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

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of distributed resources’ contribution to the grid, financial disincentives embedded in utility regulatory models, and outdated grid planning procedures are preventing full utilization of these assets.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. 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.

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 1). 1.6 cents/kWh includes benefits that are directly captured by the utility, while 3.4 cents/kWh includes environmental externality benefits that all Nevadans at large.


solarcity.com/gridx
To update discussion, SolarCity and NRDC repeated 2014 independent analysis with updated data

<table>
<thead>
<tr>
<th>Categories</th>
<th>E3 NEM Study (July 2014)</th>
<th>PUCN NEM Order (Fall 2015)</th>
<th>PUCN NEM Decision (Dec 2015)</th>
<th>PUCN Order: Sierra Pac IRP (April 2016)</th>
<th>Study Scope (May 2016)</th>
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<tbody>
<tr>
<td>Benefits</td>
<td></td>
<td></td>
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<td>Voltage Support</td>
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<tr>
<td>Utility Integration</td>
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<tr>
<td>Participant Bill Savings</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
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+

Methodology:

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Energy</td>
<td>Used EIS tool to assess project data to determine the impact of energy projects on the grid.</td>
</tr>
<tr>
<td>Energy + Environmental Economics</td>
<td>Used tools and methodologies.</td>
</tr>
<tr>
<td>Emissions</td>
<td>Calculated the emissions reduction or increase due to the project.</td>
</tr>
<tr>
<td>Economic Costs</td>
<td>Calculated the economic costs associated with the project.</td>
</tr>
</tbody>
</table>
Methodological Principles

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

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
Department of Civil and
Environmental Engineering

Tim Yeskoo, M.S.
Ph.D. Candidate
Department of Civil and
Environmental Engineering

Daniel Lashof, Ph.D.
Chief Operating Officer
NextGen Climate America, Inc.

Virginia Lacy
Principal, Electricity Practice
Rocky Mountain Institute

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**

<table>
<thead>
<tr>
<th>Type</th>
<th>Benefit and Cost Category</th>
<th>Net Benefits (Excl. Environmental)</th>
<th>Net Benefits + Environmental</th>
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</thead>
<tbody>
<tr>
<td>Benefits</td>
<td>Energy</td>
<td>3.7</td>
<td>Same</td>
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<tr>
<td></td>
<td>Line Losses</td>
<td>0.4</td>
<td>Same</td>
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<td></td>
<td>Generation Capacity</td>
<td>2.6</td>
<td>Same</td>
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<td></td>
<td>Ancillary Services</td>
<td>0.1</td>
<td>Same</td>
</tr>
<tr>
<td></td>
<td>Transmission &amp; Distribution Capacity</td>
<td>2.8</td>
<td>Same</td>
</tr>
<tr>
<td></td>
<td>CO₂ Regulatory Price</td>
<td>0.9</td>
<td>Same</td>
</tr>
<tr>
<td></td>
<td>Voltage Support</td>
<td>0.9</td>
<td>Same</td>
</tr>
<tr>
<td></td>
<td>Criteria Pollutants</td>
<td>Not included</td>
<td>0.1*</td>
</tr>
<tr>
<td></td>
<td>Environmental Externalities</td>
<td>Not included</td>
<td>1.7*</td>
</tr>
<tr>
<td></td>
<td><strong>Total Benefits</strong></td>
<td><strong>11.4</strong></td>
<td><strong>13.2</strong></td>
</tr>
<tr>
<td>Costs</td>
<td>Program Costs</td>
<td>0.1</td>
<td>Same</td>
</tr>
<tr>
<td></td>
<td>Integration Costs</td>
<td>0.2</td>
<td>Same</td>
</tr>
<tr>
<td></td>
<td>Participant Bill Savings</td>
<td>9.5</td>
<td>Same</td>
</tr>
<tr>
<td></td>
<td><strong>Total Costs</strong></td>
<td><strong>9.8</strong></td>
<td><strong>9.8</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Total Net Benefits</strong></td>
<td><strong>1.6 cents/kWh</strong></td>
<td><strong>3.4 cents/kWh</strong></td>
</tr>
</tbody>
</table>

*More recent academic studies estimate the criteria pollutants cost to be up to 5 cents/kWh\(^2\) and the social cost of carbon to be as high as 12 cents/kWh in Nevada.\(^3\)*
# 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

<table>
<thead>
<tr>
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<tr>
<td>Adjustment</td>
<td>-41%</td>
<td>-30%</td>
<td>-33%</td>
<td>-35%</td>
<td>-35%</td>
<td>-34%</td>
<td>-32%</td>
<td>-31%</td>
<td>-29%</td>
<td>-27%</td>
<td>-26%</td>
</tr>
</tbody>
</table>
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

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

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 photovoltaic (PV) with smart inverters can improve the efficiency of CVR by reducing the losses, lowering peak capacity, and reducing greenhouse 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 20%. These improvements are worth between $1.4 and $1.6 for every dollar invested in distributed solar PV production, reducing energy consumption and peak demand by 0.5% annually. A detailed methodology and accompanying calculator are provided to facilitate replication of the benefits described herein.

Takeaway 3
Reappraising 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 the 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. Underloaded capacity is built to meet peak demand that occurs in only a handful of hours per year. Although not well known, a smaller inefficient excess related to customer voltages higher than necessary voltages is delivered to most customers since no single customer can tolerate voltage below the ANSI voltage floor. In both cases, the cost of supplying electricity is increased.

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 conservation voltage reduction.

Calculator Dashboard

User Inputs

- Transformer: 25 kVA, 7200/120V or 230/480V, 1.00PF, 4, 234 E
- Secondary Conductor Type: 4/0-A
- Line Length (feet): 622
- Number of PV Systems Per Transformer: 2
- Residential Power Factor: 0.80
- CVR Zone
- Network Voltage (kV): 24.9
- Inverter Reactive Power Limit (kVAR): 0
- Targeted Low Voltage Customers in Voltage Regulation Zone: 1,000
- Total Number of Customers in Voltage Regulation Zone: 10,000
- Weighted Cost of Distributed Capacity (kW/hour): $0.015

Key Results

- Peak Load (kW): 3,300
- Peak Load Reduction (kW)(h): 10
- Annual Energy Savings per Zone (kWh)
- Annual Capacity Savings per Zone (kWh)
- Annual Energy Savings per Zone (GWh)
- Total Annual Savings per Zone (GWh)
- Annual PV Production per Zone (kWh)
- Savings Per Unit of Solar-Exported Inverter Energy (kWh)

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Thank you