Show Me the Numbers

A Framework for Balanced Distributed Solar Policies

Prepared for Consumers Union

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Available at www.synapse-energy.com

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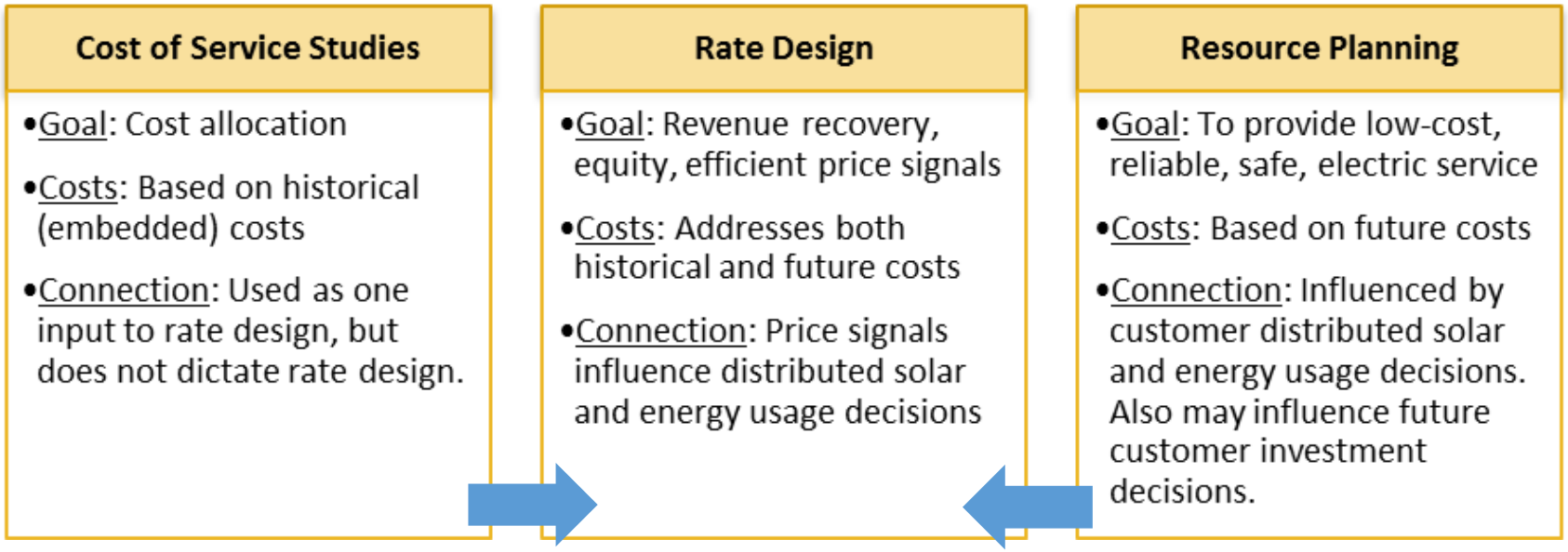
Overview

- Distributed solar policies should strike a balance between:
  - encouraging the growth of cost-effective solar resources, and
  - avoiding undue or unreasonable impacts on non-solar customers.
- Three questions should be answered to inform this balance:
  1. How will solar policies affect the development of distributed solar resources?
  2. What are the costs and benefits of distributed solar policies?
  3. What are the cost-shifting impacts of distributed solar policies?
- This report offers a framework for analyzing these questions in a way that is data-driven and transparent.
- The framework should be applied using utility-specific or state-specific data.

Distributed Solar Policies

Policy	Examples
Compensation Mechanisms	Net metering, feed-in-tariff, value-of-solar tariff, renewable energy certificates, rooftop lease payments, performance incentives
Rate Design	Fixed charges, demand charges, time-of-use rates, bypassable versus non-bypassable bill components
Up-Front Incentives and Financing	Investment tax credits, sales tax exemptions, rebates, loans, grants
Interconnection and Permitting	Expedited review, mandated time limits, zoning exemptions, interconnection and permitting fees
Integration and Planning	Hosting capacity analyses, integrated resource planning, distribution system planning
Ownership	Customer up-front purchase, third-party ownership, utility ownership and lease to customer, loans
Education, Training, And Outreach	Information, tools, workshops, online assistance, community outreach

The Role of Rate Design



1. Customer Adoption Analysis:

How will solar policies affect the development of distributed solar resources?

Customer Payback Period

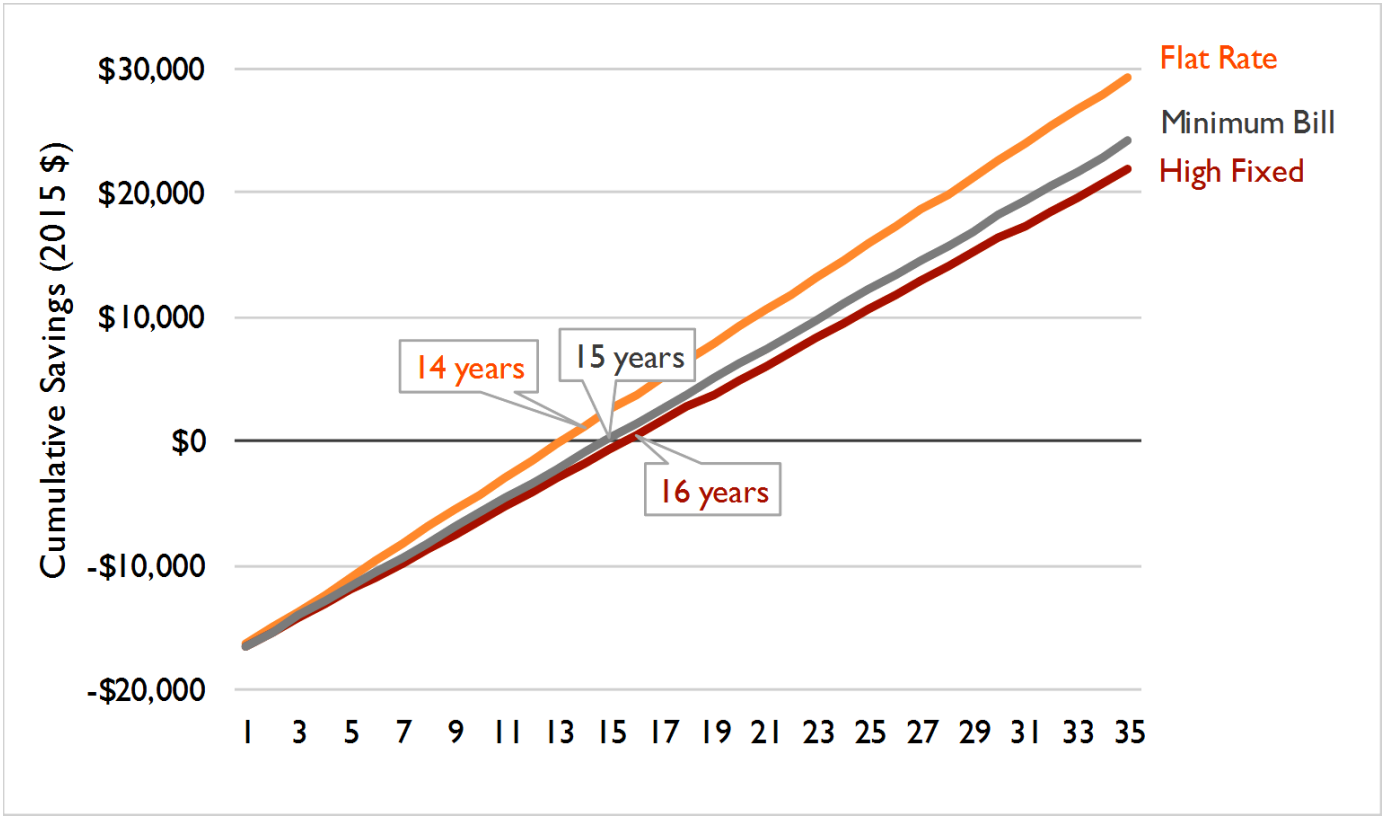
The customer payback period provides very useful information regarding customer adoption of distributed solar.

