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VALUE AND COST OF DISTRIBUTED GENERATION (INCLUDING NET METERING).	Docket No. E-00000J-14-0023

NOTICE OF FILING

The RESIDENTIAL UTILITY CONSUMER OFFICE ("RUCO") hereby provides notice of filing the Direct Testimony of Lon Huber in the above referenced matter.

RESPECTFULLY SUBMITTED this 25th day of February, 2016.

Daniel W. Pozefsky
Chief Counsel

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Arizona Corporation Commission
1200 West Washington
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COPIES of the foregoing hand delivered/ mailed this 25th day of February, 2016 to:

Teena Jibilian
Hearing Division
Arizona Corporation Commission
1200 West Washington
Phoenix, Arizona 85007

Maureen Scott
Matthew Laudone
Legal Division
Arizona Corporation Commission
1200 West Washington
Phoenix, Arizona 85007
tford@azcc.gov
rlloyd@azcc.gov
tbroderick@azcc.gov
mlaudone@azcc.gov
mscott@azcc.gov
Consented to Service by Email

Dillon Holmes
Clean Power Arizona
9635 N. 7th Street, #47520
Phoenix, Arizona 85068
dillon@cleanpoweraz.org
Consented to Service by Email

C. Webb Crockett
Patrick Black
Fennemore Craig, P.C.
2394 E. Camelback Road, Suite 600
Phoenix, Arizona 85016-3429
wcrockett@fclaw.com
pblack@fclaw.com
Consented to Service by Email

Garry Hays
Law Offices of Garry D. Hays, PC
2198 E. Camelback Road, Suite 305
Phoenix, Arizona 85016
Attorney for Arizona Solar Deployment Alliance

Court Rich
Rose Law Group, PC
7144 E. Stetson Dr., Suite 300
Scottsdale, Arizona 85251
Attorneys for The Alliance for Solar Choice
CRich@RoseLawGroup.com
Consented to Service by Email

Timothy Hogan
Arizona Center for Law in the Public Interest
514 W. Roosevelt St.
Phoenix, Arizona 85003
Attorneys for Vote Solar and Western Resource Advocates
thogan@aclpi.org
rick@votesolar.org
briana@votesolar.org
ken.wilson@westernresources.org
Consented to Service by Email

Michael Hiatt
Earthjustice
633 17th Street, Suite 1600
Denver, Colorado 80202
Attorney for Vote Solar

Craig Marks
Craig A. Marks, PLC
10645 N. Tatum Blvd., Suite 200-676
Phoenix, Arizona 85028
Attorney for Arizona Utility Ratepayer Alliance
Craig.Marks@azbar.org
Consented to Service by Email

Meghan Grabel
Osborn Maledon, PA
2929 N. Central Ave., Suite 2100
Phoenix, Arizona 85012
mgrabel@omlaw.com
gyaquinto@arizonaaic.org
Consented to Service by Email

Jennifer Cranston
Gallagher & Kennedy, PA
2575 E. Camelback Rd., Suite 1100
Phoenix, Arizona 85016
Attorneys for Grand Canyon State Electric Cooperative Association, Inc.
Jennifer.cranston@gknet.com
Consented to Service by Email for Grand Canyon State Electric Cooperative Association, Inc.
Also Attorney for Arizona Electric Power Cooperative, Inc. and Dixie Escalante Rural Electric Association, Inc., who have not consented to email service

Greg Patterson
Munger Chadwick
916 W. Adams, Suite 3
Phoenix, Arizona 85007
Attorneys for Arizona Competitive Power Alliance

Michael Patten
Timothy Sabo
Jason Gellman
Snell & Wilmer, LLP
One Arizona Center
400 E. Van Buren St., Suite 1900
Phoenix, Arizona 85004
Attorneys for Ajo Improvement Company, Morenci Water and Electric Company, Trico Electric Cooperative, Inc., Tucson Electric Power Company, and UNS Electric, Inc.

Richard Adkerson
Ajo Improvement Company
333 N. Central Ave.
Phoenix, Arizona 85004

Gary Pierson
Arizona Electric Power Cooperative, Inc.
P.O. Box 670
1000 S. Highway 80
Benson, Arizona 85602

Thomas Loquvam
Thomas Mumaw
Mellissa Krueger
Pinnacle West Capital Corporation
P.O. Box 53999, MS 8695
Phoenix, Arizona 85072
Attorneys for Arizona Public Service Co.
Thomas.loquvam@pinnaclewest.com
Consented to Service by Email

Charles Kretek
Columbus Electric Cooperative, Inc.
P.O. Box 631
Deming, New Mexico 88031

LaDel Laub
Dixie Escalante Rural Electric Association
71 E. Highway 56
Beryl, Utah 84714

Steven Lunt
Duncan Valley Electric Cooperative
379597 AZ 75
P.O. Box 440
Duncan, Arizona 85534

Dan McClendon
Marcus Lewis
Garkane Energy Cooperative
P.O. Box 465
Loa, Utah 84747

William Sullivan
Law Offices of William P. Sullivan, PLLC
501 E. Thomas Rd
Phoenix, Arizona 85012
Attorneys for Garkane Energy Coop., Mohave Electric Coop., and Navopache Electric Coop.

