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BEFORE THE PUBLIC SERVICE COMMISSION OF UTAH

In the Matter of the Application of Rocky Mountain Power to Establish Export Credits for Customer Generated Electricity	**Docket No. 17-035-61 Phase 2**

AFFIRMATIVE TESTIMONY OF CAROLYN A. BERRY, PH.D.

ON BEHALF OF

VOTE SOLAR

March 3, 2020

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I. Qualifications

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

A. My name is Carolyn A. Berry. I am a Principal with Bates White, LLC. My business address is 2001 K Street NW, North Building, Suite 500, Washington, DC 20006.

Q. Please describe your educational background.

A. I received a B.S. in economics and a B.A. in Spanish from the University of Minnesota in 1986 and Ph.D. in economics from Northwestern University in 1995.

Q. Please summarize your professional background.

A. I am a Principal with the economic consulting firm of Bates White, LLC. I have worked for over 25 years on a wide range of issues concerning competition and regulation in the electricity industry, including transmission access, market power, market manipulation, cost recovery, market restructuring and design, distributed generation, and rates. I have prepared economic analyses and filed testimony in various state and federal jurisdictions analyzing the effects of energy policy on incentives and market outcomes. I have testified before the Federal Energy Regulatory Commission, the California Public Services Commission, and the U.S. District Court for the District of South Carolina. I have an appreciation of a variety of industry perspectives, as I have worked inside a regulatory agency (Federal Energy Regulatory Commission), at an investor-owned utility (Pacific Gas & Electric Company), and as an economic consultant for regulatory commissions, state governments, regulated entities, and independent power producers. Attached to this testimony is a copy of my curriculum vitae that includes a complete list of my testimony (Exhibit 1-CAB).

II. Assignment

Q. On whose behalf are you submitting this testimony?

A. I am submitting this testimony on behalf of Vote Solar.

Q. What is the purpose of your testimony?

A. I have been asked to provide an overview of the economic and policy issues relevant to this proceeding in order to assess the economic value of solar distributed generation ("DG") exported to the Rocky Mountain Power ("RMP") electric distribution system in Utah. Based on my analysis of the value of DG solar exports and that of the other Vote Solar witnesses, I have been asked to determine an amount in cents/kilowatt hour (¢/kWh) for the value of exported Customer Generation ("CG") in RMP's service territory. My analysis and the value of CG exports is then used by Vote Solar witness Ms. Briana Kobor to recommend a just and reasonable compensation mechanism for CG exports.

Q. Why do you focus your analysis on DG solar to find a value for CG?

A. Although a variety of different distributed resource types are included in the definition of CG as codified by the Utah Public Service Commission ("Commission")[1], over 99% of CG (kW) is made up of DG solar, and the vast majority of future installations of CG in RMP's

[1] *Utah Schedule 136 – Transition Program*, RMP, p. 2, https://www.rockymountainpower.net/content/dam/pcorp/documents/en/rockymountainpower/rates-regulation/utah/rates/136_Transition_Program_for_Customer_Generators.pdf.

service territory are expected to be DG solar.[2] Given this make-up of CG, it is reasonable to base the value of CG on the value of DG solar. As such, I have not analyzed the value of non-solar CG resource types, but given the very small amounts of these resources, their specific values would not change my overall findings.

Q. What is the scope of your analysis of the value of CG?

In this proceeding, the Commission provided an opportunity for parties to conduct comprehensive studies on the value of CG to inform the appropriate compensation for CG exports. For example, the Commission stated that "parties may present evidence addressing the following costs or benefits: energy value, appropriate measurement intervals, generation capacity, line losses, transmission and distribution capacity and investments, integration and administrative costs, grid and ancillary services, fuel hedging, environmental compliance, and other considerations."[3] To assist the Commission in determining a just and reasonable compensation mechanism for customer-generated exports of electricity, I, in conjunction with Vote Solar witnesses Dr. Michael Milligan, Mr. Curt Volkmann, Dr. Albert Lee and Dr. Spencer Yang, have quantified the value that CG exports provide when CG is interconnected to RMP's distribution system. I have also evaluated additional benefits of CG that I have not quantified, but that are nonetheless important for the Commission to consider in establishing just and reasonable compensation for CG exports. I reserve the right to express

[2] Rocky Mountain Power, *Rocky Mountain Power's Customer Owned Generation and Net Metering Report and Attachment A for the Period April 1, 2018 through March 31, 2019*, Docket No: 19-035-29 Attachment A-Revised 2018 Customer Generation Report, Aug.15, 2019 https://psc.utah.gov/2019/07/01/docket-no-19-035-29/.

[3] Rocky Mountain Power, *Settlement Stipulation,* Docket No. 14-035-114, ¶ 30, Aug. 28, 2017, https://pscdocs.utah.gov/electric/14docs/14035114/296270RMPSettleStip8-28-2017.pdf.**Error! Hyperlink reference not valid.**

additional opinions, to amend or supplement the opinions in this testimony, or to provide additional rationale for these opinions as additional documents are produced, and new facts are introduced during discovery and trial. I also reserve the right to express additional opinions in response to any opinions or testimony offered by other parties in this proceeding.