Payback calculation is straightforward:

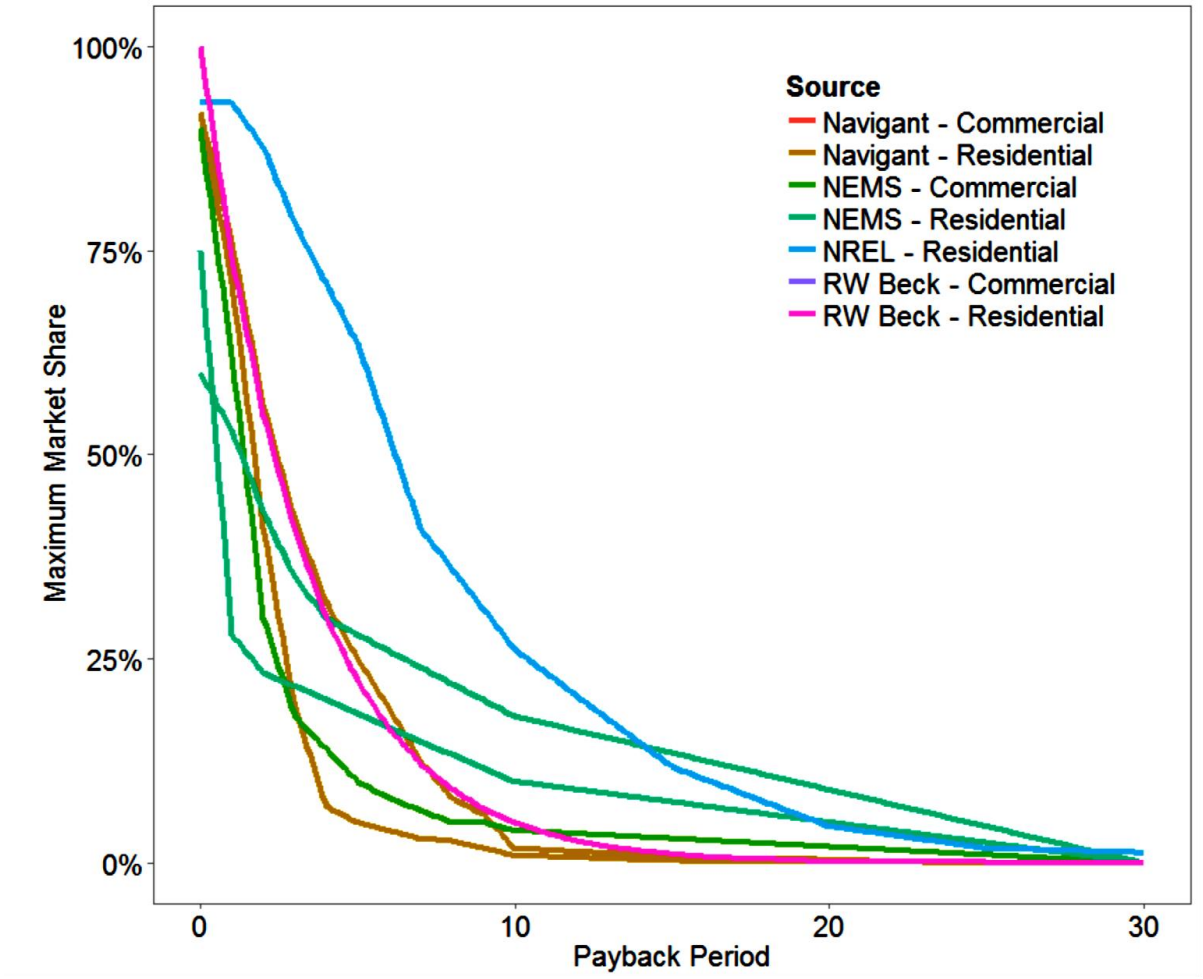
- Forecast annual customer bills without solar.
- Forecast annual customer costs with solar.
  - Upfront solar system costs
  - On-going solar system costs
  - Solar generation
- Forecast host customer benefits (tax incentives, SRECs, etc.)
- Simple payback period:
  - Year in which the cumulative benefits exceed cumulative costs.
- All of this information is readily available and not very contentious.

Hypothetical Example: Rate Design/ Compensation and Solar Adoption

Payback Period Analysis



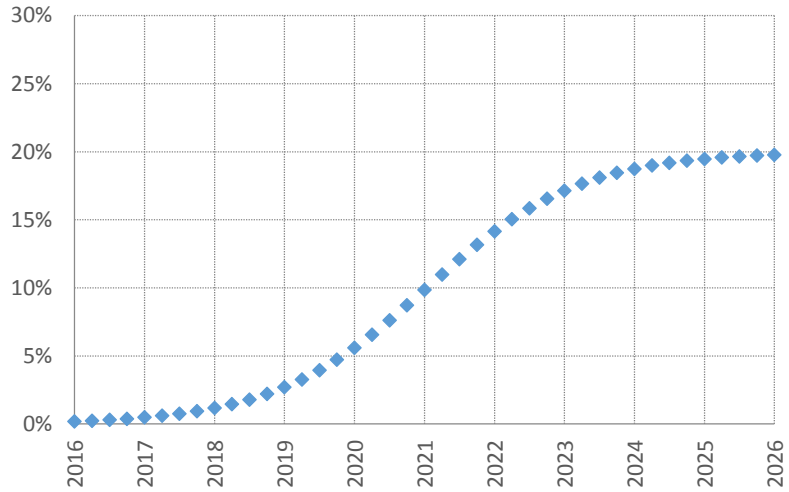
Payback Periods and Adoption Rates



Source: NREL (Sigrin et al. 2016)

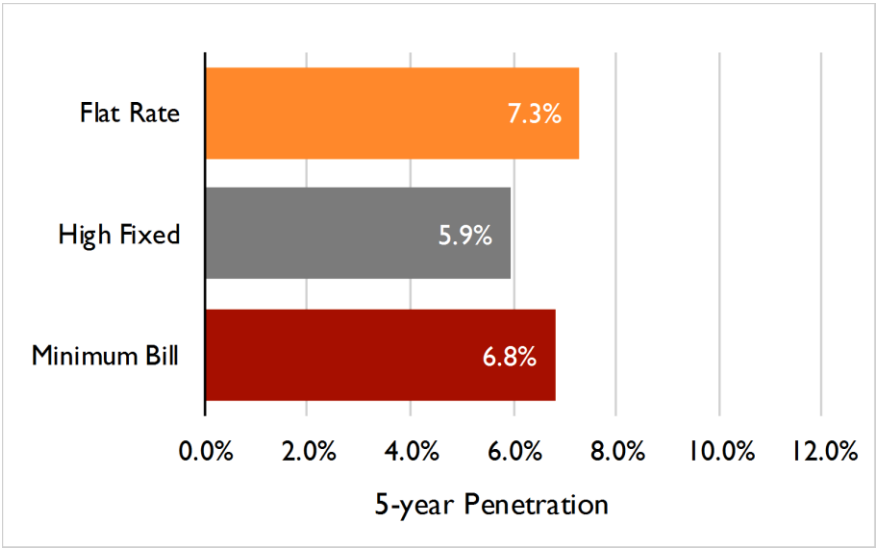
Estimated 5-Year Penetration

Bass Diffusion Model:



Graph assumes that market saturation (at 20 percent) occurs in 10 years.

2021 Penetration Level (i.e., after 5 years)



2. Cost-Effectiveness Analysis:

What are the costs and benefits of distributed solar policies?

Costs and Benefits

Benefits
Avoided Energy Costs
Avoided Generation Capacity Costs
Avoided Losses
Avoided Transmission & Distribution Costs
Avoided Environmental Compliance Costs
Avoided Ancillary Services
Reduced Risk
Societal Benefits (e.g., environmental benefits)
Costs
Administration costs
Interconnection Costs
Distribution System Upgrades
Participant Costs

This list is meant to be illustrative, not exhaustive.

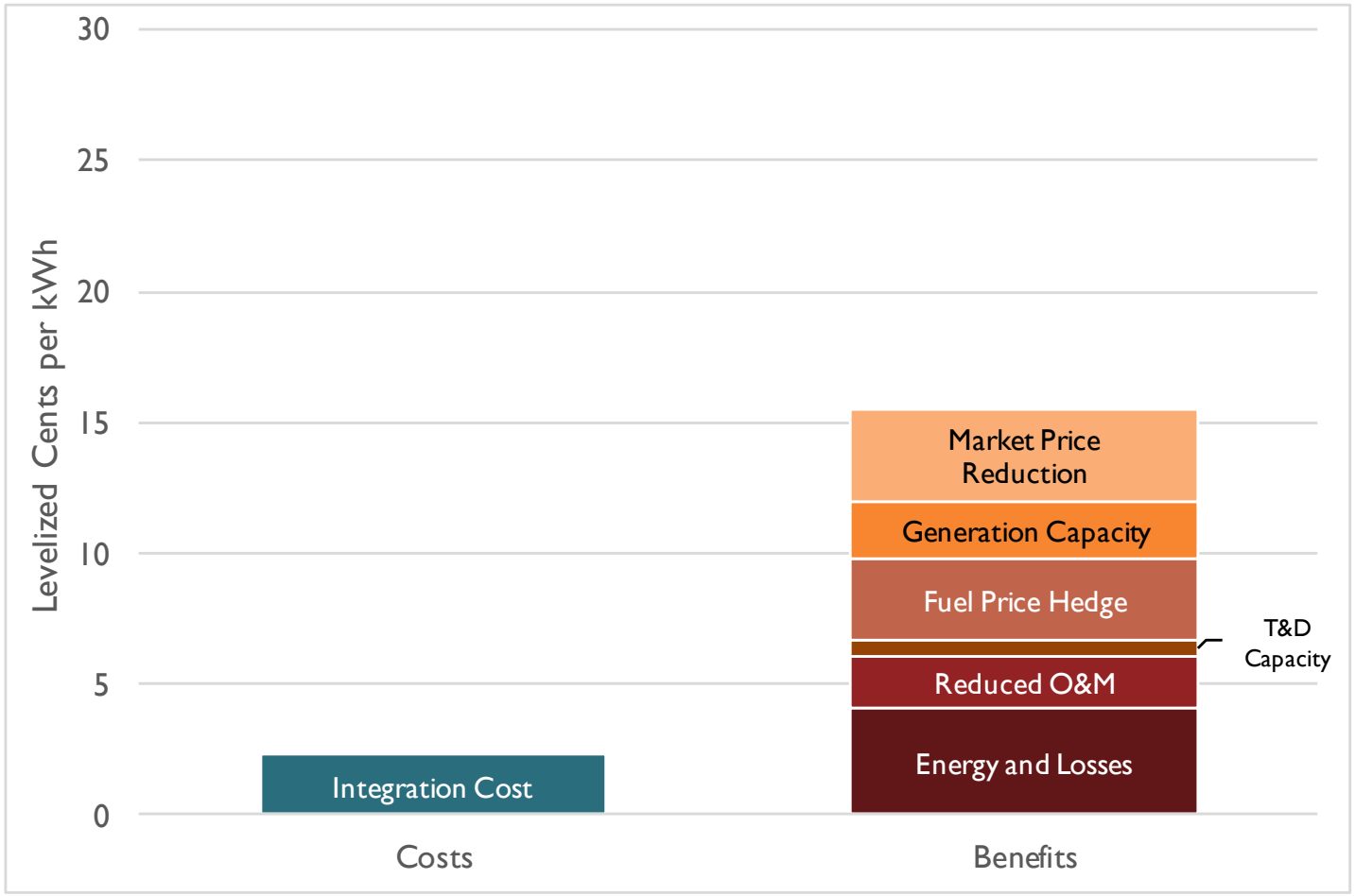
Which Costs and Benefits Should You Count?