Than Ashby
Graham County Electric Cooperative
9 W. Center St.
P.O. Drawer B
Pima, Arizona 85543

Tyler Carlson
Peggy Gillman
Mohave Electric Cooperative
P.O. Box 1045
Bullhead City, Arizona 86430

Roy Archer
Morenci Water and Electric Company,
and Ajo Improvement Company
P.O. Box 68
Morenci, Arizona 85540

Charles Moore
Paul O'Dair
Navopache Electric Cooperative
1878 W. White Mountain Blvd.
Lakeside, Arizona 85929

Jeffrey Crockett
Crockett Law Group, PLLC
2198 E. Camelback Rd, Suite 305
Phoenix, Arizona 85016
Attorney for Sulphur Springs Valley
Electric Cooperative
jeff@jeffcrockettlaw.com
kchapman@ssvec.com
jblair@ssvec.com
Consented to Service by Email

Vincent Nitido
Trico Electric Cooperative
8600 W. Tangerine Rd
Marana, Arizona 85658

Bradley Carroll
Tucson Electric Power Company
88 E. Broadway Blvd, MS HQE910
P.O. Box 711
Tucson, Arizona 85701
mpatten@swlaw.com
BCarroll@tep.com
jhoward@swlaw.com
Consented to Service by Email

David Hutchens
Kevin Larson
UNS Electric, Inc.
88 E. Broadway Blvd, MS HQE910
P.O. Box 711
Tucson, Arizona 85701

Patricia Ferre
P.O. Box 433
Payson, Arizona 85547

Nancy Baer
245 San Patricio Drive
Sedona, Arizona 86336

Mark Holohan
Arizona Solar Energy Industries Assoc.
2122 W. Lone Cactus Dr., Suite 2
Phoenix, Arizona 85027

Nicholas Enoch
Lubin & Enoch, P.C.
349 N. Fourth Ave.
Phoenix, Arizona 85003
Attorneys for IBEW Locals 387, 1116 & 769

Lewis Levenson
1308 E. Cedar Lane
Payson, Arizona 85541

Susan Pitcairn
Richard Pitcairn
1865 Gun Fury Rd
Sedona, Arizona 86336

By Cheryl Fraulob
Cheryl Fraulob

VALUE AND COST OF DISTRIBUTED GENERATION

(INCLUDING NET METERING)

DOCKET NO. E-00000J-14-0023

DIRECT TESTIMONY

OF

LON HUBER

ON BEHALF OF THE

RESIDENTIAL UTILITY CONSUMER OFFICE

FEBRUARY 25, 2016

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EXECUTIVE SUMMARY

RUCO believes that this proceeding should develop a methodology for measuring the benefits and costs of DG that can be applied in a customized manner for each Arizona utility. This would be similar in some ways to the cost effectiveness tests currently used for energy efficiency programs. As part of this methodology, RUCO supports measuring benefits and costs over a 20-year time horizon. To balance against any uncertainty this forward-looking assessment brings, the methodology and categories of values included should be approached conservatively and narrowly.

Ultimately, RUCO thinks the respective results from utilizing this methodology should inform rate design, including several upcoming rate proceedings. Over time, the method can also be used in other forums, discussions, and policy considerations. The natural evolution of how these results can be integrated into current and future proceedings, is yet to be determined, but RUCO envisions some steps happening in quick succession while others occurring over a longer time period. The first step of implementation after establishing a methodology should be to find the level of compensation needed to deliver a cost-neutral value proposition for non-solar ratepayers in each utility service territory. This should be quickly followed by an exploration into the ability for the market to handle moving beyond a breakeven transaction, thereby providing increased value to non-solar ratepayers. Next, the Commission could examine other possible compensation mechanisms for distributed solar that can maximize value to all ratepayers. Finally, the discussion could address distributed solar procurement targets and how to link these to the IRP process. In this setting, the relative costs and benefits of different renewable energy technologies can be compared and the most efficient path to reaching a specific policy goal can be determined. In fact, RUCO could envision adapting the framework accepted in this proceeding to a broader class of distributed energy resources like battery storage.

I. APPLICATION OF VALUE AND COST OF DG TO FUTURE RATEMAKING PROCEEDINGS

Q. This proceeding concerns the value and cost of distributed generation (DG). What is RUCO's understanding of the term "value" in this context?

A. Generally speaking, value describes the direct and indirect monetized benefits minus the monetized costs (or "net benefits") experienced by an individual or group of individuals (e.g. ratepayers). In this case, the value being considered is the value derived from the production of energy from DG resources. Nearly 97% of all residential ratepayers are non-DG customers, thus, RUCO is primarily concerned with the value these non-DG customers receive.

