Quantifying the Economics of Net Energy Metering in Nevada

July 29th, 2016

Distributed Energy Resources in NV

Quantifying the net benefits of distributed energy resource

SolarCity

Grid Engineering

NRDC

Distributed Energy Resources in Nevada

Quantifying the net benefits of distributed energy resources

Executive Summary

Rooftop solar photovoltaics (PV) and distributed energy resources can deliver net benefits to Nevadans today and, if thoughtfully utilized, play a significant role in Nevada's energy future. However, these benefits are not being fully realized in practice today. Narrow accounting of distributed resources' contribution to the grid, financial disincentives embedded in utility regulatory models, and outdated grid planning procedures are preventing full utilization of these assets. But these obstacles can be readily overcome. Doing so will deliver benefits to all Nevadans, as well as cement Nevada's position as a leader in the transition to a clean, resilient, and affordable electric grid.

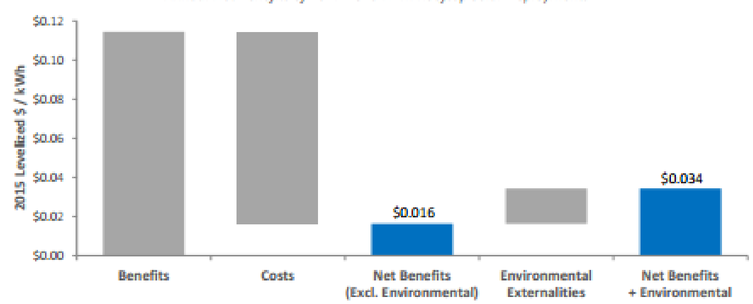
Rooftop Solar and Distributed Energy Resources Provide Net Benefits to All Nevadans

This report presents an economic analysis of the benefit of harnessing distributed energy resources (DER) – assets like rooftop solar, smart inverters, energy storage, energy efficiency, controllable loads, and electric vehicles – to build and operate a 21st century power grid. Such cost/benefit analyses are routinely performed across the industry; however, recent DER analyses in Nevada have not accounted for the full set of costs and benefits. Our analysis aims to provide a more complete accounting of the full costs and benefits of rooftop solar and DERs.

To perform this cost/benefit analysis, we build on existing industry methodologies to calculate the net benefits of rooftop solar and DERs in Nevada. Specifically, we utilize the *Nevada Net Energy Metering Public Tool*, a model used to quantify the costs and benefits of distributed generation that Energy+Environmental Economics (E3) developed for the Public Utilities Commission of Nevada (PUCN) in July 2014.[1] Then, we utilize the costs and benefits specified by the PUCN in their December 2015 Order related to net energy metered (NEM) solar deployments, as well as in their April 2016 Procedural Order related to Sierra Pacific Power Company's Integrated Resource Plan.[2,3]

Using the *Nevada Public Tool* and the PUCN-specified benefit and cost categories, we find that deploying additional NEM rooftop solar would deliver positive net benefits to all Nevadans – whether or not they own solar and DERs. While a net cost would indicate that NEM is providing a subsidy to solar, our results conclude that the opposite is true: rooftop solar provides a net benefit to all Nevadans in the range of 1.6 to 3.4 cents per kilowatt-hour (kWh) of solar production, as depicted in the figure below (and detailed on page 12). 1.6 cents/kWh includes benefits that are directly captured by the utility, while 3.4 cents/kWh includes environmental externalities that benefit all Nevadans at large.

Annual Net Benefits of 2017-2019 NEM Rooftop Solar Deployments



May 2016

solarcity.com/gridx

To update discussion, SolarCity and NRDC repeated 2014 independent analysis with updated data

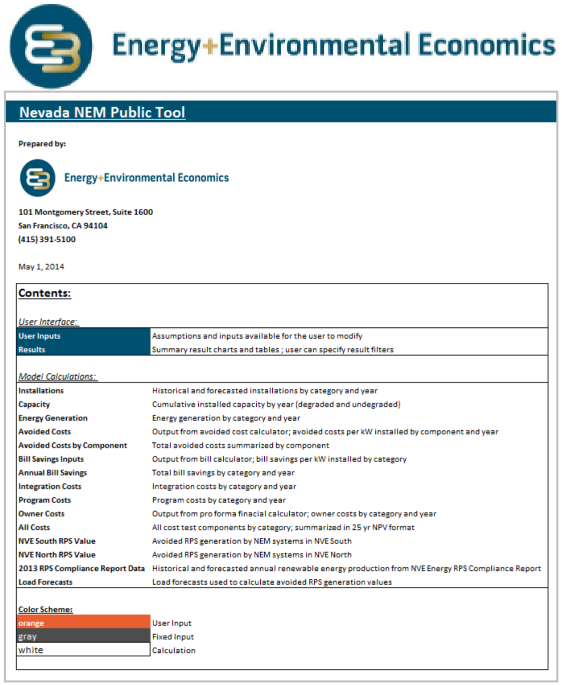
Quantified Cost/Benefit Categories in Nevada (2014-2016)[15]

