



U.S. Department of Energy
**Energy Efficiency
and Renewable Energy**

Bringing you a prosperous future where energy
is clean, abundant, reliable, and affordable

Building Technologies Program



Building
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U.S. Department of Energy
Research Leading to Zero Energy Homes

- Borrego Springs - Experiment in Pre Cooling





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Prototype - Borrego Springs

- **4 Homes - Same Floor Plan**
- **Goal 90% Cooling Savings**
 - 3 Advanced Wall Systems
 - 3 Cutting-edge Cooling Systems
 - PVs & Shading





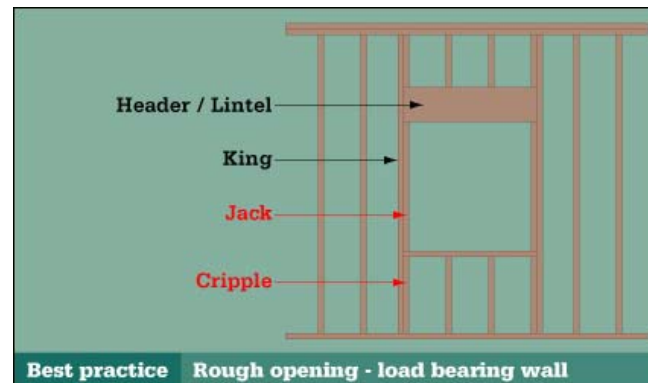
3 Advanced Wall Systems



DOW T-Mass



Structural Insulated Panels (SIP)



Optimum Value Engineered (OVE)

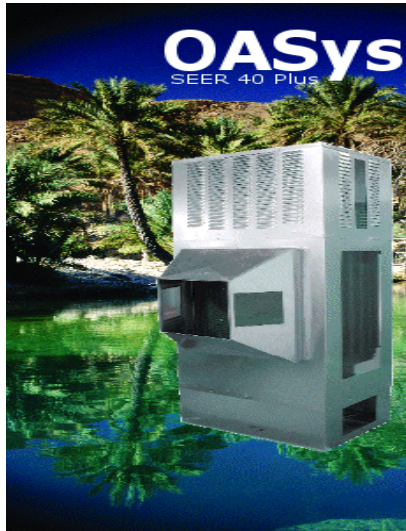


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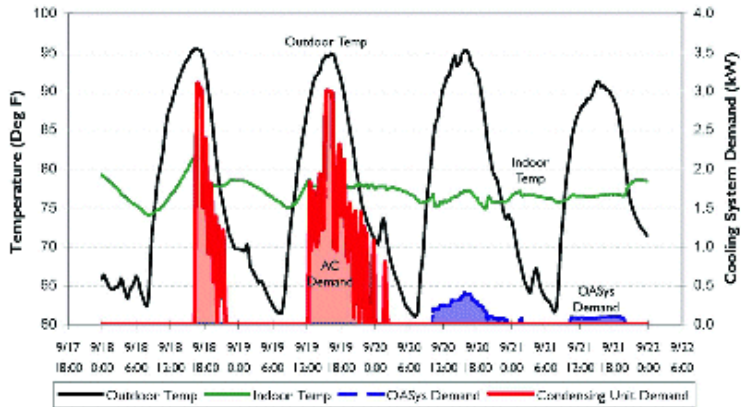
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OASys SEER 40 Plus Cooling System Demand Comparison:
Northern California Site



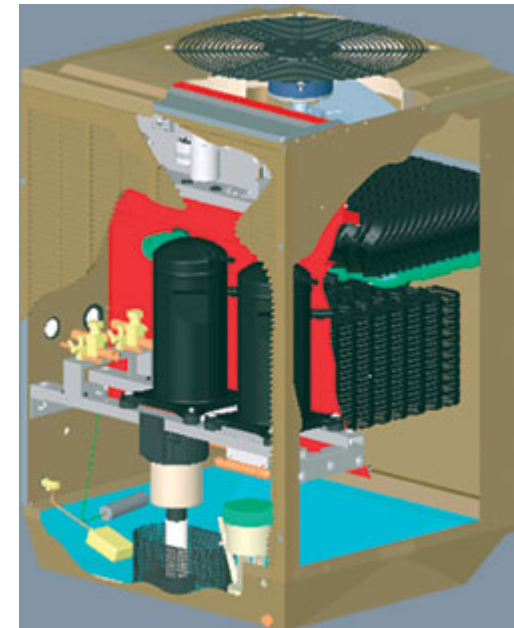
Source: Davis Energy Group
California Energy Commission
Energy Technologies Advanced Program

