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IN THE MATTER OF THE COMMISSION'S INVESTIGATION OF VALUE AND COST OF DISTRIBUTED GENERATION.	DOCKET NO. E-00000J-14-0023 **STAFF'S NOTICE OF FILING DIRECT TESTIMONY**

The Utilities Division ("Staff") of the Arizona Corporation Commission ("Commission") hereby files the Direct Testimony of Staff Consultant Howard Solganick, regarding the above-captioned matter.

RESPECTFULLY SUBMITTED this 25th day of February, 2016.

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IN THE MATTER OF THE COMMISSION'S INVESTIGATION OF VALUE AND COST OF DISTRIBUTED GENERATION	))))	DOCKET NO. E-00000J-14-0023

DIRECT TESTIMONY

OF

HOWARD SOLGANICK

FOR THE

UTILITIES DIVISION

ARIZONA CORPORATION COMMISSION

FEBRUARY 25, 2016

TABLE OF CONTENTS

EXHIBITS

EXECUTIVE SUMMARY
VALUE AND COST OF DISTRIBUTED GENERATION
DOCKET NO. E-00000J-14-0023

Mr. Solganick's direct testimony provides Staff's perspective of the relative value and cost of various forms of distributed generation and highlights the drivers to determine value and cost.

The testimony discusses distributed generation and compares it to other forms of generation.

Staff's perspective highlights the obligation of the utility to obtain goods and services at a reasonable cost and the Commission's responsibility to ensure that potential suppliers are not impacted by the utility's monopsony power.

The testimony does not set or calculate the value of solar but highlights through the use of a comparative matrix the similarities and differences between solar distributed generation and other forms of generation, distributed generation, load shifting, storage, wind, conservation and efficient appliances and HVAC.

Staff recommends moving over the long-term from net metering and banking to setting a price for excess distributed energy in the utility's rate case based upon the principles determined in this proceeding. The recommendations consider adders for transmission and distribution impacts where appropriate and proven.

INTRODUCTION

Q. Please state your name, occupation, and business address.

A. My name is Howard Solganick. I am a Principal at Energy Tactics & Services, Inc. My business address is 810 Persimmon Lane, Langhorne, Pennsylvania 19047. I am performing this assignment under subcontract to Blue Ridge Consulting Services, Inc. ("Blue Ridge").

Q. For whom are you appearing in this proceeding?

A. I am appearing on behalf of the Utilities Division Staff ("Staff") of the Arizona Corporation Commission ("Commission").

Q. Please summarize your qualifications and experience.

A. I am licensed as a Professional Engineer in Pennsylvania (active) and New Jersey (inactive). I hold a Professional Planner's license (inactive) in New Jersey. I served on the Electric Power Research Institute's Planning Methods Committee and on the Edison Electric Institute Rate Research Committee. I have been appointed as an arbitrator in cases involving a pricing dispute between a municipal entity and an on-site power supplier and a commercial landlord-tenant case concerning sub-metering and billing. I previously served on two New Jersey Zoning Boards of Adjustment as Chairman and member and a Pennsylvania Township Planning Commission as Chairman and member.

I have been actively engaged in the utility industry for over 40 years, holding utility management positions in generation, rates, planning, operational auditing, facilities permitting, and power procurement. I have delivered expert testimony on utility planning and operations, including rate design and cost of service, tariff administration, generation, transmission, distribution and customer service operations, load forecasting, demand-side management, capacity and system planning, and regulatory issues.

I have also been engaged (as a subcontractor) to review utility performance before, during, and after outages resulting from major storms in the state of Washington (major windstorm), Missouri (summer storms and ice storm), Texas (Hurricane Ike), Jamaica West Indies (Hurricane Ivan), the two 2011 storms (tropical storm Irene and a major snow storm) that affected New Jersey, and to review the emergency plan of a New England utility. Some of these assignments were at the request of the utility and others at the request of a state utility regulator. Testimony, if prepared and filed, is listed in Exhibit HS-1.

I have been engaged by clients to review proposed distributed generation contracts and the operation and integration of generating assets within power pool operations, and I have advised the Board of Directors of a public power utility consortium. For a period of four years, I was engaged by a multiple site commercial real estate organization to manage its solicitation for the purchase of retail energy. As a subcontractor, I have performed management audits for the Connecticut Department of Public Utility Control and ratebase audits for the Public Utilities Commission of Ohio and the Oregon Public Utility Commission. I also provide (as a subcontractor) support for the Staff and Commissioners of the District of Columbia Public Service Commission for electric and gas rate cases.

I have led and/or participated in consulting projects to develop, design, optimize, and implement both traditional utility operations and e-commerce businesses. These projects focused on the marketing, sale, and delivery of retail energy, energy-related products and services, and support services provided to utilities and retailers.

From 1994 to the present, I have been President of Energy Tactics & Services, Inc. From 1996 to 1998 I was a Managing Consultant for AT&T Solutions. From 1990 to 1994 I was Vice President of Business Development for Cogeneration Partners of America. In that position, I was responsible for the development of independent power facilities, most of which were fueled by natural gas and oil.

From 1978 to 1990, I held positions of progressively increasing responsibility with Atlantic City Electric Company in generation, regulatory, performance, planning, major procurement, and permitting areas.

From 1971 to 1978, I was an Engineer or Project Engineer for Univac, Soabar, Bickley Furnaces and deLaval Turbine, designing card handling equipment, tagging and printing machines, high temperature industrial furnaces, and utility and industrial power generation equipment, respectively.

I received a Bachelor of Science in Mechanical Engineering (minor in Economics) from Carnegie-Mellon University and a Master of Science in Engineering Management (minor in Law) from Drexel University. I have also taken courses on arbitration and mediation presented by the American Arbitration Association, scenario planning presented by the Electric Power Research Institute, and load research presented by the Association of Edison Illuminating Companies. I have also taken courses in zoning and planning theory, practice, and implementation in both New Jersey and Pennsylvania.

Q. Have you previously submitted testimony in regulatory proceedings?

A. Yes. I have testified and/or presented testimony (summarized in Exhibit HS-1) before the following regulatory bodies:

- Arizona Corporation Commission
- Delaware Public Service Commission
- Georgia Public Service Commission

- Jamaica (West Indies) Electricity Appeals Tribunal
- Maine Public Utilities Commission
- Maryland Public Service Commission
- Michigan Public Service Commission
- Missouri Public Service Commission
- New Jersey Board of Public Utilities
- Public Utilities Commission of Ohio
- Pennsylvania Public Utility Commission
- Public Utility Commission of Texas

Q. What is the purpose of your testimony?

A. My testimony provides Staff's perspective of the relative value and cost of various forms of distributed generation and highlights the drivers to determine value and cost. This testimony draws contrasts between various types of distributed generation and defines various drivers of value and cost.

Staff is not recommending a specific price for purchases of excess energy from any form of distributed generation or from photovoltaic systems in particular, but is highlighting those factors that apply, those that do not and those that may be so small that the value (or cost) is de minimis.

Staff recommends that the price for the purchase of excess energy by a utility should be set within the context of a utility specific proceeding such as a rate case and depends on the situation and conditions specific to that utility, along with consideration of the factors/methodology set out in Exhibit HS-3 and discussed below.

DIRECT TESTIMONY

Q. Please define distributed generation.

A. For the purposes of this proceeding Staff defines distributed generation ("DG") as on-site generation produced or stored by a variety of small, grid-connected (typically at the distribution level) devices using a variety of fuels (typically natural gas, distillate oil or feedstocks), or renewable sources (such as solar, wind, hydro, biomass, geothermal). DG may be controlled by the grid operator, thorough an aggregator or uncontrolled and either be capable of independent operation (microgrid) or dependent on the grid to operate.

Q. Please provide some examples of distributed generation.

A. Some examples of distributed generation are the following:

- Combined Heat and Power ("CHP") or "Cogeneration" using combustion turbines; diesel or spark ignition engines; boiler and steam turbine configurations; or fuel cell. Fuels commonly used include coal, heavy oil, distillate oil, natural gas, hydrogen and other feedstocks.
- On-site electrical generation uses similar technologies and fuels as CHP but does not use or export heat.
- Emergency generation generally employs combustion turbines; diesel or spark ignition engines; or fuel cells. Fuels commonly used may include distillate oil or natural gas.
- Wind Power
- Solar PV
- Tidal
- Geothermal

Q. Please describe other distinguishing characteristics.

A. DG would be expected to be smaller in size than classic utility central station generation, closer to, if not inside, load centers and more numerous.

