GAP Process Generic Scenario 1:
A Streamlined Economic Analysis for Community Solar in the Desert Southwest

September 2017
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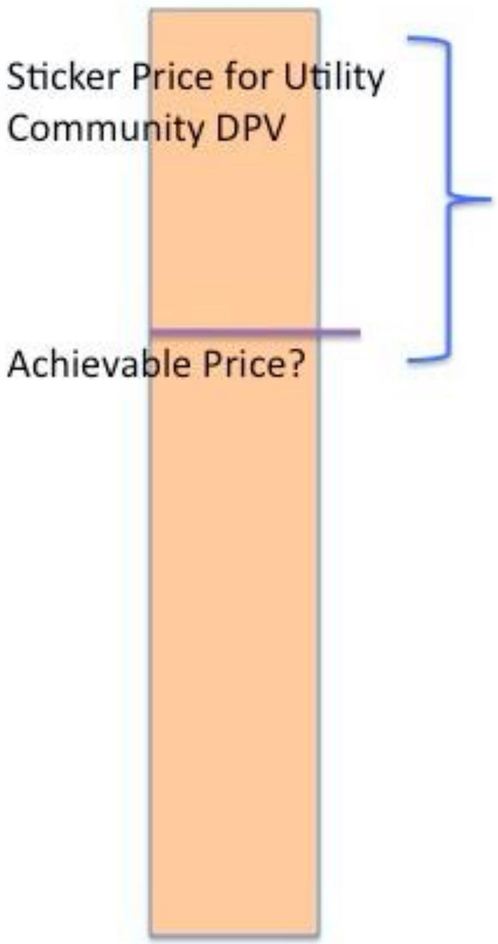
What is the GAP?



The GAP analysis is named for need to fill the gap between the baseline "sticker price" on a solar procurement and the net value that the utility can accept, in order to achieve competitive pricing on the program offer.

The GAP analysis is a process to "Get A Price" that reflects strategic DER value, but conforms closely enough to utility norms that it can be achieved and accepted by decision-makers in a relatively short time.

Methodology for the Study

CSVP's GAP analytic process evolved through a series of modeling exercises, supplemented by reviews from the Community Solar Value Project (CSVP) Utility Forum participants, led by Sacramento Municipal Utility District (SMUD) and the Platte River Power Authority. Models completed for these utilities were transformed into generic scenarios that preserved some situational characteristics, while replacing others to increase model replicability.

This scenario was modeled for a generic Southwest Desert Utility (IOU), based on available data sources and vetted with the CSVP Forum. *Readers are advised to review the GAP Process Summary Report before delving into this specific modeling report.*

Basis for the GAP Analytic Process

- One metric often used in evaluating resource acquisition decisions is the Levelized Cost of Energy (LCOE)
- LCOE is defined as the net present value (NPV) of project costs divided by the NPV of kWh output evaluated over the project life
- Traditionally, since most electricity resources were procured from central station projects on the transmission grid, only the NPV of project *costs* were compared
- When considering DERs, it is important to evaluate the *net* LCOE*,* which also incorporates incremental *benefits* of distributed PV on a levelized basis, i.e., the LBOE
- Even without including every possible benefit, the *net LCOE* analysis provides a more valid comparison of DPV resources

Purpose of the CSVP Scenario for the Desert Southwest Region

- The CSVP team developed generic scenarios to demonstrate value and pricing for Community Solar (CS) fleets in various geographic regions of the country
- The purpose of these analyses is to illustrate the impacts of various solar fleet configurations and distributed solar values customized for regions of the country with varying solar resource potential and distributed resource benefits
- The analysis for the Desert Southwest region was designed to demonstrate the value and economic viability of a 5-MW fleet of flat mount parking canopy PV structures in the hottest region of the country.
- In addition, the analysis demonstrates a simplified approach to CS program pricing that incorporates DPV benefits

DPV Value Streams / Screening and Analysis

To identify appropriate value streams for assessment, the first step is to collect data specific to the utility designing the CS program. This is accomplished with a *data collection form*. Some utility data should be readily available. Regarding solar value, the process encourages utility staff to provide *ranges of values* for DPV benefit categories that may be difficult to quantify.