III. Summary of Recommendations

Q. Please summarize your main conclusions.

A. Based on my analysis and the analyses of Dr. Michael Milligan, Mr. Curt Volkmann, Dr. Albert Lee and Dr. Spencer Yang, I conclude that the value of exported CG in RMP's service territory is 22.60 ¢/kWh. Table 1 shows the magnitude of the different value components that make up the value of CG exports. Each of these components is discussed in detail in Section VII of my testimony.

Table 1: Value of CG Exports in Utah

Category	**Value** ¢/kWh 2021USD (levelized)
Utility-Based Benefits	
Energy	
Avoided Energy	3.65
Avoided line losses	0.31
Capacity	
Avoided generation capacity	1.60
Avoided transmission capacity	1.45
Avoided distribution capacity	0.56
Grid Support Services	
Ancillary services	*nq**
Financial Risk	
Fuel price hedge	0.20
Market price effect	*nq*
Security Risk	
Reliability and resilience	*nq*
Environmental	
Carbon (CO_2) compliance costs	2.80
Utility Costs	
Integration costs	0.00
Subtotal	**10.57**
Community Benefits	
Environmental	
Health benefits from reduced air pollution	2.09
Benefits of reduced carbon emissions (CO_2)	6.57
Avoided fossil fuel lifecycle costs	*nq*
Societal	
Local economic benefits	3.37
Subtotal	**12.03**
Total Value of CG Exports	**22.60**

**not quantified*

I also conclude that changes and uncertainty in CG policy have had a negative impact on CG growth. Initially, the success of Utah's net energy metering ("NEM") program led to healthy growth in distributed generation ("DG") in Utah, allowing new entrants to take advantage of the solar-friendly climate and the rapidly decreasing cost of photovoltaic ("PV") systems which are used in small-scale DG solar installations by residential and commercial customers to innovate and expand customer options. However, after solid growth in DG between 2014 and 2016, RMP moved to retire the NEM program. As part of a settlement in 2017 between RMP and parties that opposed RMP's proposal, the rate at which residential customers were compensated for the electricity they provided to the system was lowered from the full retail energy rate to a $0.092/kWh Export Credit Rate ("ECR") for a temporary period called the "Transition Program" until the resolution of further proceedings.[4] The ECRs for non-residential customers were set much lower.[5] Additionally, caps totaling 240 MW were put on the amount of DG capacity that could participate at the proscribed ECR.[6][7] The total cap was implemented to limit the expected rapid growth of CG at the rates set under the Transition Program that could, if it exceeded 240 MW, allegedly cause undue cost shifting or operational issues. Since then, however, growth in CG in Utah has fallen sharply. As of December 31, 2019, the amount of CG

[4] *Rocky Mountain Power Electric Service Schedule No. 136*, State of Utah, Transition Program for Customer Generators, https://www.rockymountainpower.net/content/dam/pcorp/documents/en/rockymountainpower/rates-regulation/utah/rates/136_Transition_Program_for_Customer_Generators.pdf.

[5] *Id*. For example, certain large commercial customers under RMP Tariff Schedule No. 6 receive an ECR of 3.4 ¢/kWh.

[6] *Id*. at p.1. A cap of 170 MW was set for residential and small non-residential customers and a cap of 70 MW was set for large non-residential customers. *Id*. at p. 8.

[7] The ERC rates and caps are part of an interim rate program, the "Transition Program" that will terminate when the program cap is reached or upon completion of this proceeding.

capacity subscribed under the Transition Program is 62 MW, less than 26% of the total program cap of 240 MW.[8] The abrupt slowdown in CG investment has resulted in the loss of substantial benefits for RMP customers and Utah residents. Evidence shows that the value of CG exports exceeds the residential Transition ECR. One of the most important lessons of the Transition Period is that rate uncertainty has a substantial negative impact on CG development and that a simple, customer-friendly rate mechanism that recognizes the full value of CG exports is essential.

Q. Please provide an overview of the remainder of your testimony.

A. Below I provide an overview of the remainder of my testimony:

- In Section IV, I provide a summary and analysis of the impact of the Transition Program on Customer Generation. I show that the Transition Program has caused a significant decline in CG installations. This demonstrates that the compensation mechanism approved in this proceeding will have a determinative impact on the future growth of CG in RMP's service territory. A compensation mechanism that is set too low, reflective of only a portion of CG benefits, will result in diminished growth in CG and commensurately low utility and community benefits.
- Section V provides an explanation of the competitive benefits of DG solar for regulated customers, a benefit that is often overlooked in value of CG studies. RMP supplies about 75% of all electric load in Utah. This dominant market share provides little room for competitors and the fruits of competition: lower cost, innovative

[8] Exhibit 2-CAB, Attach Vote Solar 9.8.xlsx, RMP's Response to Vote Solar 9th Set Data Request – Attachment 9.8 (Feb. 6, 2020).

products and services, and customer choice. CG introduces competitive forces into the market opening a pathway to competitive benefits.

