National Renewable Energy Laboratory
Innovation for Our Energy Future

Breakeven Cost for Residential Photovoltaics in the United States: Key Drivers and Sensitivities (Report Summary)

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Outline

- Introduction
- Methodology
- Results: Near-term residential breakeven costs
- Results: Future Market Sensitivities of Breakeven Costs (2015)
- Conclusions

Introduction

- Objective: To provide an analysis of PV breakeven costs for residential customers in the United States for 2009 and 2015, including evaluation of some of the key drivers of PV breakeven both regionally and over time.
- Defining "breakeven cost": The point where the cost of PV-generated electricity equals the cost of electricity purchased from the grid.
- Caveats:
  - Focus of analysis is on overall trends and sensitivities, in order to evaluate the economic performance of an individual PV system a different/more detailed analysis would need to be carried out.
  - Breakeven does not equal market potential or guarantee market adoption for rooftop PV, in other words, we do not present a depth of market analysis.

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Breakeven Cost - Definitions

- We define the breakeven cost of PV as the point at which the net present cost (NPC) of the PV system equals the net present benefit (NPB) realized to its owner.
- The NPC is the cumulative discounted cost of the system, including initial cost, financing, tax impacts, incentives, and operation and maintenance (O&M), equal to the sum of the cost in each year multiplied by the discount factor in that year.
- The NPB is the discounted cumulative benefits of reduced electricity bills over the evaluated period or the sum of the benefits in each year multiplied by the discount factor.

Breakeven Cost - Calculation

- The breakeven cost for PV was calculated for the top 1,000 utilities in the United States, which represent about 95% of the total residential load.
- We evaluated both the breakeven cost ($/W) and the breakeven electricity price (cents/kWh).
- The breakeven system cost was calculated by iteratively varying the price of PV until the NPC equaled the NPB. Alternately, the breakeven electricity price was calculated by iteratively varying the cost of electricity until the NPB equaled the NPC.

Rates – EIA and Utility Specific Data

- Form EIA-861 data was used to determine the average cost of electricity to residential customers for each utility in 2007. We scaled each utility to 2008 values using the state average value for 2008 derived from the EIA.
- To establish the relative difference in value between the annual average cost of electricity for each utility and the actual value of PV, we used information from current (late 2008 to early 2009) tariff sheets for the largest utility in each state.
- The relative difference established a scale factor, accounting for the relative change in value associated with the actual tariff structure as well as removing fixed billing components. This scale factor was then applied to the remaining utilities in each state.

Incentives

- 30% Federal Investment Tax Credit (ITC)
- State, local, and utility incentives were derived from the DSIRE database representing incentives that were applicable as of May 21, 2009.
- Tax credits were applied at the end of year 1 in the NPC calculation.
- Exemption from sales and property tax.
- Assumed rebates are paid to the installer, rather than the homeowner, which effectively reduces the installation price to the homeowner and the basis for the federal ITC.

Base Case Assumptions

- Home-equity type loan (tax deductible interest)
- 28% marginal federal tax rate
- 20% down payment
- Real interest rate and discount rate of 5%
- 30 year loan term and evaluation period
- 30% federal investment tax credit (ITC)
- Apply existing state, local, and utility incentives
- 0.5% annual electricity price escalation (real)
- Installed cost in 2008 is $8/W
- Inverter replacement at 10 and 20 years
- South facing, 25 tilt PV system with a 77% derate factor and 0.5% annual degradation in output