For different regional scenarios in this study, the DPV values were based on available data from participating utilities. Then, ranges were estimated for data not readily available, utilizing the best data available for the region or for utilities with similar characteristics. A sample utility data request is illustrated below, and on the following slides.

Methodology for Valuing and Pricing the DPV Resource

- CSVP defines the LBOE categories as falling into four areas:
  - Generation
  - Transmission
  - Distribution
  - Societal
- The equations for calculating the net LCOE are:
  - $LCOE_{DPV\ NET} = LCOE_{DPV\ GROSS} - LBOE_{DPV}$
  - Where,

  $LBOE_{DPV} = LBOE_{GENERATION} + LBOE_{TRANSMISSION} + LBOE_{DISTRIBUTION} + LBOE_{SOCIETAL}$
- Once the $LCOE_{DPV\ NET}$ is calculated, the utility's non-bypassable wires charge is added to this value to provide an approximation for CS program pricing.

Equations

CSVP defines the LBOE categories as falling into four areas:

- Generation
- Transmission
- Distribution
- Societal

The equations for calculating the net LCOE are:

- $LCOE_{DPV\ NET} = LCOE_{DPV\ GROSS} - LBOE_{DPV}$
- Where,

↖PPA Price ↖DPV Benefits

$LBOE_{DPV} = LBOE_{GENERATION} + LBOE_{TRANSMISSION} + LBOE_{DISTRIBUTION} + LBOE_{SOCIETAL}$

Once the $LCOE_{DPV\ NET}$ is calculated, the utility's non-bypassable wires charge may be included, as usual, for bottom-line CS program pricing.

While some alteration of the wires charge may be warranted, most utilities find that very difficult to achieve. Modifications to support better pricing may be presented as an Adjusted PPA Price or Gross PPA Price + credit.

Universe of Benefits: Which Are the Minimum Required?

- Avoided transmission losses
- Avoided transmission ancillary services
- Reduced distribution line losses
- Distribution ancillary services
- Improved distribution capacity utilization; may avoid/defer upgrades

- Avoided costs of conventional wholesale power**
- Avoided/deferred conventional generation capacity investment**
- Fuel price hedging**

- Reduce GHG and other emissions**
- Reduce water use**
- Conserve ag land, sensitive land
- Meet local sustainability goals
- Other compliance values**

- Solar geographic diversity benefits, risk management
- Potential resilience benefits
- Solar siting, design & operational flexibility to capture strategic benefits

- Potential DR companion measures
- Potential customer-side storage
- Potential added project-design values, e.g., shading

** Also available to centralized PV projects

Benefits Selected for the Southwest Scenario

- The methodology is designed for a simplified analysis of a few high value benefits of DPV.
- The goal is not to “stack the bar chart” of DPV benefits as high as possible, but to estimate an approximate value of DPV that enables the utility to price the CS product competitively in the marketplace.
- Selecting a few of the highest value benefits for the utility, and using ranges of values and conservative values will help to avoid internal debate over the right numbers
- For the Southwest case, we pre-screened for four variables for the LBOE analysis:
    - Avoided Transmission Access Charges
    - Strategic Solar Design – PV Canopy Benefits
    - Avoided Energy Losses – Transmission and Distribution
    - Security - Grid Resiliency and Reliability

The Desert Southwest Narrative

For This Case:

