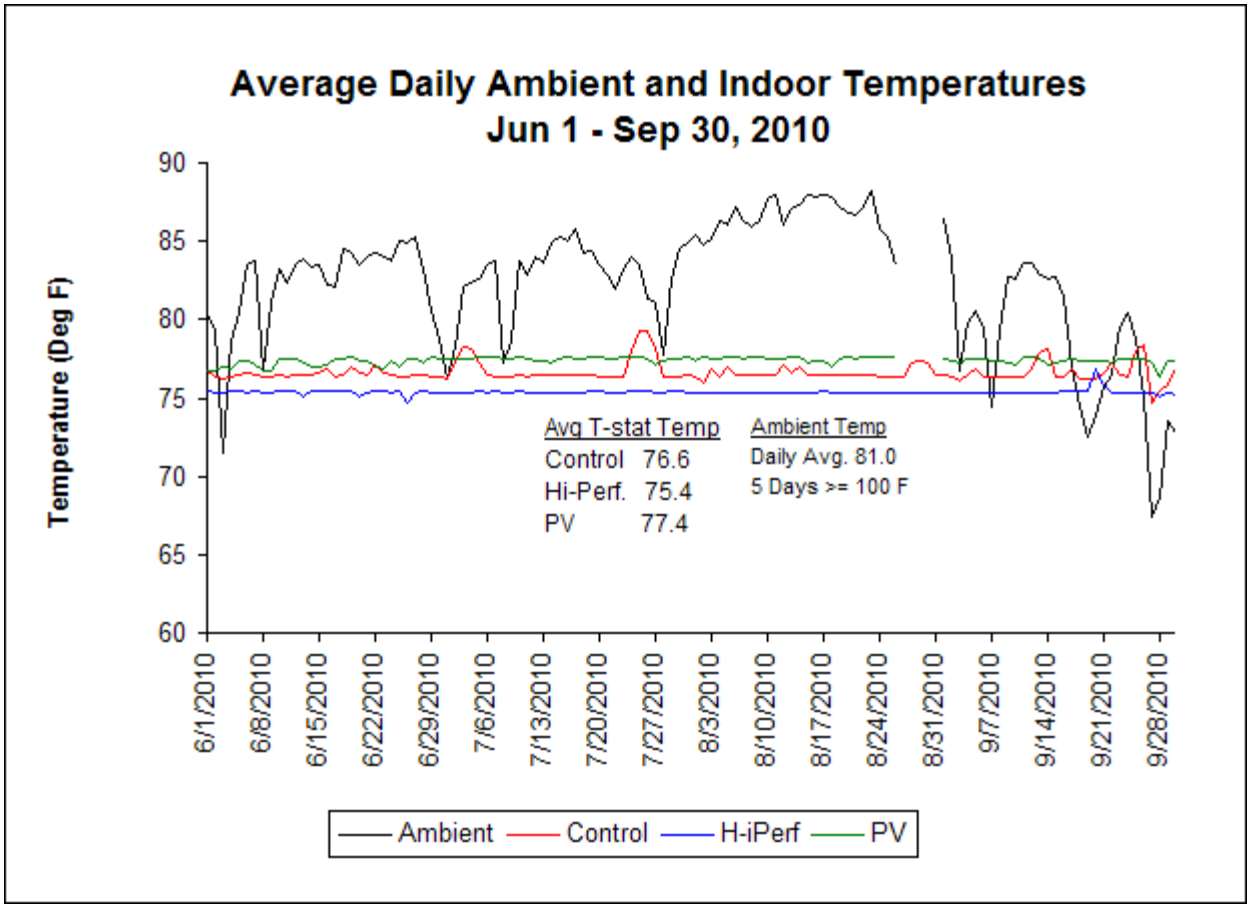
- Low temperatures
- Data collection errors