- Section VI poses the question, "What is the potential for DG solar in Utah?" The answer is, in one word, "high." DG solar is a resource that is yet untapped but that can, if allowed to develop, provide significant benefits to consumers.
- Section VII examines each component of the value of DG solar exports and provides a specific value for that component or explains the benefits of that component when quantification is not provided. Values for certain components are quantified by Vote Solar witnesses, Dr. Michael Milligan, Mr. Curt Volkmann, and Dr. Spencer Yang. Their results are included here in my testimony. Together, we quantify or evaluate the following components: avoided energy costs and avoided line losses; avoided generation, transmission, and distribution capacity; grid support services; financial risk including fuel hedge value and market price benefits; security risk in the form of reliability and resilience benefits; environmental benefits including health benefits from reduced air emissions, avoided carbon emissions, and avoided fossil fuel lifecycle costs; and finally local economic benefits. We determine that the costs of CG exports are *de minimus*. Consideration of all components is paramount to determining the value of CG exports, especially since some benefits will not materialize until sufficient CG has been installed on RMP's distribution system. The picture of value presented in Section VII can be thought of as the goal. The compensation mechanism adopted in this proceeding will set the path to get there.

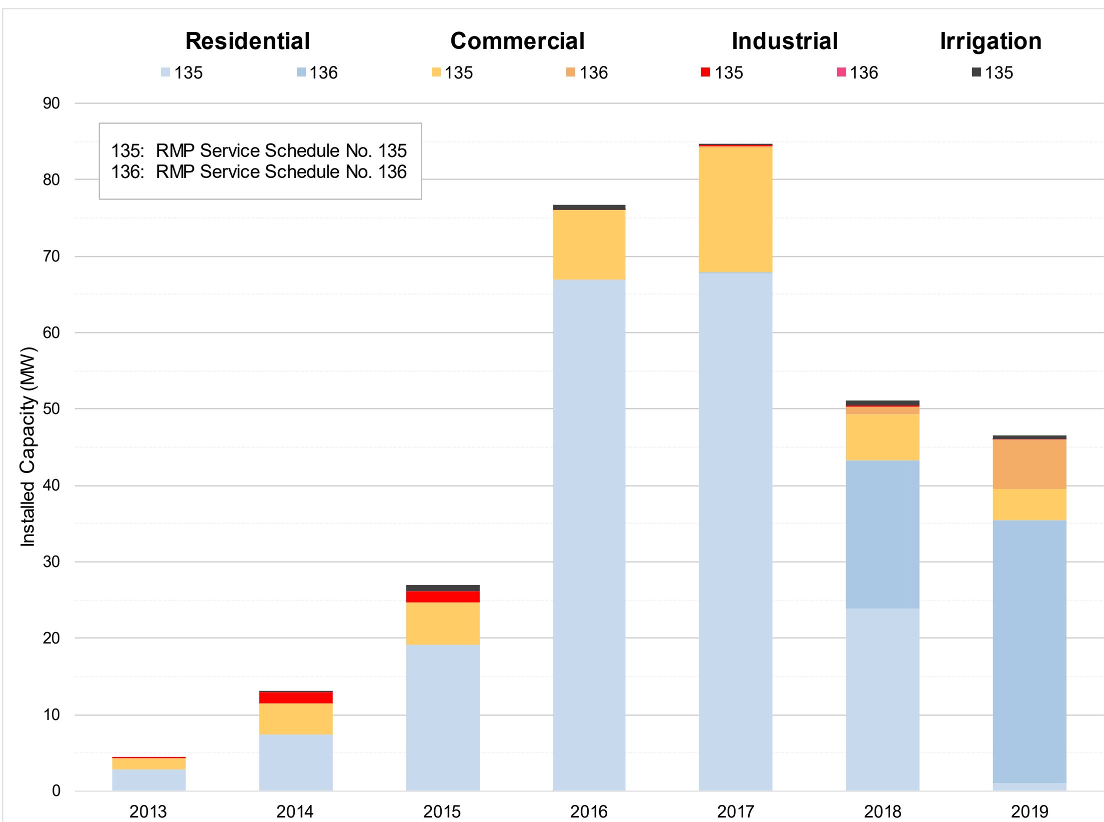
- In the last section, Section VIII, the value components are presented in a stack to show how they build to a total value of CG exports.

