# Wake of the Flood? Valuing Resilience Benefits of Energy Efficiency During Power Outages

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# Extreme conditions matter – what happens when the power goes out?

- In Texas, 200 people died as a result of Winter Storm Uri, mostly from lack of heat.
- More than half of homes in Texas's region are heated with electricity, with a combination of heat pumps and electric forced air furnaces.
- As we electrify heating, the human costs of grid failures go up, necessitating a higher level of grid reliability

# But what if we make homes more efficient?

A home that is better insulated maintains temperature better when the power is on and when the power is off.

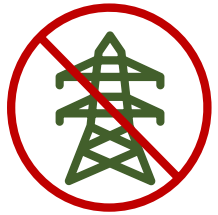
**Can we save lives by insulating homes? What is this worth?**

The Northwest Power and Conservation Council set out to quantify the value of energy efficiency during power outages.

# Building resilience is different than grid resilience.

**Building Resilience:** ability to withstand infrequent—but extreme— weather and electricity grid outage events, where buildings fail to keep people and property safe.

Resilience occurs within a home



Weather + Outage = No power to home

Resilience Pathways = Preserve property, health/safety

# We identified two main approaches to valuing building resilience.

## Direct Impact Valuation Approach

Estimate the change in costs from impacts incurred during resilience events (illness, loss of life, damage from broken pipes).

**Pros:** Easy to understand.

**Cons:** Hard to implement.

**Example: PNNL/NREL 2023 Study**

## Energy Valuation Approach

Estimate the effective energy saved by energy efficiency during a resilience event.

Multiply by energy value during those events.

**Pros:** Relatively straightforward to implement.

**Cons:** Not very direct.

**Example: Previous NW Resilience Valuation Approach.**

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APEX ANALYTICS

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# We modified our 5 step approach to valuing building resilience using energy valuation approach.

**During an outage, an inefficient home requires energy to maintain same temperature versus an efficient weatherized home.**

| | | |
|---|---|---|
|  Step 1 | **Define and Setup**: Define resilience events and build two extreme weather files spanning PNW. | Simplified weather to align with existing Larsen/Sharpe files. |
|  Step 2 | **Joint probability**: Estimate annual resilience event hours across weather bin and region. | Used Eagle-I data for last 10 years combined with real weather data. |
|  Step 3 | **Avoided Costs**: Estimate avoided cost of building resilience electricity. | Calculated avoided costs with both diesel and solar backup systems. |
|  Step 4 | **Building SIM**: Estimate building impacts by event length, weather bin, heating type, region, backup system type. | New process using REEDR for quickly modeling 100s of events. |
|  Step 5 | **Calculations**: Calculate annual resilience benefits for each segment, overall region. | Ran new measures across several NW regions. |

# How should we value energy savings during outages?

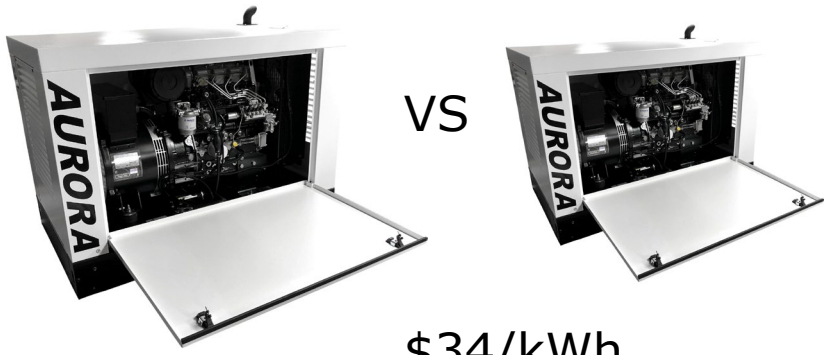
**We propose an avoided cost methodology, analogous to avoided costs for energy and peak demand.**

Define difference in cost of providing energy service between efficient case and baseline case.

**What's an avoided cost of energy during an outage?**

It's the difference in cost of ownership of a big backup system vs a smaller backup system divided by the difference in energy provided.