1. Utility Cost Test
   - Costs and benefits that affect utility revenue requirements → customer bills
   - Primary advantage: simple and focused on reducing utility costs
   - Primary limitation: does not account for energy policy goals (beside the goal of reducing costs)
2. Total Resource Cost Test
   - Utility system costs + Host customer costs
   - Primary advantage: includes the total cost of the resource
   - Primary limitation: includes all societal costs but not all societal benefits
3. Societal Cost Test
   - Utility system costs + Host customer costs + Societal impacts
   - Primary advantage: reflects the full range of policy goals
   - Primary disadvantage: might place too much emphasis on societal impacts, relative to the goal of reducing costs

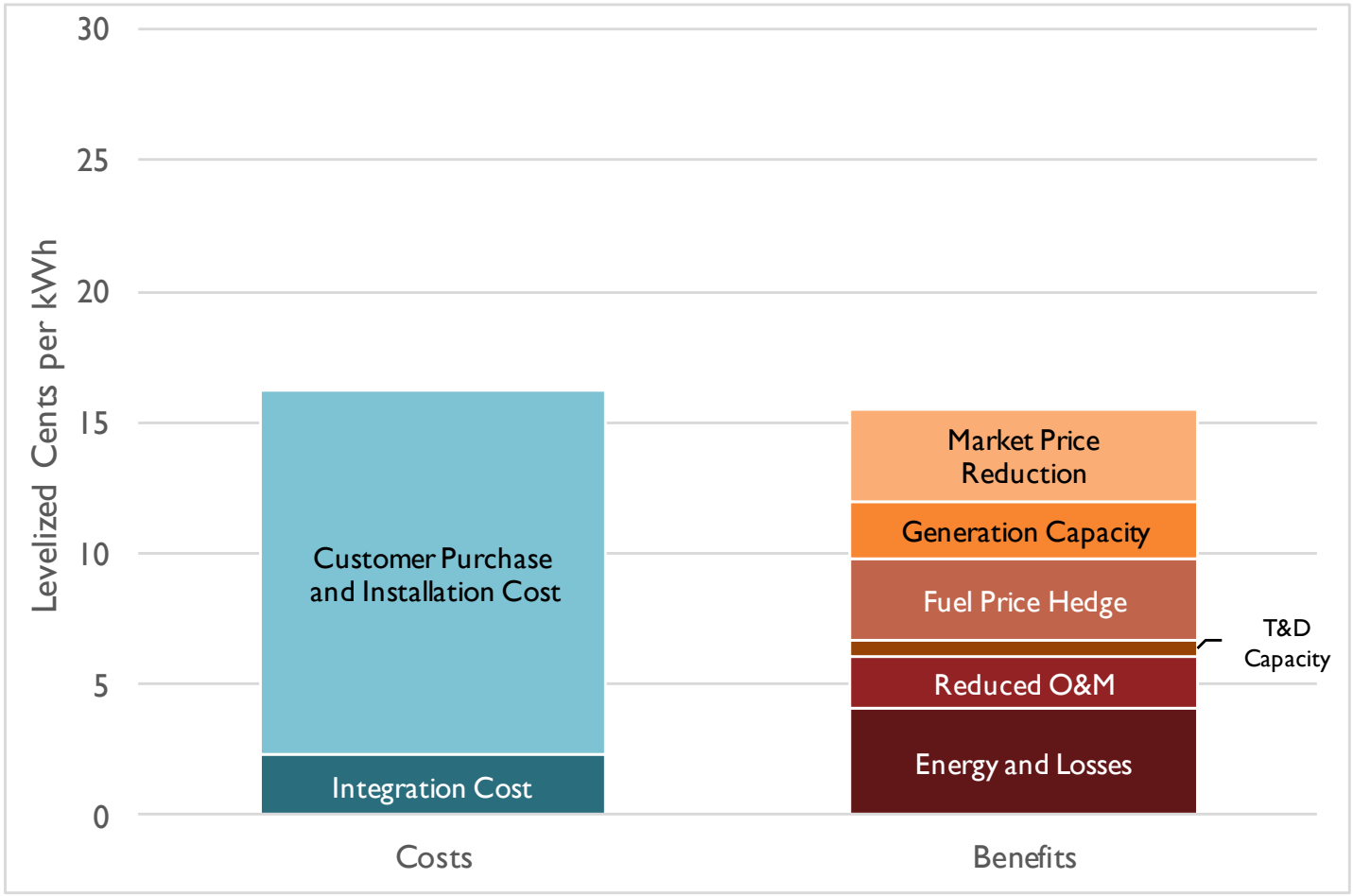
What About Lost Revenues and the RIM Test?

- The lost revenues from distributed solar generation should not be included in the cost-effectiveness analysis.
  - Including lost revenues in the analysis is the Rate Impact Measure (RIM) test.
- The RIM test conflates cost-effectiveness with cost-shifting.
  - Cost-effectiveness analyses should only include future (avoidable) costs.
  - Lost revenues are a result of historic (unavoidable, sunk) costs.
- The RIM test does not provide information needed to understand either cost-effectiveness or cost shifting.
- But lost revenues are critically important, because they can lead to cost-shifting.
- Cost-shifting should be analyzed through a rate and bill impact analysis.
  - This will provide meaningful information on how non-solar customers might be impacted by distributed solar resources.
  - Third analysis (see below).

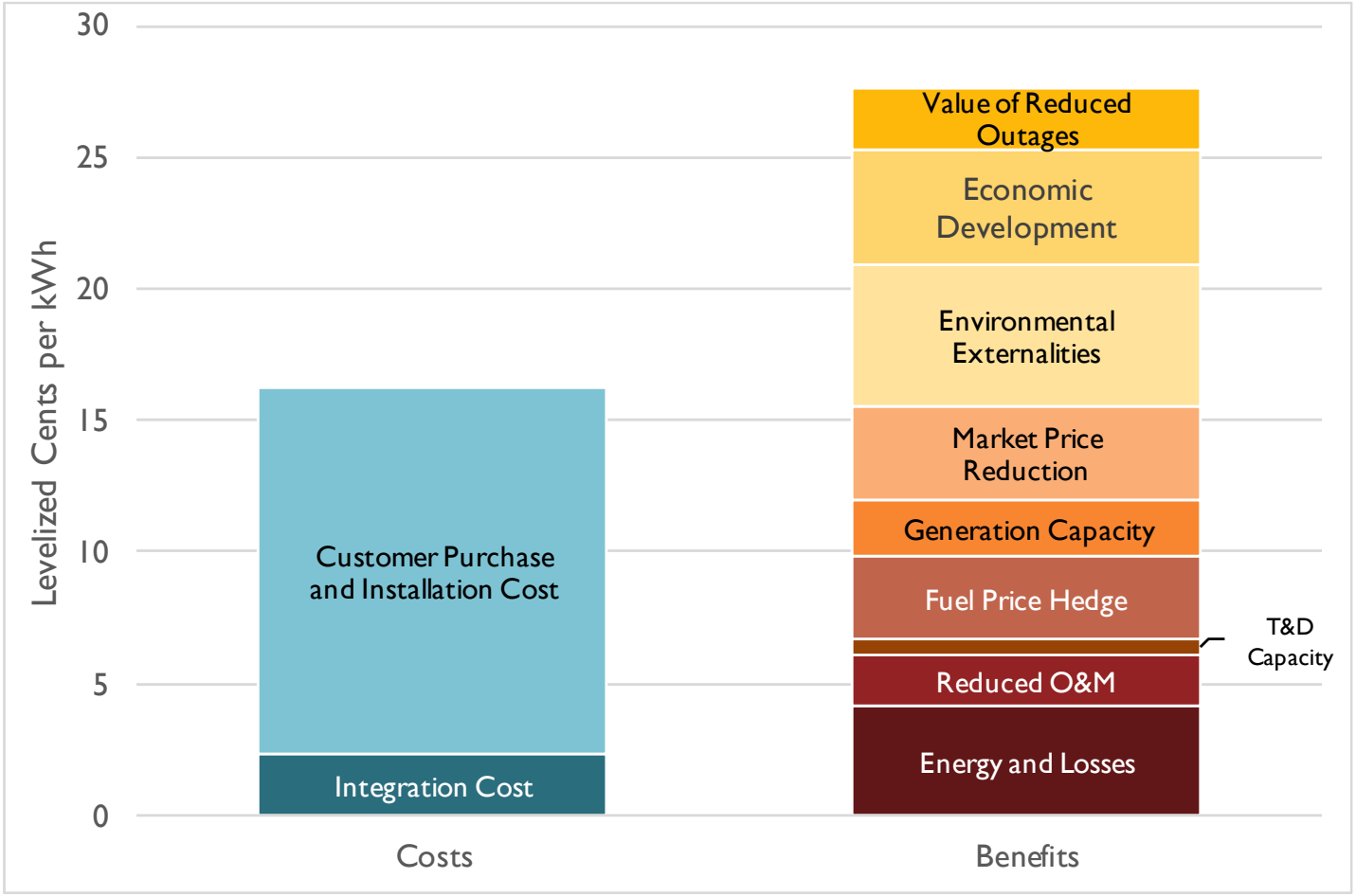
Utility Cost Test – Example of Costs and Benefits