Q. What does "cost" mean from RUCO's perspective?

A. While there are many possible definitions of cost, RUCO is primarily concerned with the costs to serve DG customers that are paid by non-DG customers. This includes any compensation paid to DG customers through net metering, incentives or other mechanisms.

Q. What should the purpose of this proceeding be?

A. RUCO agrees with Commissioner Little's statement: "Any recommended order should focus on methods and process and should not be assigning costs or values to be used in future ratemaking proceedings."

Q. Does RUCO believe that future ratemaking proceedings should be informed by the methods and process established in this proceeding?

A. Yes.

Q. Is cost the only standard that should govern future ratemaking proceedings?

A. No. As Bonbright points out, many economists have argued that "a reasonable rate is one intermediate between cost of production as the lower limit and value of the service as the upper limit, the precise point being set by practical considerations rather than by any scientific rule of ratemaking."[1] RUCO agrees with this concept and believes the Commission should strive to find solutions that maximize value to all ratepayers.

Q. Do commissions generally consider value in ratemaking proceedings?

A. Yes. Bonbright goes on to say that "the examples of value-of-service pricing embedded in the structure of rates are numerous."[2] However, he also argues that "[value-of-service standards] play important though subordinate roles [to cost] in the modern theory and practice of rate regulation."[3] RUCO tends to agree. Value should be a consideration but the amount one pays should be as cost based as possible. However, RUCO recognizes that procurement and compensation of customer sited resources necessitates a hybrid approach due to administrative challenges among other things.

[1] Bonbright, et al. *Principles of Public Utility Rates, 2nd Ed.*, page 125.
[2] *Ibid*, page 126.
[3] *Ibid*, page 137

Q. Has this Commission ever considered value in other proceedings related to ratemaking?

A. Yes. For example, in Decision No. 73130, the Commission concluded that APS demonstrated the "unique value" of its proposed purchase of Four Corners Units 4 and 5, which included "substantial economic benefits to the Navajo Nation and surrounding communities, the acceleration of lower emissions that will result in environmental improvements, and maintaining the balance of APS' diverse resource portfolio for the benefit of ratepayers."

Q. What then is the purpose of assigning costs or values to DG in future ratemaking proceedings?

A. The value (i.e. benefits minus costs) assigned to DG defines the range of possible compensation levels for DG (through a combination of rates, incentives, and/or other mechanisms) that can be assumed to be reasonable and in the public interest.

Q. Do future rates need to compensate DG at the assigned value?

A. Not necessarily. RUCO sees this as a policy decision for the Commission to consider. In RUCO's view, the ultimate goal should be to pay a rate that is closer to the initial installation cost while still maintaining a healthy DER market sector for Renewable Energy Standard compliance.

Q. Are there additional policy issues that might be considered when deciding the level of DG compensation?

A. Yes, there are several. Regulation of public utility rates is intended to be a substitute for competition. Thus, RUCO believes that the rates the Commission sets should be designed to help to maintain a highly competitive and innovative DG marketplace for the benefit of DG and non-DG customers alike. Additionally, RUCO believes that nearly all of the benefits that DG solar could provide to utility customers can also be provided by utility-scale or community solar. Recent reports indicate that utility scale solar can cost as little as 3.7 cents per kWh.[4]

Community scale solar projects connected within the distribution system can also be relatively inexpensive, with one recent example costing as little as 8 cents per kWh.[5] In contrast, solar energy from DG customers are paid at retail rates, which are typically 11-13 cents per kWh.

Q. Does this suggest that all investments made by utilities in solar should be utility-scale?

A. Not necessarily. Presuming that both DG solar, utility-scale solar, and community scale solar all provide net benefits to customers, then it would still make sense to invest in each of these options. However, RUCO believes there should be heavy consideration of how to optimally spend ratepayer money across the range of possible solar solutions. As a hypothetical example, one could assume that the ratio of benefits to cost for a typical community scale solar project is 3:1, while the ratio for a typical DG solar project is 2:1. In this case both are good investments that will yield net benefits for ratepayers. However, assuming a fixed budget, investing more heavily in community scale projects than DG projects will yield greater benefits to customers.

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[4] https://cleantechnica.com/2016/02/23/palo-alto-california-approves-solar-ppa-hecate-energy-36-76mwh-record-low/

[5] http://www.utilitydive.com/news/tesla-battery-storage-tapped-for-texas-first-community-solar-project/405690/

Q. To what extent should intangible benefits be considered?

A. DG can provide intangible benefits that may not be readily quantified and/or quantified with sufficient accuracy. Some of these include providing customers with additional energy choices, economic benefits and environmental benefits (e.g. lower water consumption by the power sector). The Commission could choose to support DG to provide these benefits as a policy matter but not in ratemaking.

Q. How then should any value assigned to DG via the methodology established in this proceeding be used to inform future rate proceedings?

