PRESENTERS

Justin Spencer

Lauren Gage

Valuing Building Efficiency Resiliency

$$= \sum_i Annual\ Expected\ Outage\ Hours_i * kWh\ Savings\ per\ Hour_i * Avoided\ Cost\ of\ Emergency\ kWh_i$$

Authors

Apex: Justin Spencer, Noah Lieb, Lauren Gage

NW Council: Annika Roberts, Laura Thomas, Tina Jayaweera

Step 1 — Define events & build climate zone weather files.

Boise, Idaho average temperature used for each outage event (45 events)

9 WEATHER SCENARIOS	5 OUTAGE DURATION EVENTS				
	Short: 6-12 hours (Daily high or low)	Medium: 12-36 hours (Daily average)	Long: 36-72 hours (3-day average)	Extended: 72+ hours (5-day average)	Extended Rolling Blackouts (5-day average)
Hottest Weather (1% annual occurrence)	111	94	91	90	90
Extremely Hot (10% annual occurrence)	108	91	88	87	87
Very Hot (90% annual occurrence)	99	84	81	79	79
Typical Summer	88	73	73	73	73
Mild Weather (average daily temperature 55-70)	75	65	65	65	65
Typical Winter	25	33	32	32	32
Very Cold (90% annual occurrence)	11	21	23	25	25
Extreme Cold (10% annual occurrence)	-12	-1	1	3	3
Coldest Weather (1% annual occurrence)	-25	-16	-13	-11	-11

Step 2 — Estimate annual event hours.

Event Name	Outage Allocation				
	Short: 6-12 hours	Medium: 12-36 hours	Long: 36-72 hours	Extended: 72+ hours	Extended Rolling Blackouts
Weather	Daily High or Low	Daily Average	(3-day average)	(5-day average)	(5-day average)
Hottest Weather (2% annual occurrence)	0.01	0.01	0.01	0.00	0.01
Extremely Hot (10% annual occurrence)	0.01	0.01	0.01	0.00	0.02
Very Hot (90% annual occurrence)	0.02	0.04	0.02	0.01	0.01
Typical Summer	0.08	0.12	0.05	0.04	-
Mild Weather (average daily temperature 55-70)	0.12	0.18	0.08	0.07	-
Typical Winter	0.39	0.59	0.27	0.22	-
Very Cold (90% annual occurrence)	0.08	0.12	0.05	0.04	0.02
Extreme Cold (10% annual occurrence)	0.04	0.06	0.03	0.02	0.11
Coldest Weather (2% annual occurrence)	0.04	0.06	0.03	0.02	0.04

Step 3 — Estimate avoided cost.

Step 3a: Δ *Generator Cost ($)* = $LargeSystem\ [Annual\ Cost] - SmallSystem\ [Annual\ Cost]$

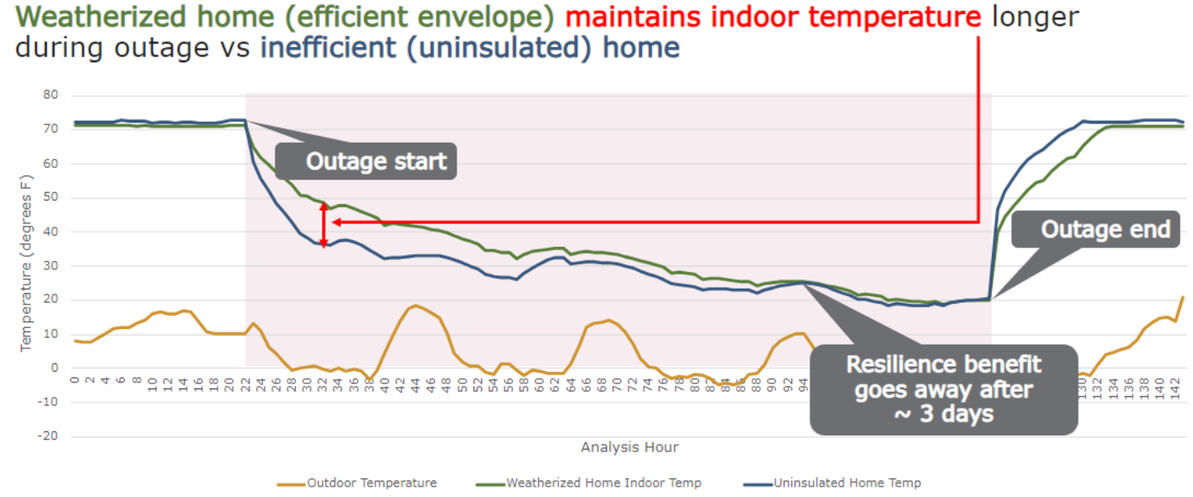
Annual cost includes capital, operating costs, and maintenance.