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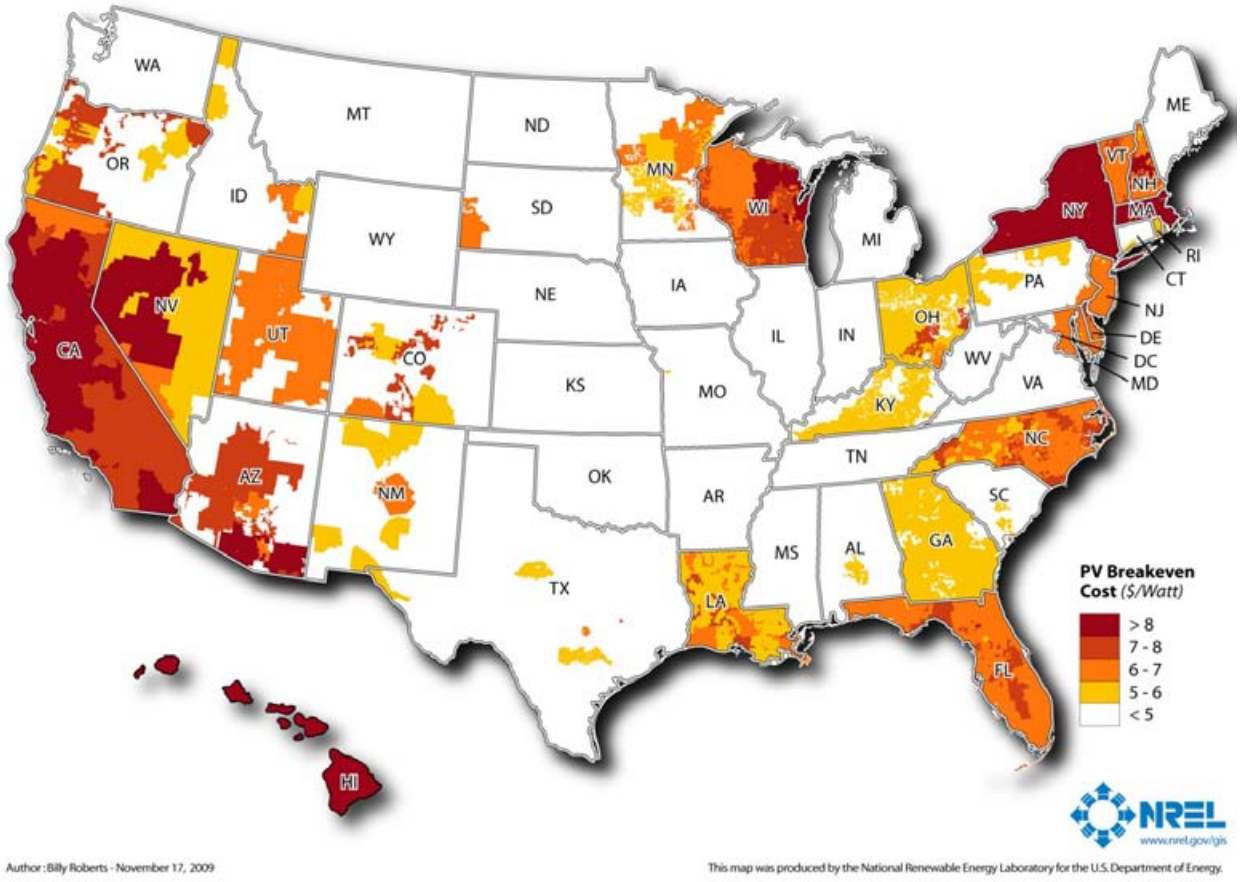
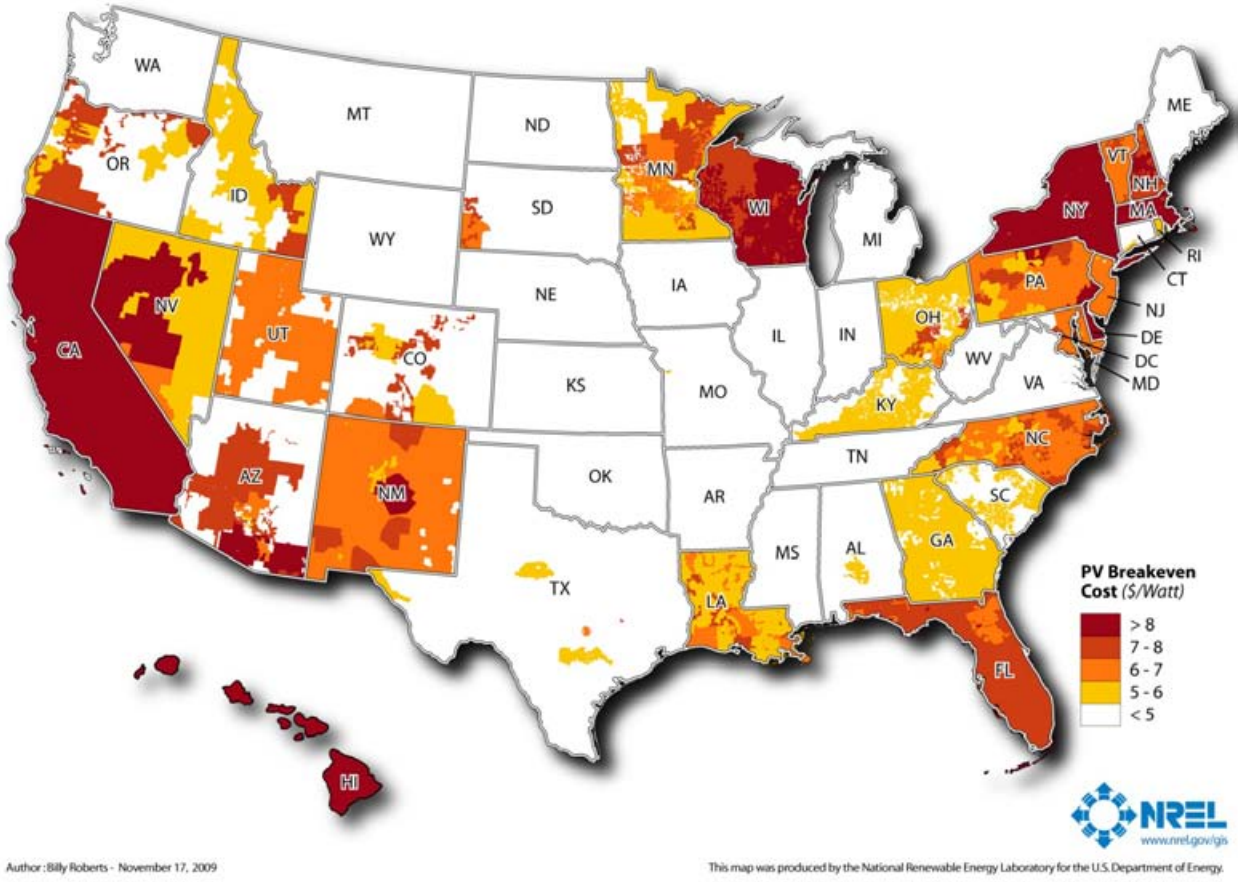
PV breakeven cost ($/W) in 2008 with base rate structure