**Diesel Generator**



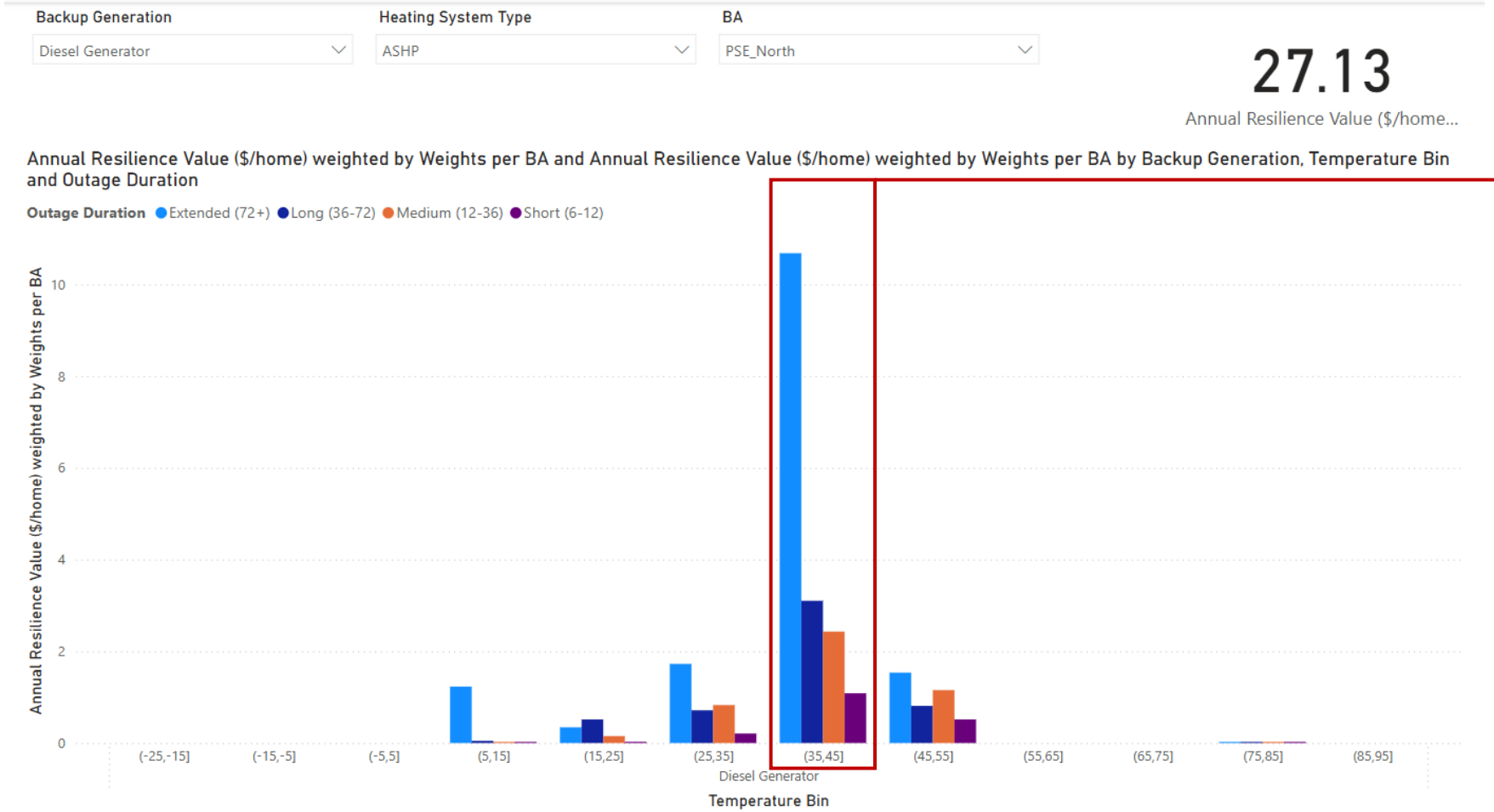

$34/kWh

**Solar and Storage**


$121/kWh

# Results: Most benefits occur during moderately cold winter weather, during longer outages.

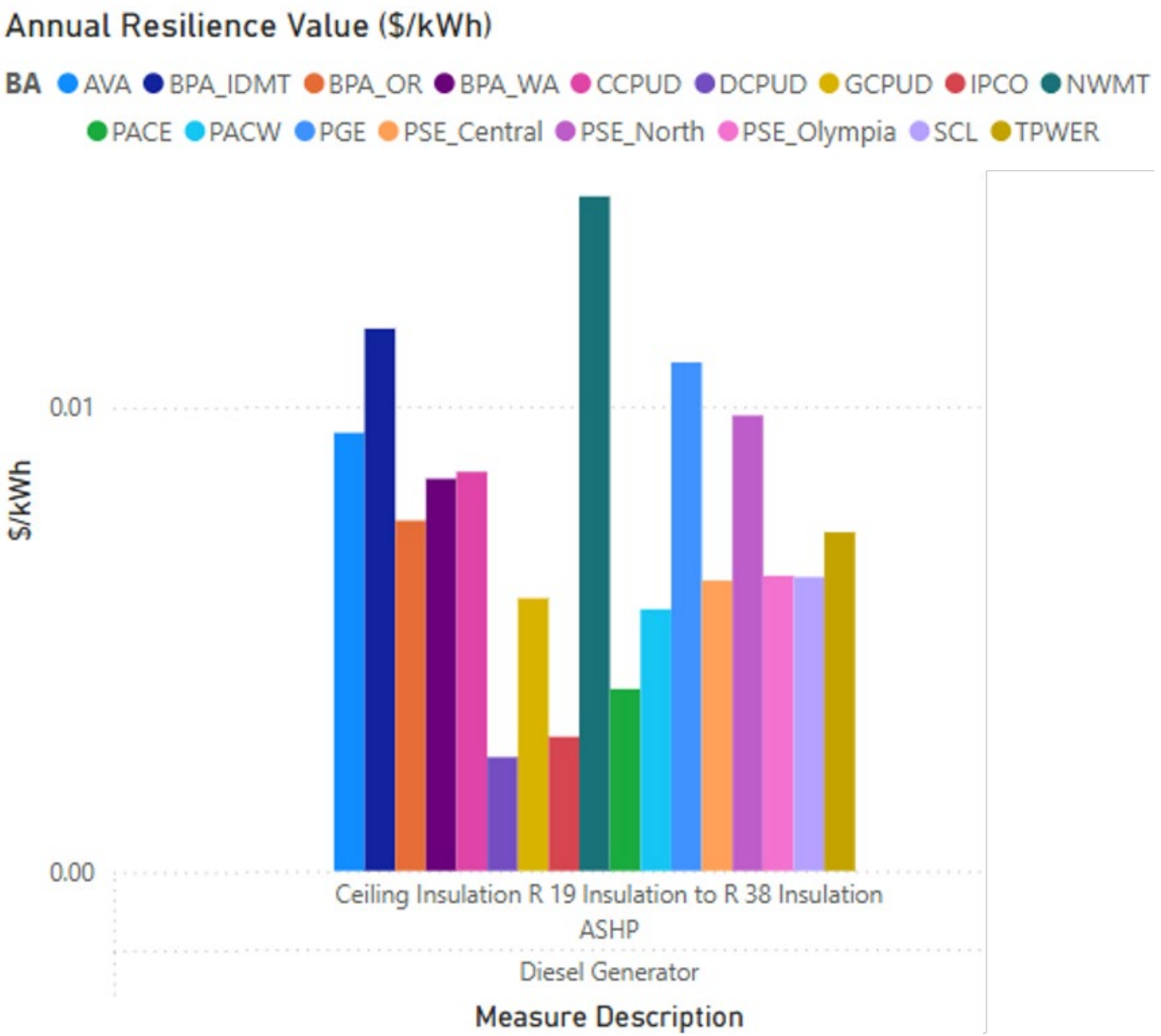
## Divide by annual electricity savings to get annual value of resilience.




- Largest electric savings occur during typical winter weather and extended and long-duration outages
- Very low summer-based resilience valuation (lack of outages + diurnal temp swings)
- Resilience valuation increases if home heats with electric furnace or decreases with natural gas