IV. Effect of Transition Program on Customer Generation

Q. What has happened to CG growth under the Transition Program?

Growth in CG has slowed substantially since the start of the Transition Program. I use two different figures to display this decrease. First, Figure 1 shows new installations in terms of capacity (MW) installed by CG customers under the NEM program (Schedule 135) and under the Transition Program (Schedule 136).[9] Residential installations dropped from 68 MW in 2017, to 43 MW in 2018, and then dropped further to 36 MW in 2019.[10] More than

Figure 1: Yearly Additions of CG Installed Capacity (MW)

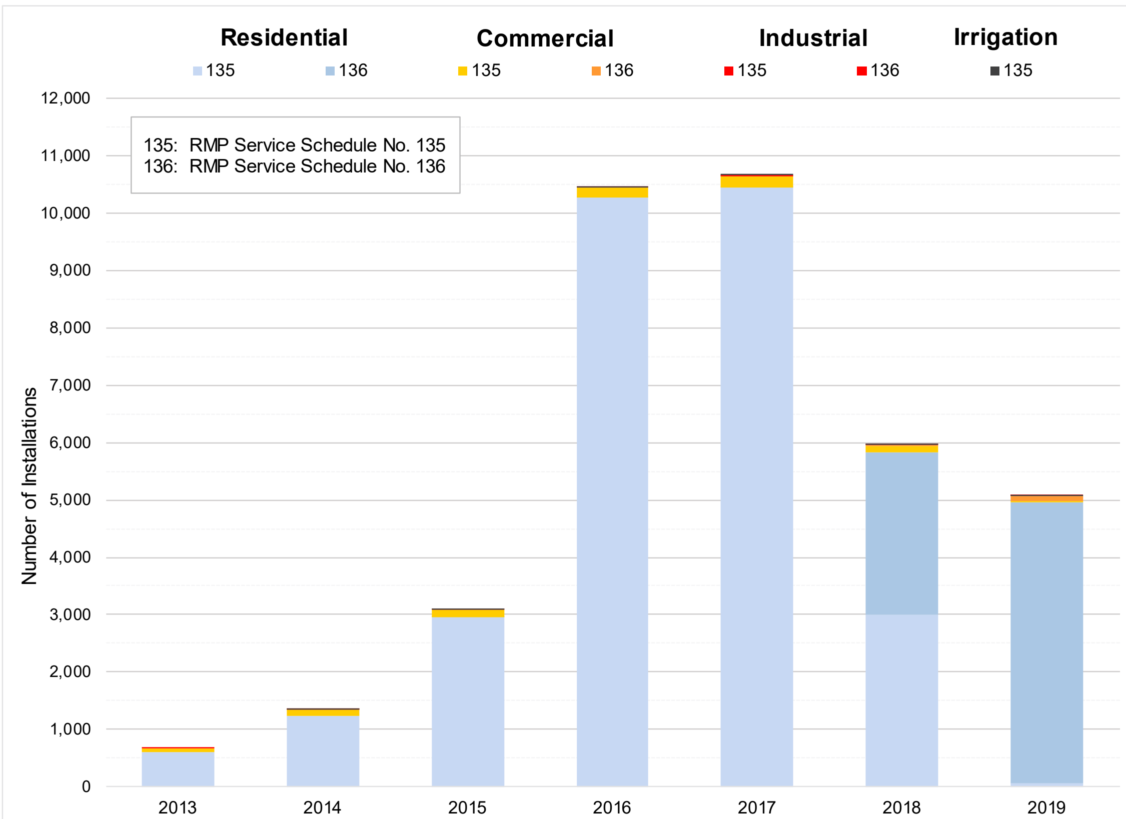


[9] Exhibit 2-CAB, Attach Vote Solar 9.8.xlsx, RMP's Response to Vote Solar 9th Set Data Request – Attachment 9.8 (Feb. 6, 2020).

[10] *Id.*

97% of DG solar customers are residential. Figure 2 shows the number of new DG solar installations each year from 2013-2019.[11] The number of installations is representative of the number of customers. It is clear that the vast majority of new CG customers are residential and that sign-ups in 2018 and 2019 have dropped after peaking in 2017.

Figure 2: Number of CG Installations by Year



Q. Why have CG installations fallen under the Transition Program?

A. The Transition Program reduced the compensation that CG customers receive for exports of electricity to the grid. In turn, this means that the amount of money that CG customers can

[11] *Id.*

save by installing rooftop solar has fallen, making the value proposition for CG customers less attractive. Perhaps even more importantly, the Transition Program put in place to temporarily resolve sharp disagreements between RMP and the CG community, has introduced significant uncertainty into the market, raising questions about DG's future in Utah. Uncertainty tends to dampen economic activity: it causes consumers to hold back on purchases, and it causes investors, including DG solar companies, to delay or cancel investments.

Q. How will the compensation mechanism determined in this proceeding affect the growth and viability of the DG solar industry?