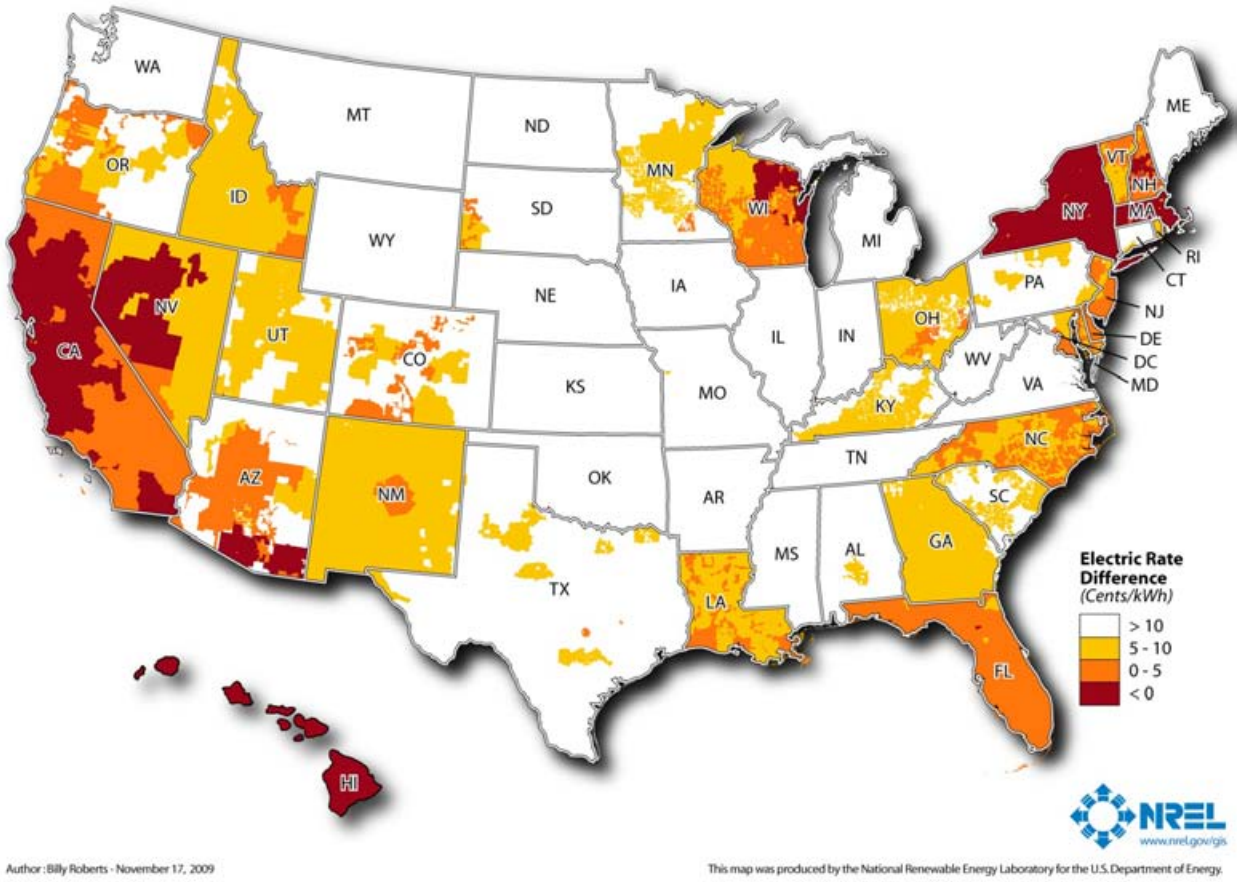
- Percentages represent portions of the load in which breakeven conditions may exist under our assumptions.
- 11% of residential electricity sales for $8/W or more.
- 42% of sales $6/W or more.
- 57% of sales $5/W or more.

PV breakeven cost ($/W) in 2008 with time-of-use rate structure



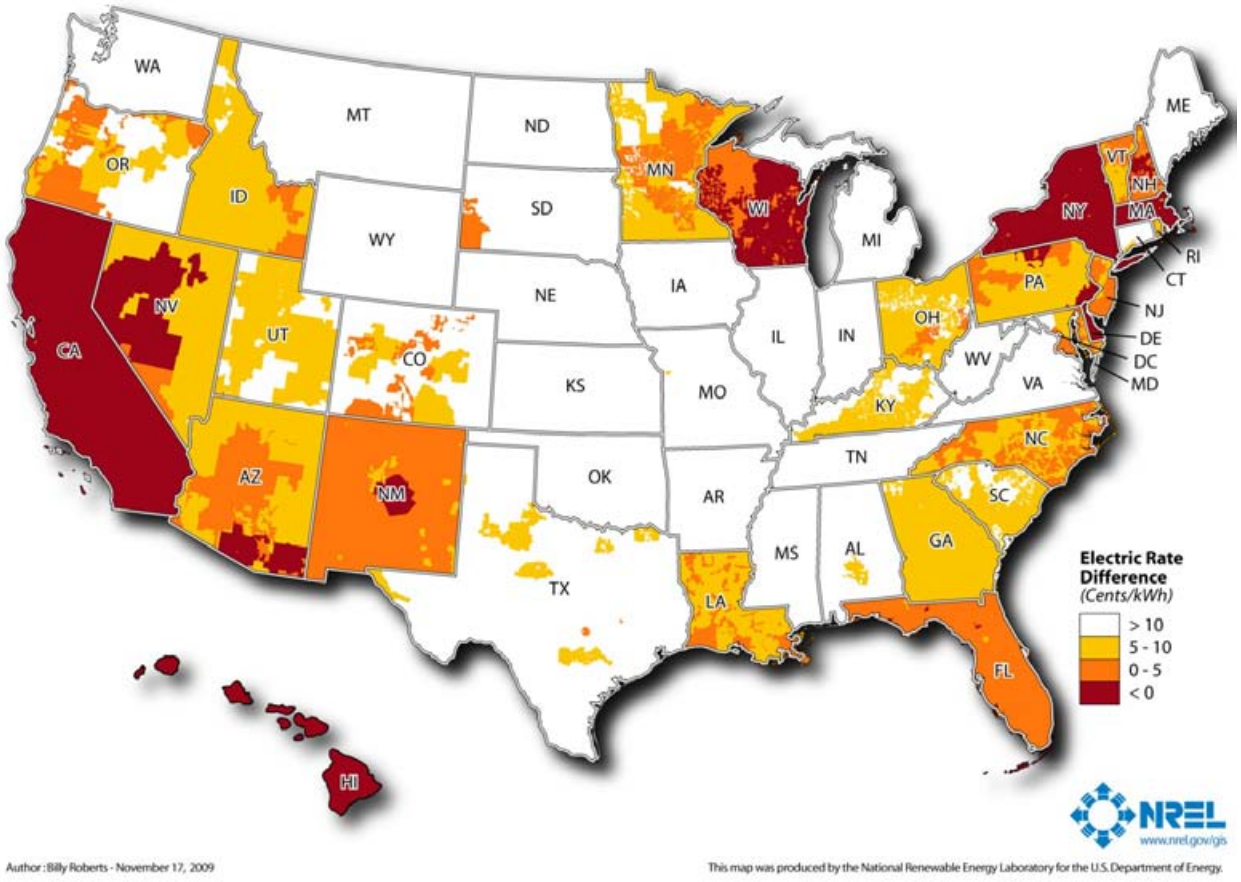
- Percentages represent portions of the load in which breakeven conditions may exist under our assumptions.
- 19% of residential electricity sales $8/W or more.
- 45% of sales $6/W or more.
- 61% of sales $5/W or more.