	Categories	E3 NEM Study (July 2014)	PUCN NEM Order (Fall 2015)	PUCN NEM Decision (Dec 2015)	PUCN Order: Sierra Pac IRP (April 2016)	Study Scope (May 2016)
Benefits	Energy	✓	✓	✓	✓	✓
	Line Losses	✓	✓	✓	✓	✓
	Generation Capacity	✓	✓		✓	✓
	Ancillary Services	✓	✓		✓	✓
	Transmission Capacity	✓	✓		✓	✓
	Distribution Capacity		✓		✓	✓
	CO_2 Regulatory Price	✓	✓		✓	✓
	Voltage Support				✓	✓
	Criteria Pollutants	✓	✓		✓	✓
	Fuel Hedging / Diversity		✓		✓	
	Environmental Externalities		✓		✓	✓
Costs	Utility Administration	✓	✓		✓	✓
	Utility Integration	✓	✓		✓	✓
	Participant Bill Savings	✓				✓

Methodological Principles

- Utilize methodologies and tools from PUCN-commissioned independent NEM assessment from 2014 (via Energy + Environmental Economics)
- Utilize publically available data, largely from NV Energy and PUCN

Nevada NEM Public Tool + Updated Inputs for 2016+


Energy+Environmental Economics

Nevada NEM Public Tool

Prepared by:

Energy+Environmental Economics

101 Montgomery Street, Suite 1600
San Francisco, CA 94104
(415) 391-5100

May 1, 2014

Contents:

User Interface:

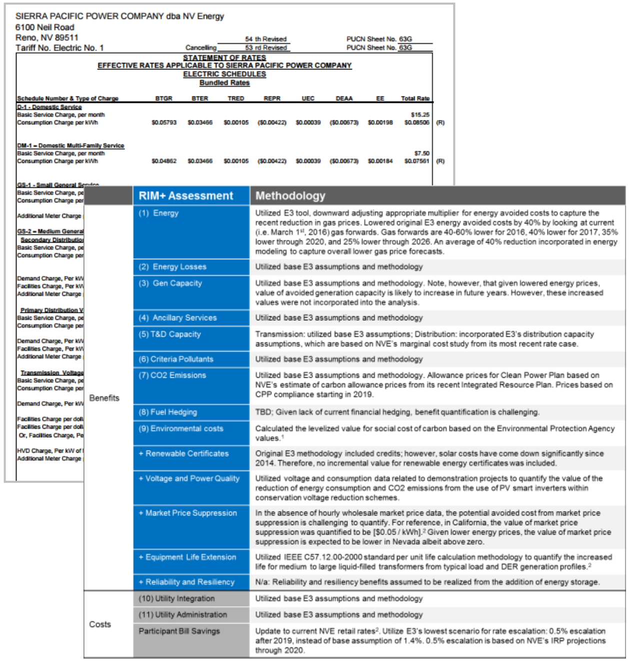
User Inputs	Assumptions and inputs available for the user to modify
Results	Summary result charts and tables ; user can specify result filters

Model Calculations:

Installations	Historical and forecasted installations by category and year
Capacity	Cumulative installed capacity by year (degraded and undegraded)
Energy Generation	Energy generation by category and year
Avoided Costs	Output from avoided cost calculator; avoided costs per kW installed by component and year
Avoided Costs by Component	Total avoided costs summarized by component
Bill Savings Inputs	Output from bill calculator; bill savings per kW installed by category
Annual Bill Savings	Total bill savings by category and year
Integration Costs	Integration costs by category and year
Program Costs	Program costs by category and year
Owner Costs	Output from pro forma finacial calculator; owner costs by category and year
All Costs	All cost test components by category; summarized in 25 yr NPV format
NVE South RPS Value	Avoided RPS generation by NEM systems in NVE South
NVE North RPS Value	Avoided RPS generation by NEM systems in NVE North
2013 RPS Compliance Report Data	Historical and forecasted annual renewable energy production from NVE Energy RPS Compliance Report
Load Forecasts	Load forecasts used to calculate avoided RPS generation values