A. The Commission should first consider the current level of compensation for DG. If the value ultimately assigned to DG is lower than the current level (i.e. DG is not cost-effective), then the Commission should develop a reasonable and gradual transition path towards that lower value. Even if the value the Commission ultimately assigns to DG is higher, the Commission should set rates that encourage increased cost effectiveness for DG installations (i.e. $/kWh of energy produced). In either case, the overarching goal is to apply some form competitive price pressure on DG compensation for the benefit of all ratepayers.

II. THE CHANGING VALUE PROPOSITION OF DG SOLAR

Q. How was the value and cost of solar considered in the development of the current net metering tariffs?

A. RUCO's understanding is that the original net metering tariffs were designed partly to encourage a new market for distributed generation which largely did not exist at the time. For example, Decision No. 69877, Finding of Fact 9 states "Net metering provides a financial incentive to encourage the installation of DG, especially renewable resources." Additionally, the costs to serve net metering customers were assumed to be roughly offset by the benefits they provided to the grid. For example, Decision No. 70567, Appendix C, Para. 2. states: "The public at large would benefit from Net Metering since it would encourage more of the electricity produced in Arizona to be generated from renewable resources and high-efficiency facilities."

Q. Over the past several years the cost of PV panels has declined significantly. Does the declining cost of panels affect the value proposition? If so, how?

A. Yes, however, the change in the value proposition depends on which perspective is assumed.

Q. How has the value proposition changed for customers that adopt PV?

A. For a customer purchasing PV panels, the value proposition would likely have improved due to the lower purchase price. For a customer leasing PV panels, the value depends upon the contract price offered by the leasing company, which may or may not reflect changes in panel prices.

Q. Do you have any examples of how contract prices have changed over time relative to installation costs?

A. Yes. In its most recent earnings report, SolarCity reported that installation costs for new system fell from $3.25 at the start of 2014 to $2.71 per watt at the end of 2015.[6] In contrast, first year contract prices were actually higher in 2015 than in 2014.

[6] http://investors.solarcity.com/common/download/download.cfm?companyid=AMDA-14LQRE&fileid=874112&filekey=0E1F3F06-1EE6-449C-A6D6-9B39E58FC62C&filename=SolarCity_4Q15_Earnings_Presentation_FINAL.pdf

Q. How has the value proposition changed for non-DG customers?

A. For all customers (including non-DG customer) the theoretical value proposition of solar PV has improved relative to other possible generation resources since procurement costs have declined along with panel prices. This is true for both distributed and utility-scale solar. However, the actual value to non-DG customers of "procuring" distributed PV as a resource depends upon the compensation being provided to DG customers by the utility. This in turn depends upon the underlying rate structure (through which compensation is currently provided via net metering), plus any incentives. In the previous era of incentives, the value of DG to non-DG customers gradually improved as incentive prices gradually declined to zero. Since then the value proposition has remained largely unchanged, except for the adoption of the Grid Access Fee.

Q. Is it appropriate to factor the cost of the panels into the reimbursement rate for net metering? If so, how?

A. Not necessarily. Panels are only one component of the overall cost to install distributed PV, which also includes customer acquisition, O&M, and tax credits.

Q. Would it be appropriate to consider the overall installation cost of distributed PV?

A. It may be appropriate, depending on the Commission's policy goals. If the Commission's goal is to improve the cost-effectiveness of DG (which RUCO supports), then one option might be to set a rate of DG compensation that somehow tracks changes in installation costs – ideally declining stepwise over time as installation costs decline. This in turn would help to minimize any non-DG ratepayer costs of distributed PV over time.

Q. Is there room for further declines in PV installation costs?

A. RUCO believes so. According to a recent study by Lawrence Berkeley National Lab, "U.S. installed prices are high compared to many other major markets, particularly with respect to Germany, China, and Australia."[7] This is attributed primarily to differences in soft costs of DG installation.

Q. What does RUCO conclude from this study?

A. RUCO concludes that there is still room for improvement in the U.S. to drive down installation costs. Ideally, lower installation costs would lead to lower DG prices for adopting customers as well as the possibility to step down DG compensation over time for the benefit of non-DG customers.

III. METHODOLOGY FOR DETERMINING VALUE AND COST

Q. What attributes should be considered when selecting a methodology to assign cost and value to DG?

A. RUCO believes that any methodology applied by the Commission to assign cost and value to DG should include the following attributes: 1) independence, 2) transparency, 3) accessibility, and 4) ability to change over time.

Q. Please explain what RUCO means by each of these attributes.

A. 1) Neutrality: the Commission's methodology should strive to be unbiased and not be unduly favorable to either utilities or DG providers.

2) Transparency: all inputs, assumptions, and calculations should be clearly described and explained.

[7] https://emp.lbl.gov/sites/all/files/lbnl-188238_2.pdf

3) Accessibility: the cost-benefit calculation should be made available to the public in the form of an electronic spreadsheet that is published on the Commission's website. RUCO suggests that this spreadsheet could be developed in this proceeding with generic, indicative values that are not related to any specific utility.

4) Ability to change: inputs and assumptions used in the calculation should change periodically over time as conditions change.

