

PNNL Lab Homes

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Welcome to the Lab Homes...

LAB HOMES

Demonstrating
tomorrow's
efficient and
smart technologies.



- ▶ Goal is to demonstrate an intelligent, responsive, energy efficient, and grid responsive home retrofit over a period of five to seven years which achieves 50% whole house energy savings.


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Lab Homes Partners

► Initial Partners

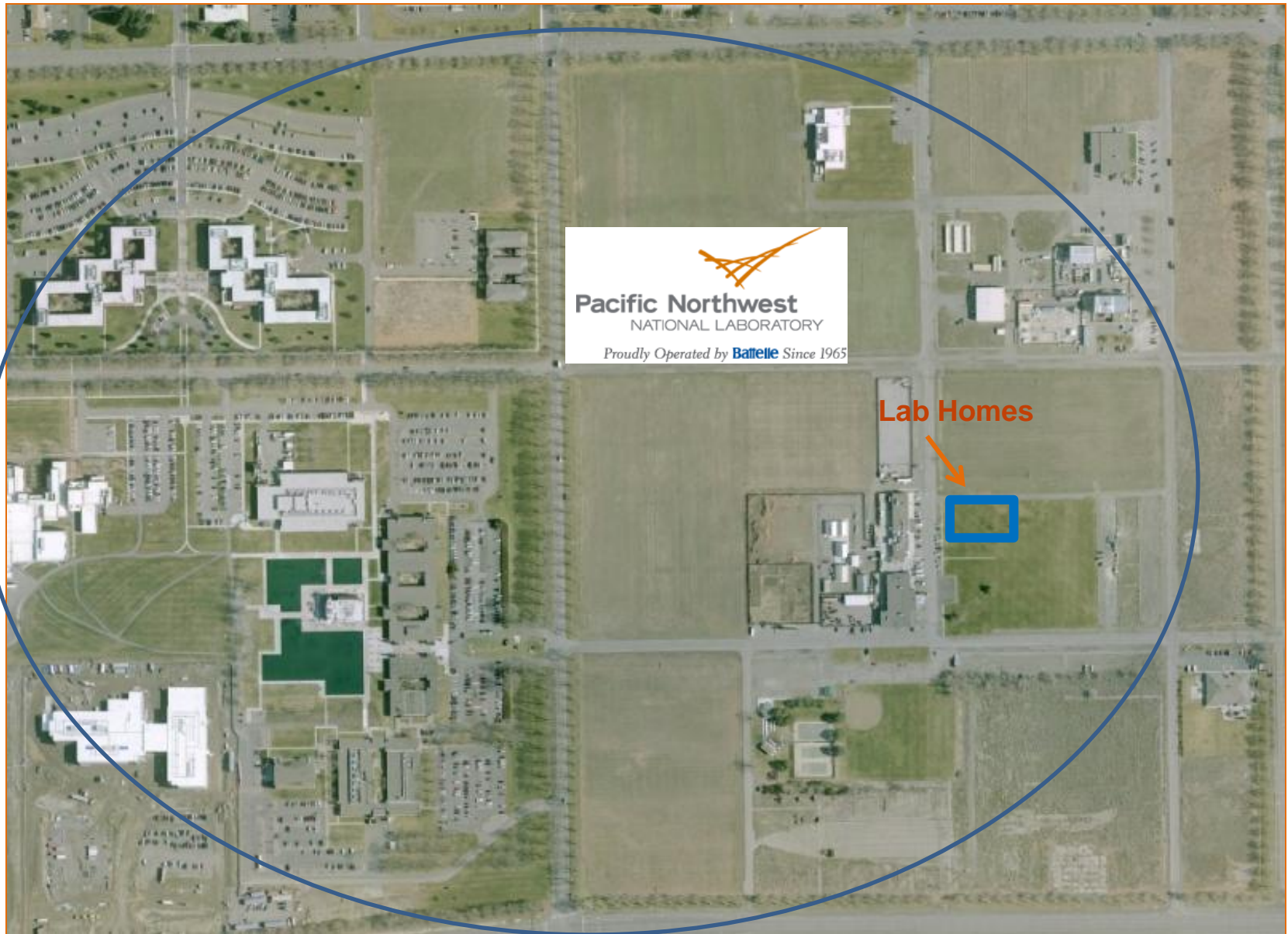
- DOE/BT/Building America-ARRA
- DOE/BT/Windows and Envelope R&D
- Bonneville Power Administration
- DOE/OE
- PNNL Facilities
- Tri Cities Research District
- City of Richland
- Northwest Energy Works
- WSU-Extension Energy Program
- Battelle Memorial Institute (made land available)

- Funding from Building America, DOE Windows and Envelope R&D and BPA secured for FY12 to investigate highly insulating (R5) windows performance.