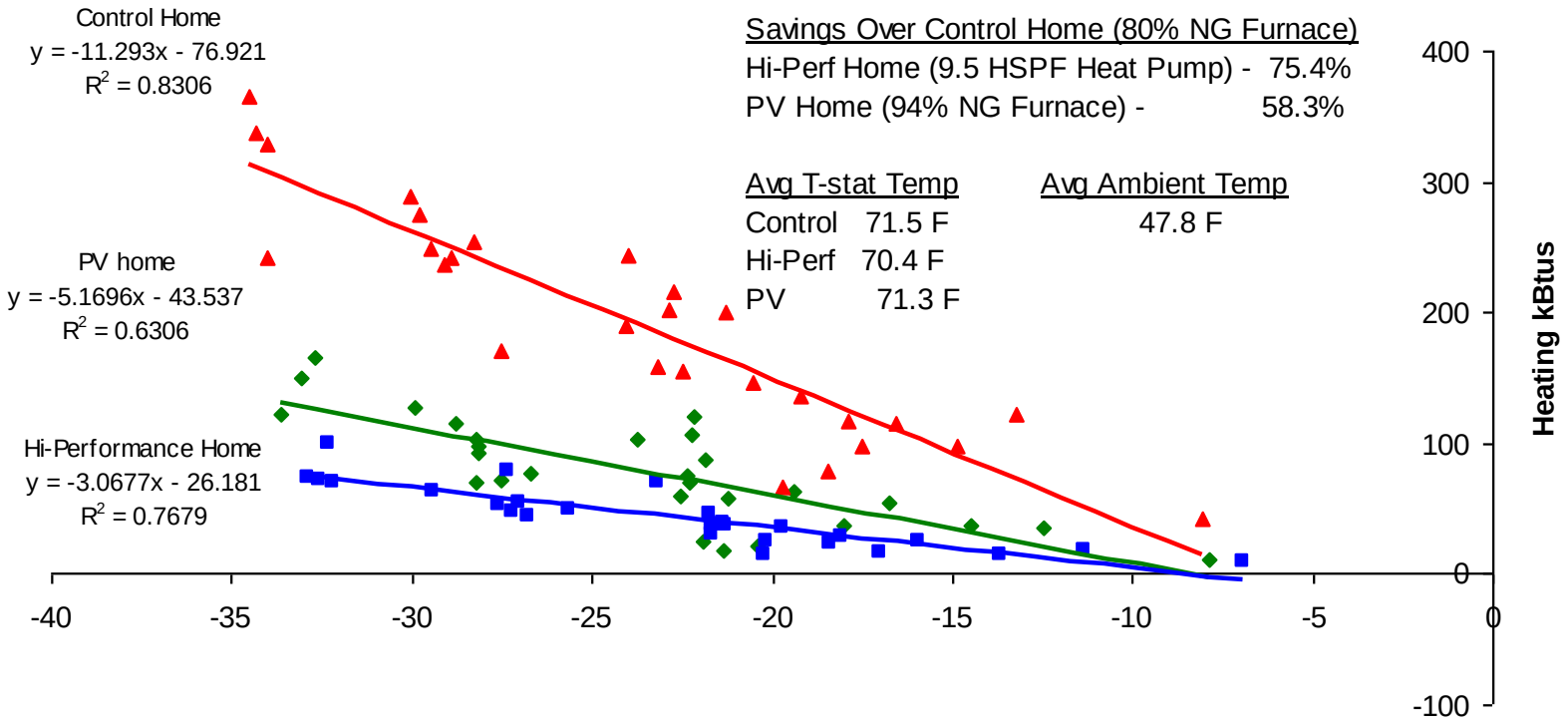
- PV home unoccupied during July and August
- Programmable T-stats not used
- Several unoccupied periods in Control home