Color Scheme:

orange	User Input
gray	Fixed Input
white	Calculation


SIERRA PACIFIC POWER COMPANY dba NV Energy
6100 Neil Road
Reno, NV 89511
Tariff No. Electric No. 1

STATEMENT OF RATES
EFFECTIVE RATES APPLICABLE TO SIERRA PACIFIC POWER COMPANY
ELECTRIC SCHEDULES
Bundled Rates

	RIM+ Assessment	Methodology
Benefits	(1) Energy	Utilized E3 tool, downward adjusting appropriate multiplier for energy avoided costs to capture the recent reduction in gas prices. Lowered original E3 energy avoided costs by 40% by looking at current (i.e. March 1st, 2016) gas forwards. Gas forwards are 40-60% lower for 2016, 40% lower for 2017, 35% lower through 2020, and 25% lower through 2026. An average of 40% reduction incorporated in energy modeling to capture overall lower gas price forecasts.
	(2) Energy Losses	Utilized base E3 assumptions and methodology
	(3) Gen Capacity	Utilized base E3 assumptions and methodology. Note, however, that given lowered energy prices, value of avoided generation capacity is likely to increase in future years. However, these increased values were not incorporated into the analysis.
	(4) Ancillary Services	Utilized base E3 assumptions and methodology
	(5) T&D Capacity	Transmission: utilized base E3 assumptions; Distribution: incorporated E3's distribution capacity assumptions, which are based on NVE's marginal cost study from its most recent rate case.
	(6) Criteria Pollutants	Utilized base E3 assumptions and methodology
	(7) CO2 Emissions	Utilized base E3 assumptions and methodology. Allowance prices for Clean Power Plan based on NVE's estimate of carbon allowance prices from its recent Integrated Resource Plan. Prices based on CPP compliance starting in 2019.
	(8) Fuel Hedging	TBD; Given lack of current financial hedging, benefit quantification is challenging.
	(9) Environmental costs	Calculated the levelized value for social cost of carbon based on the Environmental Protection Agency values.[1]
	+ Renewable Certificates	Original E3 methodology included credits; however, solar costs have come down significantly since 2014. Therefore, no incremental value for renewable energy certificates was included.
	+ Voltage and Power Quality	Utilized voltage and consumption data related to demonstration projects to quantify the value of the reduction of energy consumption and CO2 emissions from the use of PV smart inverters within conservation voltage reduction schemes.
	+ Market Price Suppression	In the absence of hourly wholesale market price data, the potential avoided cost from market price suppression is challenging to quantify. For reference, in California, the value of market price suppression was quantified to be [$0.05 / kWh].[2] Given lower energy prices, the value of market price suppression is expected to be lower in Nevada albeit above zero.
	+ Equipment Life Extension	Utilized IEEE C57.12.00-2000 standard per unit life calculation methodology to quantify the increased life for medium to large liquid-filled transformers from typical load and DER generation profiles.[2]
	+ Reliability and Resiliency	N/a: Reliability and resiliency benefits assumed to be realized from the addition of energy storage.
Costs	(10) Utility Integration	Utilized base E3 assumptions and methodology
	(11) Utility Administration	Utilized base E3 assumptions and methodology
	Participant Bill Savings	Update to current NVE retail rates[2]. Utilize E3's lowest scenario for rate escalation: 0.5% escalation after 2019, instead of base assumption of 1.4%. 0.5% escalation is based on NVE's IRP projections through 2020.

Methodological Principles

- Publish full methodology to enable others to recreate analysis and results
- Independently Peer Reviewed by following academics and stakeholders:

STANFORD UNIVERSITY

Mark Z. Jacobson, Ph.D.
Professor of Civil & Environmental Engineering
Director of Atmosphere/Energy Program
Senior Fellow, Precourt Institute for Energy

Joshua Eichman, Ph.D.
Visiting Scholar
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ROCKY MOUNTAIN INSTITUTE