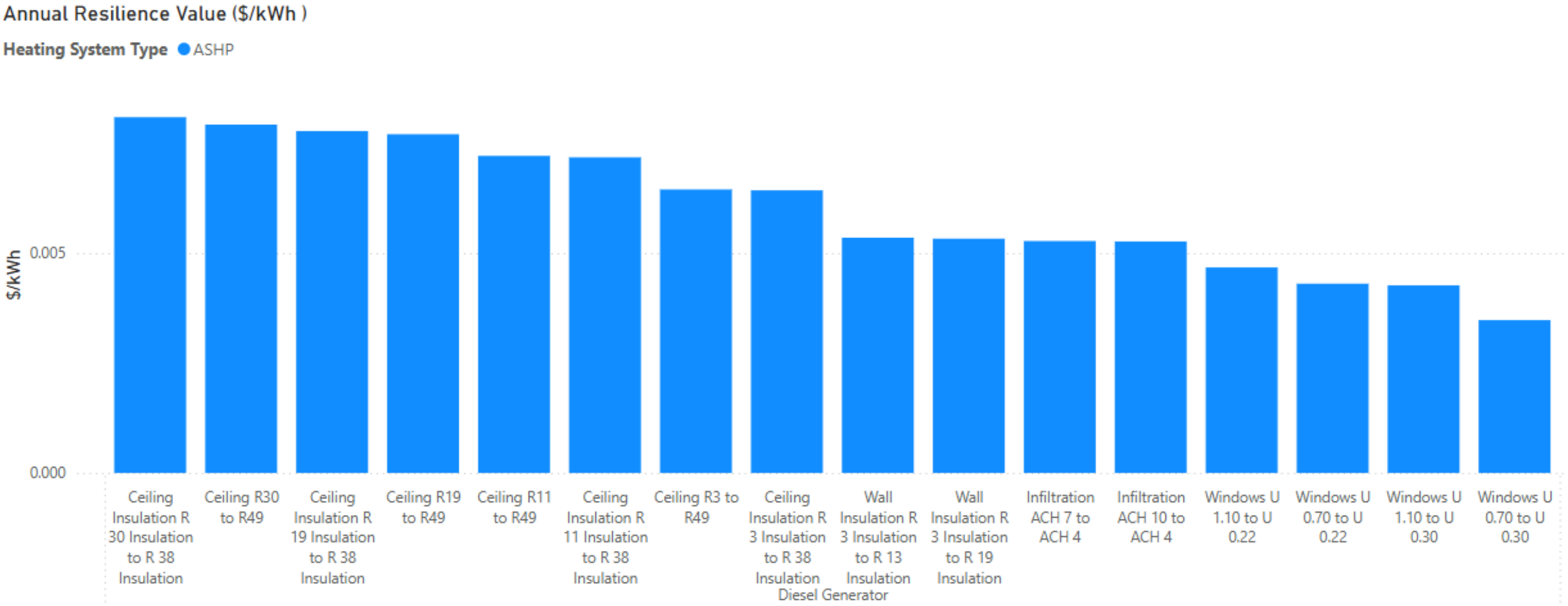
# Results: We see high variability across regions.

Variability across regions is driven by annual outage hours (and the temperature in which they occur), climate, and the relative frequency of outage durations (very short outages are excluded from benefits).



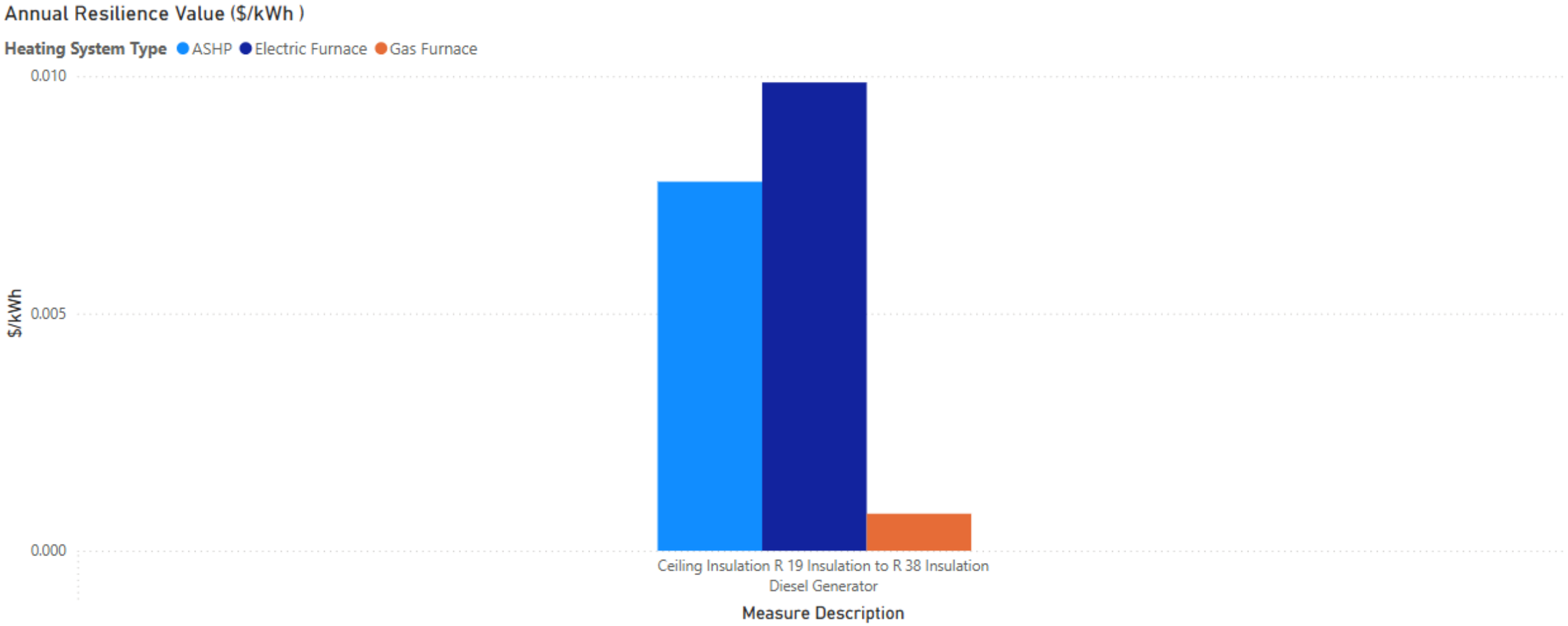
# Results: Variability across measures is low.