Direct-Indirect Evap. Cooling

Lennox 20.5 SEER

14.75 EER

Freus:
Evaporative
Condenser





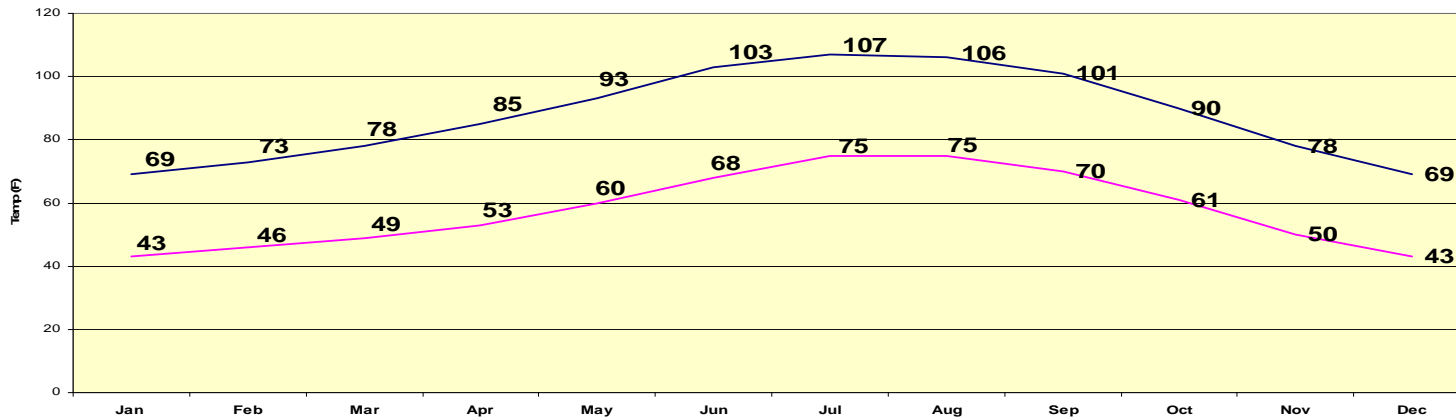
Why Borrego Springs?



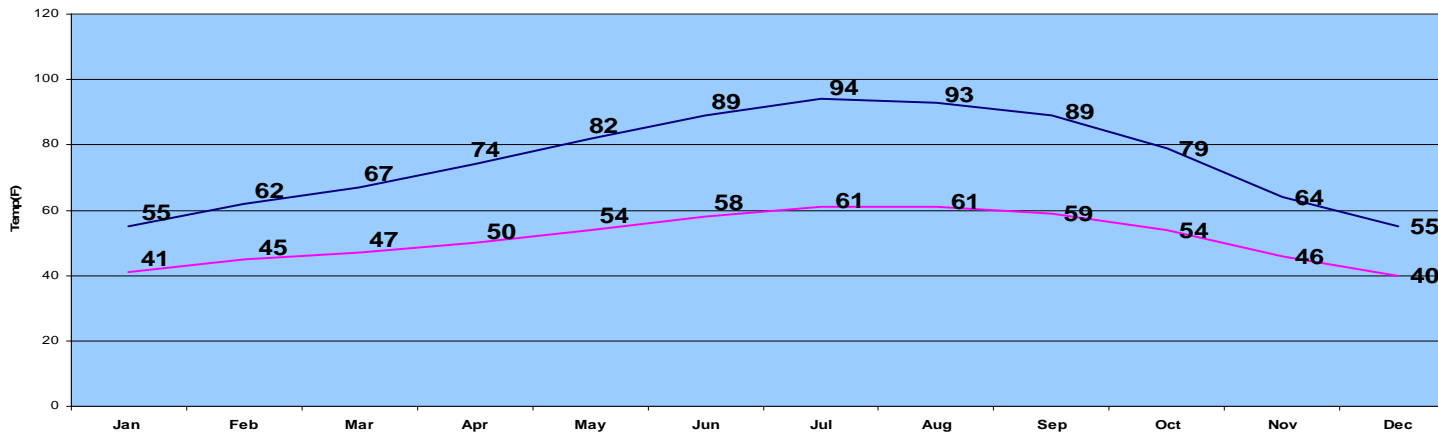


Monthly Average Temperatures

Borrego Springs Average Monthly Temperatures



Sacramento Monthly Average Temperatures





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California Counties

Borrego Springs





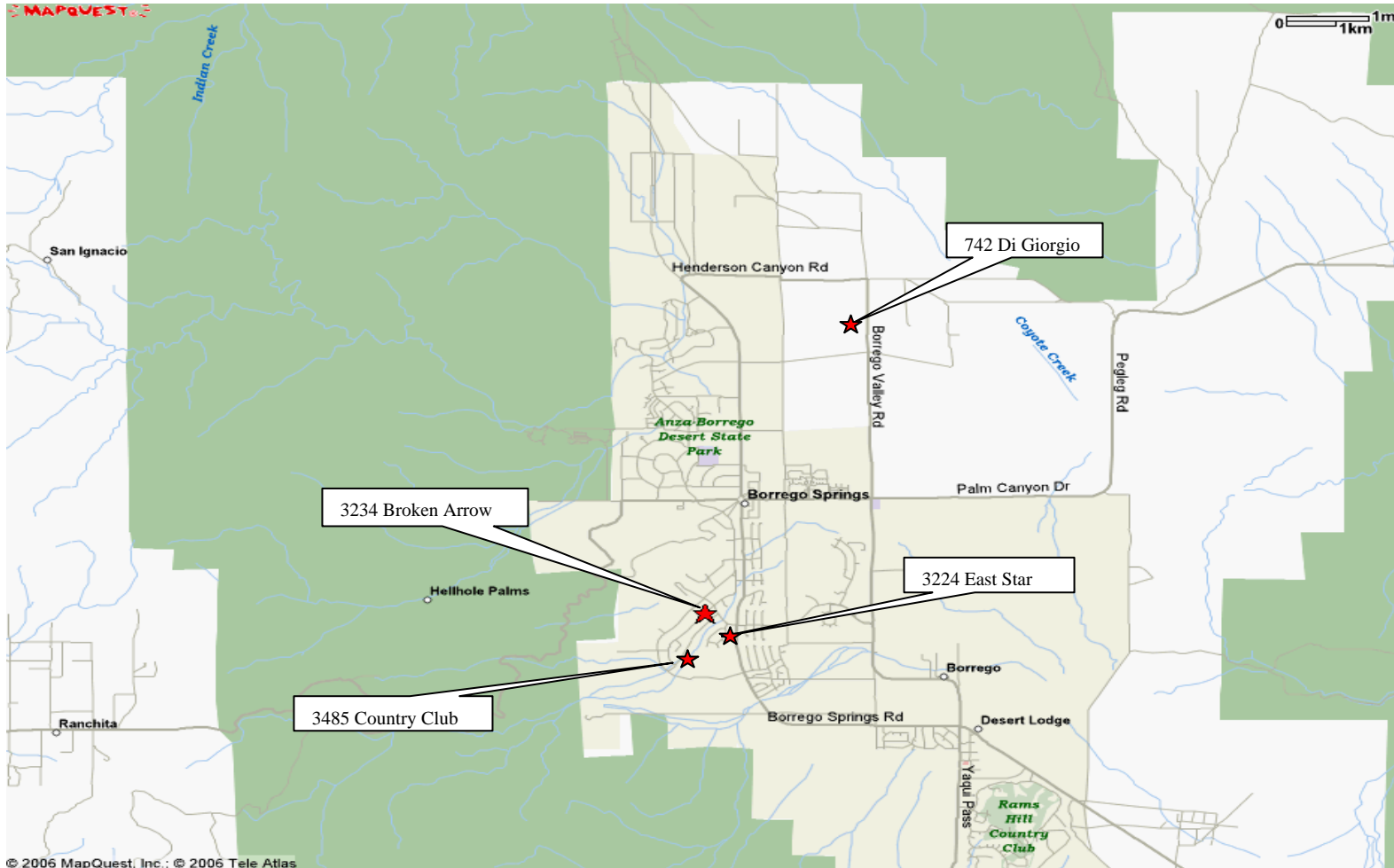
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Location, Location, Location