A. The level at which compensation for exported CG is set in this proceeding will affect the growth and viability of the DG solar industry and CG overall. A compensation mechanism that reflects the full value of CG, will reinvigorate CG growth and make future benefits possible. A compensation mechanism left at the current rate, or reduced further, will slow future growth or may even cause a further a reduction in CG installations that will prevent RMP, its customers, and the residents of Utah from the attainment of the significant future benefits. This proceeding is about determining the value of CG exports to inform just and reasonable compensation for CG exports. The larger the projected growth of CG, the larger the benefits. But future growth and development of CG depends upon the chosen level of export compensation. The chosen compensation level and method and the value of CG exports are interdependent. This interdependence should be considered by the Commission when it considers the value of CG and the determination of just and reasonable compensation for CG exports.

V. DG Solar Provides Significant Competitive Benefits for CG and Non-CG Customers[12]

Q. Can you describe how a utility's customers benefit from competitive choices?

A. The ability to produce energy through rooftop or otherwise self-installed solar panels provides a utility's customers with real choices regarding their electricity generation and consumption. It provides an opportunity for customers to become active participants in energy production and consumption decisions, but it also requires them to take on certain significant financial risks of their own in order to do so. Indeed, many residential DG solar customers state that a significant factor in their decisions to invest in rooftop solar is a desire to reduce their reliance on their retail electric power provider.[13] DG solar also provides benefits to all RMP electric customers, and not just those who choose to invest in such systems. Various residential DG solar business models provide consumers with access to non-utility sources of capital to finance their solar investments. When capital is financed by non-utility sources, all customers benefit through a reduction in utility risk. Competition by and among DG solar companies also reduces costs for all. Such competition has spurred DG solar companies to provide innovative and more fully integrated services, from project

[12] In Section V, I have adopted positions taken by Dr. David DeRamus in previously filed testimony in this proceeding. Vote Solar, *Direct Testimony on David W. DeRamus,* Docket No. 14-035-114*,* June 8, 2017, https://pscdocs.utah.gov/electric/14docs/14035114/294527DirTestDeRamus6-8-2017.pdf.

[13] Paul Balcombe, Dan Rigby, and Adisa Azapagic, *Investigating the importance of motivations and barriers related to microgeneration uptake in the UK*, Applied Energy, Vol. 130, 403, 409, Oct. 2014, https://www.sciencedirect.com/science/article/pii/S030626191400542X; *see also*, Ria Langheim, Georgina Arreola and Chad Reese, *Energy Efficiency Motivations and Actions of California Solar Homeowners,* Center for Sustainable Energy, p. 10, Aug. 2014, https://energycenter.org/thought-leadership/blog/solar-adoption-and-energy-efficiency-actions.

financing to installation. And with the resulting growth of this industry, the larger scale of operations has allowed further cost reductions to be achieved.[14] The competitive behind-the-meter solar industry has also demonstrated continued innovation in service offerings, such as the bundling of residential rooftop solar, battery storage, and energy management services.[15] This combination of different services and assets, provided by a range of companies using various innovative technologies, has the added benefit of reducing CG customers' overall energy use, which in turn lowers the utility's energy and infrastructure costs, reduces loading on the system, which lowers cost and improves grid resiliency for all customers. CG represents the competitive, innovative edge of electricity markets. The provision of innovative services and cost savings by competitive DG companies also puts pressure on regulated utilities to further improve their services and reduce their costs, which provides additional long-term benefits to all ratepayers.

Q. What types of companies have been responsible for the recent growth in DG solar?

A. DG solar exists as an option for Utah customers because of the entry into the market of a wide range of competitive businesses. The market includes panel manufacturers, installers, financing companies, developers of complementary technologies, and a wide range of service companies. Lowering costs to enable increased customer adoption has required investments and innovation by many different types of firms, operating all along the supply

[14] *Costs Continue to Decline for Residential and Commercial Photovoltaics in 2018,* National Renewable Energy Lab, Dec. 17, 2018, https://www.nrel.gov/news/program/2018/costs-continue-to-decline-for-residential-and-commercial-photovoltaics-in-2018.html.

[15] Eric Wesoff, *SolarCity's System for Self Supply in Hawaii Includes PV Storage, Water Heater and Nest Thermostat,* Green Tech Media, Feb. 25, 2016, https://www.greentechmedia.com/articles/read/SolarCitys-System-For-Self-Supply-in-Hawaii-Includes-PV-Storage-Water-He.

and development chain. Many of these firms are local, providing a stimulus to the local economy, which directly benefits Utah residents. These firms are continuing to invest in developing and deploying complementary technologies, such as “smart” inverters, batteries, and communications technologies, all of which will further expand the future benefits and opportunities from DG solar.

Q. Can you describe the potential for additional innovation in DG solar?

A. A wide range of emerging technologies are currently being developed and deployed that will further serve to drive down DG solar costs and increase its benefits to the grid and ratepayers. Smart inverters, for example, can allow residential DG solar to be accessed by the grid operator to allow for increased reliability or to be used as reactive power for local voltage support. Improved battery storage technologies, which are beginning to be installed by U.S. residential customers, as well as in utility grid operations, also allow for increased “dispatchability” of solar resources, shifting supply to the peak period of demand. Electric vehicles (EVs) plugged into smart charging stations also have the ability to be treated as flexible load resources, especially with electricity price signals that influence when and how charging is done, thus potentially helping to alleviate some of the grid integration challenges associated with the rapid growth of solar (and wind) generation more generally.