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Sited Within the Tri-Cities Research District



Lab Homes Characteristics

► Specified to represent existing manufactured and stick-built housing

- 3 BR/2BA 1493 ft² double-wide factory-built to HUD code
- All-electric with 13 SEER/7.7 HSPF heat pump central HVAC + alternate Cadet fan wall heaters throughout
- R-22 floors, R-11 walls & R-22 ceiling with composition roof
- 195.7 ft² (13% of floor) window area
- Wood (Smartpanel) siding
- Incandescent lighting
- Bath, kitchen, whole house exhaust fans
- Carpet + vinyl flooring
- Refrigerator/range
- All electric



► Modifications include extensive metering and EV charging station



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Metering and Monitoring Characteristics

- ▶ Energy metering
 - 42 individually monitored breakers with $\frac{1}{2}$ controllable and whole house
 - Itron smart billing meter
- ▶ Temperature and relative humidity
 - 15 room temperature thermocouples
 - 22 interior and exterior glass surface temperature thermocouples
 - 2 room relative humidity sensors
 - 2 mean radiant temperature sensors
- ▶ Water and Environment
 - Controllable water flows at fixtures
 - Solar insolation (pyronometer) inside home
 - Weather station (Lab Home B only)
- ▶ Data collection via Campbell Scientific data loggers
 - 1 minute, 15 minute, and hourly

Per Home!