Increase in electricity prices (Cents/kWh) required for $8/W breakeven using base rate structure in 2008



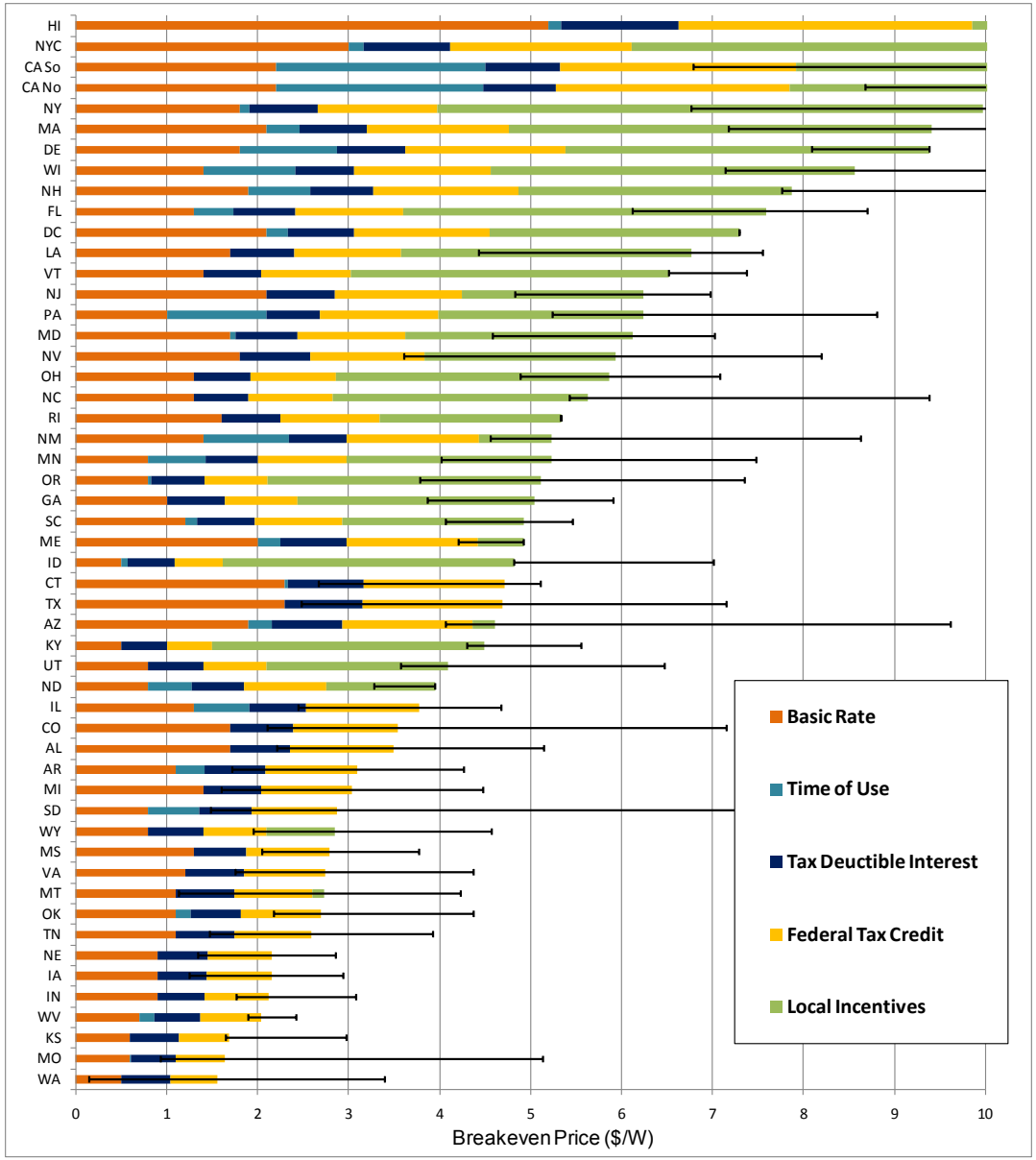
- Percentages represent portions of the load in which breakeven conditions may exist under our assumptions.
- 36% of residential electricity sales with 5 cent increase.
- 59% of sales with 10 cent increase.
- 11% of sales with no change.

Increase in electricity prices (Cents/kWh) required for $8/W breakeven using time-of-use rate structure in 2008



- Percentages represent portions of the load in which breakeven conditions may exist under our assumptions.
- 39% of residential electricity sales with 5 cent increase.
- 63% of sales with 10 cent increase.
- 19% of sales with no change.

Breakeven Range and Components by state



- The bars illustrate the breakeven value for the largest utility in each state by major cost component.
- The error bars show the variability in breakeven across utilities within a given state.
- The most attractive utilities tend to be significantly smaller than the largest utility.
- Without incentives or the ITC, half of the largest utilities in each state have a breakeven that is less than $2/W.
- “NYC” includes both New York City and Long Island, and California is split into northern and southern regions.