- A hypothetical utility with a service area in the Desert Southwest (TMY3 data for an Arizona location was used for the solar PV performance modeling)
- This region was selected due to a number of factors:
    - One the best solar resources in the nation
    - One of the hottest climates in the country
    - Summer AC-driven peak loads drive higher wholesale energy prices
    - PV canopy output has a complementary, though not perfect, generation profile with high-cost summer peak loads
    - During the hot summer peak periods, grid reliability is critical
- A 5 MW CS fleet of parking canopy PV structures strategically located on the grid to optimize resiliency and reliability benefits
- Estimated PPA price of the 5 MW PV canopy fleet: $0.103/kWh
- 30-yr PPA on the PV resource
- Utility-led, tariff-based CS program w/ full wires charges

Data Collection and Development

- Data was reviewed and analyzed for the DPV values listed below. Based on a review of data from publicly available sources, and the documentation of ranges of data, the DPV values were estimated utilizing the best data available for the region and extrapolation from other regions of the country with similar characteristics.

DATA VARIABLE	DESCRIPTION	UNITS	VALUE USED IN THIS ANALYSIS	ESTIMATED VALUE AT LOW END OF RANGE	ESTIMATED VALUE AT HIGH END OF RANGE
GENERATION SYSTEM LEVEL					
• Avoided wholesale energy and capacity purchases during PV production hours for a conventional fixed tilt mount (33.5°) PV system	• For this analysis, a proxy was used assuming the avoided generation was a natural gas combined cycle turbine. As per the EIA, the expected levelized avoided cost of energy for a PV project is $0.052/kWh	$/MWh	$0.052/kWh	$0.045/kWh	$0.09/kWh
• New generation capacity deferral or avoidance	• The value of new planned generation ($/MW) or PPAs ($/MWh) from non-solar resources deferred or avoided from DPV.	$/MW-year or $/MWh	Not Used	$0.005/kWh	$0.11/kWh
TRANSMISSION SYSTEM LEVEL					
• Avoided transmission line losses	• The line losses on the transmission system that are avoided as a result of DPV. If data is not available for real-time PV output, then system averages may be used.	%	3%	2%	4%
• Avoided transmission charges	• Avoided transmission access charges	$/MWh	$0.01/kWh	$0.018/kWh	$0.03/kWh
• Avoided ancillary service costs	• The value of avoided ancillary service costs during the periods of PV generation. If data is not available for real-time PV output, then system averages may be used.	$/MWh	Not Used	-$0.000005/MWh	$0.000015/MWh

Data Collection and Development (cont.)

DATA VARIABLE	DESCRIPTION	UNITS	VALUE USED IN THIS ANALYSIS	ESTIMATED VALUE AT LOW END OF RANGE	ESTIMATED VALUE AT HIGH END OF RANGE
DISTRIBUTION SYSTEM LEVEL					
• Avoided distribution line losses	• The real-time line losses on the distribution system level that are avoided as a result of distributed PV generation.	%	6.3%	1.5%	6.3%
• Ancillary service value	• The value of ancillary services provided by distributed PV, including but not limited to: • frequency and regulation support • reactive power • voltage support • spinning reserves	\$/MWh-year	Not Used	N/A	N/A
• Improved capacity utilization, and potentially deferred or avoided equipment upgrades and/or O&M	• The value of improved capacity utilization and deferred/avoided equipment upgrades and/or O&M	\$/MW-year (cite applicable years)	Not Used	\$0.0/kWh	\$0.07/kWh
• Grid resiliency • Reliability • Disaster recovery • Micro-grid capability	• The value of distributed PV resources in providing grid resiliency, reliability, and disaster recovery related services	\$/MWh or \$/MW-year	\$0.01/kWh	\$0.01/kWh	\$0.023/kWh

Data Collection and Development (cont.)