Across measures, higher savings measures provide higher resilience benefits ($/kWh); decreasing benefits across efficiency tiers within the same measure.



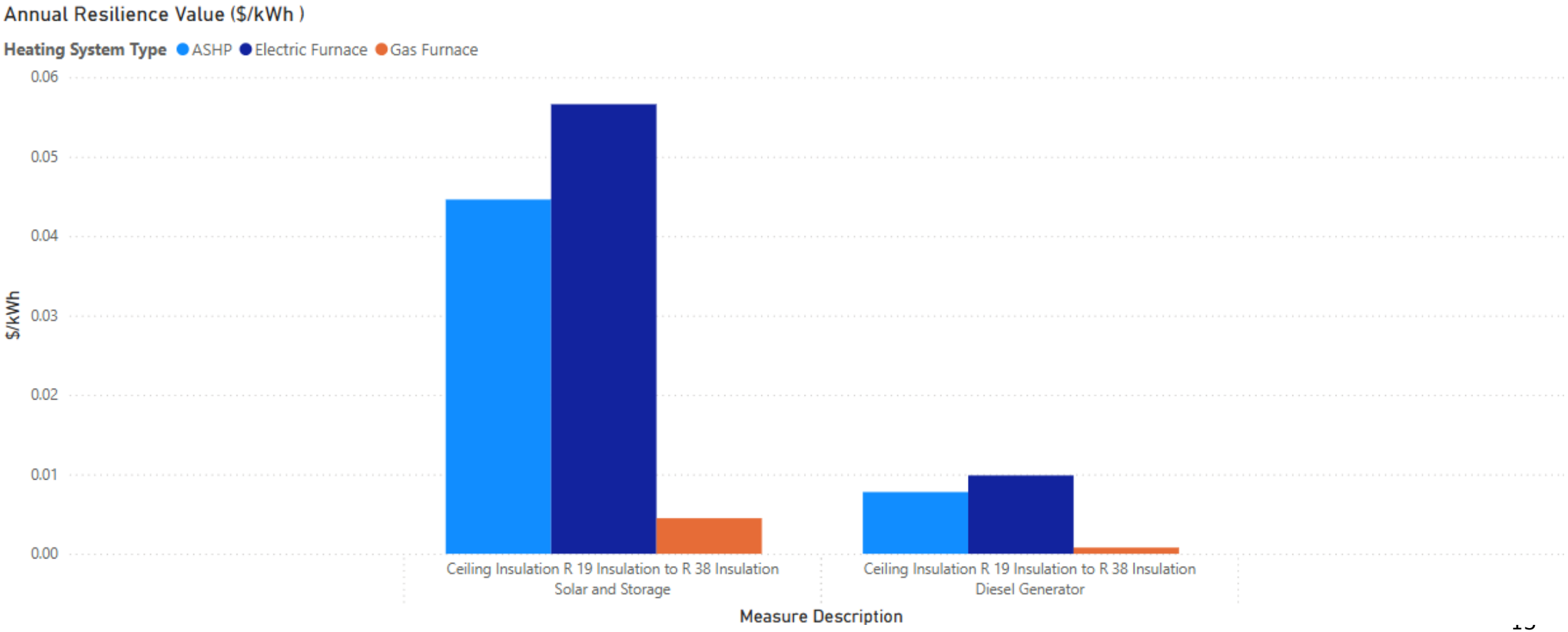
# Results: Electrically heated homes have higher value per annual kWh saved.

Gas heated homes require less electricity during a winter outage; resiliency benefits are significantly lower for gas furnaces relative to electric furnaces and ASHPs.



# Results: Solar and storage avoided costs lead to higher resilience value.

## Storage system cost (and resulting marginal abatement cost) translates to much higher resiliency values compared to a diesel generator.



# Conclusions

| | |
|---|---|
| Conclusion 1: | • Building resilience benefits of energy efficiency are real and can be quantified. |
| Conclusion 2: | • Most benefits occur during typical winter weather (at least adjacent to below-freezing temperatures). |
| Conclusion 3: | • Additional benefits are on the order of 0.5 to 5 cents/annual kWh saved. |

# Any Questions?

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