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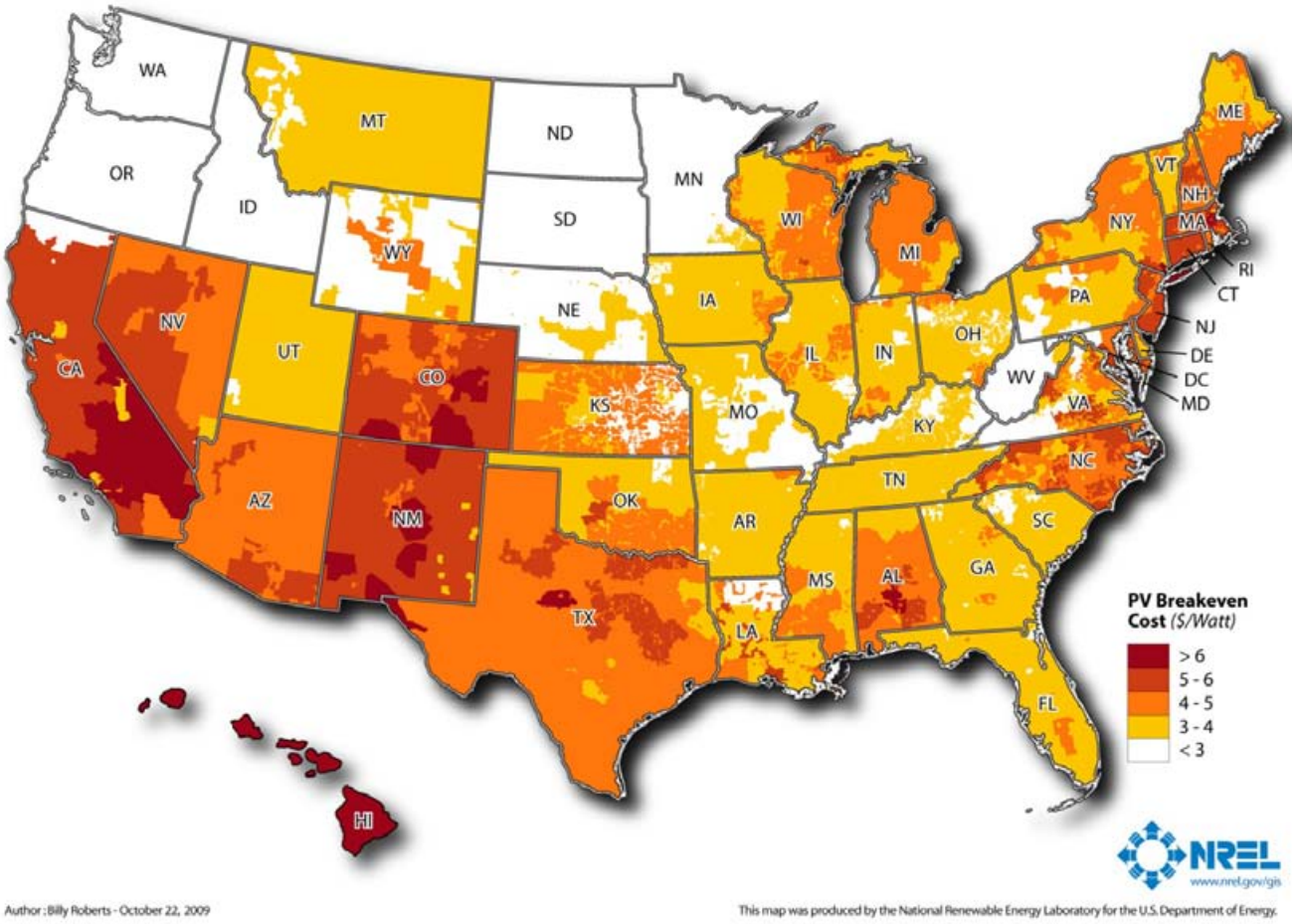
Future Base Case and Sensitivities

Base Case		Finance		Technical		Electricity		Policy	
		Low	High	Low	High	Low	High	Low	High
Down Payment	20%	Base	0%	base		base		base	
Fed Tax Bracket	28%	20%	35%						
discount rate	5%	7%	4%						
Int Rate	5%	7%	4%						
Loan Type	30yr home equity	15 yr home	base						
Eval Period	30 yrs	25yr							
Solar Resource Location	Largest Utility	base		lowest	highest				
Orientation	S - 25deg - fixed			Flat	base				
Derate	82%			82%	86%				
O&M	Solar Program Goals			EIA	Base				
Rate Type	Basic			base		base	TOU		
Electricity Price Escalation	0.5% per year					0%	1.5%		
Electric Cost Location	Largest Utility					lowest	highest		
CO2 cost	$25/ton					base		0	$50/ton
Incentives	Federal ITC							0	Base
Net Metering	Full Retail Net Metering					avoided cost	base	Base	

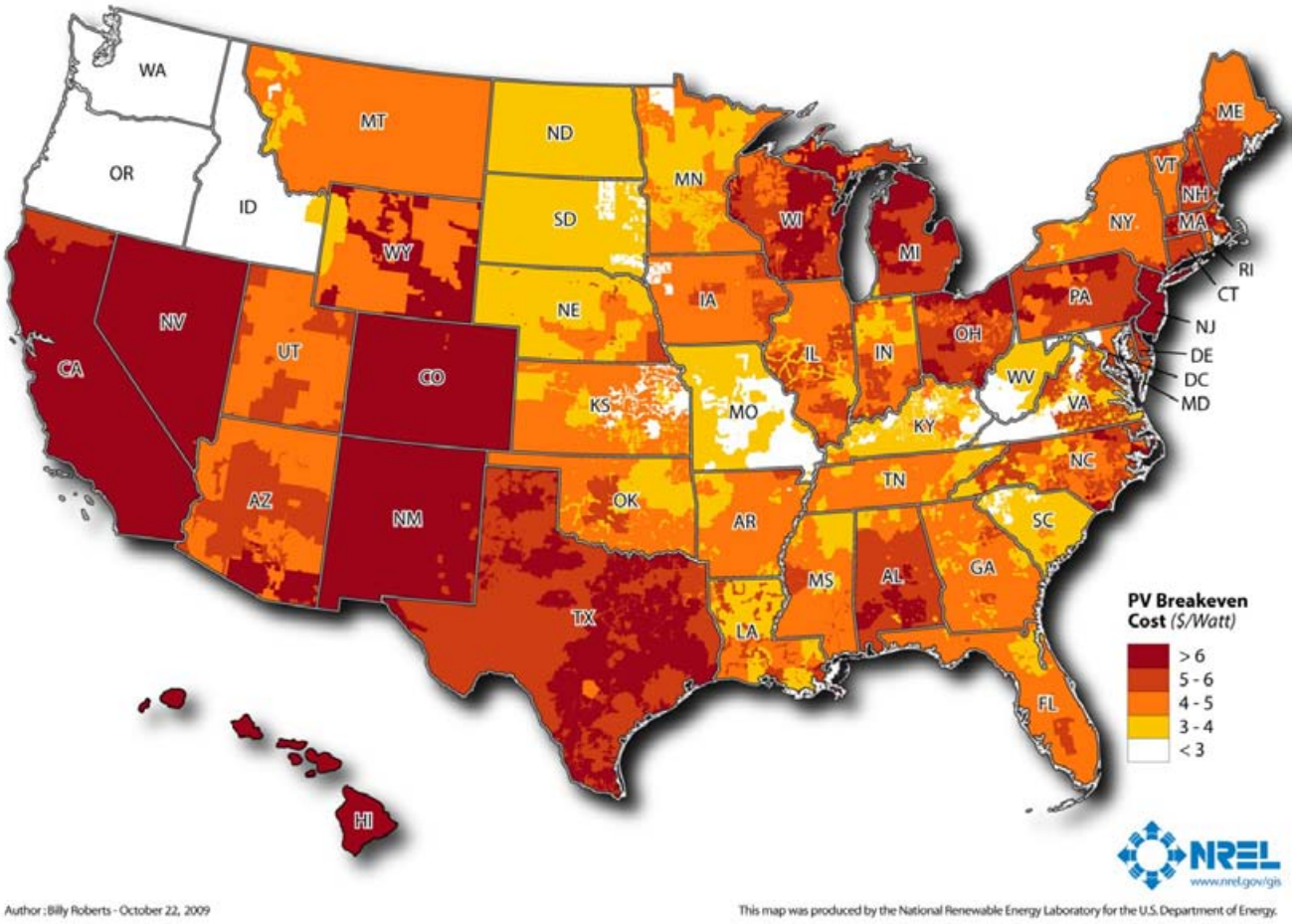
- We evaluated the sensitivity of breakeven cost in 2015 to four major drivers: technical performance, financing parameters, electricity prices and rates, and policies.