DATA VARIABLE	DESCRIPTION	UNITS	VALUE USED IN THIS ANALYSIS	ESTIMATED VALUE AT LOW END OF RANGE	ESTIMATED VALUE AT HIGH END OF RANGE
SOCIETAL BENEFITS					
• Avoided CO_2 emissions • Other avoided emissions • Avoided water consumption • Regulatory compliance (i.e., RPS, IRP, S-REC)	• These potential benefits are aggregated to capture any potential societal benefits that are directly monetized by the utility, or are anticipated to be directly monetized within the 30-year analysis period.	$/MWh	Not Used	$0.001/kWh	$0.04/kWh
UTILITY STRATEGIC VALUE BENEFITS					
• Economic development; sustainability targets • Grid modernization and electrification • Additional risk-management values • Customer service, including equity	• As these utility strategic value benefits are difficult to quantify and/or monetize, please provide brief written summaries on how these values positively impact the utility, its goals, and its overall mission as applicable.	Qualitative Discussion	Not Used		
• Customer retention / competitiveness value	• The customer retention value is the value that distributed community solar PV resources has in terms of keeping the customer and not losing them (and their revenues) to a third party PV provider.	$/MWh	Not Used		

- For this case, 4 DPV values were used for the LBOE analysis:
  - Avoided Transmission Access Charges
  - Strategic Design Value of PV Canopy Systems
  - Avoided Transmission and Distribution Energy Losses
  - Grid Resiliency and Reliability from Strategic Location

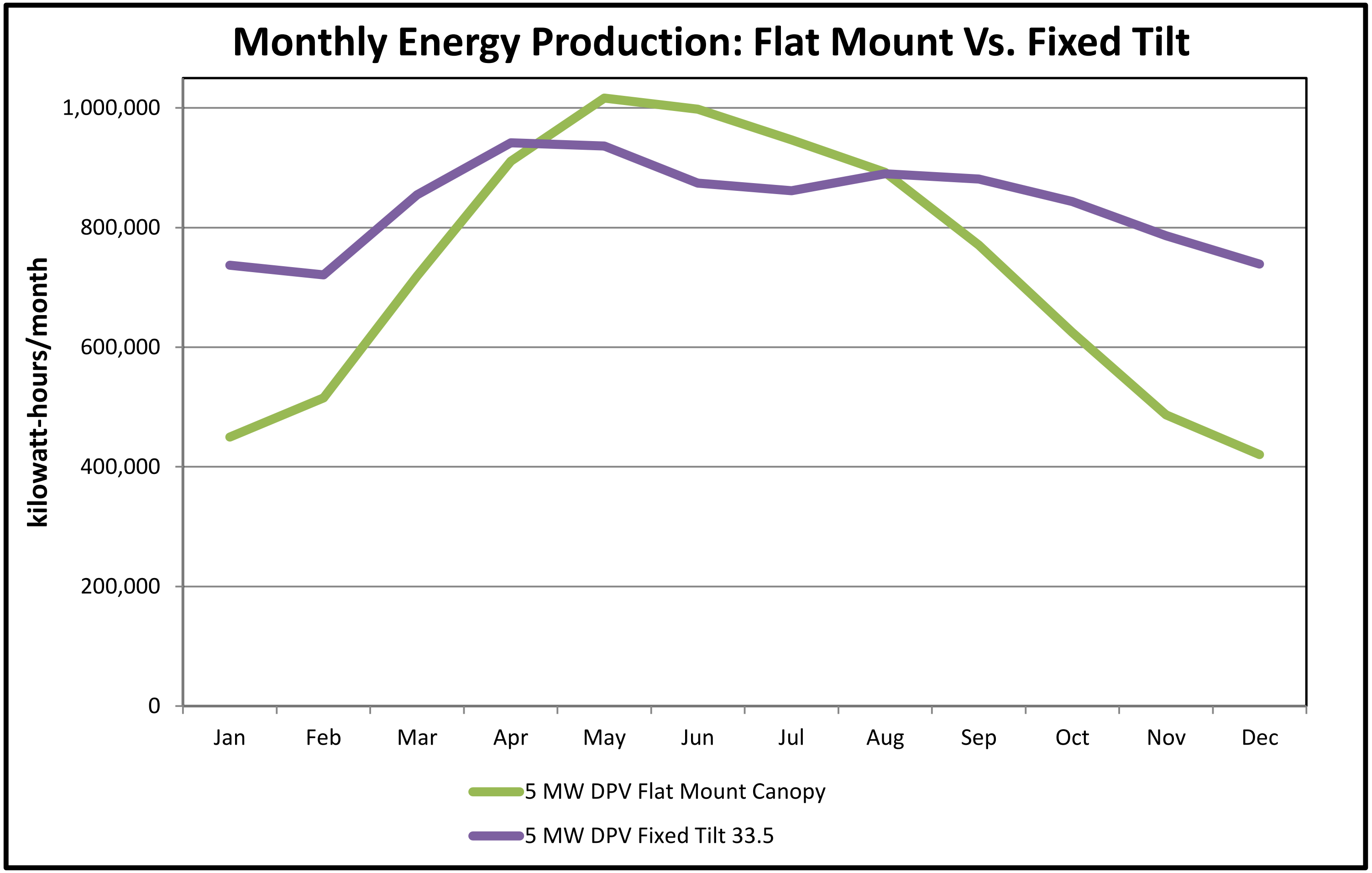
1. Avoided Transmission Access Cost Benefits