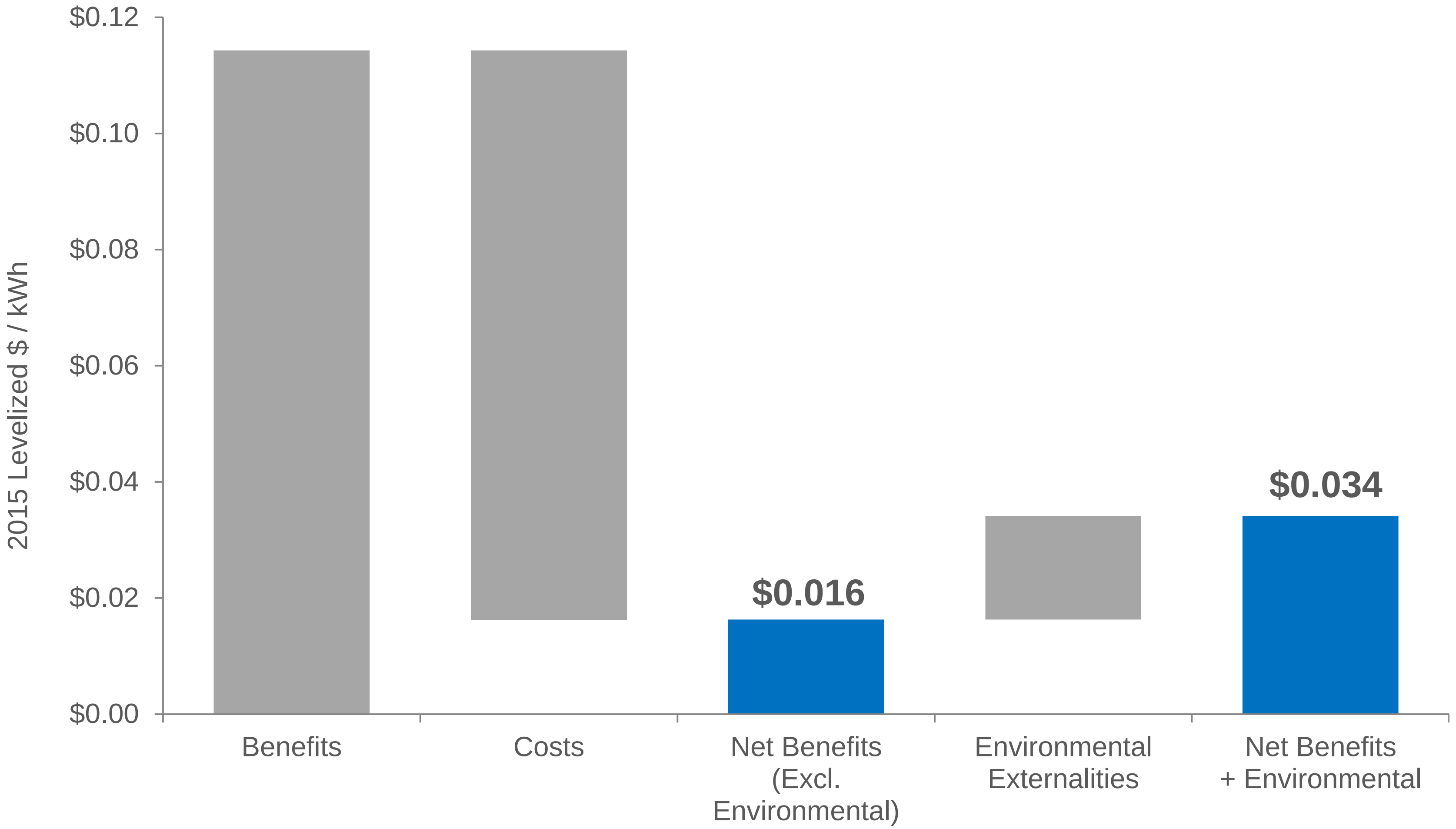
Virginia Lacy
Principal, Electricity Practice
Rocky Mountain Institute

ENERGY INNOVATION POLICY & TECHNOLOGY LLC

Michael O'Boyle
Policy Analyst
Energy Innovation

When full benefits are measured, NEM saves ALL customers

Full cost/benefit analysis performed by SolarCity and NRDC utilizing methodology as specified by PUC Nevada working group



Source: Analysis utilizing E3 Nevada Public Tool and specified inputs and methodologies