PV breakeven cost ($/W) in 2015 with base rate structure



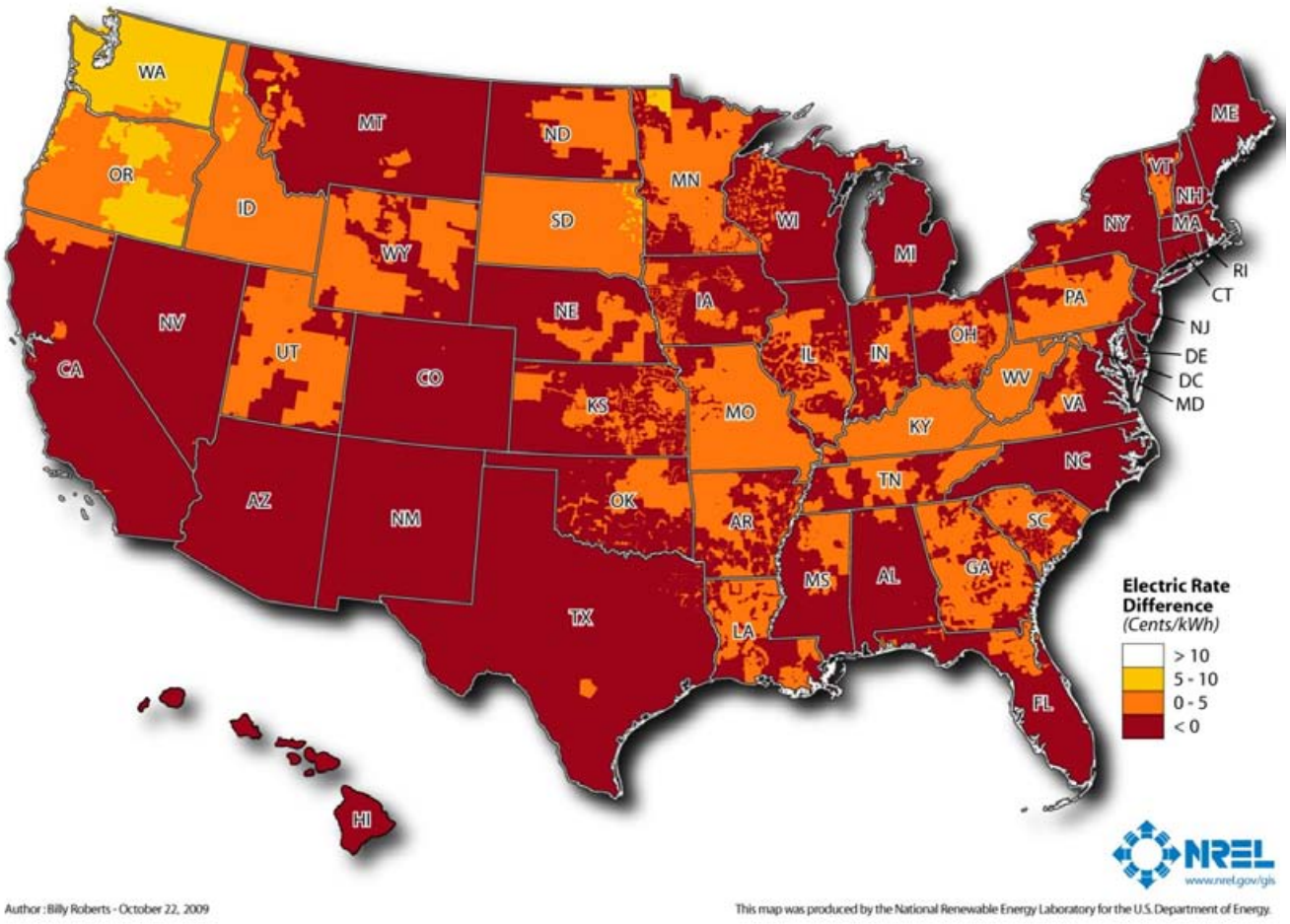
- Percentages represent portions of the load in which breakeven conditions may exist under our assumptions.
- 23% of residential electricity sales $5/W or more.
- 43% of sales $4/W or more.
- 85% of sales $3/W or more.