Q. What has been the role of utilities such as RMP in the development of DG solar?

A. Utilities with a monopoly retail franchise, such as RMP, have neither the incentive, the expertise, nor the risk capital to develop or innovate in customer-sited solar offerings. Some utilities have recently proposed their own residential DG solar programs, including customer-sited generation in their rate base (on which they are able to earn a return). Other utilities have provided residential customers with solar-based "green power" offerings, i.e., a contractual commitment to supply them with a certain amount of renewable energy from utility-scale solar or other renewable facilities (notwithstanding the fact that all electricity is commingled in the network). Thus, some utilities have been supportive of DG solar and others, more commonly, of utility-scale solar or other renewables, but usually when it involves an increase in their rate base. For example, PacifiCorp—Rocky Mountain Power's parent company—has recently proposed new resource investments of over 3,500 MW of low-cost wind generation and 3,000 MW of solar generation across Idaho, Utah, Washington, Wyoming, and Oregon through 2023.[16] In the past few years some utilities have attempted to limit or even completely stop the expansion of residential DG solar provided by competing solar companies – typically by proposing radical changes to their respective state NEM policies, including imposing prohibitively high demand charges and a dramatic reduction in the value of energy credits. With very limited exceptions, however, regulators have declined to adopt such proposals.[17,18] The majority of state NEM or value

[16] *2019 Integrated Resources Plan*, PacifiCorp, Volume I, Page 3, Oct. 18, 2019, https://www.pacificorp.com/energy/integrated-resource-plan.html.

[17] The few utilities that have imposed demand charges specifically for NEM customers include the Salt River Project (SRP) in Arizona and Santee Cooper in South Carolina. However, SRP removed the mandatory demand charge after implementation of Time of Use ("TOU") rates. While We Energies in Wisconsin attempted to impose a demand charge on residential DSG customers, the courts struck down this provision. *See* Lydersen, Kari, *Court Rejects Wisconsin Utilitys Fee on Solar Customers*, Energy News Network, Oct. 30, 2015, https://energynews.us/2015/10/30/midwest/court-rejects-wisconsin-utilitys-fee-on-solar-customers/ (last accessed March 2, 2020).

[18] *See generally*, *Database of State Incentives for Renewables & Efficiency* ("*DSIRE*"), NC Clean Energy Technology Center, https://www.dsireusa.org/ (DSIRE is a source of information on incentives and policies that support renewable energy and energy efficiency operated by the N.C. Clean Energy Technology Center.). Data on solar penetration (as of October 2016) was obtained from Ohm Home. *See 2016 Solar Penetration by State*, Ohm Home, Jan. 8, 2017, https://www.ohmhomenow.com/2016-solar-penetration-state/.

of solar programs continue to credit net excess generation at the full retail rate. Attempts to move away from NEM in Montana and Idaho, both low-penetration states, were rejected in 2019.[19]

Q. How is a utility affected by competition from CG?

A. Customer choice and CG provide benefits to electricity consumers, but they also threaten the profits of a regulated retail monopoly franchise by reducing retail sales revenue between rate cases and reducing the need for infrastructure investments on which a regulated utility earns a rate of return. For many utilities in states with traditional cost-of-service rate regulation (such as Utah), DG solar provides the only real competition that they face at the retail level. A utility subject to cost-of-service rate regulation generally maximizes its profits by maximizing the size of its allowed rate base, on which it earns an allowed rate of return. When residential customers choose to install solar panels on their roofs, they reduce their utility's retail sales, and – depending on the volume of such installations and several other factors – they may reduce the need for their utility to invest in additional generating, transmission, and distribution assets. This is exactly what is being examined in this proceeding, determining the deferral or reduction in RMP's resources, to calculate a value for CG. Thus, over the long term (and for some utilities, even in the near term), the expansion of DG solar threatens to reduce a utility's profits by potentially cutting into its rate base. Furthermore, to the extent that a utility is at risk of full cost recovery, e.g., between

[19] *Montana Rejects Changes To Net Metering In Win For Montanans, Local Jobs, And Clean Energy*, EarthJustice, Nov. 25, 2019, https://earthjustice.org/news/press/2019/montana-public-service-commission-rejects-demand-charge-implements-lower-rate-for-new-solar-customers; Sylvia, Tim, *Net metering survives in Idaho*, PV Magazine, Dec. 23, 2019, https://pv-magazine-usa.com/2019/12/23/net-metering-survives-in-idaho/.

rate cases or in the event that its costs are not deemed prudent, the loss of revenues from DG solar customers also poses a risk to a utility's profitability. From a utility's perspective, competition from DG solar providers reduces its electricity sales, increases its risk of under-recovery of its costs, contributes to the deferral and potential reduction of its investments in additional generation and transmission infrastructure, and ultimately erodes the size of its rate base over the long term.