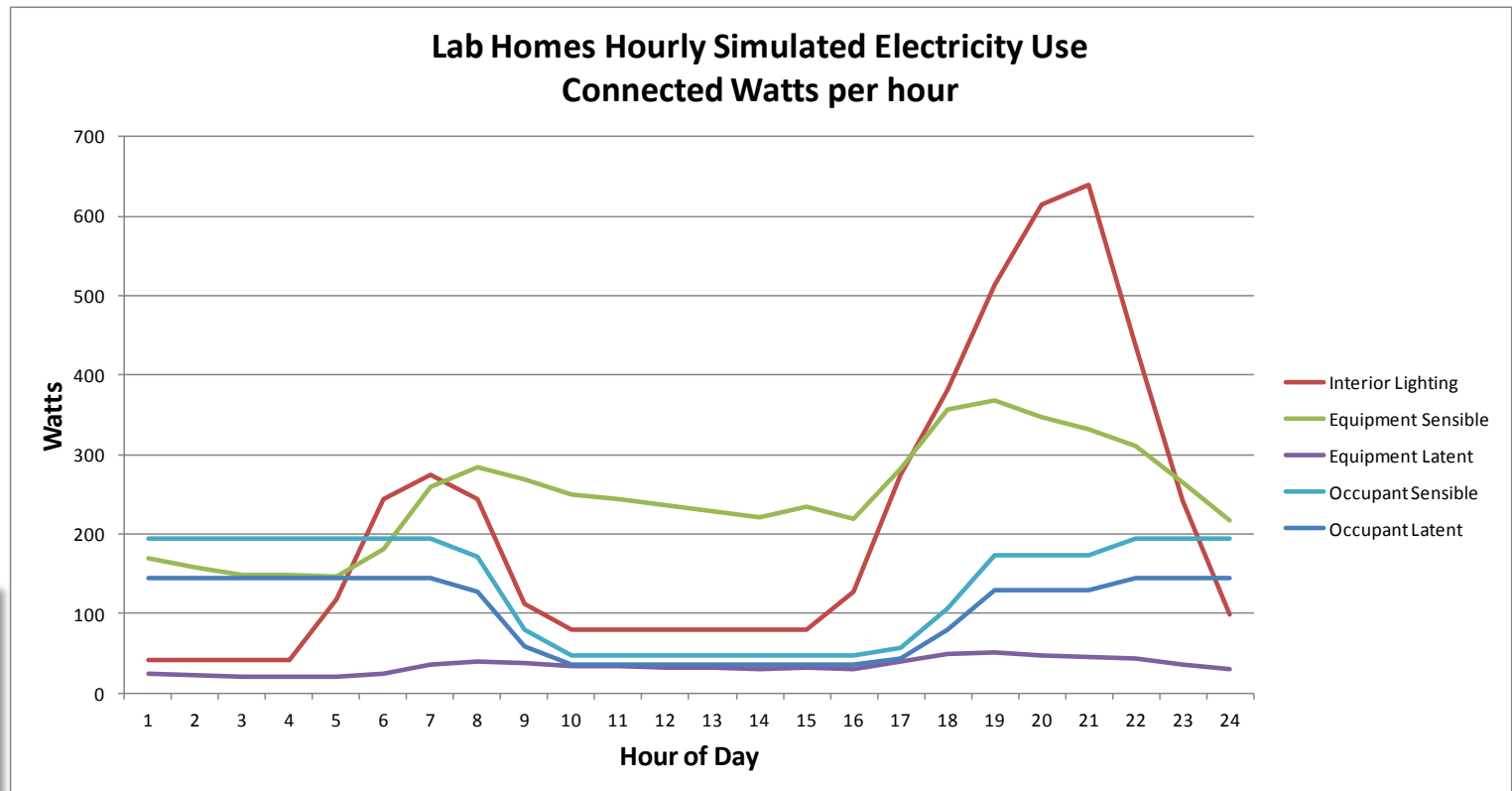


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Occupancy Simulation

- ▶ Simulation in accordance with Building America House Simulation Protocol (Hendron and Engebrecht, 2010)