Q. Please describe some of the potential positive attributes of distributed generation.

A. DG is alleged to have potential positive attributes (compared to utility central station generation) due to:

- Size
- Dispersed location
- Ability to operate on a smaller grid
- Potentially less transmission required
- Potential to support load during transmission and/or distribution outages
- Lower environmental impact
- Disparate ownership and financing

Q. Please describe some of the potential negative attributes of distributed generation.

A. DG is alleged to have potential negative attributes (compared to utility central station generation) due to:

- Size – higher cost per kilowatt
- Efficiency – higher cost per kilowatt hour
- Financing – higher costs per kilowatt
- Interconnection costs
- Lack of control and coordination
- Impact on grid control – voltage, reactive, etc.
- Greater and local environmental impact (closer to public and/or noise issues)
- Lack of fuel supply flexibility

Q. What value can a utility operated generating unit provide that DG does not?

A. Utility operated generation typically would have dual fuel capabilities (in some areas), maximum emergency generation and rapid return from unit outages. These capabilities allegedly result from the difference between the obligation to serve and meeting contractual requirements.

Q. Please explain Staff's perspective as you developed this testimony.

A. Staff's perspective is based on the concept that what happens behind the meter is the customer's business. Whether load is reduced by conservation, insulation, high efficiency appliances, storage or the installation of a DG system that is solely the customer's right and decision and a proper rate structure will offer accurate price signals to assist a customer making a decision. Any excess energy not needed by the customer can then be delivered to the utility and purchased at its value at the time and location of delivery.

Staff's perspective also assumes residential and small general service rates will transition to a Three-Part Time of Use ("TOU") structure which offers customers the opportunity to decide when and how much energy to consume and when and how much demand to impose on the system. (Larger customers have been served on three part rates for many years).

Staff recognizes that utilities, utility shareholders, solar vendors, regulators, C&I customers and residential customers all have different perspectives and value propositions. Staff's perspective or viewpoint is to look at costs and values from the perspective of all of the utility's customers. This perspective is derived from Staff's role in the regulatory process to assist the Commission in ensuring that rates are based on reasonable costs. Utilities have a responsibility, and the Commission acts as an enforcement mechanism, to provide service at the lowest reasonable cost. Examples include reviewing procurement results, policies and process, considering the effectiveness of the utility's operations and reviewing the utility's participation in its service territory.

Q. Please define reasonable cost.

A. The utility has an obligation to spend no more than what is necessary to provide any element of service. The "reasonable" standard does not imply that the utility should ignore laws or regulations to obtain a rock bottom price nor does it permit that any and all expenditures made by the utility to be part of the cost of service. The standard is not a requirement to pay the least but to pay based on an evaluation of cost and other relevant parameters at the time the decision was made by the utility. In certain circumstances, reasonable cost may be tempered by other regulatory directives such as purchases within the utility's service territory or meeting fuel diversity goals.

Q. What is a monopsony?

A. A monopsony is one buyer and many competing sellers, which (absent regulation) may allow the buyer to drive down (or dictate) the price paid for the seller's output. In some ways the classic utility regulatory model demands that the utility act as a monopsony in procuring inputs such as fuel and purchased power in order to provide energy to retail customers at the lowest reasonable costs. The Commission assumes a role to ensure that the utility's purchasing power does not unreasonably affect competitors such as energy service companies of all types.

Q. Are consumers and businesses capable of making investments without an assured cost or value stream?

A. Yes. Life is inherently uncertain yet most people manage to make long-term financial decisions such as purchasing a home, a vehicle or higher education without guarantees by the vendor, a third party or the government as to financial success. Businesses do have partial governmental support from the tax code's applicable loss provisions, while individuals have less protection.

Energy efficiency measures do not receive a fixed or guaranteed future price for the energy (that will no longer be purchased) and energy efficiency ("EE") has some of the attributes and characteristics of DG.

When a consumer or business purchases a hybrid, electric, diesel or high mileage automobile the purchaser isn't promised a fixed price for fuel to ensure long-term savings. There is an economic risk associated with those decisions and yet high efficiency vehicles get purchased. DG solar systems and efficient autos are in a similar price range.

Q. Please compare and contrast the purchase of excess energy from DG as compared to a full buy and full sell pricing regime.

A. Staff's perspective assumes that what happens behind the meter is the customer's business and excess energy (if any) is sold to the utility at some regulated price. This is conceptually different than having the customer purchase all of his/her energy consumption from the utility and sell all of the production from a DG installation to the utility. Changing the "regime" from Staff's excess energy view to a buy all/sell all view will change the calculation of values and costs.

The buy all/sell all view inherently treats EE measures differently than DG. Staff's perspective treats the DG energy used by the customer behind the meter as a reduction in costs to the customer at the retail tariff rate just as energy efficiency is a reduction in cost to the customer at the retail tariff rate.

Q. Please describe Exhibit HS-2.

A. Exhibit HS-2 is a five-page excerpt (pages 13 to 17) of a report prepared by the Rocky Mountain Institute ("RMI") Electricity Innovation Lab titled "A Review of Solar PV Benefit & Cost Studies, 2nd Edition". Staff attached these pages as an exhibit because Staff considers the definitions used in the document to be clear and useful for the discussion of Staff's matrix (Exhibit HS-3). The use of these definitions is not all inclusive, as the RMI report does not include the emergency conditions discussed below. Also as evident in Staff's matrix, certain items are not assigned values (or costs) by Staff, such as capacity-generation (short term), capacity-scheduling/forecasting, risk-fuel price hedging and social.

Q. Is Staff introducing and supporting the complete RMI report?

A. No. Staff is only using the definitions contained in the RMI Report and thus has attached only those pages to my testimony. Staff's use of RMI's definitions should not be viewed by parties to be an endorsement by Staff of the RMI Report itself and/or its findings or conclusions.

Q. Please define the terms used in Staff's matrix (Exhibit HS-3).

A. The definitions of the terms used are the following:

- <u>Avoided Cost</u> – The costs of energy that would have been produced or purchased but for the existence of the DG. These costs may be hourly or may be aggregated based on a delivery profile for convenience or better understanding. If the avoided costs are based on generating facilities meeting environmental requirements then the costs of environmental compliance are included within the avoided cost. The losses to the point of delivery should also be included. [On-Peak, Off-Peak, Losses-Energy]

- Cost and Value – The cost of energy being stored or shifted, which at a later point will be used to deliver value. Value occurs when the DG is used to support loads and cost is incurred in preparation for action. [Load Shifting, Storage-Energy]
- Increased Cost – Increased costs such as additional meters to be read, more complex billing, and incremental customer contact before DG installation or during DG operation.
- One Time Cost – Incremental costs for installation of metering arrangements and communications protocols to connect DG to the grid.
- Value – The provision of services delivered to the grid such as reactive power or frequency control. This value maybe limited due to the amount of storage, when load can be shifted or when the DG is in operation. [Load shifting, Storage-Energy, Solar, Wind] The value may not be limited if the DG can be dispatched at any time and run for indefinite intervals. [Responsive Generation]
- Time Specific Avoided Cost – The costs of emergency generation or other efforts to carry load. [Emergency (shortage)]
- Time Specific Payment – The value created by the ability to absorb energy when requested. [Low Load (Excess generation)]
- Outage Prevention Value – The ability to deliver energy during emergencies at the transmission or distribution level including maintaining service for long periods.
- Limited Outage Prevention Value – The ability to deliver energy during emergencies at the transmission or distribution level including maintaining service for limited periods or when DG is in operation.
- ELCC – Equivalent Load Carrying Capability is the value of DG based upon its performance including its dispatchability, the length of time the capacity is available and the coincidence between the capacity available and peak loads.

- Specific Location Only – Value available due to geographic location, such as the ability to eliminate or defer additional assets on specific distribution feeders, substations or transmission lines.
- Maybe if Aggregated – Value can be delivered if enough DG can be aggregated and controlled to deliver a meaningful response or service.

Q. Please explain the term "Responsive" as used in Exhibit HS-3.

A. DG that can be controlled by an entity that is not the owner and/or user (host) of the DG equipment/facility is considered "Responsive". A grid operator or the local load-serving utility may handle control. A third party may aggregate multiple smaller responsive DG units. The intent of control is to allow DG to be dispatched to meet common or emergency operating conditions.

Q. Does Staff recommend increasing the value of energy by considering extra or incremental environmental costs?

A. No. Avoided cost values the kWh provided at the costs the utility does not incur (energy if short term and capacity (or some portion) in the longer term). If a generating unit must meet specific environmental standards (NOx, SOx, water usage, maybe carbon) those costs are already included the costs to construct and/or operate the plant.