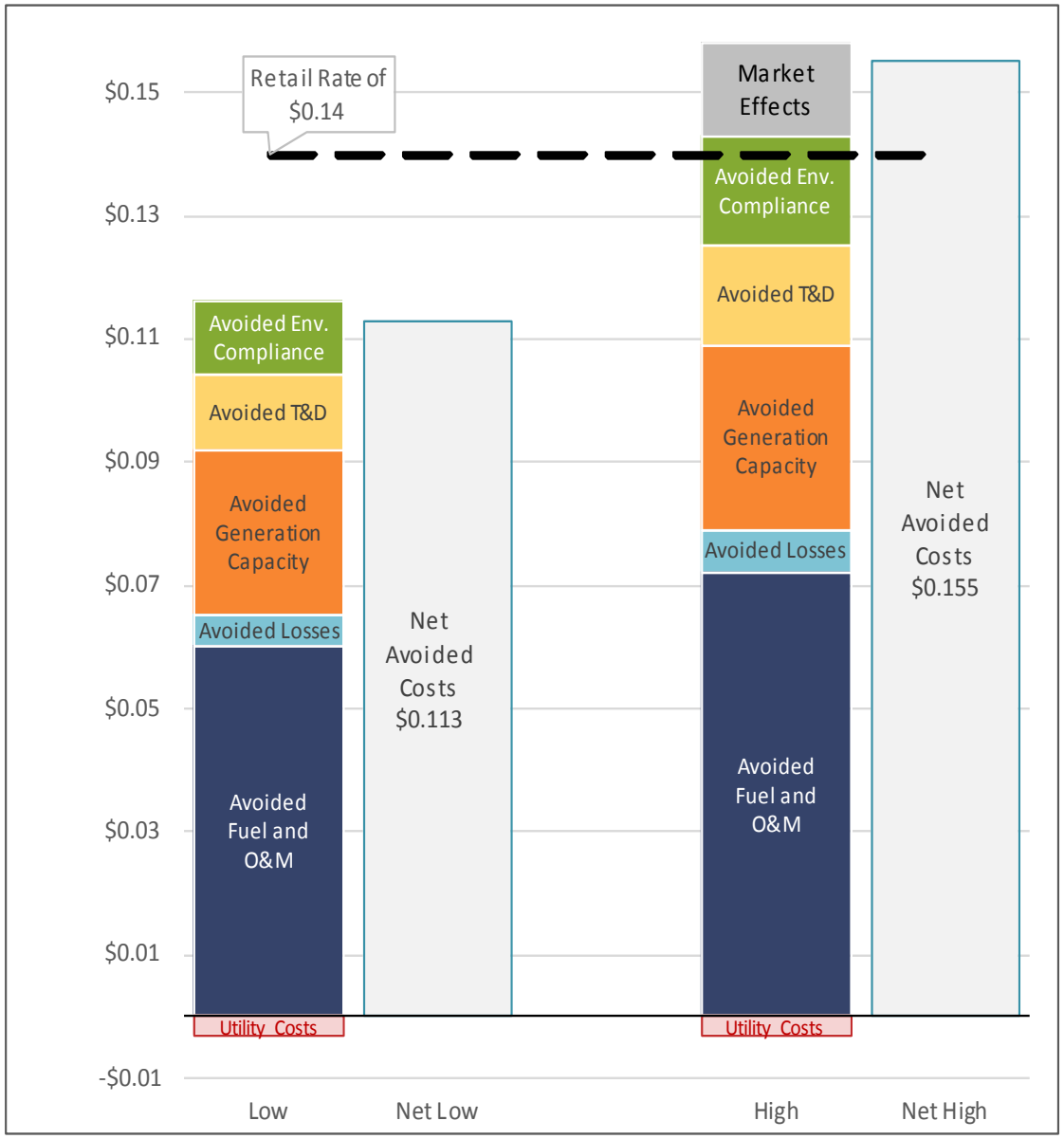
TRC Test – Example of Costs and Benefits



Societal Cost Test – Example of Costs and Benefits



Illustrative Example



High and Low Utility Avoided Costs Modeled

Cost-Effectiveness Results

3. Rate and Bill Impact Analysis:

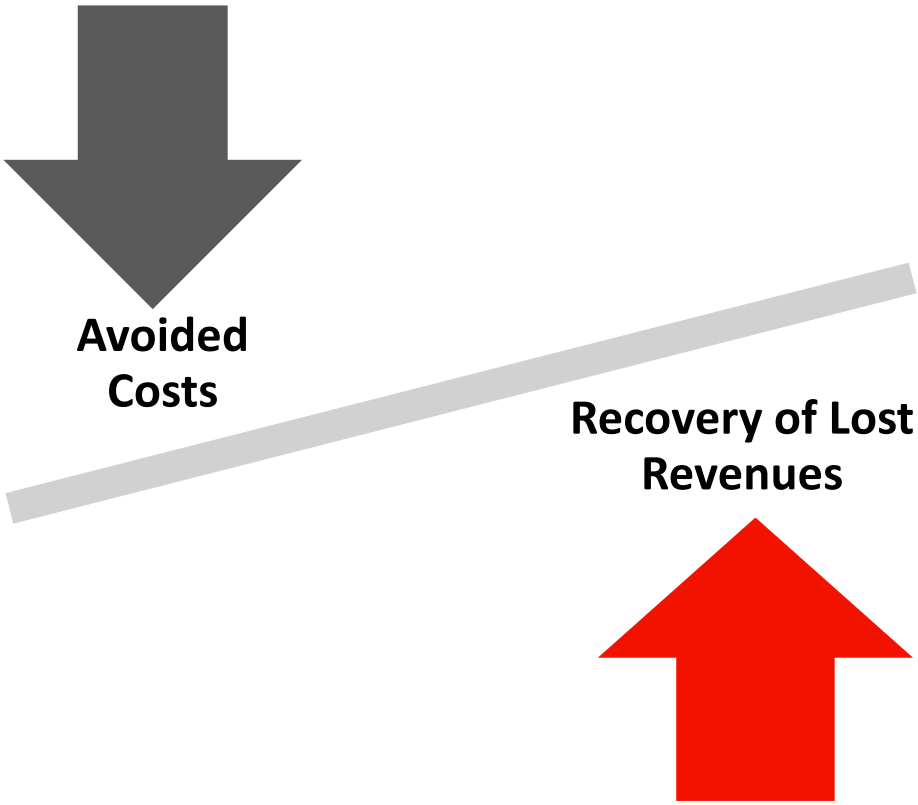
What Are the Cost-Shifting Impacts of Distributed Solar Policies?

Rate and Bill Impact Analysis

- Use same information and similar approach as cost-effectiveness analysis.
  - But include the effect of lost revenues
- Scenario without PV policy:
  - Forecast all the utility system costs
  - Forecast the utility sales
  - Rates = costs/sales
  - Monthly bills = rates times monthly sales
- Scenario with PV policy:
  - Utility system costs (reduced by avoided costs, increased by integration costs)
  - Utility sales (reduced by PV generation)
  - Rates = costs/sales
  - Monthly bills = rates times monthly sales
- Rate and bill impacts = difference between scenarios.
- Should estimate both short-term and long-term impacts.

Net Impact on Rates

- Which effect is bigger?