VI. Solar Potential in Utah

Q. What is the potential for DG solar to be productive and cost effective in RMP's service territory?

A. The potential is high. Currently the level of penetration of DG solar in Utah is low giving room for substantial growth. The costs of solar have declined dramatically and continue to decline. Innovation in solar-related technologies and services continues. Utah has abundant sunshine (i.e., insolation) favorable to DG solar and a growing population to employ in the DG solar industry. Many businesses have entered the Utah market and many customers are interested in acquiring DG solar.

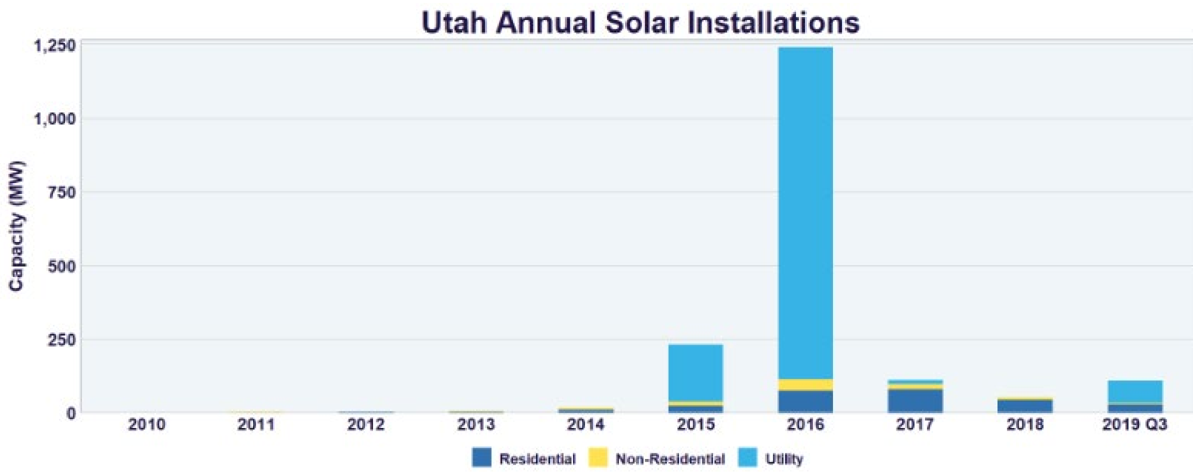
Q. In total, how much solar is currently installed in Utah?

A. As of the third quarter of 2019 (the latest quarter from which information is available), there were 1,758 MWs of solar installed in Utah.[20] Of this amount a small fraction is DG solar.

[20] *Utah Solar,* Solar Energy Industries Association, Dec. 11, 2019, https://www.seia.org/state-solar-policy/utah-solar.

The vast majority of solar capacity in Utah is still utility-owned/utility-scale solar located far from load. This can be seen in Figure 3.

Figure 3: Annual Solar Installations in Utah (MW)[21]



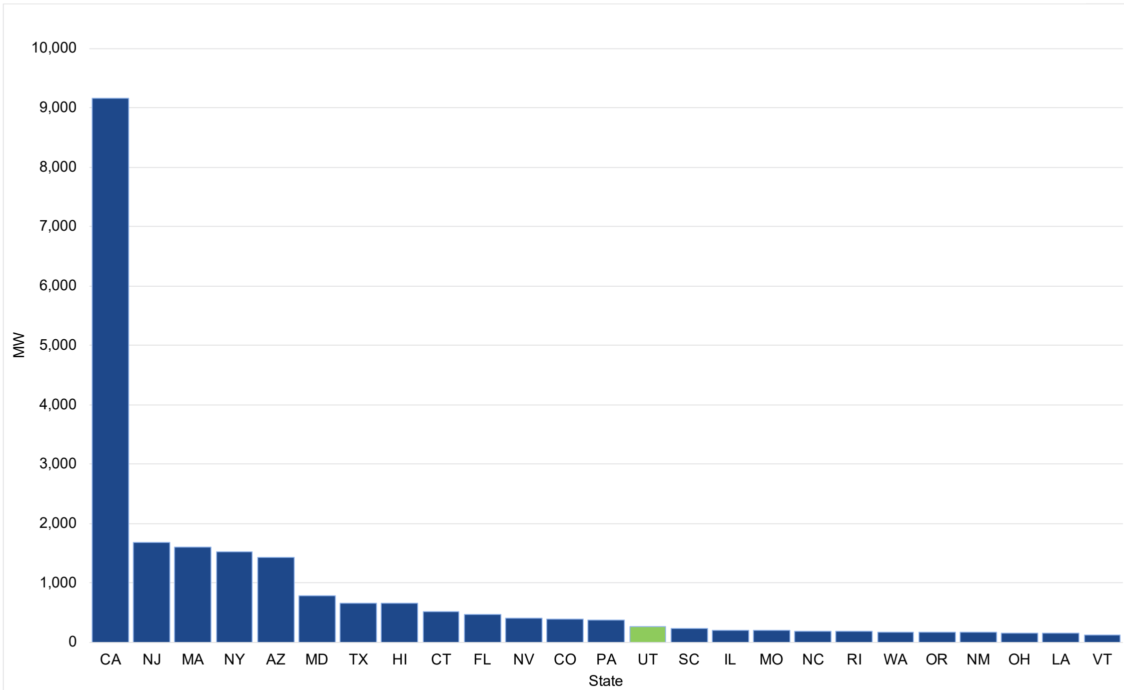
Q. How does Utah compare to other states in the U.S.?