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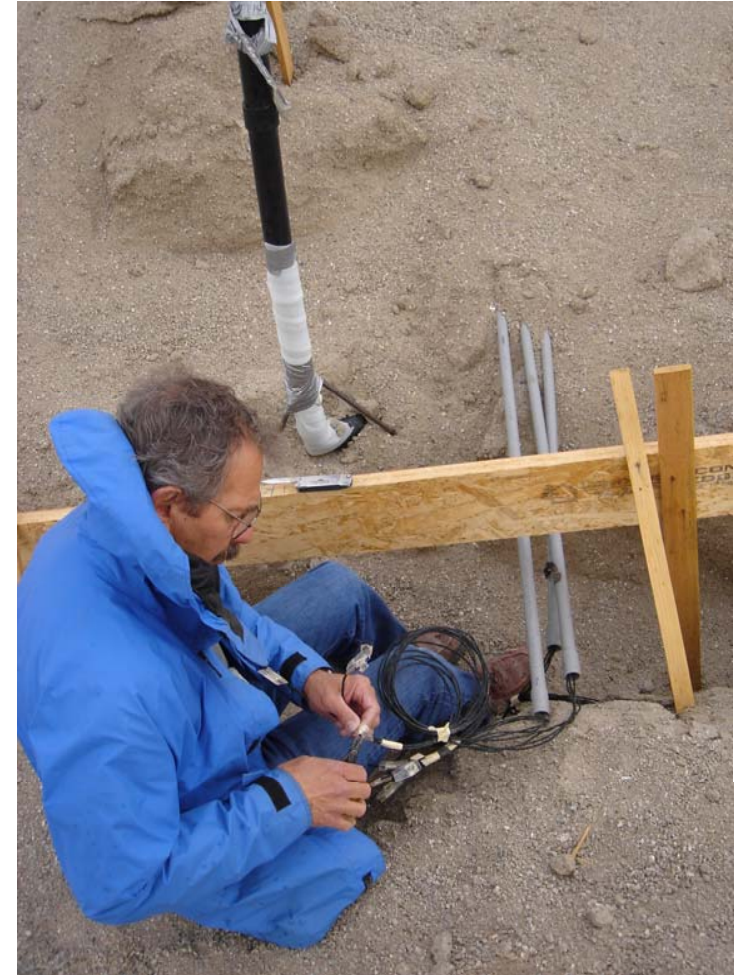
All four homes have:

- Dual Pane LowE Squared Glass
- Tankless Water Heaters
- HERS Tested
- Recirculating Hot Water System
- Radiant Heating
- 3.75kW DC Photovoltaic System



Monitoring:

- 4 Side-by-Side Homes
 - 3 Wall Systems
 - 3 HVAC Systems
- Ground-Coupling
- Wall T's
- Cooling Energy
- Whole-House Energy
- Solar Generation
- TOU/Night Cooling and Peak Load Impacts





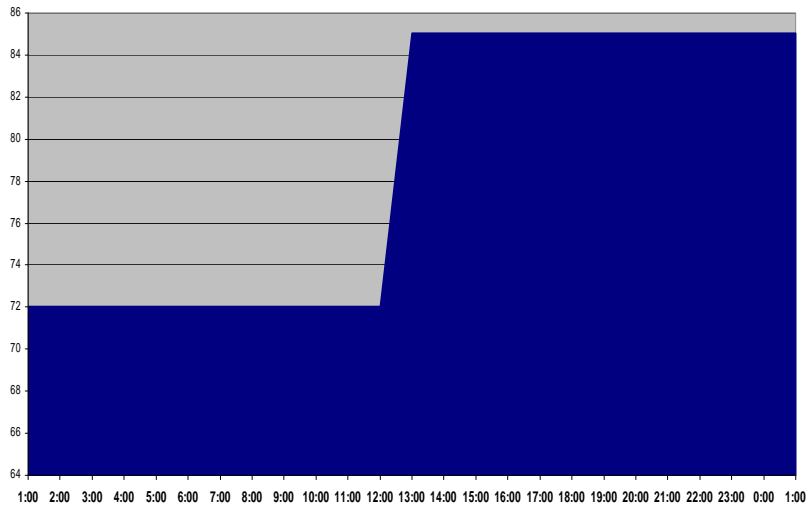
Experimental Goals

- Pre-cool the home, then allow no cooling, to observe temperature change over a period of time
- Observe possible benefit in peak energy avoidance.
- Characterize overall wall effectiveness in maintaining comfort