- Not all transmission costs are avoided on a 1:1 basis
- Yet we know now that DPV avoids significant Transmission Access Charge (TAC) costs; several sources are above beyond EIA's "postage stamp" avoided cost estimate of $0.016/kWh.
- Example: A recent filing with the Arizona Corporate Commission suggests $0.03/kWh value for avoided TAC charges from DPV resources – other studies on avoided costs of transmission support these higher end value estimates.
- For this case in the Desert Southwest, a conservative $0.01/kWh LBOE for avoided TAC costs was used in the analysis.

2. Strategic DPV Design Benefit

- Incremental benefit of the avoided wholesale power cost savings provided by a parking canopy PV system relative to a conventional fixed-tilt PV system:
  - 5 MW flat-mount parking canopy PV system: $0.005/kWh on a levelized basis

In the Desert Southwest region, flat-mount carports offer summer peak production benefits that supplant high-priced AC-driven peak wholesale energy purchases. While the PV generation profile does not perfectly match with regional utilities' system load profiles, it does provide significant savings from avoided peak period energy purchases/generation.



Annual Energy Production Comparison:

- **Fixed Tilt: Baseline**
- **Flat Mount Canopy: -13%**

Summer Season Energy Production Comparison:

- **Fixed Tilt: Baseline**
- **Flat Mount Canopy: +8%**

3. Avoided Transmission & Distribution Energy Losses

- Avoided transmission and distribution system losses are often included in DPV value analyses, as generation near system loads reduces T&D line losses and proportional purchases of energy.
- T&D system losses have traditionally been undervalued in DPV benefit analyses, as very little real-time data is available on avoided line losses during the periods of PV generation. As a result, T&D system loss averages are typically used. However, DPV generation occurs when system loads and ambient temperatures are highest, which corresponds to increased line losses.
- For this analysis, we relied on data from a Lawrence Berkeley Labs report which cites a time-differentiated avoided energy line loss value on the distribution system from DPV generation of 6.3% within the study region. It also cites avoided capacity line losses of 11%; this value was not used in the analysis as capacity prices in the Southwest have been low, historically.
- This analysis also incorporated a transmission system level line loss of 3%, which is a proxy for a average annual line loss value. Together, avoided T&D line losses from DPV were estimated at 9.3%.
- The LBOE of avoided T&D line losses was determined multiplying 9.3% of the DPV fleet's annual energy generation by the Levelized Avoided Cost of Energy (LACE) from PV generation. The LACE value used is the lowest value in the range provided by EIA of $0.052/kWh.
- The resulting LBOE of T&D energy losses correspondingly was $0.052/kWh