Q. Please describe common emergency operating conditions that are considered in Exhibit HS-3.

A. I envision at least two emergency conditions:

- A period of time when there is potentially not enough energy and capacity to support the expected load. In this situation a utility or grid operator might disconnect interruptible load, move all available generation to maximum capability (max emergency), issue requests for customers to reduce or shed load and if necessary involuntarily curtail loads based on a predetermined load shedding plan. The intent of the utility or grid operator is to maintain the stability of the system for the maximum number of customers or load. This situation may be caused by fuel shortages, adverse weather (storms), temperature and/or humidity exceeding design conditions, insufficient reserve margins, loss of generating units, loss of transmission lines and on a more local basis insufficient distribution capability.

- A period of time when there is potentially too much energy as compared to the expected load on the system. In this situation a utility or grid operator might back down generating units below economic costs, shutdown units without regard to recommended operating protocols and/or pay other systems to take the unneeded energy. The intent of the utility or grid operator is to maintain the stability of the system. This situation may occur during periods of low loads (commonly at night with little or no space conditioning load – spring or fall) combined with generating units that are defined as "must run" or with specific minimum generation.

Q. Please describe the distinction between long-term and short-term as used in Exhibit HS-3.

A. A long-term impact is sufficient in timing and magnitude to change the utility's system plan and eliminate or significantly defer the purchase or construction of generation, transmission and/or distribution facilities.

Q. Please explain Staff's matrix, Exhibit HS-3.

A. Exhibit HS-3 was developed to demonstrate the range of capabilities of various forms or types of DG (and other comparable alternatives) and then relate those capabilities to the value that DG may provide the utility (and its customers) or impose on the utility and its customers.

The exhibit is not designed to detail or list all types of DG or differentiate by fuel type or environmental impact but rather to focus the discussion on the capabilities and the related value and costs and portions thereof.

Q. How does Staff envision using Exhibit HS-3?

A. Staff recommends that Exhibit HS-3 be used to develop the value and cost for various forms of distributed generation during a utility's rate case or other proceeding. Staff does not suggest that a value (and cost) must be developed for every category of DG listed in Exhibit HS-3 at this time but only for technologies in use in Arizona or expected to be available in the marketplace in the near future.

Q. What conclusions does Staff draw from Exhibit HS-3?

A. After developing Exhibit HS-3 and considering appropriate methodologies to develop value and cost, Staff determined that there is a range of value that can be applied to DG and that it is inappropriate to use the same value for all types of DG. Specifically:

- DG that is "Responsive" is more valuable to the utility than DG that is not responsive due to the ability to react to emergency conditions on the utility system or provide reactive power.
- Energy provided to the utility by DG has a time dependent value such as avoided energy costs (including variable operations & maintenance ("O&M")).
- Generation capacity provided to the utility by DG has full value only if it is provided coincident to peak load conditions.

- Transmission needs can only be offset over a long-term horizon or when specific geographical areas can be targeted to avoid or delay new transmission construction, but transmission charges may be reduced in the short-term.
- Distribution capacity is only reduced when the utility's engineering design standards (to meet customer requirements) can be reduced or when specific geographical areas can be targeted to avoid or delay new distribution construction.
- System losses can vary due to electrical properties and timing, therefore loss factors for capacity and energy are different.
- Interconnection costs exist and some (such as metering and protection) are due only to the existence of DG.
- Some values and costs are small and incremental and thus not worth developing and including:
    - Billing costs (calculation and processing) of excess energy credits
    - On-going customer service
- Some values are inherent in the avoided cost methodology including:
    - Environmental costs (air, water and solid waste) are inherent in the fixed and variable costs of avoided capacity and energy, as the avoided facility must meet applicable regulations.
- There may be mismatches between avoided utility facilities and DG such as:
    - Dual (backup) fuel capabilities
    - Must run requirements of CHP to meet thermal loads
    - Renewable Energy Certificates ("REC")

Q. How should Staff's matrix be used?

A. Staff's matrix should be used to evaluate specific eligible costs and value of energy, capacity and other services delivered to the grid by DG (of all types) during each utility's rate case and/or integrated resource planning processes.

Q. How has electric metering changed recently?

A. For a number of years utilities have been able to measure the consumption of energy over very narrow time periods (hourly or even 15 minute intervals) but the challenge has been recording that data cost effectively. Interval data has been used for load research to provide an understanding of how different customers use energy and the data were typically recorded on magnetic tape and analyzed in bulk. While interval data were suitable for load research purposes and a small number of large customers, it was difficult to provide the data to a large number of customers at a reasonable cost.

Similarly, time-of-use meters could accumulate energy usage in a few time-differentiated periods but these data were only recorded and reported as On-Peak, Shoulder and Off-Peak periods and did not offer much information to the customer, such as when the energy was used on an interval basis.

Advanced Metering Infrastructure ("AMI") has benefited from the declining costs of electronic versus mechanical metering devices and the ability to analyze data on a customer-specific basis. Utilities that have installed AMI often develop meter data management systems that allow for the extraction of energy and demand data for billing purposes. AMI installations can provide near real time information but are limited by data transmission speeds and processing raw data efficiently.

Q. What impact does AMI have on DG?

A. AMI can be used not only to measure the energy consumed (and the associated demand) by a customer but can also detail the excess energy provided by a customer and when that energy is delivered to the utility.

Q. Why is AMI relevant in the context of DG and net metering?

A. Net metering was useful and appropriate when the costs of metering excess energy on a time of delivery basis using older interval metering probably exceeded the value of the excess energy delivered by a DG system.

Q. Does the Commission have rules on net metering?

A. I have been informed that the Commission's current net metering rules are contained in Title 14, Chapter 2, Article 23 of the Arizona Administrative Code ("A.A.C.") (A.A.C. Section 14-2-2301 et seq.).

Q. What were the advantages of net metering?

A. Net metering:

- Acted as an incentive to encourage DG
- Was easily understood by customers
- Caused little or no cost increases in the metering and billing process
- Was an acceptable starting point for the net value of DG

Q. What were the disadvantages of net metering?

A. Net metering:

- Failed to educate customers about the time varying value and cost of energy
- Equated the value of excess energy to retail energy without adequate foundation

- Allowed a customer to bank energy (i.e., store energy on the utility and withdraw it later without any cost for that storage function)

Q. What is Staff's recommendation for net metering?

A. Staff recommends that over the long-term net metering and the banking of excess energy associated with net metering be eliminated and replaced with a direct mechanism for purchasing excess DG energy that reflects the concepts discussed in Exhibit HS-3.

Q. Why should energy banking be eliminated?

A. Energy banking distorts the costs and value of DG because it does not recognize the time varying value of energy and does not recognize the impact on the utility system. DG solar may be exported during the winter and during mid-day, yet may offset energy purchases that would otherwise occur in the summer. Other, relatively minor considerations include, for example, when excess DG energy is fed back into the utility system it most likely passes through the customer's distribution transformer where some of that energy is lost as heat. If the energy is delivered to a nearby customer it also most likely will pass through another distribution transformer incurring further losses. However "banked" energy is not reduced by the possible losses but "returned" to the customer when needed to meet load. The concept of banking excess energy treats DG differently that emerging storage devices, which if located on the customer's side of the meter will have losses (into and out of storage) that storage customers will pay for.

Q. What would be an ideal price mechanism for excess DG energy?

A. In a perfect world excess DG energy would be priced at real time avoided costs, with capacity compensated separately based upon effective load carrying capabilities and various peak conditions. However, presently the costs of tracking hourly delivery of excess DG energy, billing and informing customers in order to properly price the excess DG energy for small installations would be significant compared to the amounts involved and therefore a seasonal or time period average price for excess DG may be cost effective.

Q. How does Staff recommend setting a price for excess DG energy?

A. Staff recommends that DG customers be offered a price that is understandable, easy to administer, is consistent with the utility's other opportunities to purchase energy with similar characteristics and comports with the utility's responsibility to procure energy at a reasonable price. Since the utility has market power as a purchaser, it is appropriate that the price be examined by the Commission and set in a rate proceeding.

The price offered should begin with avoided energy costs along with appropriate losses specific to that utility and/or its interconnected systems. The price may be further increased if there is demonstrated or forecast capacity value for generation.

If the Commission determines a particular value formula, in this proceeding, then follow-on proceedings such as rate cases and/or integrated resource planning processes are opportunities for specific utilities to quantify the value of DG.

Q. Should the price of excess DG energy include a transmission component?

A. If the deferral or elimination of transmission assets and/or costs can be demonstrated. This situation may occur when enough DG can be aggregated in a specific geographic location to make an incremental difference. This value component should be an adder.