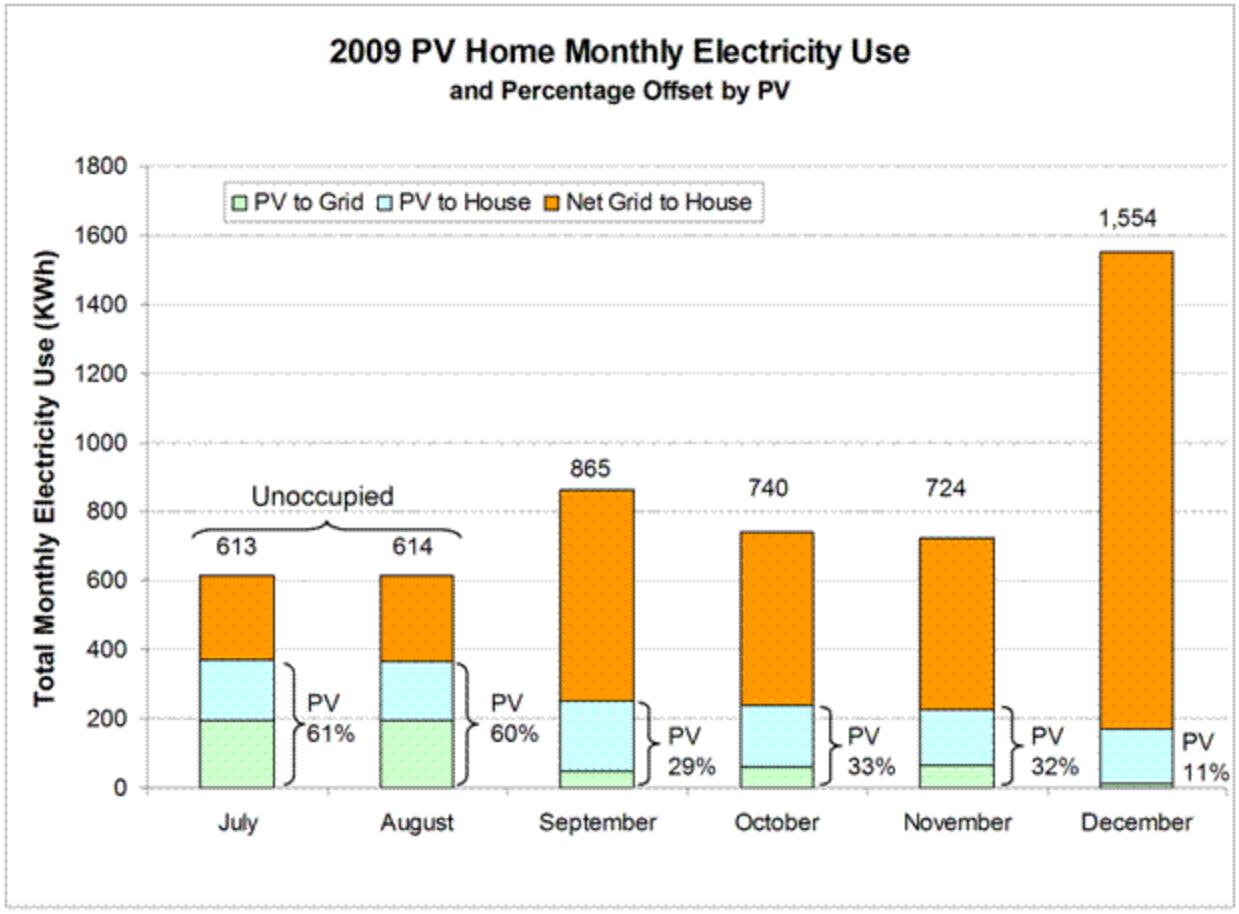
5 Days removed from 122 day data set due to datalogger failure