Q. Are there any threshold questions the Commission must answer before selecting a methodology to calculate cost and value?

A. Yes. The Commission must decide what perspective(s) should be included and prioritized when evaluating the overall costs and benefits of DG.

Q. What possible perspectives could be considered when evaluating the overall costs and benefits of DG?

A. Cost and benefits from DG can be considered from multiple perspectives, including 1) the DG-adopting customers, 2) non-DG customers, 3) the utility (i.e. all ratepayers), and 4) the total economy. These perspectives are similar to those established through the traditional Demand Side Management (DSM) cost-effectiveness tests.

Q. Does the Commission already use any of these cost-effectiveness tests?

A. Yes, the Commission uses the Societal Cost Test to evaluate the cost-effectiveness of utility DSM portfolio investments. This test takes the perspective of the total economy.

Q. Which perspective(s) does RUCO recommend that the Commission consider in the proceeding for evaluating costs and benefits of DG?

A. RUCO recommends that the Commission consider the cost and benefits of DG from each of these perspectives, however it should prioritize one perspective for ratemaking proceedings that relate to DG.

Q. Which perspective should be prioritized for ratemaking purposes?

A. RUCO believes the value assigned for ratemaking purposes should be limited to the costs and benefits from the perspective of non-DG customers, which make up the majority of residential ratepayers. It is also important to understand that this method assumes that utilities are entitled to recover fixed costs that have already been authorized by the Commission. Thus any reduction in utility revenues from DG are assumed to be made up through future price increases to non-participants (e.g. through adjustors such as the LFCR or in future rate increases approved by the Commission).

Q. Why not just use the Societal Cost test for DG like Energy efficiency?

A. DG, and rooftop solar in particular, has many attributes that differ from energy efficiency. RUCO believes these differences are substantial enough to warrant the use of a different evaluation approach. These differences are explained below:

1. **Less Accessibility** -- Generally speaking, DG solar is not accessible to customers that are renters, have structural impediments, or live on fixed incomes. Thus, not all customers have an equal opportunity to benefit from DG solar. In contrast, every customer has the opportunity to take part in some form of energy efficiency. Cost allocation tensions can arise between DG and non-DG

customers in a way that is not evident with energy efficiency. For this reason, RUCO believes that more attention must be paid to the possibility of cost-shifting than is necessary when considering efficiency programs. This suggests to RUCO that the evaluation approach for DG should have an increased emphasis on the perspective of non-DG customers.

2. **Less Diverse Grid Impacts** - Energy efficiency encompasses a large and diverse set of measures that have different attributes and impacts. Some measures can offset base load energy, some are just on-peak, and others provide a mix of load impacts depending on the customer's habits. In contrast, DG solar has only a handful of configurations and orientations such that each DG system impacts to the grid in a similar way. Solar PV systems, especially in localized areas can mimic each other in ways energy efficiency measure cannot. For instance, when a cloud front comes in all the areas, PV production will decrease. Energy efficiency measures, on the other hand, do not have that type of predictable and sequenced response.

3. **Masking not Reducing** – PV systems mask a customer's load, meaning that if the solar panels stop functioning, for whatever reason, the grid must be available to meet the customer's needs. In a sense, PV hides load from the utility. Energy efficiency measures on the other hand, reduce load, often times permanently. If an Energy efficiency measure fails (e.g. if an appliance malfunctions), the customer load is also reduced. This lack of dependability is important when one considers PV on an aggregated basis.

4. **Can Increase Utility System Cost -** The general production characteristic of solar, aggregated and at high penetrations, can change system wide load shapes to create new demands on the system. Large amounts of solar without batteries can create ramping needs and fast-start backup generation requirements. The diversity and inherent "on the margin savings" attribute of energy efficiency does not yield these effects. Meaning Energy efficiency does not radically reduce load to zero or get exported, rather it reduces load incrementally and broadly throughout the system.

5. **The Benefits are Concentrated** - Solar PV can deliver energy production (e.g. for one high usage customer with a large roof and PV system) that is equivalent to the amount of savings achieved from many households installing energy efficiency measures. In fact, participating solar customers can be net zero users during peak solar hours in a way energy efficiency adopters cannot match. As such, the benefits of DG solar are more concentrated among a smaller group of individuals, whereas for energy efficiency the benefits are spread among a very large and diverse group of participants.

For these reasons, RUCO believes it is more appropriate to evaluate impacts from the perspective of non-DG customers, rather than the total economy.

Q. How specifically should costs and benefits be calculated from the perspective of non-DG solar customers?

A. RUCO agrees with Commissioner Little's statement that the methodology should be "based on locational and production benefits associated with particular DG installations." Additionally, RUCO agrees with Commissioner Little that "The methodology should evaluate DG installations using a levelized cost of electricity calculation, calculated over the useful life of the system." That is, costs and benefits should be represented as the net present value (in dollars) per kWh produced. RUCO recommends levelizing the costs and benefits over twenty years, which is typical lifetime for a solar DG system.