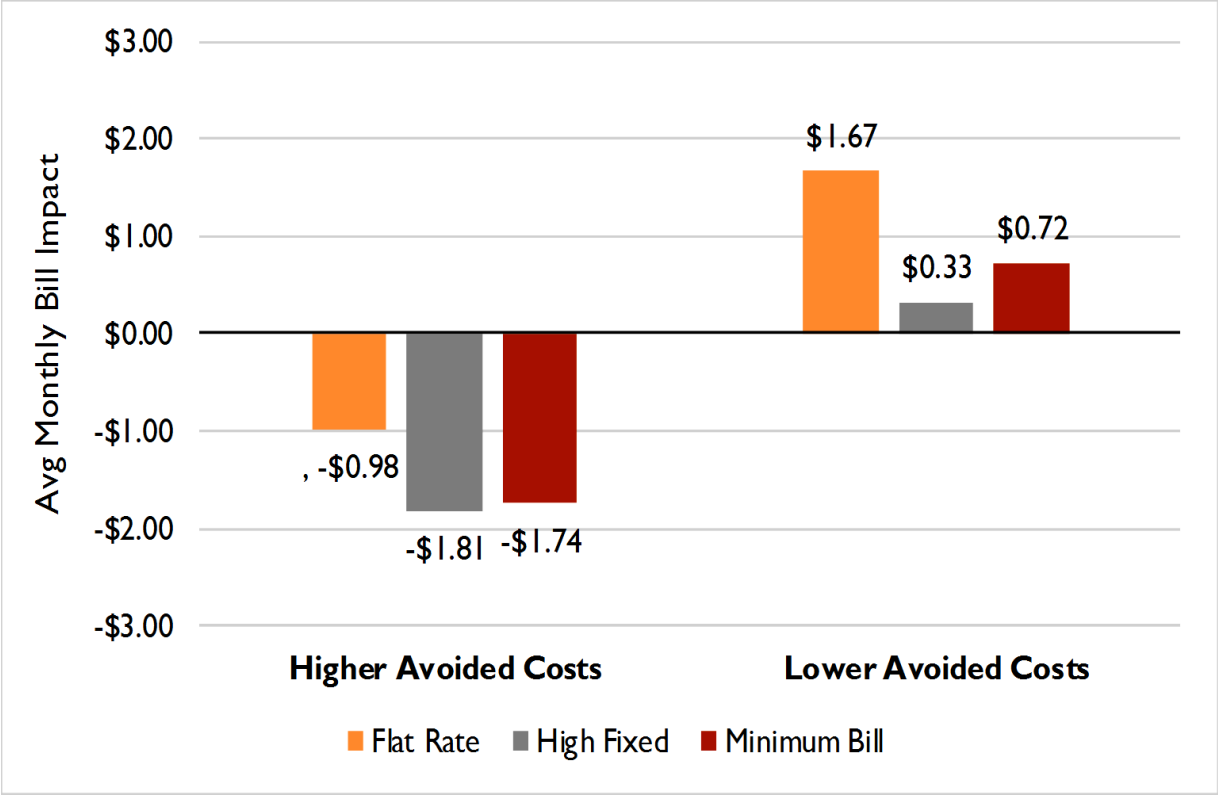
Solar Generation Credits vs. Avoided Costs

Long-term average impacts:

Net Utility Avoided Costs Exceeds Credit	=	Rate Decrease
Net Utility Avoided Costs Less Than Credit	=	Rate Increase

Cost-Shifting: Example Results

Average impacts over 25 years



Framework:

Present and Consider Results of all Three Analyses

Hypothetical Results: Low Avoided Costs

	1. Distributed Solar Development		2. Cost Effectiveness			3. Rate and Bill Impacts	
	Customer Payback	5-Year Penetration	Utility Net Benefits	TRC Net Benefits	Societal Net Benefits	Avg. Bill Impact	Long-Term Avg. Bill Impact
	Years	%	*2015 $ Million*	*2015 $ Million*	*2015 $ Million*	*2015 $/mo*	%
Flat Rate	14	7%	$2,400	$900	$1,100	$1.67	1.1%
High Fixed Charge	16	6%	$2,000	$700	$900	$0.33	0.2%
Minimum Bill	15	7%	$2,300	$800	$1,000	$0.72	0.5%

Hypothetical Results: High Avoided Costs

	1. Distributed Solar Development		2. Cost Effectiveness			3. Rate and Bill Impacts	
	Customer Payback	5-Year Penetration	Utility Net Benefits	TRC Net Benefits	Societal Net Benefits	Avg. Bill Impact	Long-Term Avg. Bill Impact
	Years	%	*2015 $ Million*	*2015 $ Million*	*2015 $ Million*	*2015 $/mo*	%
Flat Rate	14	7%	$3,300	$1,800	$2,000	-$0.98	-0.7%
High Fixed Charge	16	6%	$2,700	$1,400	$1,600	-$1.81	-1.2%
Minimum Bill	15	7%	$3,100	$1,600	$1,800	-$1.74	-1.2%

Important Considerations

- Results will be different for each state and, perhaps, each utility.
  - Analyses should be state-specific or utility-specific.
  - The results in our report cannot be applied to your state.
- Cost-effectiveness and cost-shifting analyses are very sensitive to avoided costs.
  - Avoided cost estimates should (a) be directed by regulators, (b) allow for stakeholder review and input, (c) transparent to all, and (d) updated as needed.
  - Can use a range of avoided costs.
- Results will likely change over time as conditions change.
  - All three analyses should be updated on a regular basis.
  - Solar policies should be updated, prospectively, on a regular basis to reflect the results of new analyses.

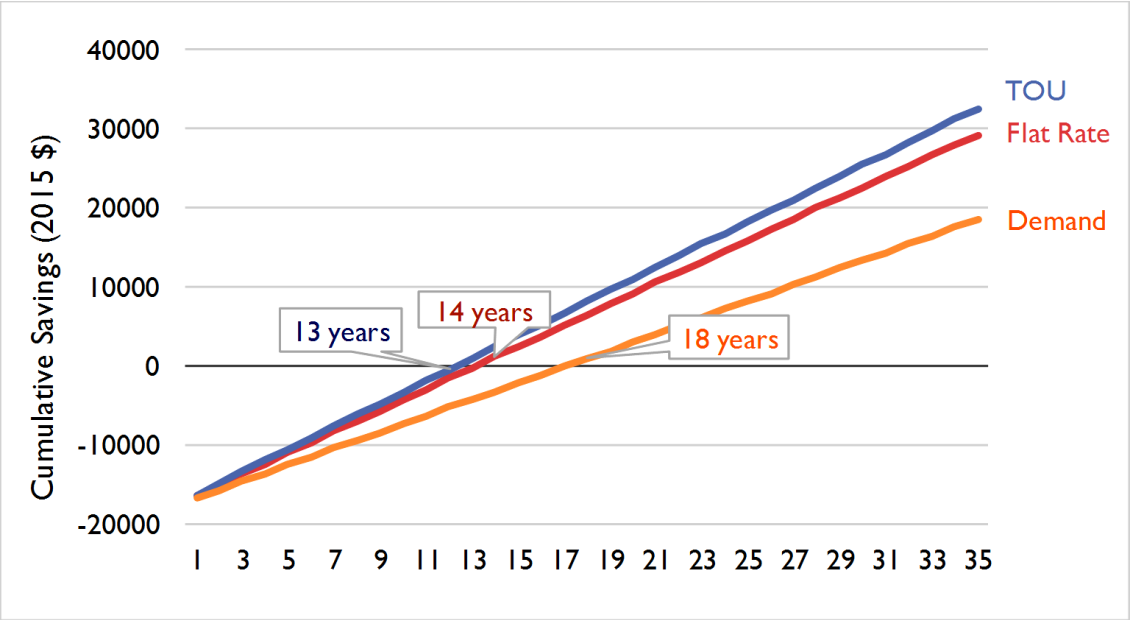
Illustrative Example:

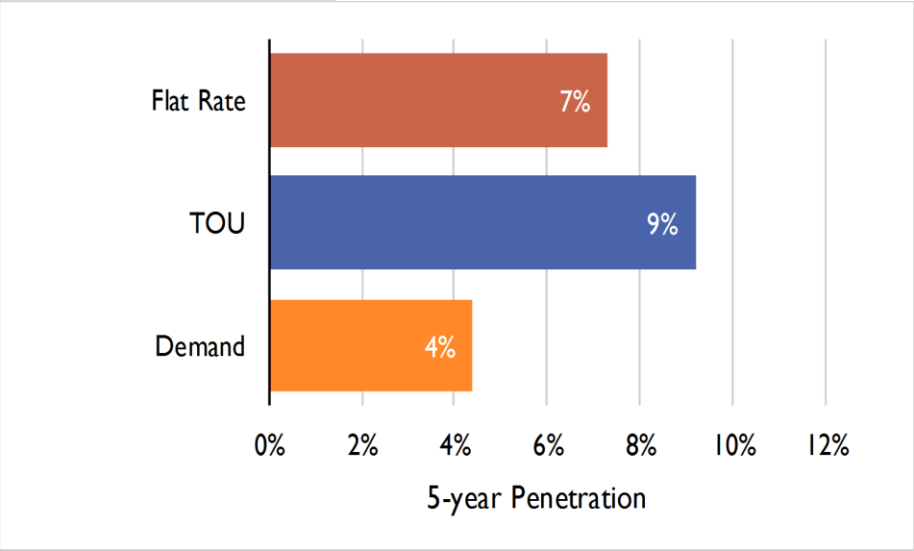
Other Rate Designs

Flat Rate vs. TOU vs. Demand Charge

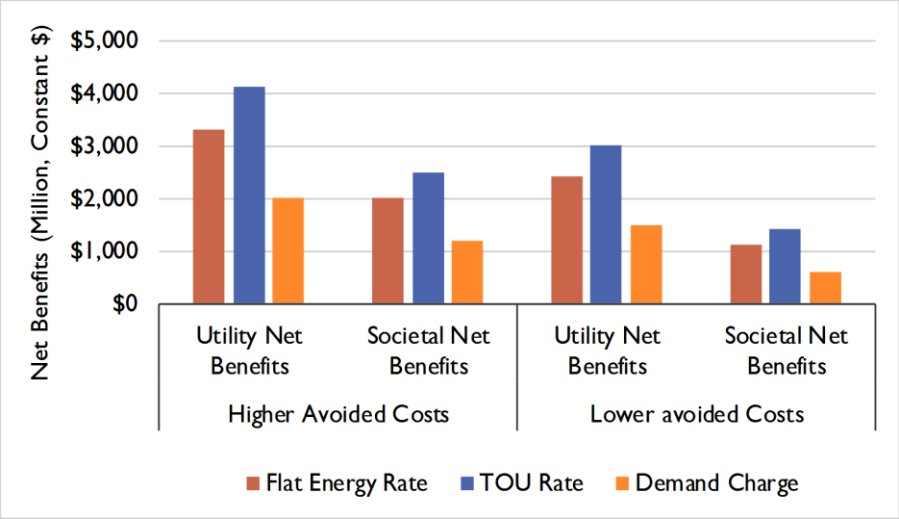
Policy	Rate Design
Flat Rate	$0.14/kWh $5 fixed charge
TOU	$0.155/kWh Peak (9 am - 8:59 pm) $0.110/kWh Off-peak (9 pm – 8:59 am) $5 fixed charge
Demand Charge	$0.11/kWh $10/kW (based on maximum hour of month) $5 fixed charge