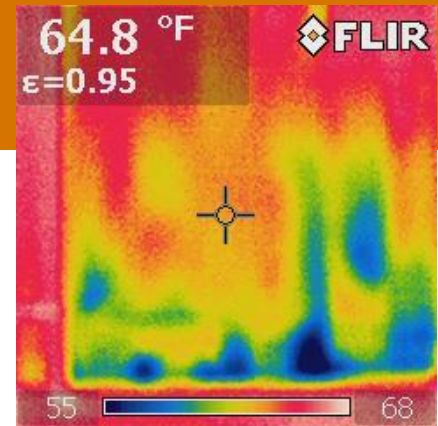


60W light simulating adult occupant

Null Testing

► Building construction comparison

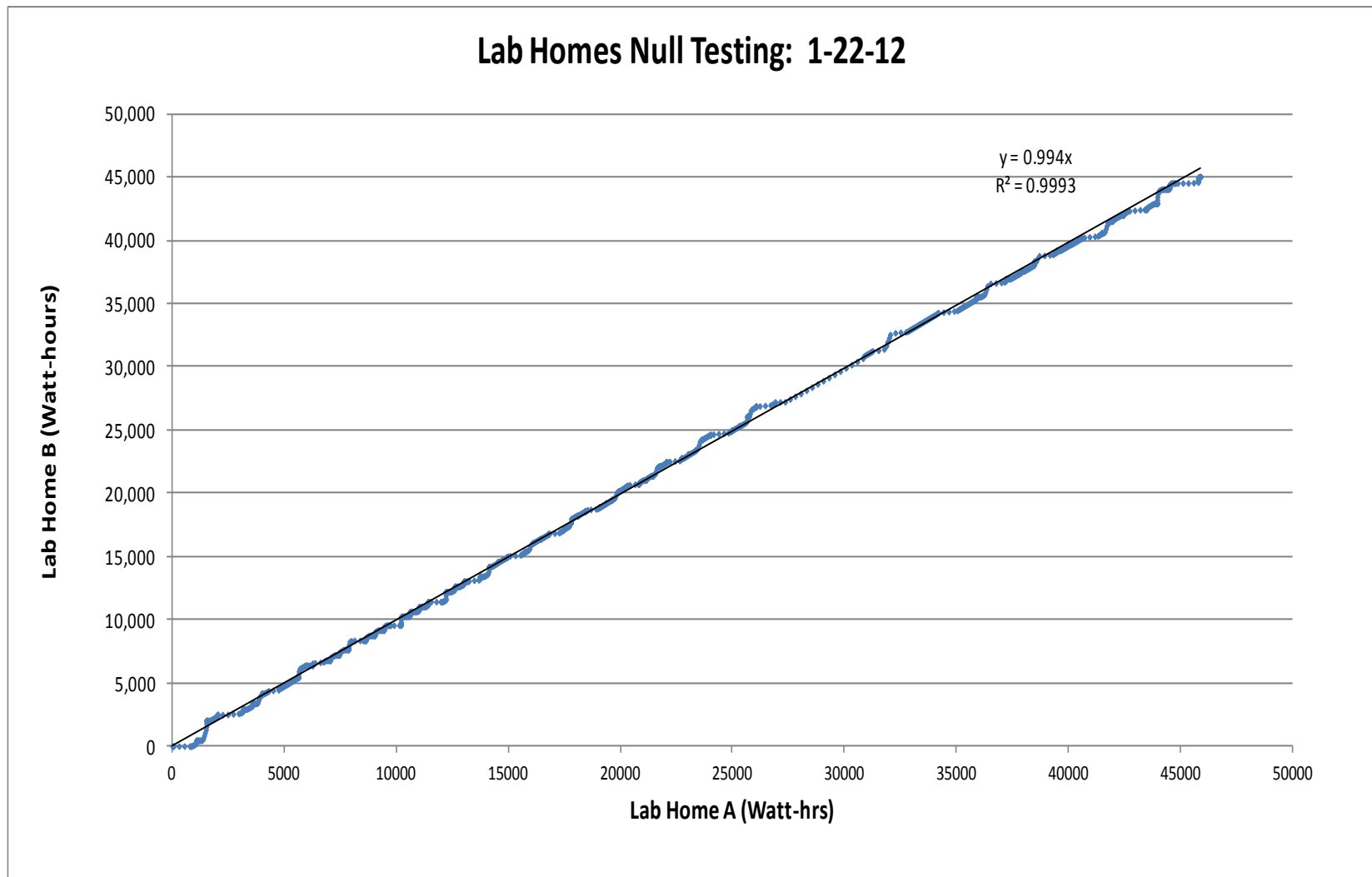
- Homes' air leakage (CFM air flow @50Pa) was within 6.2%
- Homes' duct leakage (CFM air flow @50Pa) was within 2%, similar distribution performance
- Heat pumps' performance similar ΔT across coil and air handler flow within 6%
- Ventilation fans' flows within 2.5%
- Thermal conductivity with IR camera shows settling of R-11 batt insulation in 2x6 wall cavity in both homes.



SUMMARY DATA				
	Baseline Home		Experimental Home	
	Average Value	+/- Error	Average Value	+/- Error
CFM@25	491.6	30.4	492.8	30.5
CFM@50	657.6	27.8	701.4	26.7
ACH50	3.16	0.13	3.38	0.13
ACH_n*	0.15	0.01	0.16	0.01
*n = 21.5, based on single story home in zone 3, minimal shielding				