Detailed Results

Annual Net Benefits of 2017-2019 NEM Rooftop Solar Deployments

Type	Benefit and Cost Category	Net Benefits (Excl. Environmental)	Net Benefits + Environmental
		2015 Levelized cents/kWh	
Benefits	Energy	3.7	Same
	Line Losses	0.4	Same
	Generation Capacity	2.6	Same
	Ancillary Services	0.1	Same
	Transmission & Distribution Capacity	2.8	Same
	CO_2 Regulatory Price	0.9	Same
	Voltage Support	0.9	Same
	Criteria Pollutants	Not included	0.1*
	Environmental Externalities	Not included	1.7*
	Total Benefits	**11.4**	**13.2**
Costs	Program Costs	0.1	Same
	Integration Costs	0.2	Same
	Participant Bill Savings	9.5	Same
	Total Costs	**9.8**	**9.8**
	Total Net Benefits	**1.6 cents/kWh**	**3.4 cents/kWh**

*More recent academic studies estimate the criteria pollutants cost to be up to 5 cents/kWh[22] and the social cost of carbon to be as high as 12 cents/kWh in Nevada.[23]

Energy

- Methodology for Avoided Energy
  - Used Public Tool’s standard framework, but updated the energy-related values to reflect the dramatic drop in natural gas prices
  - Compared historical gas forward curves to current gas forwards to create annual adjustment factors
  - These adjustment factors were applied to the avoided cost categories for energy, losses, and ancillary services

Avoided Energy Adjustment

Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026-2043
Adjustment	-41%	-30%	-33%	-35%	-35%	-34%	-32%	-31%	-29%	-27%	-26%

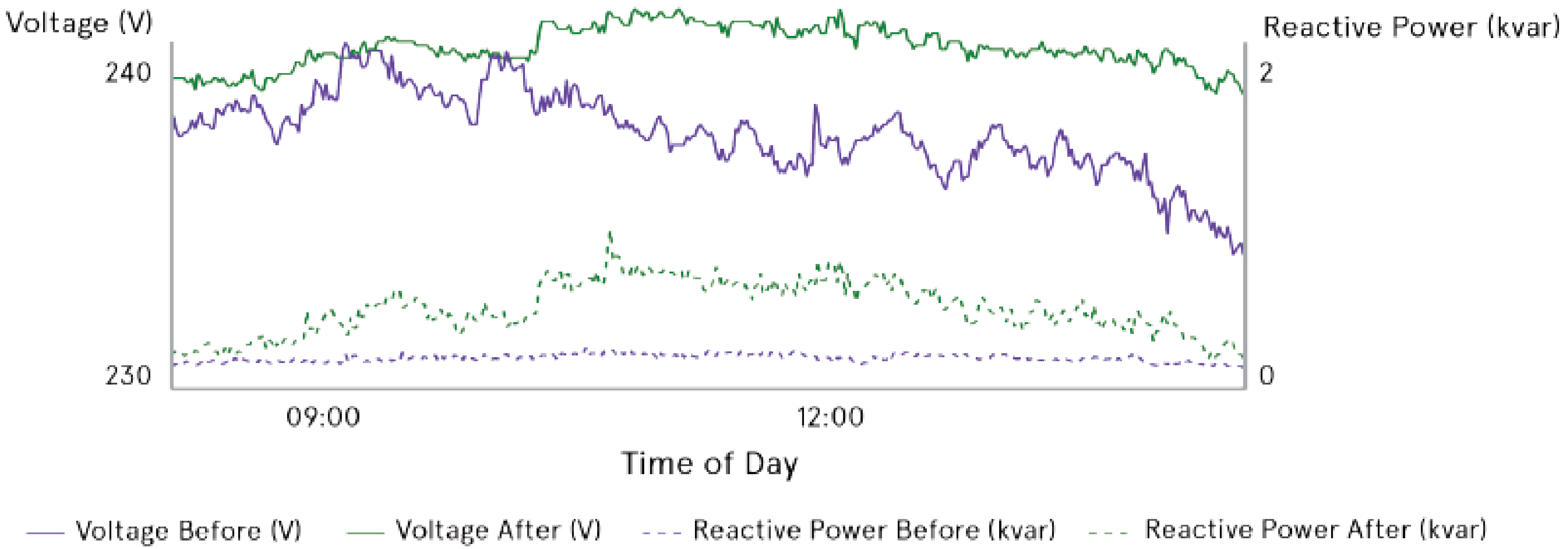
Generation Capacity

- Methodology
  - Did not make any modifications to Public Tool's standard approach
  - Resource balance years from NVE 2013 IRPs inform when the transition occurs between short-run marginal capacity costs and long-run marginal capacity costs
  - The full capacity value is then discounted (using the same factor used within NVE's IRPs) to reflect the proportion of nameplate capacity assumed to contribute toward system reliability