Q. Please summarize the key details of RUCO's preferred analysis framework for determining cost and value of DG solar.

A. RUCO recommends that costs and benefits of DG solar be calculated as follows:

- All DG solar generation is included (both exports and self-consumption)
- Costs and benefits are considered primarily from the perspective of non-DG customers.
- Costs and benefits are calculated as levelized values over 20 years of DG energy production (i.e. LCOE is used).
- The methodology should only include costs and benefits that are easily quantified and focus on categories that are related to the energy system.
- Benefits or costs that are more indirect or speculative in nature (e.g. secondary economic impacts) should be considered qualitatively, but not be calculated in the value methodology.

Q. How should the Commission capture the details of its cost and value methodological framework?

A. The Commission should publish a technical reference manual that explains how costs and benefits are determined and the major assumptions included in each.

IV. COSTS OF DG SOLAR

Q. What cost categories should be included in the Commission's methodology?

A. RUCO recommends the following costs be considered:

- Utility revenues lost from DG solar customers due to DG adoption (with an anticipated annual escalator),
- Incremental utility system costs due to DG solar adoption (e.g. integration costs, administration costs, etc.).

RUCO believes it is important to differentiate between these two costs categories – the first representing sunk costs not caused by DG customers (but could be allocated to them) and the second representing marginal costs caused by DG customers.

Q. What are the most important inputs and assumptions for calculating costs?

A. The most important cost assumption is the change in revenue collected by the utility from the customer before and after the customer installs a DG system.

Q. How should this change in revenue be determined?

A. The change in revenue should be determined by looking at the average customer's contribution to fixed cost revenue compared to that of a DG adopter.

Q. How does the intermittent nature of DG solar affect its value and costs?

A. RUCO believes that variability and uncertainty in solar PV's output can lead to some incremental costs to operate the system. For example, utility system operators may need to hold additional operating reserves to account for unexpected changes in solar energy output. However, RUCO does not believe that these costs are likely to play a large role in the overall value and cost of DG. According to APS' 2012 Solar PV Integration Cost study, the incremental cost of operating reserves needed to maintain reliability with higher penetrations of solar was $0.002/kWh in 2020 and $0.003/kWh in 2030.[8] Only a fraction of this cost would be attributable to DG solar as opposed to utility-scale solar.

Q. Are there technologies that could reduce the intermittency of DG solar?

A. Yes. For example, a customer could install a battery energy storage system in conjunction with DG solar. Note, that such capabilities can be sited on the customer side of the meter, or on the utility side of the meter. It has been shown in other places that storage has the capability to not only reduce intermittency, but can be used to support the grid when not being used for local services.

Q. Should an "intermittency factor" be applied to more accurately determine cost and value?

A. Possibly. To the extent that a device such as a battery storage system could reduce DG output variability, it could lower the incremental integration costs attributable to that system. An "intermittency factor" might be one way to represent the lower integration costs attributable to a particular DG system that also has storage.

Q. Is it possible for DG solar to be more dispatchable?

A. Yes. This is possible through energy storage. It is also possible to some degree with smart inverters, but may require some amount of pre-curtailment.

[8] https://www.aps.com/library/renewables/PVReserveReport.pdf

Q. How does this ability to dispatch or the lack of ability to dispatch affect the value and cost of DG solar?

A. This could increase DG's value by providing additional ancillary services to the utility system.

Q. Will the bidirectional energy flow associated with DG solar require modifications or upgrades to the distribution system?

A. DG solar may reduce distribution system costs in certain circumstances. For example, geo-targeting high value sections of the distribution system with solar DG can yield locational higher than average locational benefits. However, RUCO is aware of some scenarios where costs could be increased. This might occur on circuits with high enough PV penetration that power flows in the reverse direction, leading to the need to upgrade certain protection equipment.

Q. How should the cost of these upgrades be considered when determining the cost and value of DG solar?

A. These costs should be treated similarly to integration costs described above.

Q. Would the required upgrades vary based on location and penetration of DG solar?

A. Yes.

Q. Should the costs for DG installations vary based on these factors?

A. Possibly. However, more information is needed about the frequency of these upgrades and the magnitude of their costs.

V. BENEFITS OF DG SOLAR

Q. To what degree is DG solar energy production coincident with peak demand?

A. DG solar resources can produce some energy during peak demand hours, at least for now. Thus, DG solar provides value in terms for reducing peak demand (i.e. "capacity value").

Q. Does the cost and value of DG solar vary depending on whether or not energy production is coincident with peak demand?

A. Yes. A major category of benefits that DG solar provides is avoided capacity costs. To the extent that DG production coincides with peak demand, it has the potential to defer investments in new capacity resources, thereby avoiding costs for all ratepayers.

Q. Are there policies that the Commission could consider that address this issue?

A. Yes. The Commission could assign a higher value to DG resources producing energy that better coincides with peak hours (i.e. resources that have a higher capacity value). The precise capacity value should be determined by calculating the Effective Load Carrying Capability (ELCC) of the DG resource. It should be noted that DG resources can be combined to increase the ELCC, such as combining storage with solar.