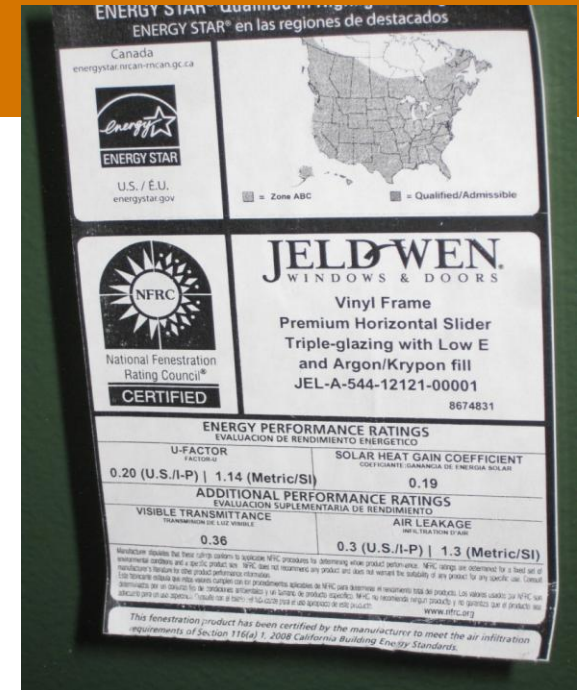
Null Testing

► Whole House energy consumption comparison



Current Experiment

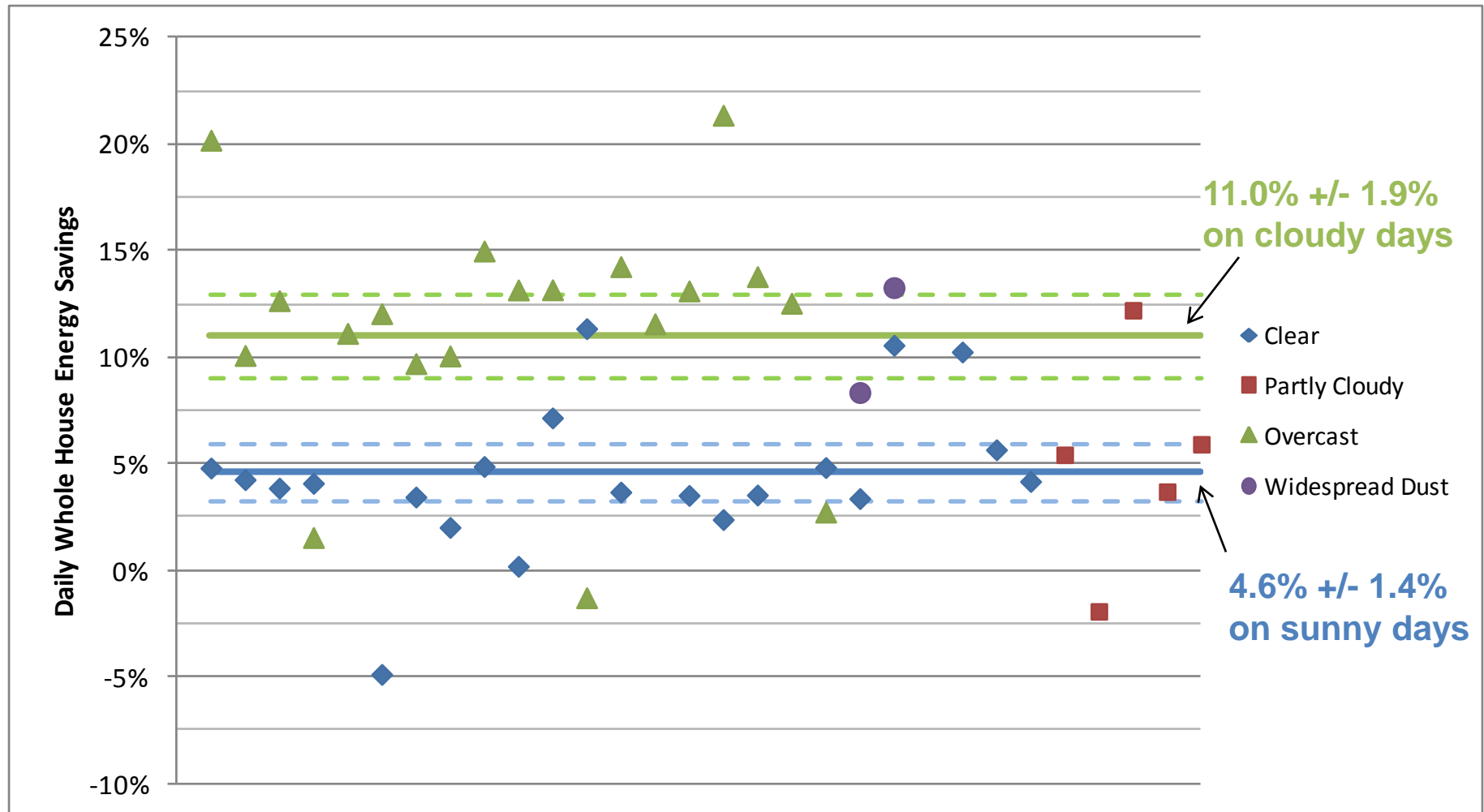
- ▶ Energy consumption and thermal comfort impact of highly insulating (R-5) windows
 - Jeld Wen triple pane, argon/krypton filled, vinyl frame, triple Low-e 366 coating on two inside panes
 - Compared to “typical” double pane, aluminum frame clear glass windows
 - No window treatments in either home