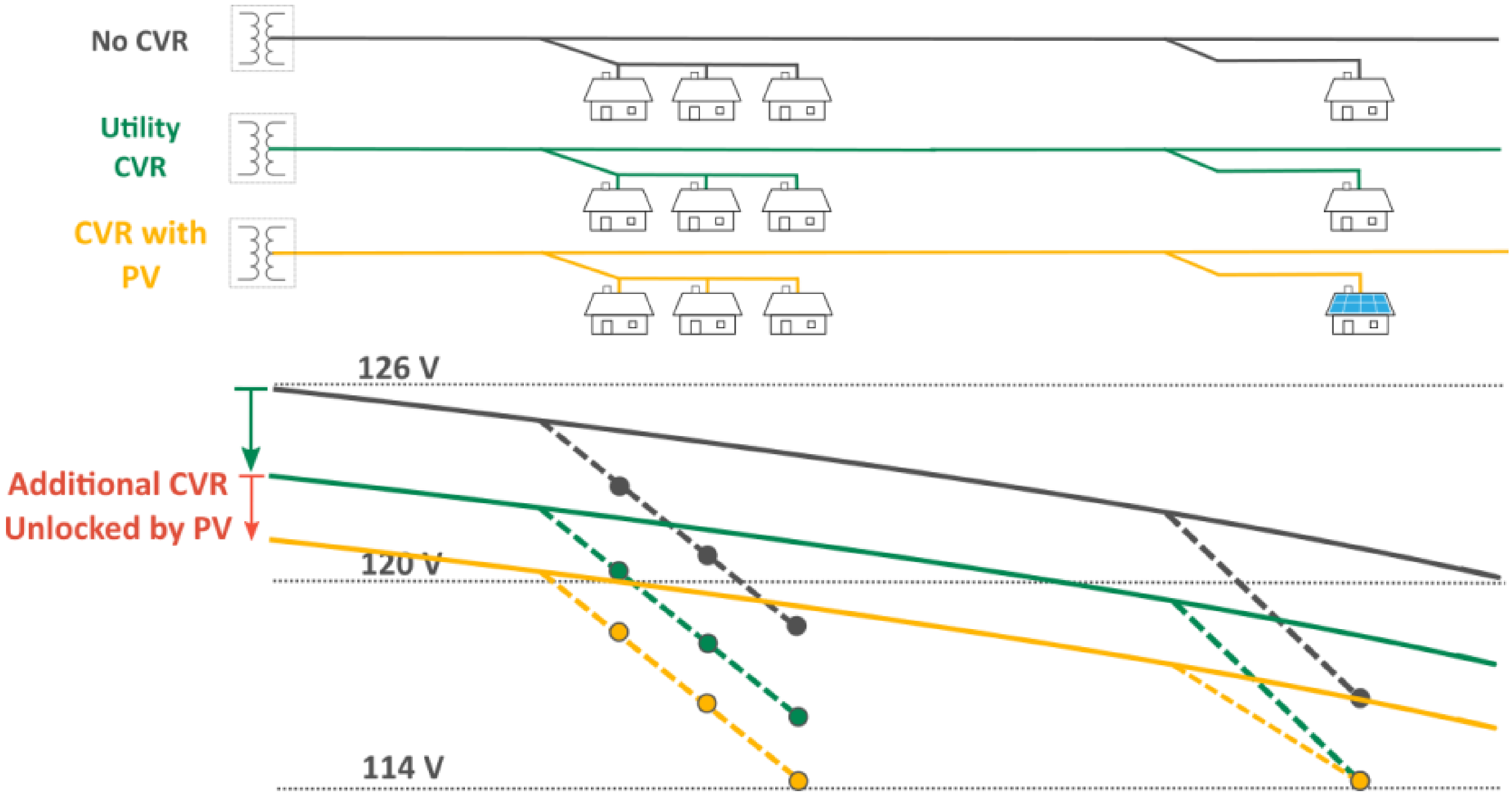
- Alternative Methodology
  - Sierra Pacific Power's recently approved 2nd Amendment to its 2014-2016 Action Plan (Docket No. 15-08011) included a new methodology for calculating the avoided cost payments for up to 25 MWs of PURPA QF contracts.
  - This methodology produced monthly average $/MWh rates that NVE indicates will serve as a cap on long-term payments to winning bids in future competitive QF solicitations.