Q. How does the value and cost of DG solar change as penetration levels rise?

A. As the penetration of solar PV increases, peak demand is pushed further into the evening hours, thereby diminishing the capacity value of incremental DG solar (and other PV resources).

Q. How should this be considered in rate making and resource planning contexts?

A. The value of DG should reflect the capacity value as determined by the ELCC calculation. This will adequately incorporate the effect of diminishing capacity value as penetration increases. If capacity values are assigned to individual DG resources, this value should reflect the value at the time the resource was installed and should persist over the life of the asset.

Regarding resource planning, varying levels of DG deployment are typically not analyzed in the IRP process. RUCO believes that the Commission should encourage utilities to analyze differing levels of DG deployment as they develop their IRPs.

Q. Should the fuel cost savings to the utility associated with DG solar be considered in the value and cost determination?

A. Yes. Fuel cost savings are a major category of benefits that DG solar provides.

Q. How do we deal with uncertainty of future fuel prices?

A. Future fuel prices should be estimated based on a forward price curve, such as those used in utility IRPs. If there are additional fuel savings after the period of the forward price curve, a simple escalation rate can be applied.

Q. Does the deployment of DG solar result in changes in the need for transmission capacity? If so, how should those changes be included in the value and cost considerations?

A. Possibly. To the extent that DG solar reduces peak load on the transmission system, it may be able to defer the need to build additional transmission lines. Such deferrals should be considered as a benefit resulting from DG. However, due to the locational nature of this benefit, RUCO believes a conservative approach is needed unless the evidence is highly compelling. That said, transmission savings tied to new generation is more straightforward and should be treated accordingly.

Q. Does the deployment of DG solar result in changes in the need for distribution capacity? If so, how should those changes be included in the value and cost considerations?

A. Possibly. To the extent that DG solar reduces peak load on certain distribution circuits, it may be able to defer the need to perform distribution system upgrades. Such deferrals should be considered as a benefit resulting from DG. However, due to the locational nature of this benefit, RUCO believes a conservative approach is needed unless the evidence is highly compelling.

Q. Based on your testimony thus far, what benefit categories should be included in the Commission's methodology?

A. The primary benefits derived from DG are those related to the avoided costs associated with energy production and delivery. Thus the benefits of DG should mainly include the following categories in relative order of significance:

- Avoided energy costs (including line losses)
- Avoided generation capacity costs (including line losses)

- Avoided transmission system costs
- Avoided distribution system costs

Q. What are the key inputs and assumptions for calculating these benefits?

A. Some of the key assumptions for calculating benefits are as follows:

Benefit Category	Key Inputs and Assumptions
Avoided energy costs (including line losses)	• Fuel price forecast and/or escalation rate • Marginal production cost of energy during hours of DG production • Marginal line losses during hours of DG production • Societal discount rate
Avoided generation capacity costs (including line losses)	• Year in which the next marginal unit of generation capacity is needed • Cost of the next marginal unit of generation capacity • DG capacity value • Marginal capacity losses during hours of DG production • Planning reserve margins • Societal discount rate • Inflation rate • Weighted average cost of capital • Fixed O&M costs (projected in year of capacity need) • Variable O&M costs
Avoided transmission system costs	• Year in which transmission investment is needed • Cost of avoided transmission • DG capacity value

	• Societal discount rate • Inflation rate • Weighted average cost of capital • O&M costs
Avoided distribution system costs	• Year in which distribution investment is needed • DG capacity value • Societal discount rate • Inflation rate • Weighted average cost of capital • O&M costs

Q. What other benefits could be considered?

A. Another benefit that might be considered is off-system sales. To the extent that DG solar frees up utility-owned generation capacity, this capacity could be used to sell electricity to other utilities. These benefits should also be included as part of the value of DG solar. Finally, locational benefits and ancillary service benefits should be part of the framework and quantified when circumstances allow it. For example, future load additions like electric vehicles may bring congestion to certain portions of the distribution system that DG could relieve.

Q. Does RUCO recommend defining the inputs and assumptions in this proceeding?

A. Yes. While numerical values should not be assigned, the Commission should establish how numerical values will be determined for each input and assumption. For data gathering, RUCO suggests first starting in each utility's IRP plan. Any data voids should be estimated and studied as a follow up to this track but should not slow progress in this proceeding.

Q. How does cost and value of DG solar vary based on the orientation of the panels?

A. The orientation of distributed PV panels will affect the output at different times of day. Traditionally, rooftop PV has been oriented due south to maximize overall kWh energy output. Alternatively, solar PV could be oriented to increase output during hours of peak demand (e.g. west-facing). While this would slightly reduce the overall kWh produced, it would also have the effect of increasing the overall capacity value of solar PV.

Q. How would the installation of single or dual axis trackers change the output or efficiency of the DG solar system?

A. Implementing single or dual axis tracking would have a similar effect of increasing output during peak hours (and all other hours as well).