	Baseline Home Windows		Highly Insulating Windows	
	Windows	Patio Doors	Windows	Patio Doors
U-Value	0.68	0.66	0.2	0.2
SHGC	0.7	0.66	0.19	0.19
VT	0.73	0.71	0.36	0.37
AL	N/A	N/A	0.3	0.1

Heating Season Results

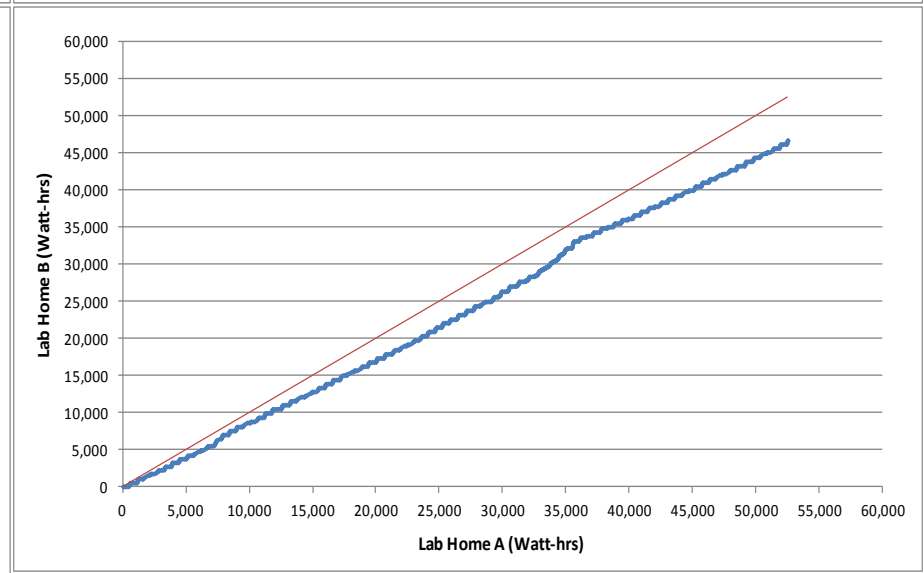