Flat Rate vs. TOU vs. Demand Charge



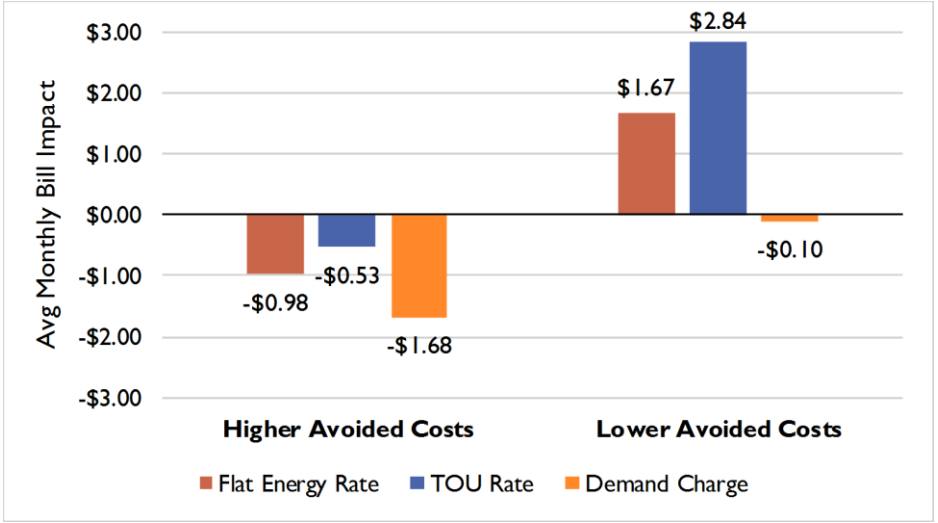


Flat Rate vs. TOU vs. Demand Charge



Cost-Effectiveness (Net Benefits)

Monthly Bill Impacts on Non-Solar Customers

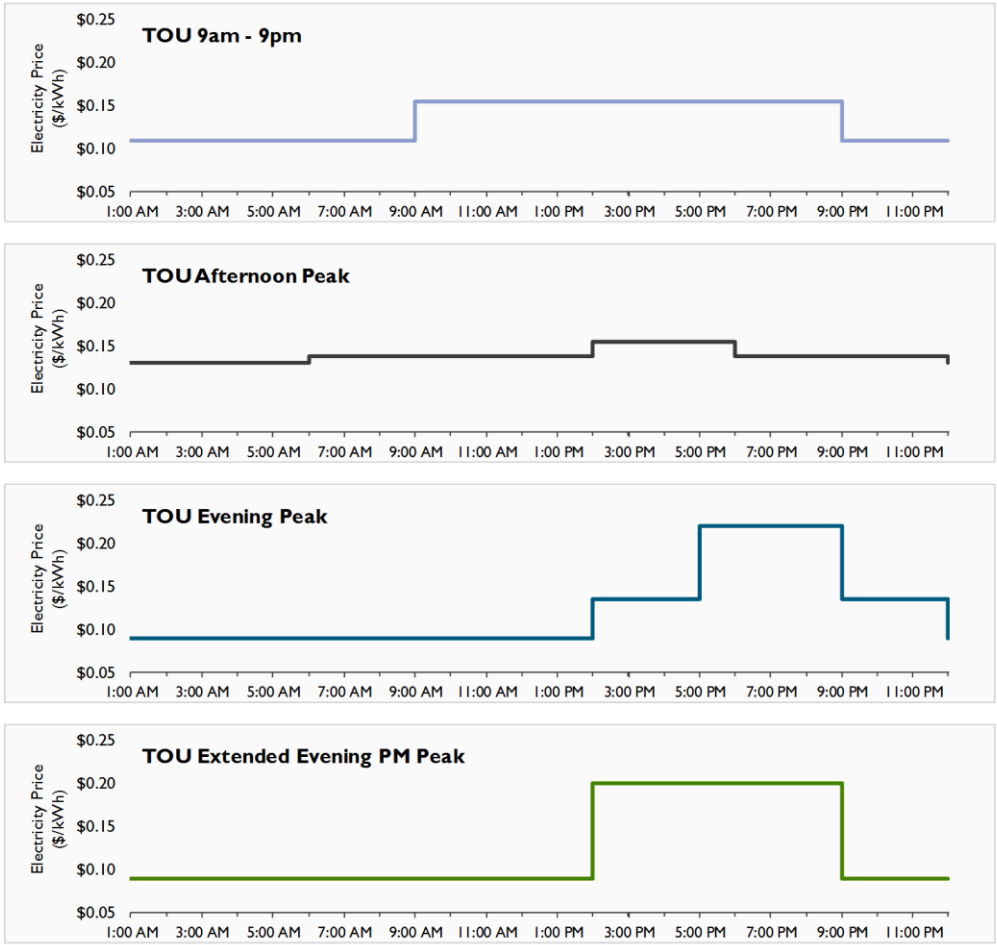


Illustrative Example:

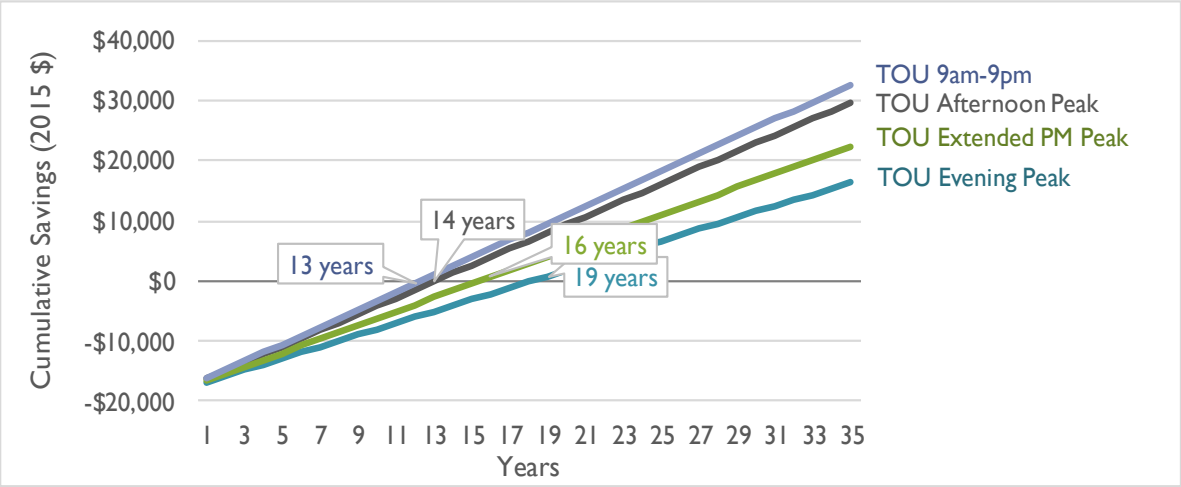
TOU Rate Sensitivity

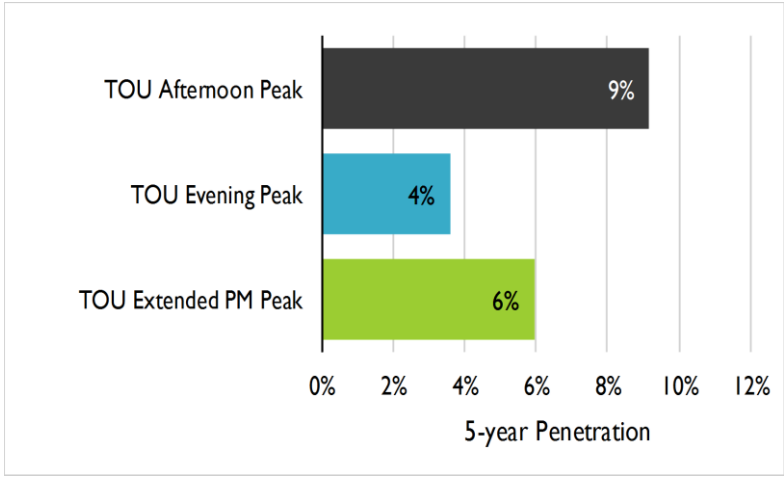
TOU Rate Sensitivity

TOU Rate Name	Hours	Rate Design
TOU Afternoon Peak	Peak: 2:00 pm – 5:59 pm Shoulder: 6:00 am – 1:59 pm, 6:00 pm – 11:59 pm Off-Peak: 12:00 am – 5:59 am	Peak: $0.155 Shoulder: $0.138 Off-Peak: $0.130
TOU Evening Peak	Peak: 5:00 pm – 8:59 pm Shoulder: 2:00 pm – 4:59 pm, 9 pm – 11:59 pm Off-Peak: 12:00 am – 1:59 pm	Peak: $0.220 Shoulder: $0.135 Off-Peak: $0.090
TOU Extended PM Peak	Peak: 2:00 pm – 8:59 pm Off-Peak: 9:00 pm – 1:59 pm	Peak: $0.200 Off-Peak: $0.090