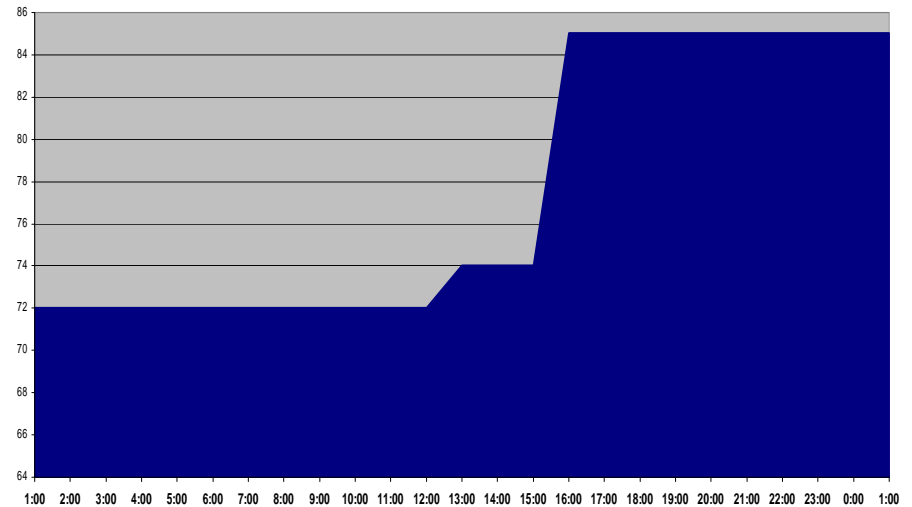


Pre-Cooling Strategy

Tuesday & Wednesday Cooling Strategy



Thursday Pre-Cooling Strategy





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www.clarumzeroenergy.com

Floor Plan



3 Bedrooms - 3 Bathrooms
Approximately 2000 SF

CLARUM HOMES

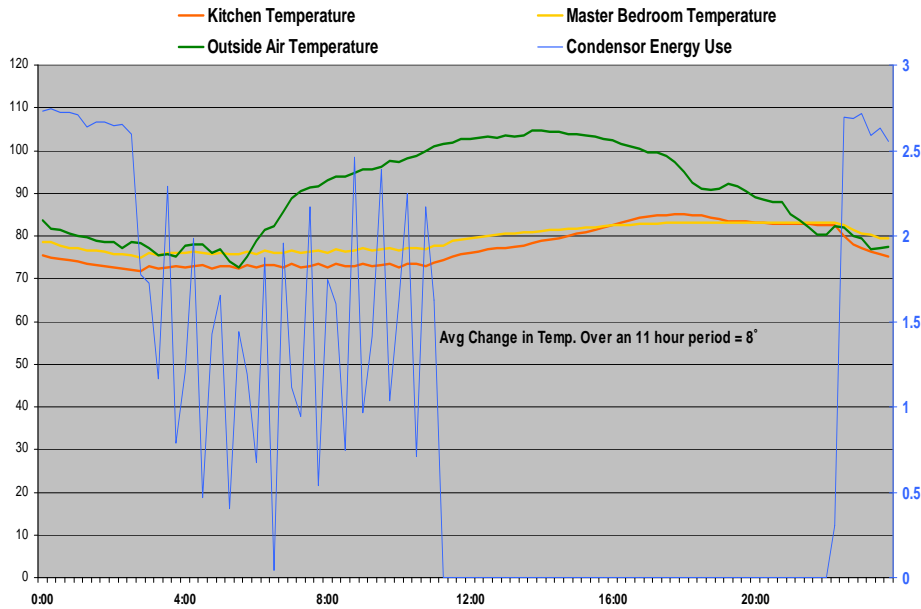
Our Name Means Quality.