Q. Should this variability be reflected in rates?

A. Capacity value is a major value component when considering any resource addition, including DG. To the extent that westward orientation and tracking systems are able to increase the capacity value of distributed solar, these attributes should be included in the overall determination of a DG system's value. The Commission could then in turn use this information to develop rates that compensate DG systems accordingly.

Q. How is the value and cost of DG solar affected when coupled with some type of storage?

A. The incremental value that storage provides depends on how the stored energy is dispatched. Much like the orientation and tracking systems I described earlier, if storage is dispatched to increase output during the hours of system peak, then it could help to increase the value of DG by increasing the capacity benefit.

Q. Should deployment of storage technologies be encouraged? If so, how?

A. RUCO believes that any compensation scheme for DG resources should strive to be technology neutral and provide compensation based primarily on the value provided to the grid. An appropriate compensation scheme that adequately recognizes this value should, by extension, encourage storage.

VI. ADDITIONAL COST AND BENEFIT CONSIDERATIONS

Q. How does the value and cost of DG solar compare to the value and cost of community scale and utility scale solar?

A. Generally speaking, community and utility scale solar located within the distribution system have been shown to be more cost effective (lower $/W) than DG solar. DG solar may yield some additional benefits in terms of avoided line losses versus utility scale, however these are not anticipated to be large. Favorable costs of utility and community scale solar should not be used to determine that DG solar cannot be cost-effective, or should not be pursued. However, such findings do suggest that other forms of solar may offer some of the same benefits but at a much lower cost. This information should be used by the Commission to determine an overall portfolio strategy that maximizes benefits at the best price.

Q. How do the value and costs of DG solar compare to that of wind or other renewable resources?

A. Other renewable resources can produce similar environmental benefits to DG solar. However, these resources have very different operating profiles than DG solar. Thus, the benefits each resource type provides to the grid is likely to be very different than DG in terms of avoided costs. Moreover, wind and other non-DG renewables are most commonly deployed as utility scale resources. Thus, the costs for these resources would likely be recovered by all utility rate payers in an equal fashion.

Q. How does the value and cost of DG solar compare to that of energy efficiency?

A. As a demand-side resource, energy efficiency has some similarities to DG in that the cost and value can be evaluated from multiple perspectives. In Arizona, energy efficiency is evaluated from the perspective of the total economy through the Societal Cost Test. Energy efficiency programs implemented by utilities in Arizona have generally been very cost effective with benefit to cost ratios exceeding 1.0 in nearly all cases. RUCO is not aware of similar evaluations that have been performed for DG, making a direct comparison difficult to make. As mentioned, one notable difference between energy efficiency and DG is that utility energy efficiency portfolios are designed so that all customers can participate in some type of efficiency measure. In contrast, DG may not be available to all of a utility's customers, and thus the full value of DG may be inaccessible for certain customers. Moreover, the Commission has different policies for DG and energy efficiency which can distort the overall cost picture. The Commission mandates a 4.5% DG carve-out compared to a 20% energy efficiency standard with most measures taking place on the customer's premises just like DG. However, the energy efficiency portfolio requires that measures be tested for cost-effectiveness, while DG solar is not.

Q. Does the cost and value of DG solar vary based on the specific customer location?

A. Yes. However this value potential is highly location-specific and unique to each distribution circuit. For example, under some circumstances, DG solar may be able to defer investments in equipment upgrades on the distribution system that would otherwise be needed to accommodate load growth. In other cases, high penetration of DG solar may lead to reverse power flow conditions that necessitate upgrades to protection equipment. RUCO does not anticipate these costs to be very significant or very common at current DG penetration levels.

Q. Should this variability be reflected in rates?

A. To the extent that utilities are willing and able to share information about their distribution system planning activities, then it may be possible to consider the locational variability of DG's cost and value. In turn, the Commission could use this information to develop compensation mechanisms that reflect this locational variability. RUCO believes it will be important to gather information about these issues in the long run so that they can be reflected in the valuation. However, RUCO believes these factors are less likely to be significant drivers of costs or benefits in the near term compared to other components (e.g. avoided generation and fuel cost) and should not distract from other elements in the valuation process.

Q. How much should secondary economic impacts of DG solar deployment be considered in the value and cost considerations?

A. For the sake of simplicity and rate making, RUCO recommends against attempting to quantify benefits and/or costs related to larger macroeconomic impacts such as job losses or gains.

Q. Do investments in other types of generation technology have similar, greater or lesser secondary economic impacts? If so, how?

A. As with my previous answer, RUCO believes these considerations stretch beyond the scope of this proceeding and should only be considered qualitatively until further information is available.

Q. Does the deployment of DG solar result in a reduction in the use of water in electric generation? How should this be considered when determining DG solar value?

A. Yes. Traditional thermal generation requires significant amounts of water. The costs of this should be reflected in the variable energy costs avoided from DG. Concerns about future water shortages may also be another policy issue for the Commission to consider.

Q. Does this conclude your testimony?

A. Yes.