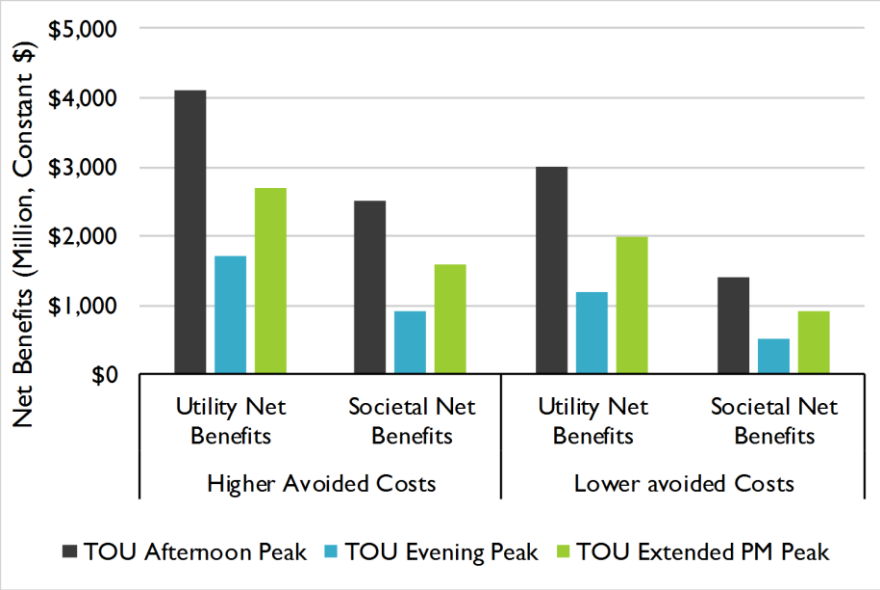


TOU Payback and Penetration



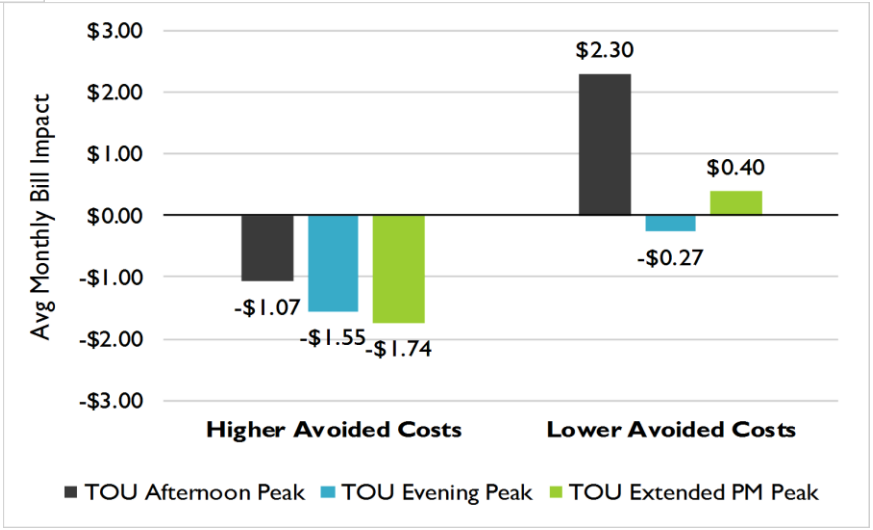


TOU Cost-Effectiveness and Cost-Shifting



Cost-Effectiveness (Net Benefits)

Monthly Bill Impacts on Non-Solar Customers



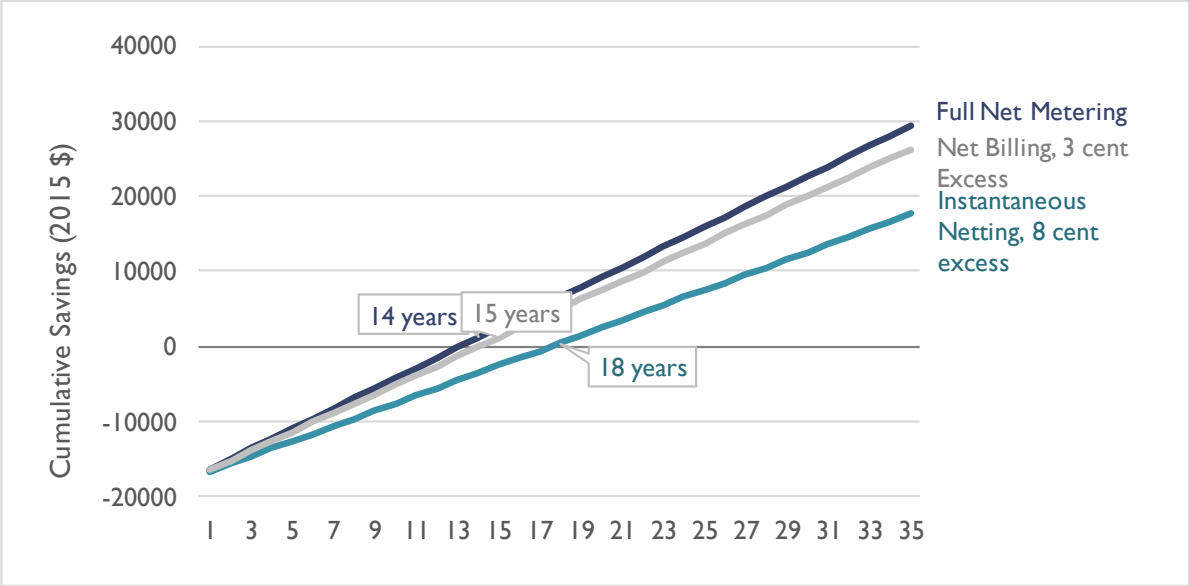
Illustrative Example:

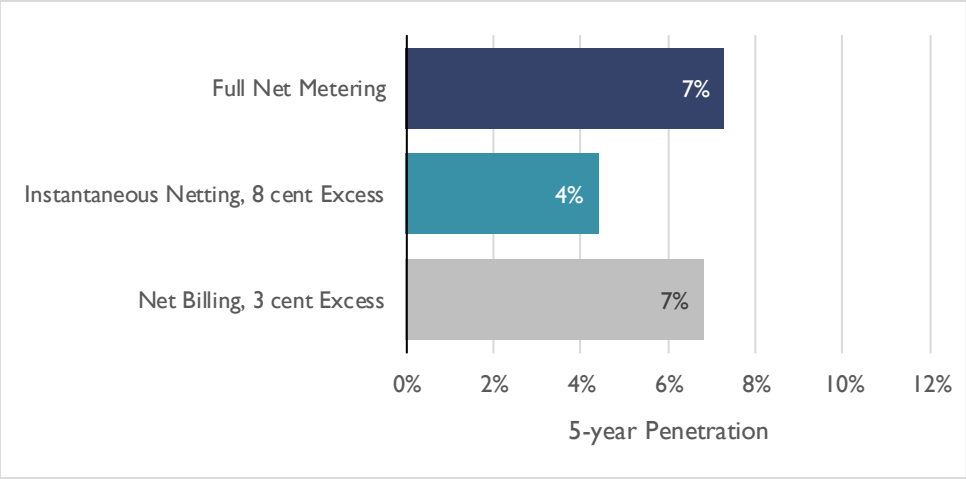
Alternative Compensation Mechanisms

Alternative Compensation Mechanisms

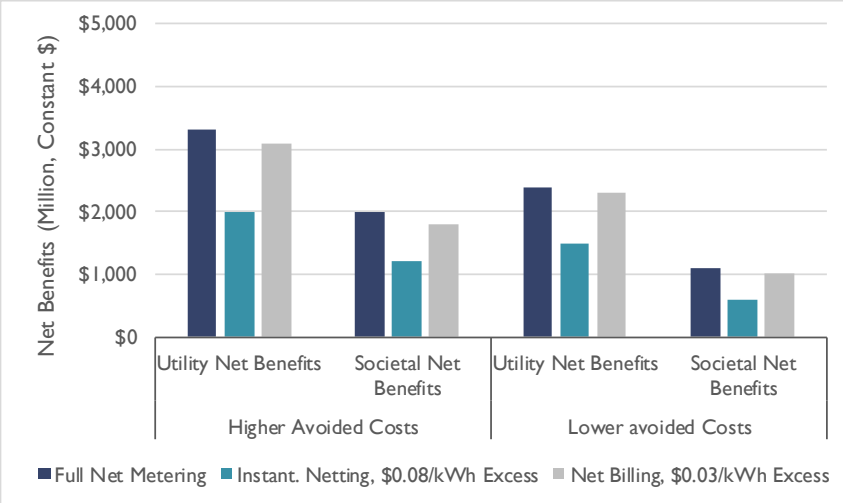
Policy	Credit for Behind-the-Meter Generation	Credit for Generation Exported to Grid	Credit for Monthly Excess Generation
Full Net Metering	Full retail rate ($0.14)	Full retail rate ($0.14)	Full retail rate ($0.14)
Instantaneous Netting	Full retail rate ($0.14)	$0.08 for any generation not consumed immediately on-site	$0.08
Net Billing	Full retail rate ($0.14)	Full retail rate ($0.14) until generation exceeds consumption	$0.03