PV breakeven cost ($/W) in 2015 with time-of-use rate structure



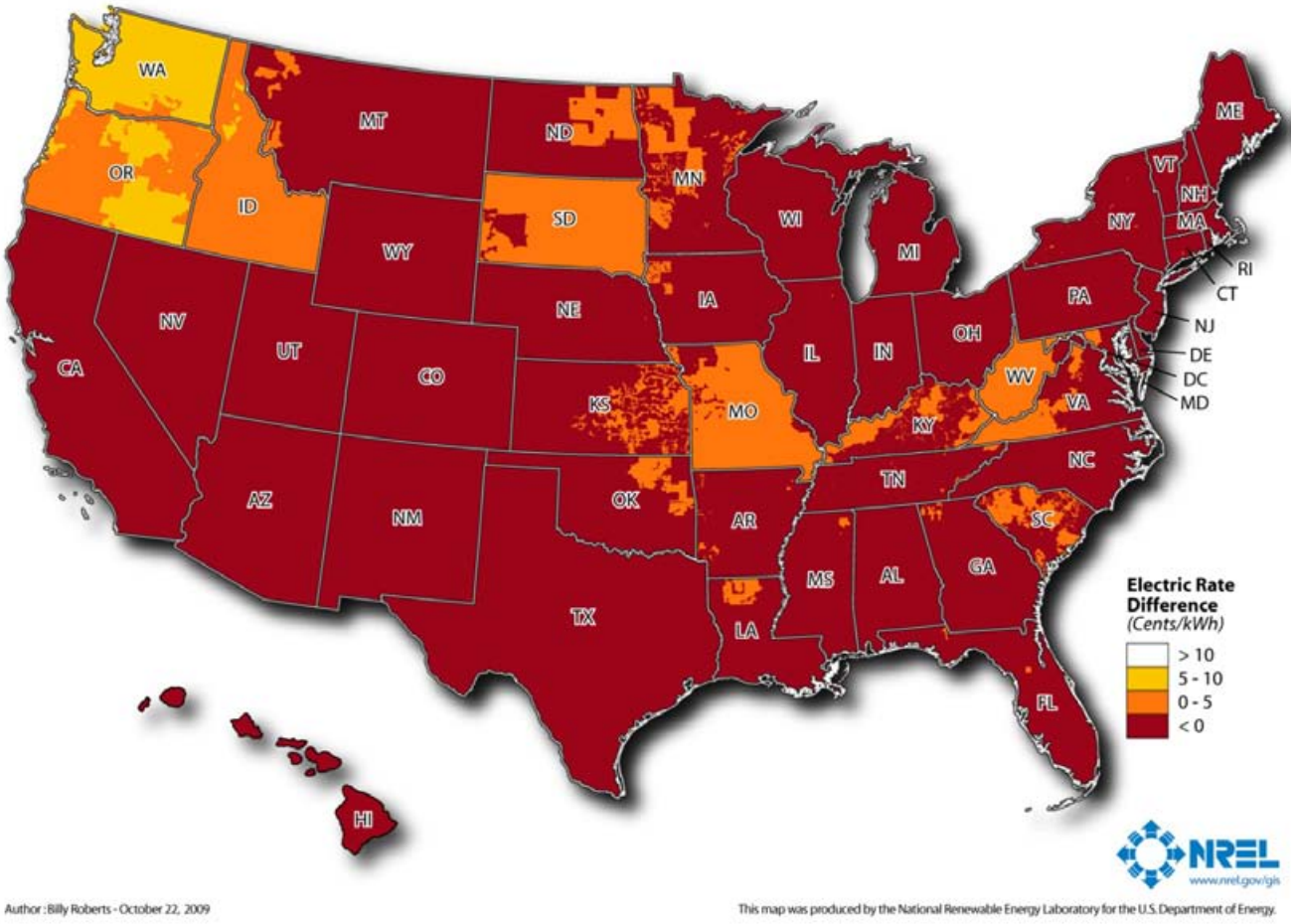
- Percentages represent portions of the load in which breakeven conditions may exist under our assumptions.
- 47% of residential electricity sales $5/W or more.
- 75% of sales $4/W or more.
- 91% of sales $3/W or more.

Increase in electricity prices (Cents/kWh) required for $3.5/W breakeven using base rate structure in 2015



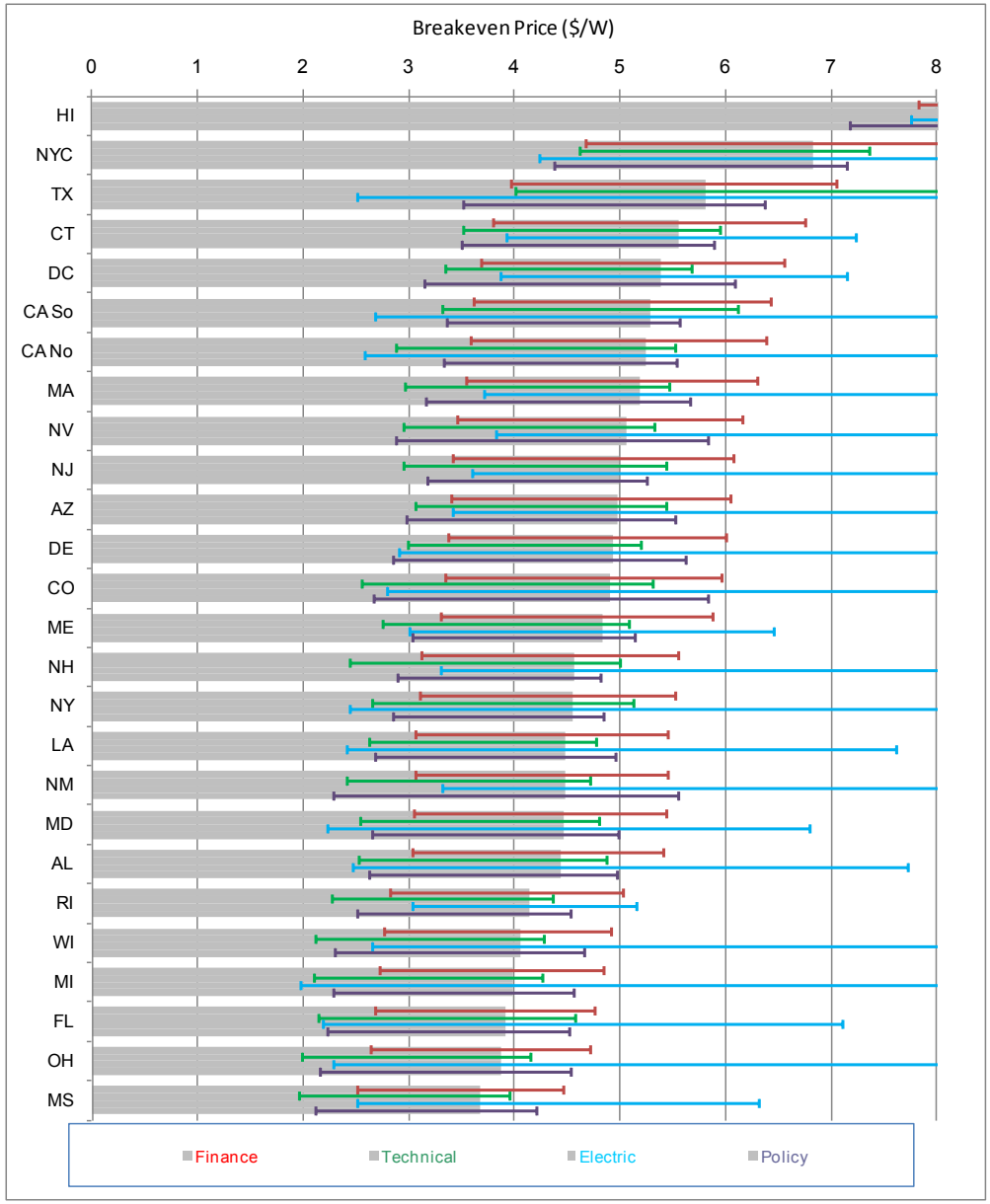
- Percentages represent portions of the load in which breakeven conditions may exist under our assumptions.
- 97% of residential electricity sales with 5 cent increase.
- 67% of sales with no change.