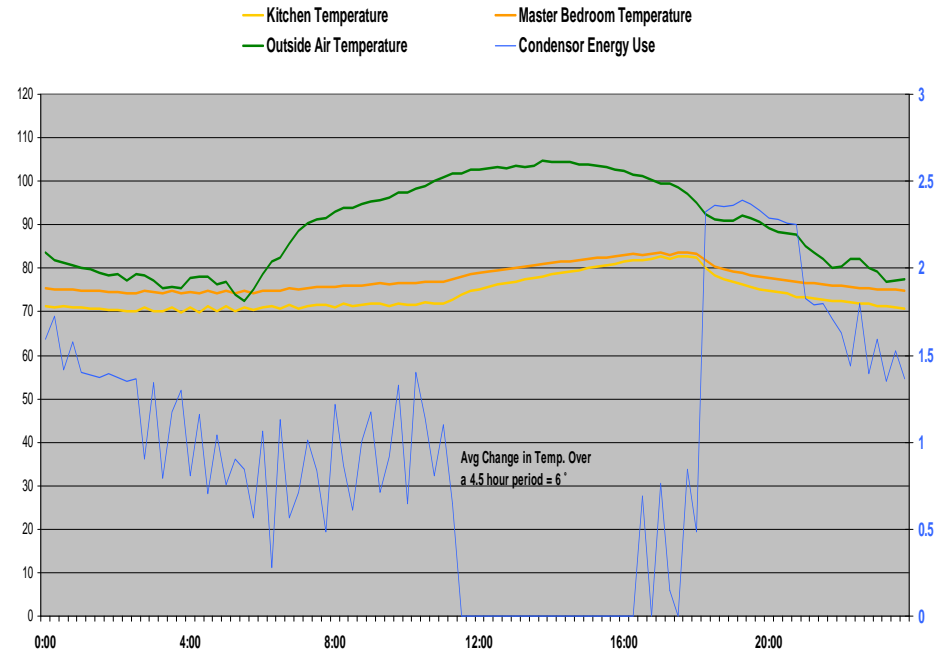


SIP Panel Home and "OVE" Home

Aug 16th: SIP Home



Aug 16th: OVE Home

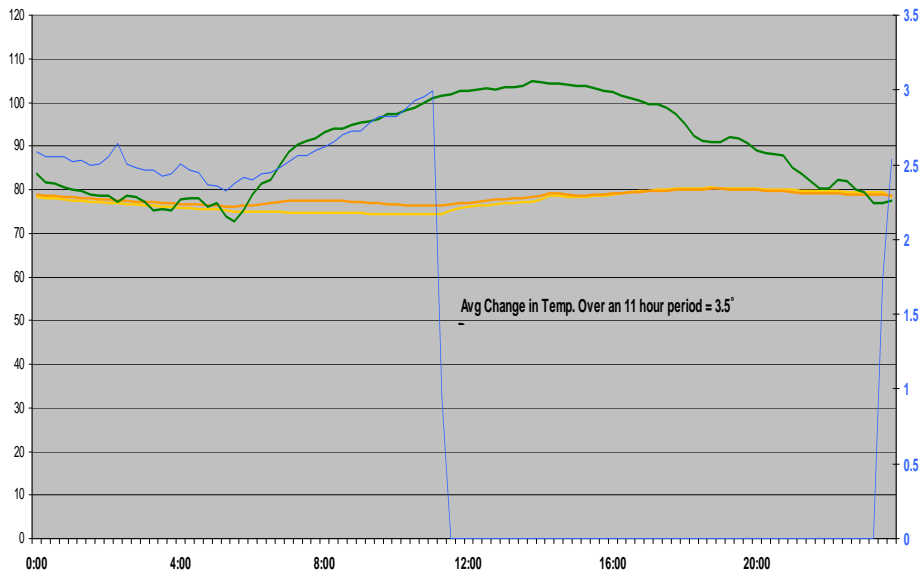




T-Mass Home and "OVE" Home

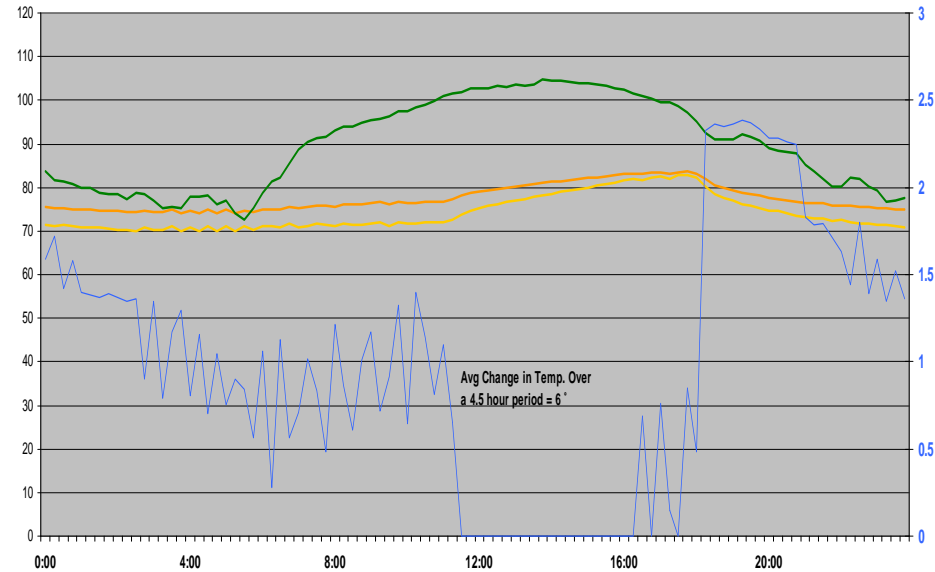
Aug 16th: T-Mass Home

— Kitchen Temp — Master Bedroom Temp
— Outside Air Temperature — Condensor Energy Use



Aug 16th: OVE Home

— Kitchen Temperature — Master Bedroom Temperature
— Outside Air Temperature — Condensor Energy Use