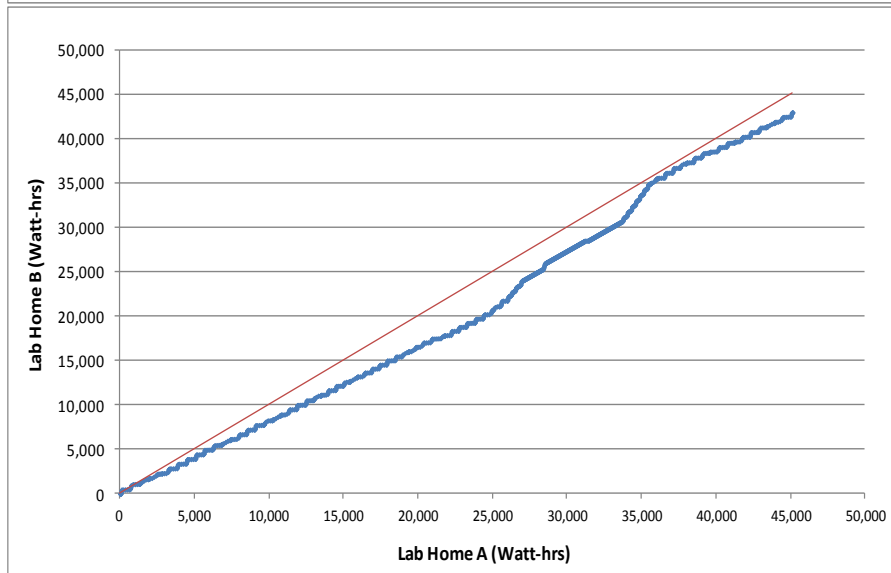
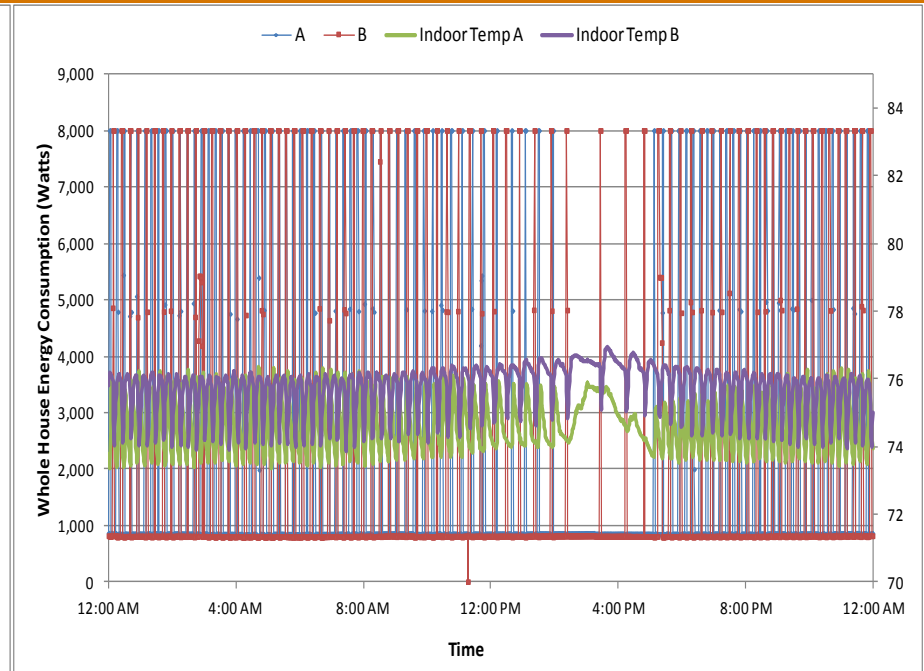
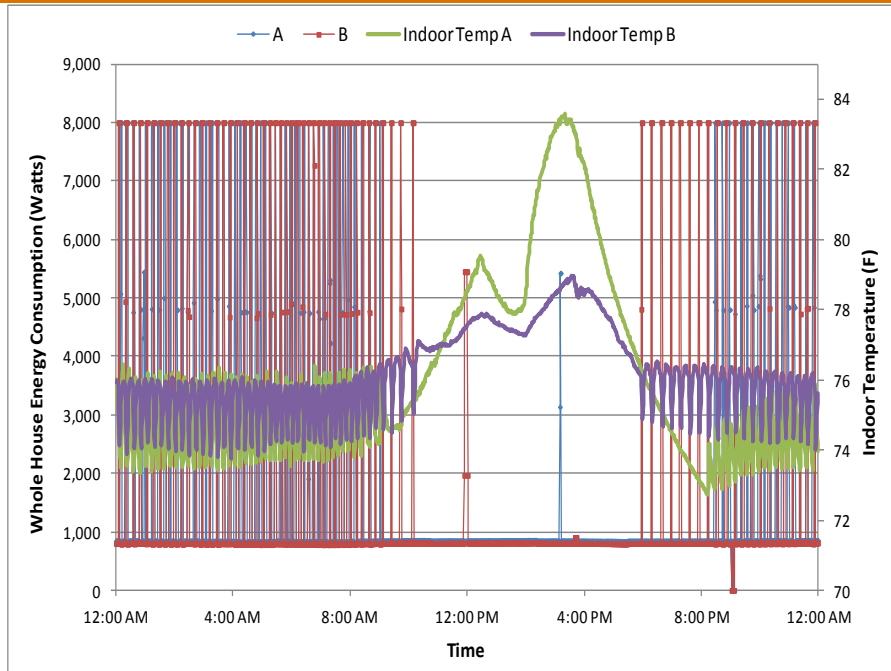
- ▶ Overall 7.6% +/- 1.9% heating season whole house savings
- Strong dependence on weather



