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

Thermal Performance of Exterior Envelopes of Whole Buildings XI

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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

- 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

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

Overall Peak Reduction
Hi-Performance: 6 kW
PV Home: 8 kW
HVAC Comparisons

Monthly Cooling & Heating Energy
Control Home

Monthly Cooling & Heating Energy
Improved Heat Pump Home

Monthly Cooling & Heating Energy
Improved Home-100% Spray Foam
1st Year Results

![Bar chart showing annual energy used in million BTU for CP1, CP2, and CP3. The chart includes categories such as Solar Energy Reduction, Lighting & Misc. Loads, Cooktop, Dryer, Hot Water, and Heating, Cooling & Air Circulation.](image)
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)


Avg T-stat Temp
Control 76.6
Hi-Perf. 75.4
PV 77.4

Ambient Temp
Daily Avg. 81.0
5 Days >= 100 F
Heating kBtus Vs. Delta T
February, 2010

Control Home
\[ y = -11.293x - 76.921 \]
\[ R^2 = 0.8306 \]

PV home
\[ y = -5.1696x - 43.537 \]
\[ R^2 = 0.6306 \]

Hi-Performance Home
\[ y = -3.0677x - 26.181 \]
\[ R^2 = 0.7679 \]

Savings Over Control Home (80% NG Furnace)
Hi-Perf Home (9.5 HSPF Heat Pump) - 75.4%
PV Home (94% NG Furnace) - 58.3%

Avg T-stat Temp
Control 71.5 F
Hi-Perf 70.4 F
PV 71.3 F

Avg Ambient Temp
47.8 F

Avg Daily Delta T (deg F) (Outdoor - Indoor)
PV Home Monthly Energy Use
and Percentage Offset by PV

- Jan-10: 1,439 kWh (PV 14%)
- Feb-10: 1,073 kWh (PV 20%)
- Mar-10: 838 kWh (PV 40%)
- Apr-10: 803 kWh (PV 34%)
- May-10: 1,039 kWh (PV 31%)
- Jun-10: 1,176 kWh (PV 29%)
- Jul-10: 1,158 kWh (PV 29%)
- Aug-10: 1,154 kWh (PV 28%)
- Sep-10: 1,072 kWh (PV 26%)
- Oct-10: 824 kWh (PV 38%)

Legend:
- PV to Grid
- PV to House
- Net Grid to House
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
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