Wall Sensor Locations



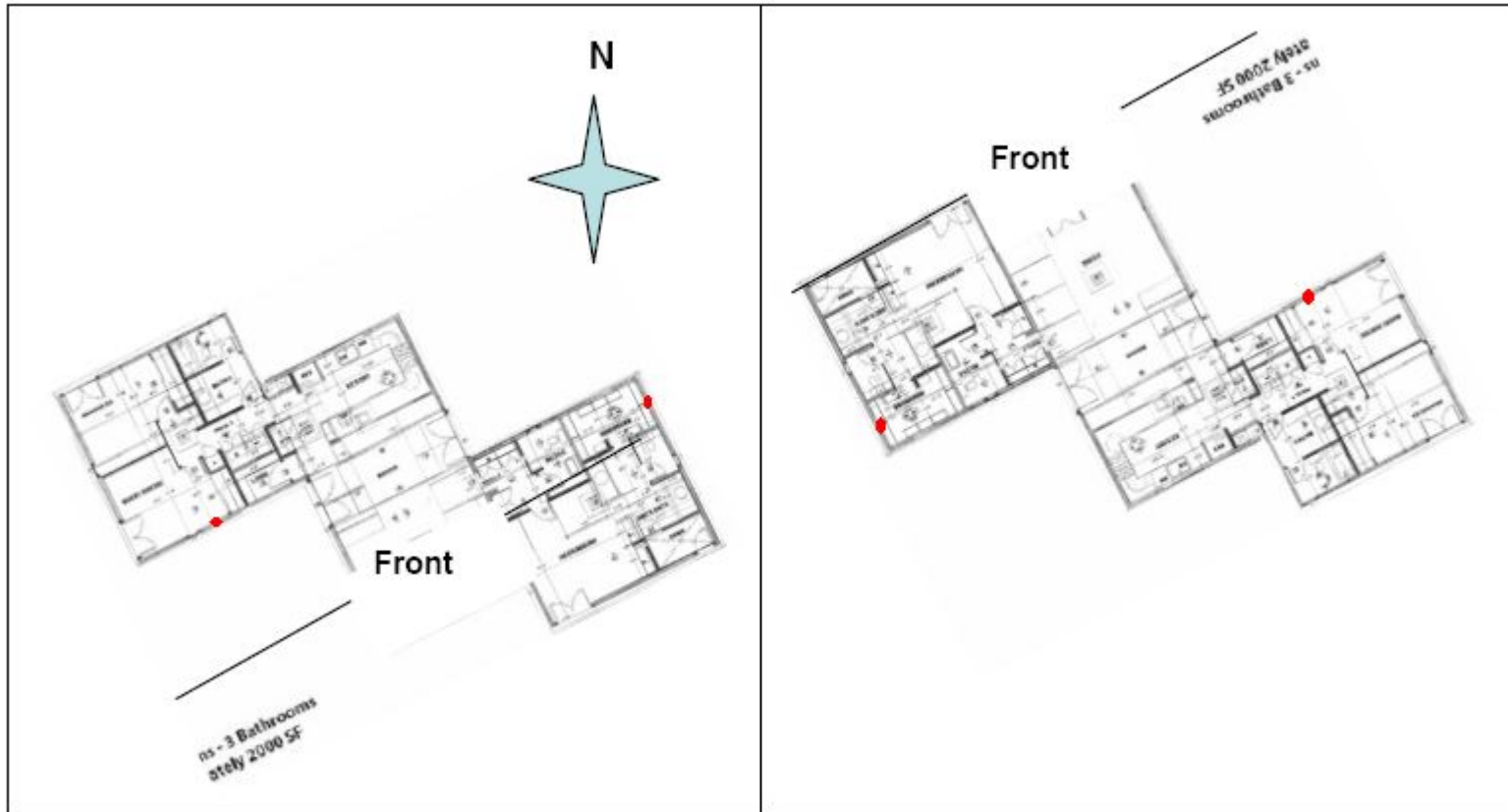


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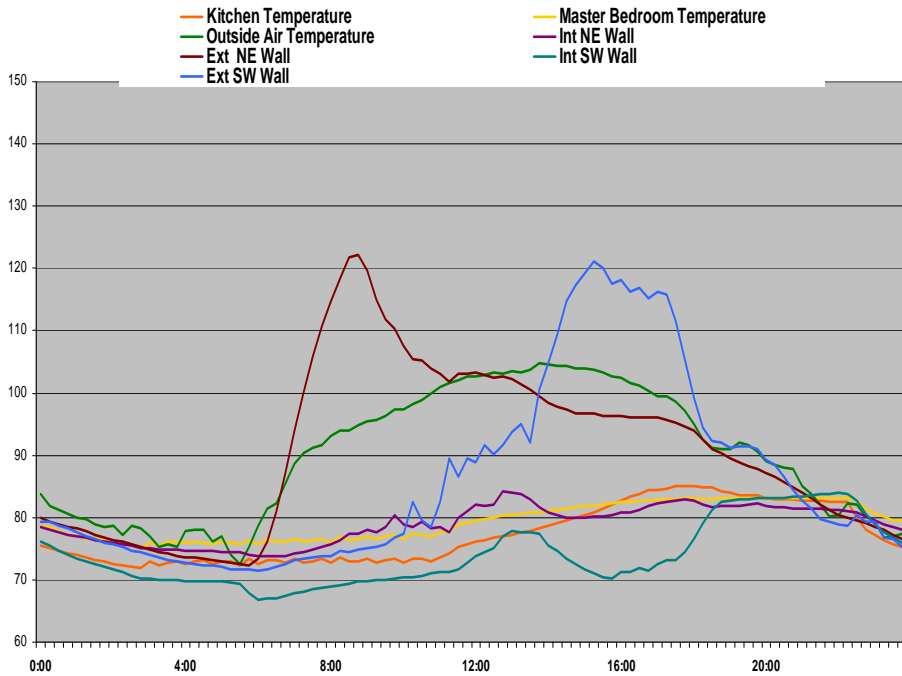
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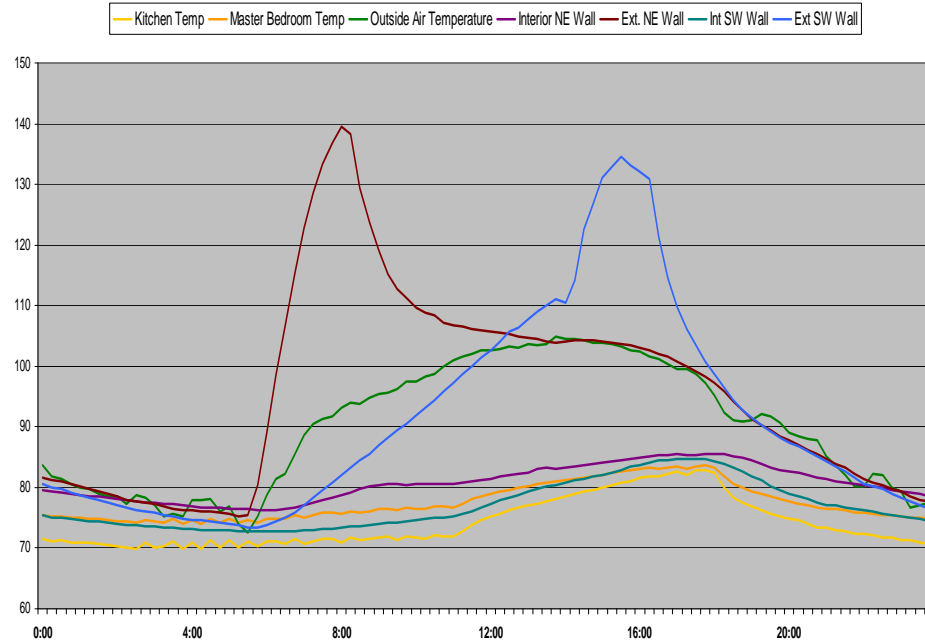