Q. Should the price of excess DG energy include a distribution component?

A. If the deferral or elimination of distribution assets and/or costs can be demonstrated. This situation may occur when enough DG can be aggregated in a specific distribution area (feeder or substation) to make an incremental difference. A feeder focused RFP process could be used. This value component should be an adder.

Q. Should the price of excess DG energy recognize environmental effects?

A. As discussed above, the avoided energy value includes an environmental component that reflects the fixed and variable costs necessary for a generating unit to meet environmental standards, therefore no adder is needed. Payment for the value of the RECs should be an adder only if the utility purchasing the DG energy also receives the REC; otherwise society will pay for the REC twice. This value component should be an adder.

Q. How often should the price of excess DG energy be reset?

A. For the time being, Staff recommends that the price of various components be reset in the context of regulatory proceedings such as rate cases and be presumed to be in effect until the next case.

Q. Should the price of excess DG energy aggregate various periods or vary with time of delivery?

A. For the administrative convenience of the utility and the DG customer, one or more prices can be set for homogeneous types of DG with similar delivery patterns that reflect a weighted average of cost and delivery periods.

Q. In the UNS Electric rate case, Staff has provided a model to determine the impact of various rate design changes on solar DG customers. How do you view the use of the model in valuing DG?

A. The model Staff has developed is useful in examining "value" of solar DG only from the perspective of the solar DG customer. It only adds another dimension to the analysis as the value of solar differs from the perspective of each stakeholder. Utilities, utility shareholders, solar vendors, regulators, non-residential customers and residential customers will all have different perspectives and value propositions. However, it is important to note that the model does not estimate the profitability of solar vendors and their impact on solar DG customers.

Q. Are you sponsoring the model in this case?

A. No. Staff intends to utilize the model as another tool in upcoming rate cases looking at this issue in attempting to determine the impact of various proposals on existing and future DG customers. I am simply bringing this to parties' attention in this docket to demonstrate that we need to consider new tools to look at the value concept in a comprehensive fashion and from different perspectives.

Q. Is it your intent to address the issues raised by the Commissioners letters to this docket?

A Yes. Below Staff addresses many of the issues raised by the Chairman in his December 22, 2015 letter. Staff will attempt to address the issues raised by the other Commissioners' letters in rebuttal or during the hearing in this case.

Q. What issues did Chairman Little ask parties to address in this proceeding?

A. Chairman Little posed many questions for the parties to this docket to address in order to provide a better record for consideration. Staff addresses a number of his questions:

2. 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?
    - The declining cost of PV panels (and balance of system) should, all other parameters held constant, increase the profitably of a customer's PV system

investment. Declining costs of PV panels also reduces the cost of utility developed and third party developed large scale PV installations, which should be considered competition for distributed PV installations.

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

   - More expensive panels (per se) do not create any greater value. There should be no need to consider the cost of panels (or the resultant system cost) when considering net metering. Each decision-maker decides whether the benefit received is adequate for undertaking the cost of panels.

4. Does the cost and value of DG solar vary based on the specific customer location? Should this variability be reflected in rates?

   - The costs of DG solar may vary due to customer specific conditions such as roof orientation and tree shading. A locational variation in value (treated as an adder) may occur if the DG solar is located on a distribution feeder that can benefit from the mass installation of systems and offset distribution investment. Above the distribution level the value of DG solar is not significantly affected by location within a compact service territory.

6. How is the value and cost of DG solar affected when coupled with some type of storage? Should deployment of storage technologies be encouraged? If so, how?

   - With a versatile rate design such as a Three Part-TOU rate, the value of behind the meter storage will increase due to the ability to both reduce demand and shift energy consumption and export of DG energy. Adding storage to a DG solar installation may effectively allow shifting of DG solar production closer to load peaks to increase ELCC.

7. How does the value and cost of DG solar compare to the value and cost of community scale and utility scale solar? How do the value and cost of DG solar compare to that of wind or other renewable resources? How does the value and cost of DG solar compare to that of energy efficiency?

   - Due to economies of scale, community and utility solar may provide lower costs compared to DG solar while providing most or all of the value. Energy efficiency can provide similar distributed "effects" along with local employment and spending impacts.

8. How does the intermittent nature of DG solar affect its value and costs? Are there technologies that could reduce the intermittency of DG solar? Should these additional costs result in changes to the value and the cost of DG solar? Should an "intermittency factor" be applied to more accurately determine cost and value?

   - As discussed above, dispatchable generation (distributed or utility owned) offers the flexibility to provide system support at any hour of the year; DG solar or wind is inferior in that regard. Storage could be used to mitigate some of the limitations of DG solar or wind. When a price is set for the purpose of delivered excess energy, intermittency must be taken into account unless a varying real time price is used as a component of the net value formula.

9. To what degree is DG solar energy production coincident with peak demand? Does the cost and value of DG solar vary depending on whether or not energy production is coincident with peak demand? Are there policies that the Commission could consider that address this issue?

- Peak demand (and its timing) can vary among utility systems depending on the mix of load and therefore a blanket statement cannot be made. The value of DG does vary with time and can affect both the avoided cost of energy and the customers demand. ELCC is a method to reflect the capacity value of an intermittent technology. Staff notes that most utilities planning processes are well able to address the issue of any resource's relationship to coincident peak demand and, thus, this can be assessed by each utility in a relevant proceeding.

10. Is it possible for DG solar to be more dispatchable? How does the ability to dispatch or the lack of ability to dispatch affect the value and cost of DG solar?

- At present DG solar as commonly installed is not dispatchable. If advanced inverters are installed along with a centralized dispatch function then the output of a DG solar system can be reduced due to system or feeder congestion. As discussed above, dispatchable generation that can be increased and made available is more valuable than generation that follows weather and daylight. Absent the use of storage Staff is not aware of a method (except storage) to substantially increase the output of DG solar on command. Tracking is expected to be used to maximize production, but not for dispatchability.

12. How much should secondary economic impacts of DG solar deployment be considered in the value and cost considerations? Do investments and other types of generation technology have similar, greater or lesser secondary economic impacts? If so, how?

- Staff recommends that secondary economics should not be considered in value and cost considerations of any resource choice because they are not rewarded in the other cases of customer inspired conservation, insulation, high efficiency appliances and storage. Comparisons of local job content can vary between technologies and whether jobs are construction, operations or maintenance, sales and finance. Comparisons of local equipment content can vary between technologies and whether equipment is manufactured locally or produced in the United States or imported. These variations preclude valuing secondary economic impacts easily or accurately, except in very rare circumstances.

13. How does the value and cost of DG solar change as penetration levels rise? How should this be considered in rate making and resource planning contexts?

- As the penetration of DG solar increases there may be positive and negative impacts at the distribution level. The positive impact of DG solar may mitigate a future distribution investment. At the generation level, DG solar may provide no savings for other customers if the avoided costs all flow to the DG solar customer. As penetration increases, intermittency may require increased dispatch and control activities and costs. If the production of DG on a feeder becomes significant (higher penetration) the negative impacts on a feeder can be mitigated through interconnection (and other equipment) and potentially smart inverters. Staff recommends this consideration be deferred until DG solar penetration exceeds 15 percent and the issue becomes more relevant.

14. Should the fuel cost savings to the utility associated with DG solar be considered in the value and cost determination? If so, how do we deal with the uncertainty of future fuel prices?

- Yes, fuel and other operational saving form the bulk of the avoided costs that establish the value of excess energy delivered to the utility. Fuel forecast variability is a significant problem that capacity planners treat by using a variety of forecasts and scenarios to make decisions probabilistically. As discussed above other technologies such as energy efficiency and fuel-efficient vehicles are not promised a fixed price for the life of the asset. Staff recommends each utility use the same fuel price forecast for each potential resource in its planning process so that DG is considered on the same bases as, say, a natural gas plant. Staff recommends dealing with fuel forecast variability by not setting too long of a term of prices for excess energy and instead use a mechanism to recalibrate periodically.

17. Does the grid itself add value to DG solar? If so, how should the value of the grid be considered when assessing the value and cost of DG solar?

- Yes, DG solar as generally installed requires connection to the utility grid to operate and to sell excess DG energy. Most inverters will not operate without voltage and frequency from the grid. With a Three Part-TOU rate, the costs of the grid connection will be paid for by most DG solar customers.

18. 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?

- Yes, if water is consumed in electric generation (such as cooling, steam cycle blowdown, NOx control or power augmentation); but that cost difference should already be accounted for in the fixed and variable O&M costs that are included in avoided costs. Therefore, no value adder is needed for water unless it has been inadvertently overlooked in the avoided cost comparison.

19. Are there disaster recovery or backup benefits associated with the development of DG solar? Are they reliable and quantifiable enough to determine tangible benefits that might accrue to the grid?