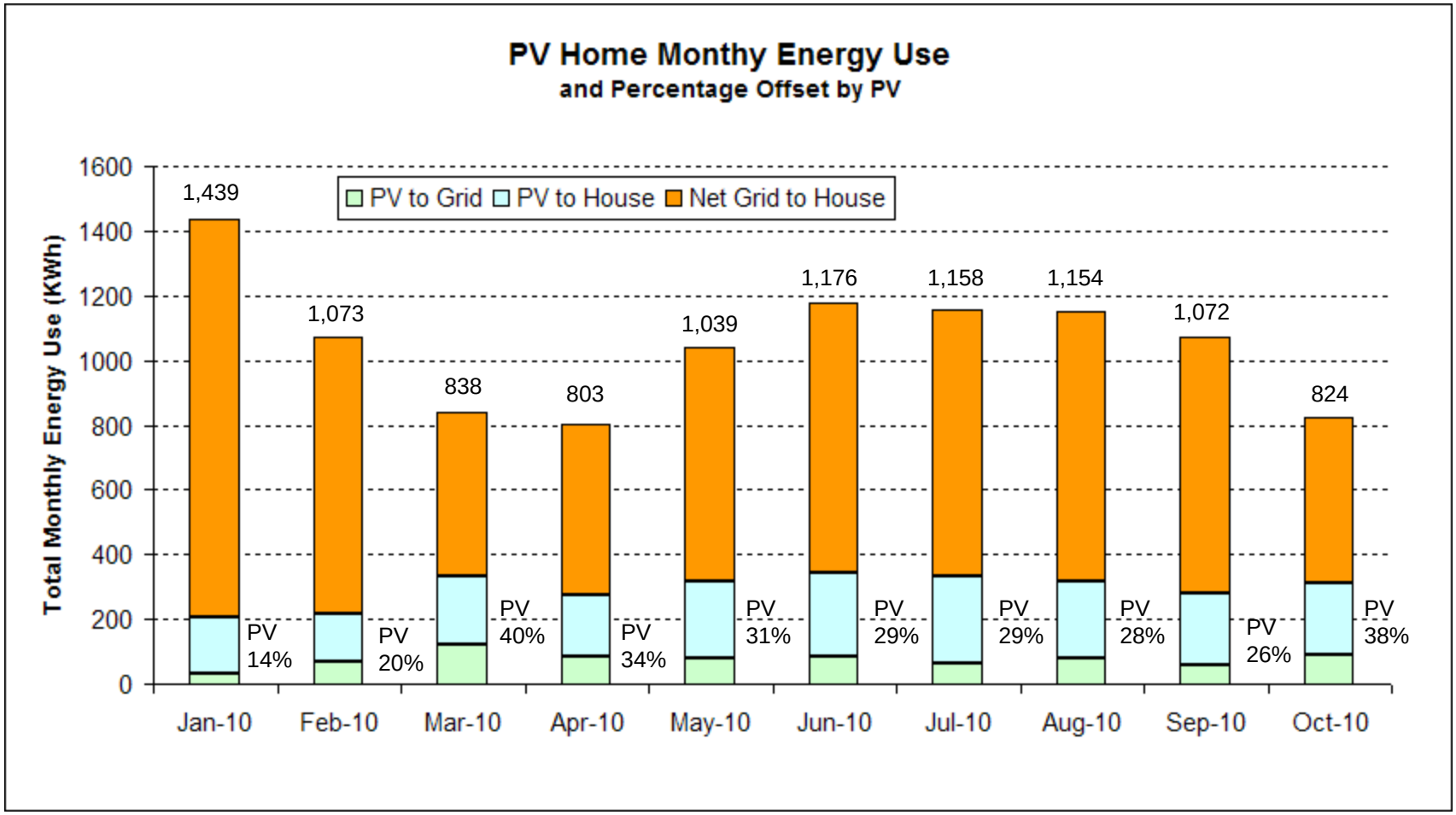

Average Daily Ambient and Indoor Temperatures
Jun 1 - Sep 30, 2010
Temperature (Deg F)
90
85
80
75
70
65
60
6/1/2010
6/8/2010
6/15/2010
6/22/2010
6/29/2010
7/6/2010
7/13/2010
7/20/2010
7/27/2010
8/3/2010
8/10/2010
8/17/2010
8/24/2010
8/31/2010
9/7/2010
9/14/2010
9/21/2010
9/28/2010
Avg T-stat Temp
Control 76.6
Hi-Perf. 75.4
PV 77.4
Ambient Temp
Daily Avg. 81.0
5 Days >= 100 F
Ambient
Control
H-iPerf
PV

Heating kBtus Vs. Delta T
February, 2010



Avg Daily Delta T (deg F) (Outdoor - Indoor)


2009 PV Home Monthly Electricity Use
and Percentage Offset by PV
Total Monthly Electricity Use (KWh)
1800
1600
1400
1200
1000
800
600
400
200
0
PV to Grid
PV to House
Net Grid to House
Unoccupied
613
614
865
740
724
1,554
PV 61%
PV 60%
PV 29%
PV 33%
PV 32%
PV 11%
July
August
September
October
November
December


PV Home Monthy Energy Use
and Percentage Offset by PV
Total Monthly Energy Use (KWh)
PV to Grid
PV to House
Net Grid to House
1600
1400
1200
1000
800
600
400
200
0
1,439
1,073
838
803
1,039
1,176
1,158
1,154
1,072
824
PV 14%
PV 20%
PV 40%
PV 34%
PV 31%
PV 29%
PV 29%
PV 28%
PV 26%
PV 38%
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10

Conclusions

- 6 to 8 kW (62 to 83%) demand reductions over control home on hottest day during utility peak period
- Peak air conditioning loads reduced 1.2 to 2.9 kW (28 to 68%) during same period.
- 55 to 77% cooling energy savings in improved homes
- 2.4kW grid-tied photovoltaic array provided 25-30% of total electric energy needs during most months & offset 100 % of annual HVAC energy consumption

Acknowledgements

- Lake Flato Architects, Inc.
  - preconstruction modeling and development of construction specifications
- Woodside Homes of South Texas
  - ensured adoption of modified building techniques
- Builder's Energy Rater
  - assistance in photo documentation and adoption of new construction practices