Increase in electricity prices (Cents/kWh) required for $3.5/W breakeven using time-of-use rate structure in 2015



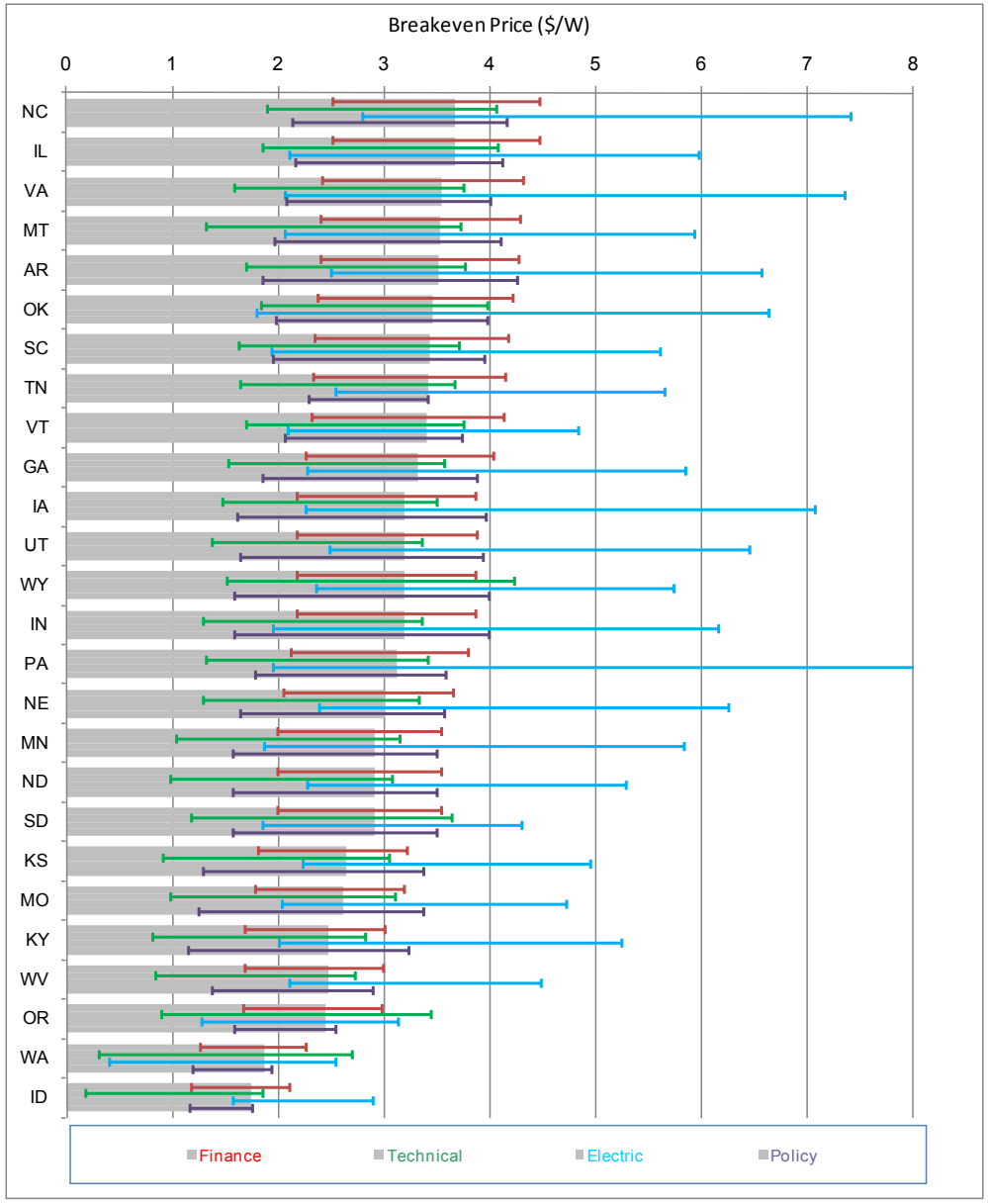
- Percentages represent portions of the load in which breakeven conditions may exist under our assumptions.
- 98% of residential electricity sales with 5 cent increase.
- 88% of sales with no change.

Range of PV breakeven costs in 2015 scenarios: Top 26 regions



- The grey bars illustrate the breakeven value for the largest utility in each state,
- The error bars show the sensitivity of breakeven to the four major drivers.
- Electricity price is the biggest driver of breakeven cost, followed by finance factors, policy issues, and technical performance.
- Excluding HI, the breakeven range is between $1.6/W and $6.2/W.
- “NYC” includes both New York City and Long Island, and California is split into northern and southern regions.

PV breakeven costs in 2015 scenarios: Bottom 26 regions



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- The most important drivers of the breakeven cost of PV are non-technical factors, including the cost of electricity, the rate structure, and the availability of system financing, as opposed to technical parameters such as solar resource or orientation.
- Currently, the break-even cost of PV in the United States varies by more than a factor of 10 (from less than $1/Watt to over $10/Watt) despite a much smaller variation in solar resource.
- Breakeven conditions are currently observed in the Southwest where they are driven by resource availability and in the Northeast where they are driven by high electricity prices.
- Breakeven conditions will begin to occur in the Southeast and Midwest as PV prices decline.