- No, for single installations that include inverters that shut down energy production when the grid is unavailable, DG solar offers no benefits and a slight increase in the time for restoration (due to safety measures that must be taken to protect line personnel). Yes, if DG solar installations are aggregated and fitted with smart inverters and controls to allow "island" operation, only those customers within the island will have service during mass outages. However, the presence of islanded load pockets will complicate restoration and increase the time to return non-islanded customers due to the need to obtain distribution dispatch clearances and resynchronize the islanded load.

20 What, if any, costs are associated with the utility providing voltage support and/or frequency support or other ancillary services in support of DG solar installations?

- If the impact of providing voltage support and/or frequency support or other ancillary services are identified and become significant, they should be taken into consideration. Also see the response to # 17.

Q. Does this conclude your direct testimony?

A. Yes, it does.

Testimony - Howard Solganick

Arizona Corporation Commission
Case – UNS Electric Docket No. E-04204A-12-0504 (June 2013 and July 2013)
Client - Staff of the Arizona Corporation Commission
Scope - Testimony covered revenue decoupling, cost of service, revenue allocation, rate design and other related issues.

Case – Tucson Electric Power Company Docket No. E-01933A-12-0291 (December 2012 and January 2013)
Client - Staff of the Arizona Corporation Commission
Scope - Testimony covered revenue decoupling, cost of service, revenue allocation, rate design and other related issues.

Case – Arizona Public Service Company Docket No. E-01345A-11-0224 (November and December 2011)
Client - Staff of the Arizona Corporation Commission
Scope - Testimony covered revenue decoupling, cost of service, revenue allocation, rate design and other related issues.

Public Service Commission of Delaware
Case - Delmarva Power & Light Company Docket No. 10-237 (October 2010)
Client - Staff of the Delaware Public Service Commission
Scope - Testimony covered cost of service, revenue allocation, rate design and other related issues including revenue stabilization and miscellaneous charges.

Case - Delmarva Power & Light Company Docket No. 09-414 (February 2010)
Client - Staff of the Delaware Public Service Commission
Scope - Testimony covered cost of service, revenue allocation, rate design and other related issues including revenue stabilization and weather normalization.

Case - Delmarva Power & Light Company Docket No. 09-277T (November 2009)
Client - Staff of the Delaware Public Service Commission
Scope - Testimony covered an analysis of a straight fixed variable rate design for small gas customers and implementation issues.

Case - Delmarva Power & Light Company Docket No. 06-284 (January 2007)
Client - Staff of the Delaware Public Service Commission
Scope - Testimony covered cost of service, revenue allocation, rate design and other related issues including revenue stabilization or normalization.

Georgia Public Service Commission
Case – Atlanta Gas Light Company Docket No. 31647 (August 2010)
Client – Public Interest Advocacy Staff of the Georgia Public Service Commission
Scope - Testimony covered revenue forecast, cost of service, revenue allocation, rate design and other related issues.

Case – Atmos Energy Corporation Docket No. 27163 (July 2008)
Client – Public Interest Advocacy Staff of the Georgia Public Service Commission
Scope - Testimony covered rate design and other related issues.
Jamaica (West Indies) Office of Utility Regulation
Case - Electricity Appeals Tribunal (August 2007)

Client - Jamaica Public Service Company, Ltd.
Scope - "Witness Statement" on behalf of the Jamaica Public Service Company Limited. This Statement covered issues relating to recovery of expenses incurred due to Hurricane Ivan.

Maine Public Utilities Commission
Case - Northern Utilities, Accelerated Cast Iron Replacement Program Docket No. 2005-813 (2005)
Client - Public Advocate of the State of Maine
Scope - Testimony covered an analysis of the program's economics and implementation.

Public Service Commission of Maryland
Case - Chesapeake Utilities Corporation Case No. 9062 (August 2006)
Client - Office of the Maryland People's Counsel
Scope - Testimony covered cost of service, rate design and other related issues.

Case - Baltimore Gas & Electric's (1993)
Client - As president of the Mid Atlantic Independent Power Producers
Scope - Testimony covered BG&E's capacity procurement plans.

Michigan Public Service Commission
Case - Consumers Energy Company Case No. U-15245 (November 2007)
Client - Attorney General Michael A. Cox (Don Erickson, Esq.)
Scope - Testimony covered cost of service, rate design and revenue allocation.

Case - Consumers Energy Company Case No. U-15190 (July 2007)
Client - Attorney General Michael A. Cox (Don Erickson, Esq.)
Scope - Testimony covered issues related to Consumers Energy's gas revenue decoupling proposal.

Case - Consumers Energy Company Case No. U-15001 (June 2007)
Client - Attorney General Michael A. Cox (Don Erickson, Esq.)
Scope - Testimony covered issues related to Consumers Energy and the MCV Partnership.

Case - Consumers Energy Company Case No. U-14981 (September 2006)
Client - Attorney General Michael A. Cox (Don Erickson, Esq.)
Scope - Testimony covered issues relating to the sale of Consumers interest in the Midland Cogeneration Venture.

Case - Consumers Energy Company Case No. U-14347 (June 2005)
Client - Attorney General Michael A. Cox (Don Erickson, Esq.)
Scope – Testimony covered cost of service and revenue allocation.

Missouri Public Service Commission
Case – AmerenUE Storm Adequacy Review (July 2008)
Client – KEMA/AmerenUE
Scope – Oral testimony covered KEMA's review of AmerenUE's system major storm restoration efforts.

Case – Veolia Energy Kansas City, Inc. File No. HR-2011-0241 (September 2011)
Client – City of Kansas City, Missouri
Scope – Testimony covered various aspects of the Company's tariff provisions and the impact on the City of Kansas City.
New Jersey Board of Public Utilities

Case - Cogeneration and Alternate Energy Docket # 8010-687 (1981)
Case - PURPA Rate Design and Lifeline Docket # 8010-687 (1981)
Case - Atlantic Electric Rate Case - Phases I & II Docket # 822-116 (1982)
Case - Power Supply Contract Litigation – Wilmington Thermal Systems Docket # 2755-89 (1989)
Case - NJBPU Atlantic Electric Rate Case - Phase II (1980-81) Docket # 7911-951 (Before the Commissioners of the New Jersey Board of Public Utilities)
Client - Employer was Atlantic City Electric Company.
Scope - The cases listed above covered load forecasting, capacity planning, load research, cost of service, rate design and power procurement.

Public Utilities Commission of Ohio
Case - The Application of Ohio Edison Company, The Cleveland Electric Illuminating Company, and The Toledo Edison Company Case 07-551-EL-AIR (January 2008)
Client - Ohio Schools Council
Scope - Testimony covers issues related to rate treatment of schools.

Case - The Application of the Columbus Southern Power Company 08-917-EL-SSO and the Ohio Power Company Case 08-918-EL-SSO (October 2008)
Client - Ohio Hospital Association
Scope - Testimony covers issues related to rates for net metering and alternate feed service and related treatment of hospitals.

Pennsylvania Public Utilities Commission
Case - York Water Company Docket No. R-00061322 (July 2006)
Client - Pennsylvania Office of Consumer Advocate
Subject - Testimony covered cost of service, rate design and other related issues, also supported the settlement process.

Case – Pennsylvania- American Water Company Docket No. R-2008-232689 (August 2010)
Client – Municipal Sewer Group
Subject - Testimony covered capacity planning, construction, treatment of future load and associated revenue, cost of service, rate design, capacity fee and other related issues.