Step 3b: Δ *Annual Generator Use (kWh)* = $LargeSystem\ [Annual\ Outage\ Hours\ x\ Avg\ kW\ load\ during\ outage] - SmallSystem\ [Annual\ Outage\ Hours\ x\ Avg\ kW\ load\ during\ outage]$

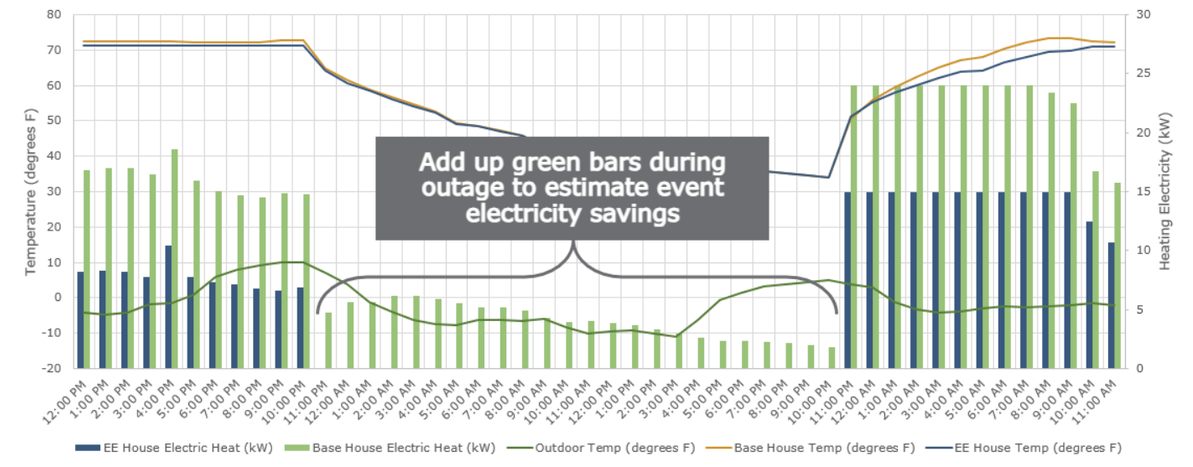
Step 3c: *Avoided cost ($/kWh)* = $\frac{\Delta Generator\ Cost\ (\$)}{\Delta\ Annual\ Generator\ Use\ (kWh)}$

Step 4 — Estimate building impacts by event.

Compare modeled indoor temperature during long duration outage during very cold weather



Electric energy required in inefficient home to maintain indoor temperature matching efficient (weatherized) home



Step 5 — Calculate annual resilience benefits.

For each event, estimate annual energy avoided and multiply by value of avoided energy.

Annual event value ($) = $Marginal\ avoided\ cost\ (\frac{\$}{avoided\ resilient\ kWh}) * Event\ hours/year * resilience\ savings\ /\ hour\ (kW))$

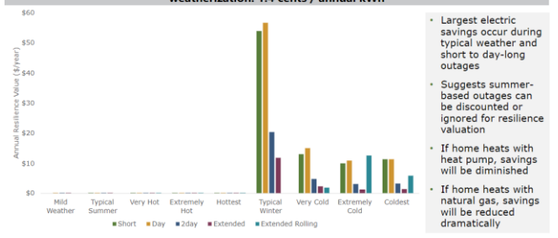
The total annual resilience value is the sum of all annual event values.

Total annual resilience value($) = $\Sigma(Annual\ event\ values)$

Resilience also represented as ratio of annual resilience value relative to energy saved

Resilience value per annual kWh saved ($/kWh) = $Total\ value\ /\ annual\ kWh\ saved$

Divide by annual electricity savings value to get total annual value of resilience for weatherization: 1.4 cents / annual kWh



- Largest electric savings occur during typical weather and short to day-long outages
- Suggests summer-based outages can be discounted or ignored for resilience valuation
- If home heats with heat pump, savings will be diminished
- If home heats with natural gas, savings will be reduced dramatically

Link to Study Webpage

Link to Resilience Valuation Tool