4. Grid Resilience and Reliability

- DPV can provide distribution system benefits by increasing the resilience and reliability of local grids.
- This value can be provided by:
  - Reducing outages and congestion along the T&D network
  - Reducing large-scale outages through strategic geographic dispersion of DPV and increasing the diversity within the distribution system's generation and energy management technology portfolio
  - Providing back-up power sources during m outages through the combination of DPV, energy management, and grid isolation strategies.
- This strategic DPV value was included in the Desert Southwest region study due to the fact that grid reliability is a premium value in the hottest region of the country. As distribution systems become stressed on the hottest days of the year, it is critical to human health and life to ensure that outages do not occur. DPV can play a role enhancing grid security and reliability.
- The Rocky Mountain Institute in its review of solar PV benefit and cost cites a range of values between 1.0 and 2.3 cents per kWh for the benefits of DPV in providing grid reliability and resiliency support.
- For this analysis, CSVP selected the low value in the range of 1.0 cents/kWh

Results from the Net LCOE Analysis

- $LCOE_{DPV\ NET} = LCOE_{DPV\ GROSS} - LBOE_{DPV}$
- Where,

$LBOE_{DPV} = LBOE_{TRANSMISSION} + LBOE_{DISTRIBUTION}$

$LBOE_{DPV} = LBOE_{TRANSMISSION\ COSTS} + LBOE_{STRATEGIC\ DESIGN} + LBOE_{T\&D\ LOSSES} + LBOE_{GRID\ RELIABILITY}$

$LBOE_{DPV}$= 1.0 cents + 0.5 cents + 0.5 cents + 1.0 cents

$LBOE_{DPV}$= 3.0 cents

- Then,

$LCOE_{DPV\ NET}$ = 10.3 cents – 3.0 cents = 7.3 cents

Additional Economic Analysis Results

- In additional to the net LCOE analysis, CSVP also calculated conventional metrics of the value of CS in DPV applications. These metrics were based on the assumed 5 MW fleet of parking canopy PV system geographically dispersed throughout a utility service area.
- The metrics and corresponding values for this scenario are:
  - Real Value of Lifecycle Cash Value (2017$): $14.0M
  - Net Present Value of Lifecycle Cash Flow: $6.2M
  - Average Annual Cash Flow (2017$): 465,000
  - Years to Cash Flow Positive: <1
  - Internal Rate of Return: N/A since cash flow positive from Year 1
  - Benefit-Cost Ratio: 1.6

Pricing Analysis of the Community Solar Program

- The final step of the valuation of DPV in CS applications for the Desert Southwest case was to develop an indicative pricing estimate.
- The approach to developing indicative pricing is simple and straightforward. The methodology starts with the calculated *net* LCOE for the CS program fleet, and then adds the non-bypassable wires charge provided in the current residential rate tariff (conservatively assuming that this charge is temporarily unchangeable).
- This approach to indicative program pricing allows for full cost recovery and revenue retention based on the existing non-bypassable wires charge for the utility. Rather than subtracting DPV benefits from existing wires charges, the benefits are already accounted for in the *net* LCOE calculation.
- For this regional case, the program price is estimated at 10.4 cents per kWh.
- Based on a preliminary review of existing residential retail rates in the region, as well as the PPA/lease rates of third-party NEM PV systems – the indicative CS program pricing is in a competitive range with existing utility rates in the region, as well as private NEM offerings.

The Analyst and the Project

Joe Bourg is President and Founder of Millennium Energy, LLC and is lead project analyst for CSVP. He focuses on utility solar program design and evaluation and solar project development support, including business model assessment.

The Community Solar Value Project is focused on improving community-solar program value, through solar + storage + DR and other strategies, at electric utilities in Sacramento and beyond. Led by Extensible Energy, LLC, and drawing on support from four additional firms, CSVP provides expert utility-process leadership and tools. Contact info@communitysolarvalueproject.com

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Small Print: Acknowledgements and Disclaimer

This paper include information, data, or work funded in part by the Office of Energy Efficiency and Renewable Energy (EERE), U.S. Department of Energy, an agency of the United States Government, under Award Number DE-EE0006905.

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