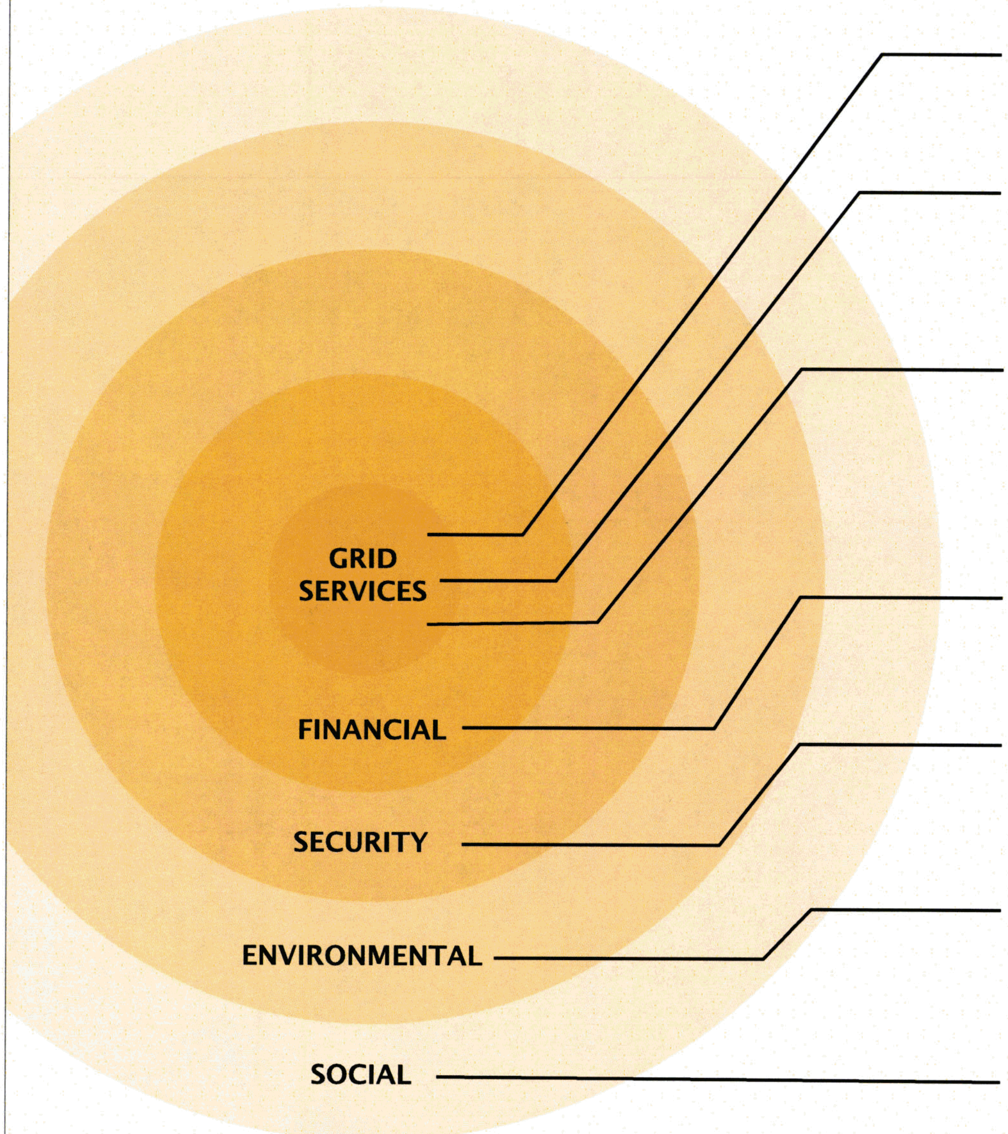
Case – Pennsylvania- American Water Company Docket No. R-2008-232689 (August 2008)
Client – Municipal Sewer Group
Subject - Testimony covered cost of service, rate design, capacity fee and other related issues, also supported the settlement process.

Public Utilities Commission of Texas
Case – Determination of Hurricane Restoration Costs Docket No. 36918 (April 2009)
Client – CenterPoint Energy Houston Electric, LLC
Subject – Testimony covered the reasonableness of the client's Hurricane Ike restoration process for an outage covering over two million customers and a restoration period of 18 days

BENEFIT & COST CATEGORIES

Electricity Innovation Lab
ROCKY MOUNTAIN INSTITUTE

For the purposes of this report, **value is defined as net value, i.e. benefits minus costs.** Depending upon the size of the benefit and the size of the cost, value can be positive or negative. A variety of categories of benefits or costs of DPV have been considered or acknowledged in evaluating the value of DPV. Broadly, these categories are:



ENERGY

- energy
- system losses

CAPACITY

- generation capacity
- transmission & distribution capacity
- DPV installed capacity

GRID SUPPORT SERVICES

- reactive supply & voltage control
- regulation & frequency response
- energy & generator imbalance
- synchronized & supplemental operating reserves
- scheduling, forecasting, and system control & dispatch

FINANCIAL RISK

- fuel price hedge
- market price response

SECURITY RISK

- reliability & resilience

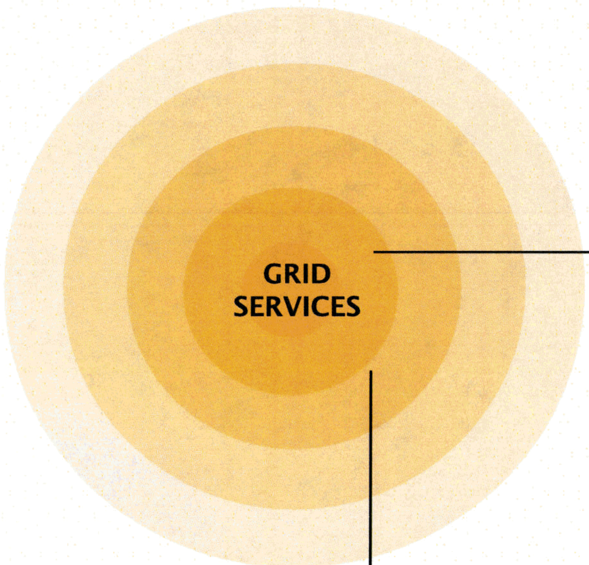
ENVIRONMENTAL

- carbon emissions (CO_2)
- criteria air pollutants (SO_2, NO_x, PM)
- water
- land

SOCIAL

- economic development (jobs and tax revenues)

BENEFIT & COST CATEGORIES DEFINED



ENERGY

Energy value of DPV is positive when the solar energy generated displaces the need to produce energy from another resource at a net savings. There are two primary components:

- **Avoided Energy** - The cost and amount of energy that would have otherwise been generated to meet customer needs, largely driven by the variable costs of the marginal resource that is displaced. In addition to the coincidence of solar generation with demand and generation, key drivers of avoided energy cost include (1) fuel price forecast, (2) variable operation & maintenance costs, and (3) heat rate.

- **System Losses** - The compounded value of the additional energy generated by central plants that would otherwise be lost due to inherent inefficiencies (electrical resistance) in delivering energy to the customer via the transmission and distribution system. Since DPV generates energy at or near the customer, those losses are avoided. Losses act as a magnifier of value for capacity and environmental benefits, since avoided energy losses result in lower required capacity and lower emissions.

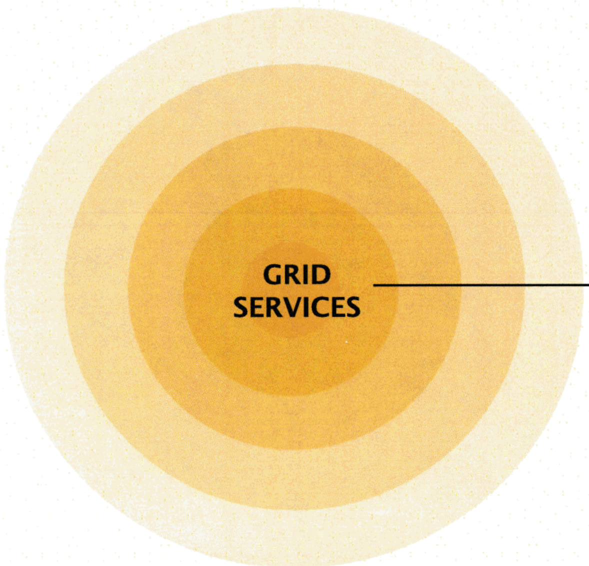
CAPACITY

Capacity value of DPV is positive when the addition of DPV defers or avoids more investment in generation, transmission, and distribution assets than it incurs. There are two primary components:

- **Generation Capacity** - The cost of the amount of central generation capacity that can be deferred or avoided due to the addition of DPV. Key drivers of value include (1) DPV's effective capacity and (2) system capacity needs.

- **Transmission & Distribution Capacity** - The value of the net change in T&D infrastructure investment due to DPV. Benefits occur when DPV is able to meet rising demand locally, relieving capacity constraints upstream and deferring or avoiding T&D upgrades. Costs occur when additional T&D investment is needed to support the addition of DPV.