- Rationale: We considered replacing the values in the Public Tool framework with these "Capped Long-Term Avoided Costs" as approved in the IRP docket, but decided against it for the following reasons:
  - Using these monthly average values would lose the hourly granularity that the Public Tool approach is based upon. *Hourly granularity* is important to properly reflect the coincidence of solar generation with hourly prices.
  - These capped LTAC values were approved for a *narrow and specific purpose*. They have not been approved as the basis for compensating DG or as the benchmark for assessing the cost-effectiveness of other demand side programs like EE and DR.
  - The basis for compensating wholesale supply side resources is fundamentally different than quantifying the value of retail distributed assets, as they are fundamentally *different products*.

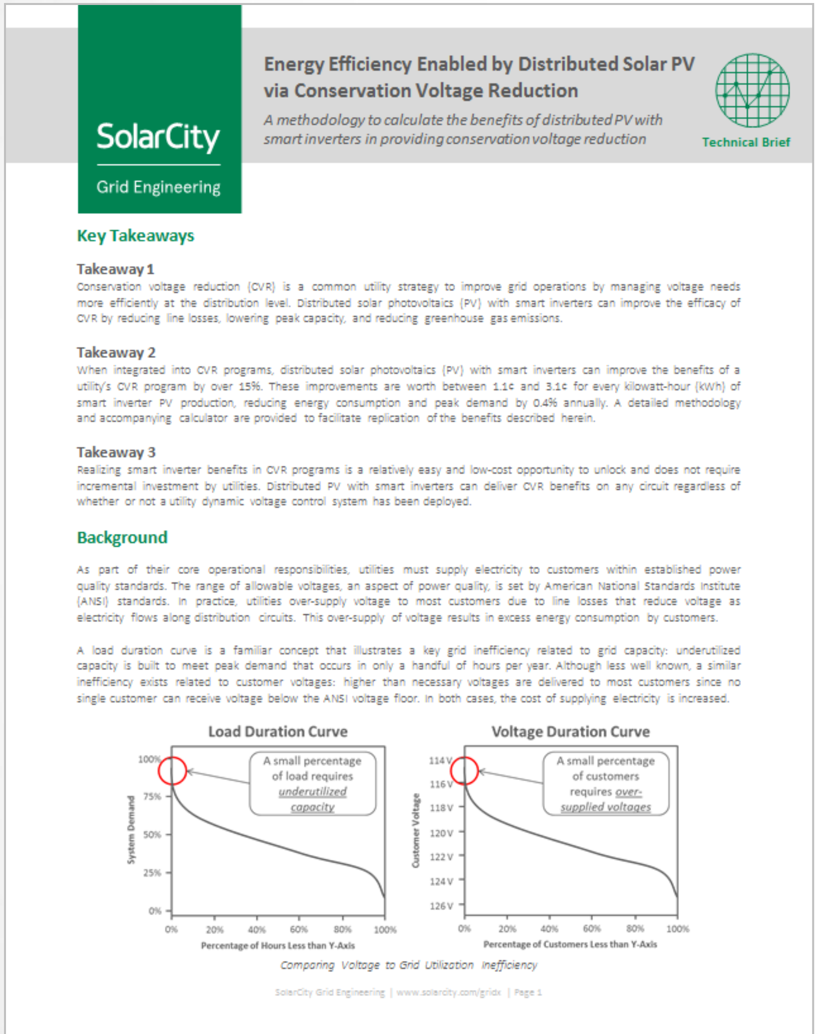
Voltage Support



Conservation Voltage Reduction (CVR)



CVR Methodology and Calculator



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Energy Efficiency Enabled by Distributed Solar PV via Conservation Voltage Reduction

A methodology to calculate the benefits of distributed PV with smart inverters in providing conservation voltage reduction

Technical Brief

Key Takeaways

Takeaway 1

Conservation voltage reduction (CVR) is a common utility strategy to improve grid operations by managing voltage needs more efficiently at the distribution level. Distributed solar photovoltaics (PV) with smart inverters can improve the efficacy of CVR by reducing line losses, lowering peak capacity, and reducing greenhouse gas emissions.

Takeaway 2

When integrated into CVR programs, distributed solar photovoltaics (PV) with smart inverters can improve the benefits of a utility's CVR program by over 15%. These improvements are worth between 1.1¢ and 3.1¢ for every kilowatt-hour (kWh) of smart inverter PV production, reducing energy consumption and peak demand by 0.4% annually. A detailed methodology and accompanying calculator are provided to facilitate replication of the benefits described herein.