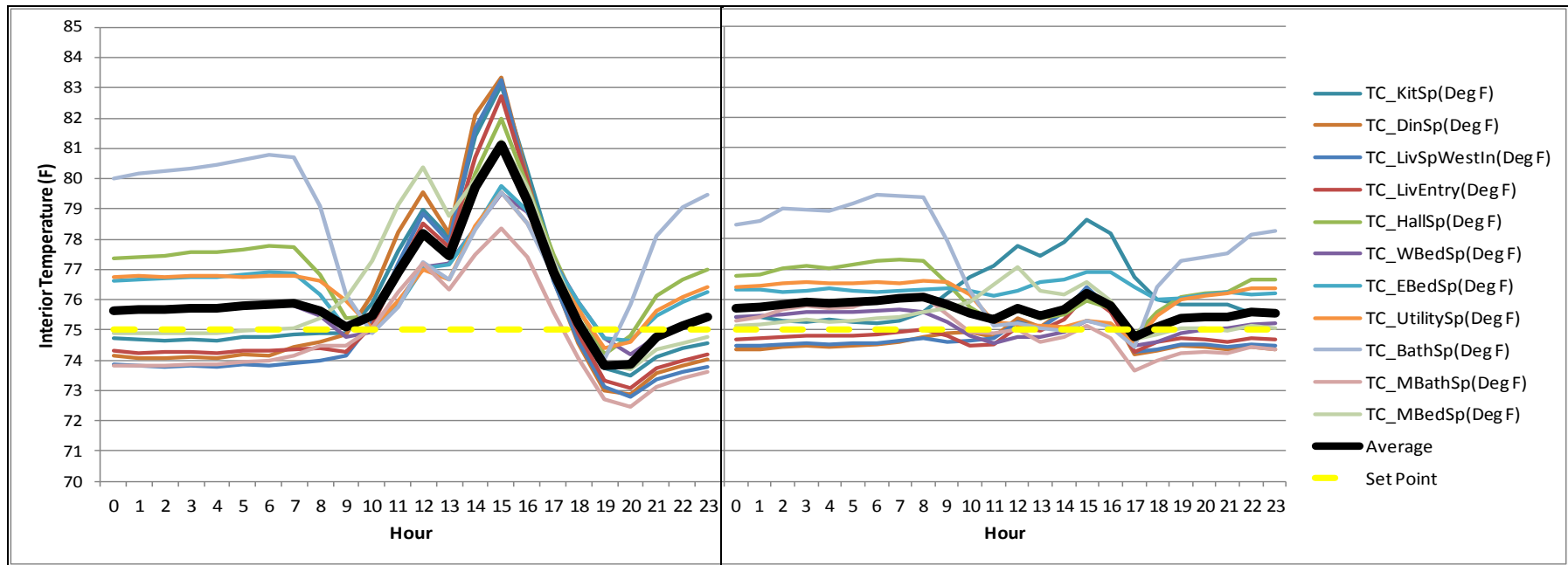
Sunny

vs.

Cloudy



Impact on thermal comfort



- ▶ Also examined window condensation potential and peak load impacts
- ▶ Results show significant energy savings and thermal comfort improvement
 - Also suggest R-5 windows will be very beneficial in summer cooling season due to low SHGC
- ▶ Heating season report to be finalized in June

Future Research Agenda

- ▶ Initial study is focused on thermal performance of highly insulating (R5) windows (FY11/12).
- ▶ Future planned research will evaluate grid-smart appliances & smart electric vehicle charging stations.
- ▶ Future potential research may include ducted heat pump water heater, low-e storm windows, efficient enclosures, innovative HVAC technologies, non-intrusive load monitoring, and solar-thermal/PV.



The “multiple (5) outdoor refrigerator” experiment



For more info....

► Visit our website (under development):

- <http://labhomes.pnnl.gov/>



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About Lab Homes

Welcome to the PNNL Lab Homes!

The Pacific Northwest National Laboratory "Lab Homes" project is the first of its kind in the Pacific Northwest region. PNNL has purchased two custom factory-built double-wide homes and set them up, side by side, on the PNNL campus to conduct energy



► Contact the research team:

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