BENEFIT & COST CATEGORIES DEFINED

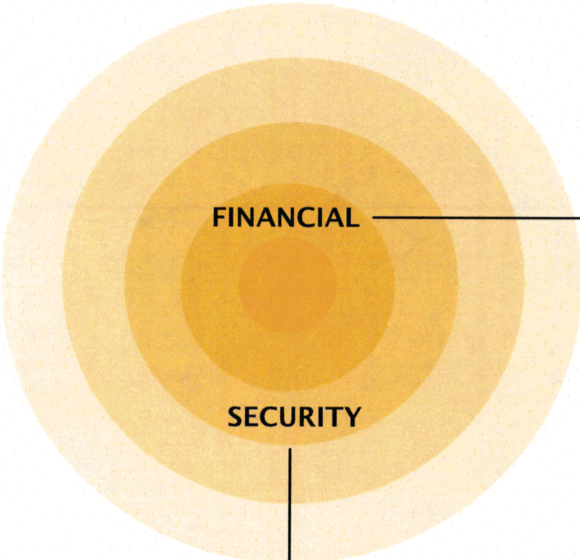


GRID SUPPORT SERVICES

Grid support value of DPV is positive when the net amount and cost of grid support services required to balance supply and demand is less than would otherwise have been required. Grid support services, which encompass more narrowly defined ancillary services (AS), are those services required to enable the reliable operation of interconnected electric grid systems. Grid support services include:

- **Reactive Supply and Voltage Control**— Generation facilities used to supply reactive power and voltage control.
- **Frequency Regulation**—Control equipment and extra generating capacity necessary to (1) maintain frequency by following the moment-to-moment variations in control area load (supplying power to meet any difference in actual and scheduled generation), and (2) to respond automatically to frequency deviations in their networks. While the services provided by regulation service and frequency response service are different, they are complementary services made available using the same equipment and are offered as part of one service.
- **Energy Imbalance**—This service supplies any hourly net mismatch between scheduled energy supply and the actual load served.
- **Operating Reserves**—Spinning reserve is provided by generating units that are on-line and loaded at less than maximum output, and should be located near the load (typically in the same control area). They are available to serve load immediately in an unexpected contingency. Supplemental reserve is generating capacity used to respond to contingency situations that is not available instantaneously, but rather within a short period, and should be located near the load (typically in the same control area).
- **Scheduling/Forecasting**—Interchange schedule confirmation and implementation with other control areas, and actions to ensure operational security during the transaction.

BENEFIT & COST CATEGORIES DEFINED



FINANCIAL RISK

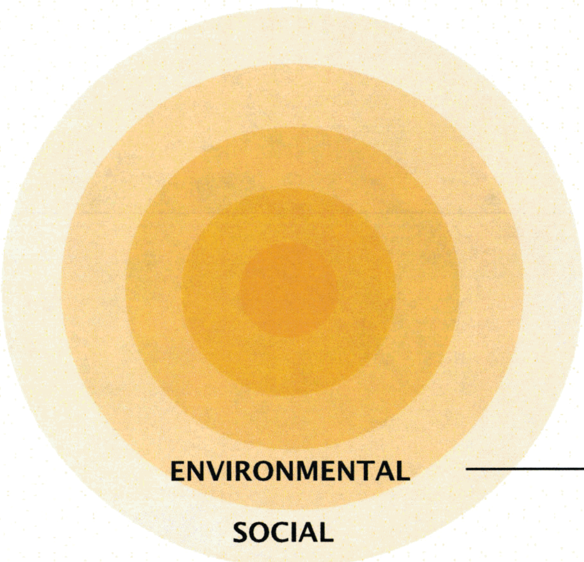
Financial value of DPV is positive when financial risk or overall market price is reduced due to the addition of DPV. Two components considered in the studies reviewed are:

- **Fuel Price Hedge** - The cost that a utility would otherwise incur to guarantee that a portion of electricity supply costs are fixed.
- **Market Price Response** - The price impact as a result of DPV's reducing demand for centrally-supplied electricity and the fuel that powers those generators, thereby lowering electricity prices and potentially commodity prices.

SECURITY RISK

Security value of DPV is positive when grid reliability and resiliency are increased by (1) reducing outages by reducing congestion along the T&D network, (2) reducing large-scale outages by increasing the diversity of the electricity system's generation portfolio with smaller generators that are geographically dispersed, and (3) providing back-up power sources available during outages through the combination of PV, control technologies, inverters and storage.

BENEFIT & COST CATEGORIES DEFINED



ENVIRONMENTAL

Environmental value of DPV is positive when DPV results in the reduction of environmental or health impacts that would otherwise have been created. Key drivers include primarily the environmental impacts of the marginal resource being displaced. There are four components of environmental value:

- **Carbon** - The value from reducing carbon emissions is driven by the emission intensity of displaced marginal resource and the price of emissions.
- **Criteria Air Pollutants** - The value from reducing criteria air pollutant emissions—NO_X, SO_2, and particulate matter—is driven by the cost of abatement technologies, the market value of pollutant reductions, and/or the cost of human health damages.
- **Water** - The value from reducing water use is driven by the differing water consumption patterns associated with different generation technologies, and is sometimes measured by the price paid for water in competing sectors.
- **Land** - The value associated with land is driven by the difference in the land footprint required for energy generation and any change in property value driven by the addition of DPV.
- **Avoided Renewable Portfolio Standard costs (RPS)** - The value derived from meeting electricity demand through DPV, which reduces total demand that would otherwise have to be met and the associated renewable energy that would have to be procured as mandated by an RPS.

SOCIAL

The studies reviewed in this report defined social value in economic terms. The social value of DPV was positive when DPV resulted in a net increase in jobs and local economic development. Key drivers include the number of jobs created or displaced, as measured by a job multiplier, as well as the value of each job, as measured by average salary and/or tax revenue.

Value of Distributed Generation				
DG Type	Generation			
DG Characteristics & Capabilities	Off Grid	No Export	Responsive	Non-Responsive
Energy				
On-Peak	Not Applicable	Not Applicable	Avoided Cost	Avoided Cost
Off-Peak			Avoided Cost	Avoided Cost
Losses-Energy			Avoided Cost	Avoided Cost
Emergency (shortage)			Time Specific Avoided Cost	
Low Load (Excess generation)			Time Specific Payment	
Capacity				
Generation				
Emergency			Outage Prevention Value	
Long-term			ELCC	ELCC
Short-term				
Losses			Proportional to ELCC	Proportional to ELCC
Transmission				
Emergency			Outage Prevention Value	
Long-term			Proportional to ELCC	Proportional to ELCC
Short-term			Specific Location Only	Specific Location Only
Losses			Proportional to ELCC	Proportional to ELCC
Distribution				
Emergency			Outage Prevention Value	
Long-term			Proportional to ELCC	Proportional to ELCC
Short-term			Specific Location Only	Specific Location Only
Losses			Proportional to ELCC	Proportional to ELCC
Reactive			Value	
Frequency Regulation			Value	
Energy Imbalance			Maybe if Aggregated	
Operating Reserves			Maybe if Aggregated	
Scheduling/Forecasting				
Risk				
Fuel Price Hedge				
Market Price Response			Yes	Yes
Environmental				
Carbon			Maybe In Avoided Cost	Maybe In Avoided Cost
NOX SOX			In Avoided Cost	In Avoided Cost
Water			In Avoided Cost	In Avoided Cost
Land			In Avoided Cost	In Avoided Cost
Social				
Customer				
Meter & Reading	100%		Increased Cost	Increased Cost
Service Drop	100%			
Billing	100%		Increased Cost	Increased Cost
Customer Service	100%		Increased Cost	Increased Cost
Interconnection	No Cost	No Cost	One Time Cost	One Time Cost

Value of Distributed Generation / DG Type / DG Characteristics & Capabilities	Load Shifting: Responsive	Load Shifting: Non-Responsive	Storage-Energy: Responsive	Storage-Energy: Non-Responsive
Energy				
On-Peak	Avoided Cost	Avoided Cost	Avoided Cost	Avoided Cost
Off-Peak	Cost or Value	Cost	Both	Retail Purchase
Losses-Energy	Avoided Cost	Avoided Cost	Avoided Cost	Avoided Cost
Emergency (shortage)	Time Specific Avoided Cost		Time Specific Avoided Cost	
Low Load (Excess generation)	Time Specific Payment		Time Specific Payment	
Capacity				
Generation				
Emergency	Ltd Outage Prevention Value		Ltd Outage Prevention Value	
Long-term	ELCC	ELCC	ELCC	ELCC
Short-term				
Losses	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC
Transmission				
Emergency	Ltd Outage Prevention Value		Ltd Outage Prevention Value	
Long-term	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC
Short-term	Specific Location Only	Specific Location Only	Specific Location Only	Specific Location Only
Losses	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC
Distribution				
Emergency	Ltd Outage Prevention Value		Ltd Outage Prevention Value	
Long-term	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC
Short-term	Specific Location Only	Specific Location Only	Specific Location Only	Specific Location Only
Losses	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC
Reactive	Ltd Value		Ltd Value	
Frequency Regulation				
Energy Imbalance				
Operating Reserves				
Scheduling/Forecasting				
Risk				
Fuel Price Hedge				
Market Price Response	Yes	Yes	Yes	Yes
Environmental				
Carbon	Maybe In Avoided Cost	Maybe In Avoided Cost	Maybe In Avoided Cost	Maybe In Avoided Cost
NOX SOX	In Avoided Cost	In Avoided Cost	In Avoided Cost	In Avoided Cost
Water	In Avoided Cost	In Avoided Cost	In Avoided Cost	In Avoided Cost
Land	In Avoided Cost	In Avoided Cost	In Avoided Cost	In Avoided Cost
Social				
Customer				
Meter & Reading	Increased Cost	Increased Cost	Increased Cost	Increased Cost
Service Drop				
Billing	Increased Cost	Increased Cost	Increased Cost	Increased Cost
Customer Service	Increased Cost	Increased Cost	Increased Cost	Increased Cost
Interconnection	One Time Cost	One Time Cost	One Time Cost	One Time Cost