Payback and Penetration



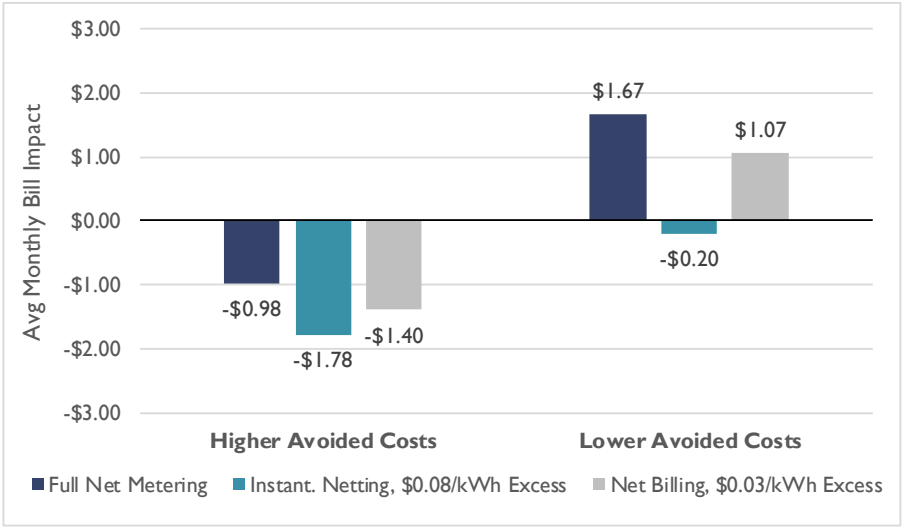


Cost-Effectiveness and Cost-Shifting



Cost-Effectiveness (Net Benefits)

Monthly Bill Impacts on Non-Solar Customers



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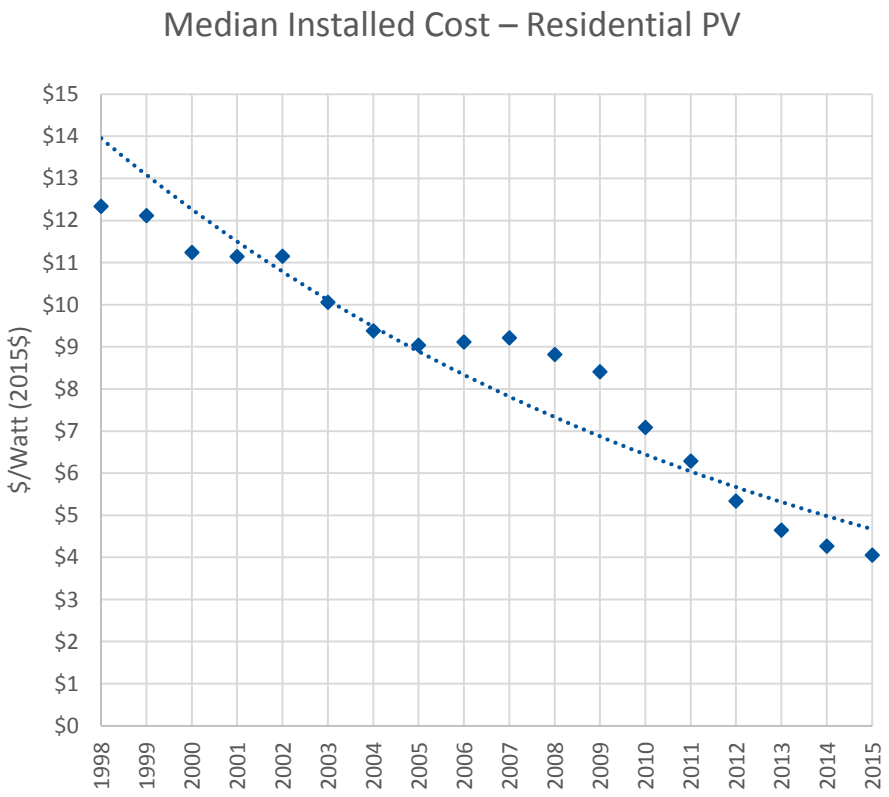
About Synapse Energy Economics

- Synapse Energy Economics is a research and consulting firm specializing in energy, economic, and environmental topics. Since its inception in 1996, Synapse has become a leader in providing rigorous analysis of the electric power sector for public interest and governmental clients.
- Staff of 30+ experts
- Located in Cambridge, Massachusetts

Appendix

Solar Costs

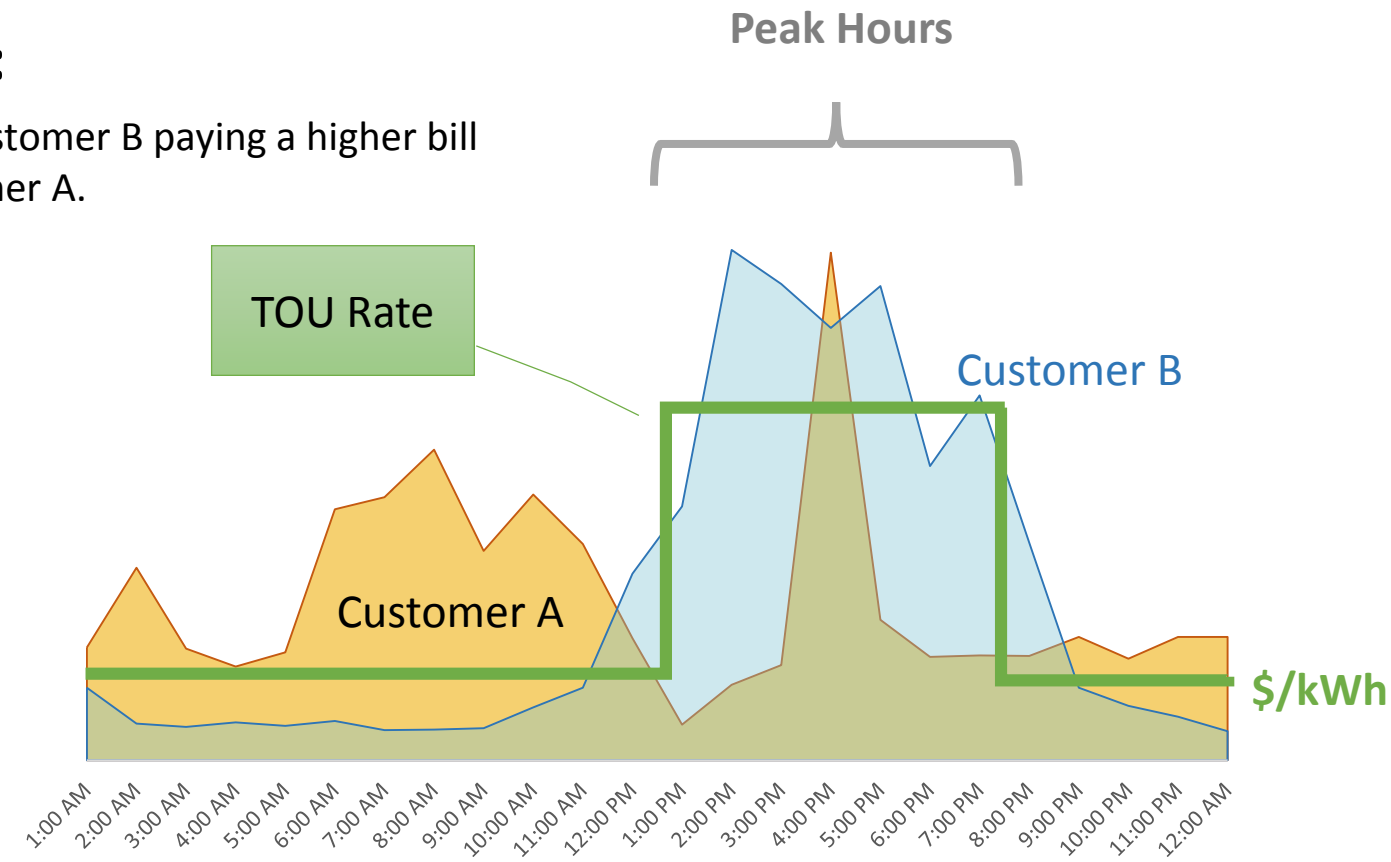
- Will mainland penetrations follow Hawaii if costs continue to fall?



Source: Barbose and Darghouth, LBNL, Tracking the Sun IX, 2016

Demand Charge vs. TOU Rates

- **Demand Charge:**
  - Customer A and Customer B pay the same bill.
- **TOU Rates:**
  - Result in Customer B paying a higher bill than Customer A.



Full Net Metering

- Full retail rate for all generation ("one-for-one netting")
- Credits rolled over to following month at full retail rate

May:

Monthly total generation = 950 kWh

Monthly total consumption = 900 kWh

Net consumption = -50 kWh ← "Excess Generation"

Customer Bill: $0.12 x -50 kWh = -$6.00

June:

Monthly total generation = 1000 kWh

Monthly total consumption = 1200 kWh

Net consumption = 200 kWh

$0.12 x 200 kWh = $24.00

Credit from May = $6.00

Customer Bill: $18.00

Other Compensation Options

- **Net Billing** with Reduced Compensation for Monthly Excess Generation
- **Instantaneous Netting** with Reduced Compensation for Exports to Grid