Takeaway 3

Realizing smart inverter benefits in CVR programs is a relatively easy and low-cost opportunity to unlock and does not require incremental investment by utilities. Distributed PV with smart inverters can deliver CVR benefits on any circuit regardless of whether or not a utility dynamic voltage control system has been deployed.

Background

As part of their core operational responsibilities, utilities must supply electricity to customers within established power quality standards. The range of allowable voltages, an aspect of power quality, is set by American National Standards Institute (ANSI) standards. In practice, utilities over-supply voltage to most customers due to line losses that reduce voltage as electricity flows along distribution circuits. This over-supply of voltage results in excess energy consumption by customers.

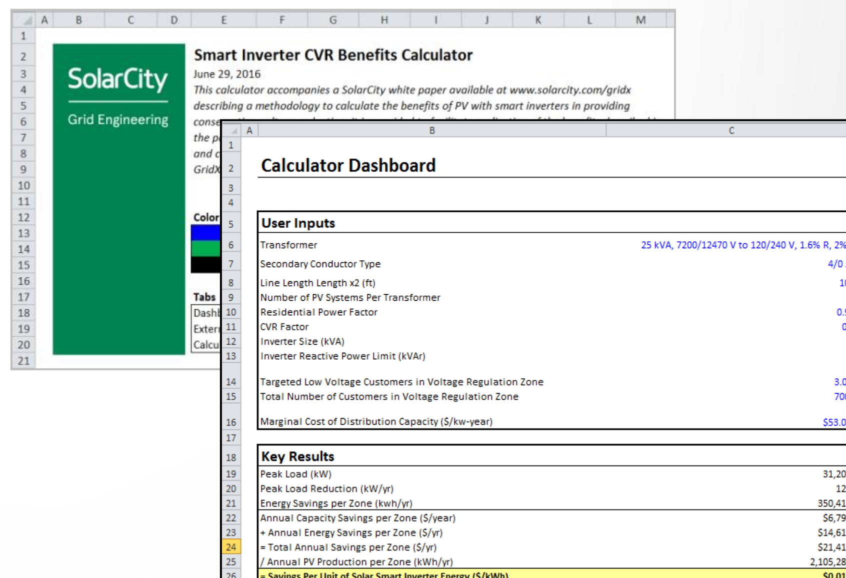
A load duration curve is a familiar concept that illustrates a key grid inefficiency related to grid capacity: underutilized capacity is built to meet peak demand that occurs in only a handful of hours per year. Although less well known, a similar inefficiency exists related to customer voltages: higher than necessary voltages are delivered to most customers since no single customer can receive voltage below the ANSI voltage floor. In both cases, the cost of supplying electricity is increased.

Comparing Voltage to Grid Utilization Inefficiency

SolarCity Grid Engineering | www.solarcity.com/gridx | Page 1

Energy Efficiency Enabled by Distributed Solar PV via Conservation Voltage Reduction

A methodology to calculate the benefits of distributed PV with smart inverters in providing conservation voltage reduction



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Smart Inverter CVR Benefits Calculator

June 29, 2016

This calculator accompanies a SolarCity white paper available at www.solarcity.com/gridx describing a methodology to calculate the benefits of PV with smart inverters in providing

Color

Tabs

Calculator Dashboard

User Inputs	
Transformer	25 kVA, 7200/12470 V to 120/240 V, 1.6% R, 2% X
Secondary Conductor Type	4/0 Al
Line Length Length x2 (ft)	100
Number of PV Systems Per Transformer	1
Residential Power Factor	0.95
CVR Factor	0.8
Inverter Size (kVA)	5
Inverter Reactive Power Limit (kVAr)	5
Targeted Low Voltage Customers in Voltage Regulation Zone	3.0%
Total Number of Customers in Voltage Regulation Zone	7000
Marginal Cost of Distribution Capacity ($/kw-year)	$53.00
Key Results	
Peak Load (kW)	31,200
Peak Load Reduction (kW/yr)	128
Energy Savings per Zone (kwh/yr)	350,412
Annual Capacity Savings per Zone ($/year)	$6,798
+ Annual Energy Savings per Zone ($/yr)	$14,613
= Total Annual Savings per Zone ($/yr)	$21,411
/ Annual PV Production per Zone (kWh/yr)	2,105,287
= Savings Per Unit of Solar Smart Inverter Energy ($/kWh)	**$0.010**

NRDC | SolarCity

Thank you