Value of Distributed Generation	Solar				
DG Type	Fixed Axis			Tracking	
DG Characteristics & Capabilities	South	West	Responsive	Responsive	Non-Responsive
Energy					
On-Peak	Avoided Cost	Avoided Cost	Avoided Cost	Avoided Cost	Avoided Cost
Off-Peak	Avoided Cost	Avoided Cost	Avoided Cost	Avoided Cost	Avoided Cost
Losses-Energy	Avoided Cost	Avoided Cost	Avoided Cost	Avoided Cost	Avoided Cost
Emergency (shortage)					
Low Load (Excess generation)					
Capacity					
Generation					
Emergency					
Long-term	ELCC	ELCC	ELCC	ELCC	ELCC
Short-term					
Losses	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC
Transmission					
Emergency			Outage Prevention Value	Outage Prevention Value	
Long-term	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC
Short-term	Specific Location Only	Specific Location Only	Specific Location Only	Specific Location Only	Specific Location Only
Losses	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC
Distribution					
Emergency			Outage Prevention Value	Outage Prevention Value	
Long-term	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC
Short-term	Specific Location Only	Specific Location Only	Specific Location Only	Specific Location Only	Specific Location Only
Losses	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC
Reactive			Value	Value	
Frequency Regulation			Maybe if Aggregated	Maybe if Aggregated	
Energy Imbalance			Maybe if Aggregated	Maybe if Aggregated	
Operating Reserves					
Scheduling/Forecasting					
Risk					
Fuel Price Hedge	Yes	Yes	Yes	Yes	Yes
Market Price Response	Yes	Yes	Yes	Yes	Yes
Environmental					
Carbon	Maybe In Avoided Cost	Maybe In Avoided Cost	Maybe In Avoided Cost	Maybe In Avoided Cost	Maybe In Avoided Cost
NOX SOX	In Avoided Cost	In Avoided Cost	In Avoided Cost	In Avoided Cost	In Avoided Cost
Water	In Avoided Cost	In Avoided Cost	In Avoided Cost	In Avoided Cost	In Avoided Cost
Land	In Avoided Cost	In Avoided Cost	In Avoided Cost	In Avoided Cost	In Avoided Cost
Social					
Customer					
Meter & Reading	Increased Cost	Increased Cost	Increased Cost	Increased Cost	Increased Cost
Service Drop					
Billing	Increased Cost	Increased Cost	Increased Cost	Increased Cost	Increased Cost
Customer Service	Increased Cost	Increased Cost	Increased Cost	Increased Cost	Increased Cost
Interconnection	One Time Cost	One Time Cost	One Time Cost	One Time Cost	One Time Cost

Value of Distributed Generation		Wind	
DG Type			
DG Characteristics & Capabilities		Responsive	Non-Responsive
Energy			
On-Peak		Avoided Cost	Avoided Cost
Off-Peak		Avoided Cost	Avoided Cost
Losses-Energy		Avoided Cost	Avoided Cost
Emergency (shortage)			
Low Load (Excess generation)		Time Specific Payment	
Capacity			
Generation			
	Emergency		
	Long-term	ELCC	ELCC
	Short-term		
	Losses	Proportional to ELCC	Proportional to ELCC
Transmission			
	Emergency		
	Long-term	Proportional to ELCC	Proportional to ELCC
	Short-term	Specific Location Only	Specific Location Only
	Losses	Proportional to ELCC	Proportional to ELCC
Distribution			
	Emergency		
	Long-term	Proportional to ELCC	Proportional to ELCC
	Short-term	Specific Location Only	Specific Location Only
	Losses	Proportional to ELCC	Proportional to ELCC
Reactive		Value	
Frequency Regulation		Maybe if Aggregated	
Energy Imbalance			
Operating Reserves			
Scheduling/Forecasting			
Risk			
Fuel Price Hedge		Yes	Yes
Market Price Response		Yes	Yes
Environmental			
Carbon		Maybe In Avoided Cost	Maybe In Avoided Cost
NOX SOX		In Avoided Cost	In Avoided Cost
Water		In Avoided Cost	In Avoided Cost
Land		In Avoided Cost	In Avoided Cost
Social			
Customer			
Meter & Reading		Increased Cost	Increased Cost
Service Drop			
Billing		Increased Cost	Increased Cost
Customer Service		Increased Cost	Increased Cost
Interconnection		One Time Cost	One Time Cost

Value of Distributed Generation		Increased Conservation	Increased Insulation
DG Type			
DG Characteristics & Capabilities			
Energy			
On-Peak		Avoided Cost	Avoided Cost
Off-Peak		Avoided Cost	Avoided Cost
Losses-Energy		Avoided Cost	Avoided Cost
Emergency (shortage)			
Low Load (Excess generation)			
Capacity			
Generation			
	Emergency		
	Long-term	ELCC	ELCC
	Short-term		
	Losses	Proportional to ELCC	Proportional to ELCC
Transmission			
	Emergency		
	Long-term	Proportional to ELCC	Proportional to ELCC
	Short-term	Specific Location Only	Specific Location Only
	Losses	Proportional to ELCC	Proportional to ELCC
Distribution			
	Emergency		
	Long-term	Proportional to ELCC	Proportional to ELCC
	Short-term	Specific Location Only	Specific Location Only
	Losses	Proportional to ELCC	Proportional to ELCC
Reactive			
Frequency Regulation			
Energy Imbalance			
Operating Reserves			
Scheduling/Forecasting			
Risk			
Fuel Price Hedge		Yes	Yes
Market Price Response		Yes	Yes
Environmental			
Carbon		Maybe In Avoided Cost	Maybe In Avoided Cost
NOX SOX		In Avoided Cost	In Avoided Cost
Water		In Avoided Cost	In Avoided Cost
Land		In Avoided Cost	In Avoided Cost
Social			
Customer			
Meter & Reading			
Service Drop			
Billing			
Customer Service			
Interconnection		No Cost	No Cost

Value of Distributed Generation		Efficent Appliances		Efficient HVAC	
DG Type					
DG Characteristics & Capabilities		Responsive	Non-Responsive	Responsive	Non-Responsive
Energy					
On-Peak		Avoided Cost	Avoided Cost	Avoided Cost	Avoided Cost
Off-Peak		Avoided Cost	Avoided Cost	Avoided Cost	Avoided Cost
Losses-Energy		Avoided Cost	Avoided Cost	Avoided Cost	Avoided Cost
Emergency (shortage)					
Low Load (Excess generation)		Time Specific Payment		Time Specific Payment	
Capacity					
Generation					
	Emergency				
	Long-term	ELCC	ELCC	ELCC	ELCC
	Short-term				
	Losses	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC
Transmission					
	Emergency				
	Long-term	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC
	Short-term	Specific Location Only	Specific Location Only	Specific Location Only	Specific Location Only
	Losses	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC
Distribution					
	Emergency				
	Long-term	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC
	Short-term	Specific Location Only	Specific Location Only	Specific Location Only	Specific Location Only
	Losses	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC	Proportional to ELCC
Reactive					
Frequency Regulation					
Energy Imbalance					
Operating Reserves					
Scheduling/Forecasting					
Risk					
Fuel Price Hedge		Yes	Yes	Yes	Yes
Market Price Response		Yes	Yes	Yes	Yes
Environmental					
Carbon		Maybe In Avoided Cost	Maybe In Avoided Cost	Maybe In Avoided Cost	Maybe In Avoided Cost
NOX SOX		In Avoided Cost	In Avoided Cost	In Avoided Cost	In Avoided Cost
Water		In Avoided Cost	In Avoided Cost	In Avoided Cost	In Avoided Cost
Land		In Avoided Cost	In Avoided Cost	In Avoided Cost	In Avoided Cost
Social					
Customer					
Meter & Reading					
Service Drop					
Billing					
Customer Service					
Interconnection		No Cost	No Cost	No Cost	No Cost