SIP Panel Home and “OVE” Home

Aug 16th: SIP Home



Aug 16th: OVE Home

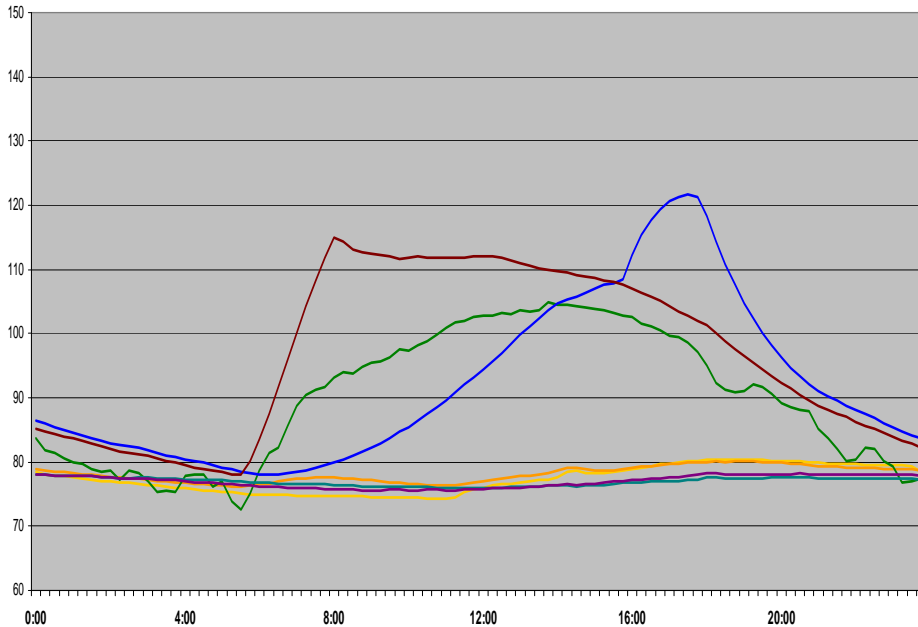




T-Mass Home and "OVE" Home

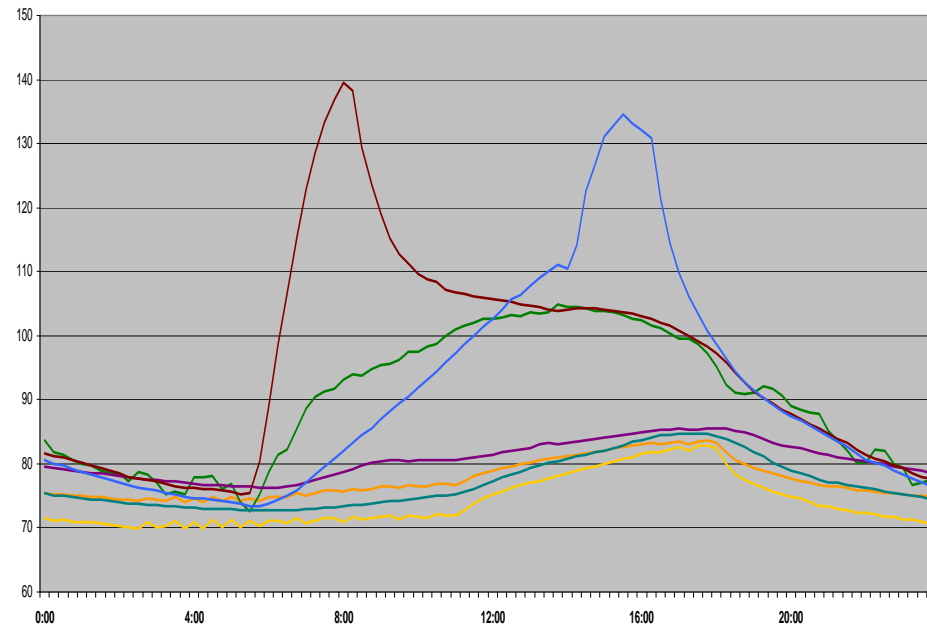
Aug 16th: T-Mass Home

- Kitchen Temp
- Int NE Wall
- Ext SW Wall
- Master Bedroom Temp
- Ext NE Wall
- Outside Air Temperature
- Int SW Wall



