

# Exterior Shades PNNL Lab Homes Study

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# PNNL Lab Homes Testing Platform in Richland, Washington

Lab Homes Characteristics

- Specified to represent existing manufactured and stick-built housing
- 3 BR/2BA, ~1500 ft<sup>2</sup>
- All-electric with 13 SEER/7.7 HSPF heat pump central HVAC
- R-22 floors, R-11 walls & R-22 ceiling with composition roof
- 195.7 ft<sup>2</sup> (13%) window area with doublepane clear glass aluminum-framed windows





# **Exterior Shades at PNNL Lab Homes**

### **Product Characteristics**

- 1% Openness
- Black Color
- Remote Control
- Wind Sensor



### **Installation at Lab Home**





## **Project Background**

- Past studies have shown the fenestration • load of lab homes is largely dependent on 3 Windows. Exterior shades were obtained for each window:
  - South Facing Slider Door
  - West Facing Slider Door
  - West Facing Window
- Interior Vinyl Shades were in "constant" use • for remaining 2 South Facing Windows (Both baseline and test lab home). Allows for study to focus assessment on Exterior Blinds in Dining and Living Room.



\*3 Windows – Focal Point of Study \*2 Remaining South Facing Windows

## **Experimental Plan: Interior Vinyl Shades vs. Exterior Shades**

**Baseline Lab Home** (Interior Vinyl Shading in Dining Room)

**Pacific** 

Northwest NATIONAL LABORATOR



Test Lab Home (Closed Exterior Shades)



#### Each home maintained at 75°F by identical **13 SEER Heat Pump**



# **Experimental Results: Interior Vinyl Shades vs. Exterior Shades**

Solar

**Average Daily Outdoor** 

- Experimental Results are shown as HVAC Energy ulletReduction (kWh) for Space Cooling at Lab Home with Exterior Shades
- Results are shown with respect to Average Outdoor ۲ Solar Irradiance (W/m<sup>2</sup>) and Average Outdoor Temperature (°F)
- Across experimental days, HVAC Energy Savings ulletranged from 0.7 to 2.7 kWh with Usage of Exterior Shades compared to Interior Vinyl Shades in **Baseline Home**
- Internal Loads not simulated in Lab Homes for  $\bullet$ Exterior Shades project. Existing Cooling Load resulted in energy savings ranging from 9% to 25%.

#### **HVAC Energy Reduction (kWh) for** Each Test Day with Exterior Shades





6



# **Experimental Results: Exterior Shades with Respect to Baseline Cases**

Savings (kWh)

Energy

HVAC

- Experimental Results are shown as HVAC Energy Reduction (kWh) for Space Cooling as a Function of Average Outdoor Solar Irradiance (W/m<sup>2</sup>)
- The two Baseline Cases are shown: Interior Vinyl Shading and No Shading
- Across experimental days, HVAC Energy Savings with Exterior Shades varied with respect to the **Present Outdoor Solar Irradiance**

#### **HVAC Energy Reduction (kWh) for** Each Test Day with Exterior Shades



Average Daily Outdoor Solar Irradiance (W/m<sup>2</sup>)

# 300



## **Exploring HVAC Savings of Exterior Shades with Respect to Other Shading Strategies**

Results are not directly comparable due to multiple experimental differences, but the data provides a point of reference for specific shading strategies.

		Range of Values from R	
	PNNL Lab Homes Setup	Outdoor Temperature (°F)	Solar Irradian (W/m²
Exterior Shades (2019)	<ul> <li>Exterior Shades: 3 Windows</li> <li>Vinyl Interior: 2 Windows</li> <li>No Internal Load Simulation</li> </ul>	71 – 76	120 – 2
Double-Cell Cellular (2017)	<ul> <li>Double-Cell Cellular: All Windows</li> <li>Internal Load Simulation</li> </ul>	72 – 80	NA





# **Experimental Results: Interior Vinyl Shades vs. Exterior Shades**

#### Mean Radiant Temperature in Dining Room

### Interior Window Surface: Dining Slider



Each home maintained at 75°F at Hallway Thermostat Location





# Exterior Shades vs. No Shading without HVAC Usage

- Experimental Results are shown for test day in which HVAC system was turned OFF in Lab Homes
- Baseline Lab Home consisted of No Shading compared to Exterior Shades in Test Lab Home
- Results provide a comparison of indoor temperature rise with and without shading
- Average Daily Outdoor Temperature on Test Day was 62°F



# utdoor Solar rradiance (W/m²)