Aug 16th: OVE Home

- Kitchen Temp
- Master Bedroom Temp
- Outside Air Temperature
- Interior NE Wall
- Ext. NE Wall
- Int SW Wall
- Ext SW Wall





Results

- OVE House
 - 4.5 hours to reach 85° set point, with an extrapolated temperature change of 9° over 11-hour interval
- SIP House
 - Never reached 85° set point with a temperature differential of 8°
- T-Mass House
 - Never reached 85° set point with a temperature differential of 3.5°



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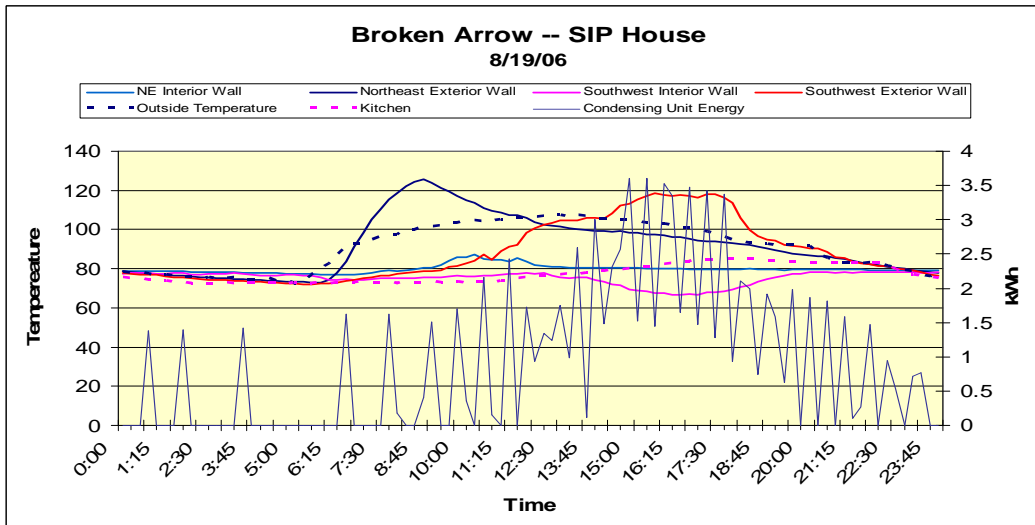
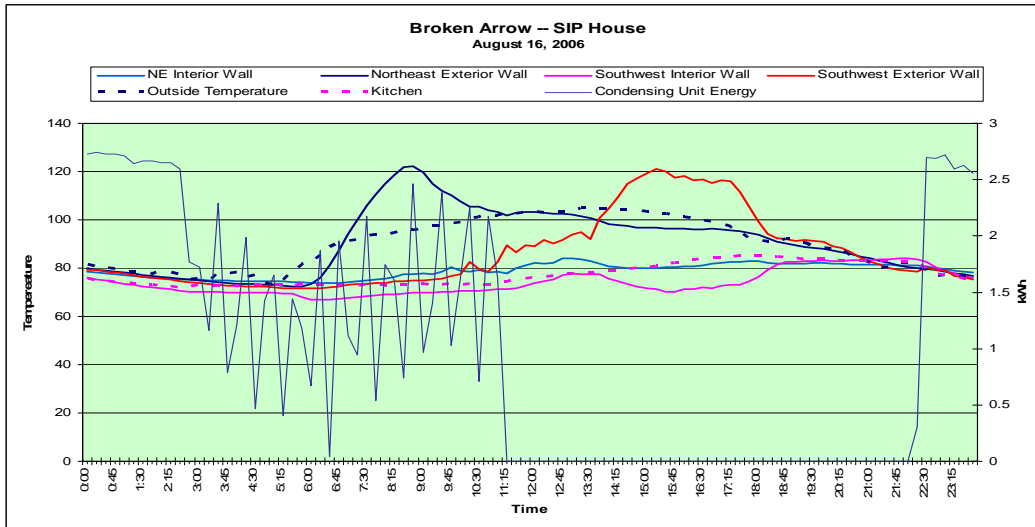
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Thank You

Questions?



Broken Arrow – SIP Wall, OASys + Conventional AC



Broken Arrow	Pre-Cooling	78° Set Point
Total Cooling Load (kWh)	23.31	22.52
On-Peak Load (kWh)	0.0	13.27
Off-Peak Load (kWh)	23.31	9.25
Peak Demand (kW)	2.74	3.61



Borrego Wall Systems - Pre-Cooling vs. Set Point Cooling

	Broken Arrow		Wagon/Country Club		East Star	
Scenario	Pre-Cooling	78° Setpoint	Pre-Cooling	78° Setpoint	Pre-Cooling	78° Setpoint
Wall System	SIP		T-MASS [®] ™		2 x 6 Wood Frame	
Cooling System	OASYS +Conventional AC		OASys + Conventional Ducted AC (14 SEER equivalent)		Lennox AC	
Total Cooling Load (kWh)	23.3055	22.5165	30.282	33.861	23.889	23.4675
On-Peak Load (kWh)	0.00	13.269	0.00	16.083	0.7335	13.914
Off-Peak Load (kWh)	23.3055	9.2475	30.28	17.778	23.1555	9.5535