A. Utah lags behind many other states in terms of solar investment. Figure 4 below shows total small-scale solar installations in Utah compared to the top 25 states in terms of installed small-scale PV capacity.[22]

[21] *Id.*

[22] *Form EIA-861M detailed data*, United States Energy Information Administration, https://www.eia.gov/electricity/data/eia861m/ (Last visited March 20, 2020) (For 2016 through 2018 data is final. Data for 2019 is preliminary and subject to change.).

Figure 4: EIA Small-Scale Solar Capacity by State (MW), December 2019



Q. What are the future prospects for the DG solar industry?

A. DG solar is becoming increasingly widespread, in part due to the rapidly dropping cost of installed systems. Advances in technology and manufacturing efficiency have driven down significantly the cost of photovoltaic ("PV") modules. The resulting increase in sales, in turn, has led to economies of scale, further lowering costs. With increased scale and experience, competing firms have also been able to lower the costs of financing, marketing, customer acquisition, design, and installation. Figure 5 below shows the decline in overall installed costs for residential PV systems.[23] National median installed prices for residential

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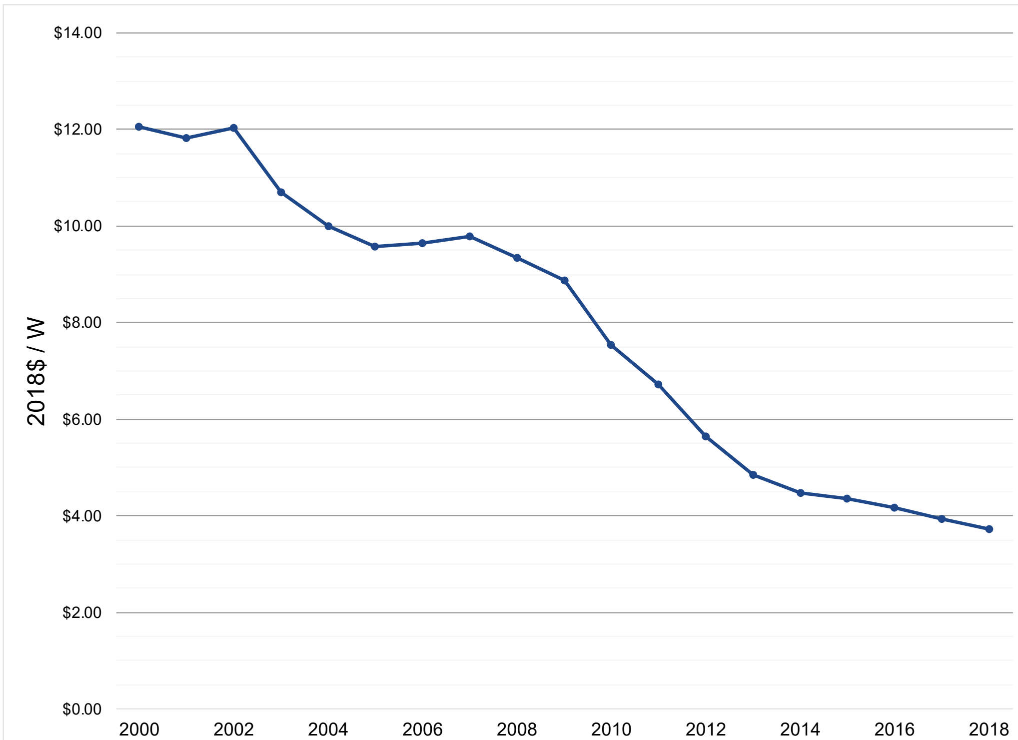
[23] Galen Barbose and Naim Darghouth, *Tracking the Sun 2019 Edition,* Lawrence Berkeley National Laboratory, Figure 13, p. 18, Oct. 2019, https://emp.lbl.gov/tracking-the-sun.

rooftop PV systems declined from $12.00/W in 2000 to $3.70/W in 2018, a reduction in installed costs of about 70% between 2000 and 2018.

Figure 5: Residential PV Median Installed Price (2018$/W) in the United States



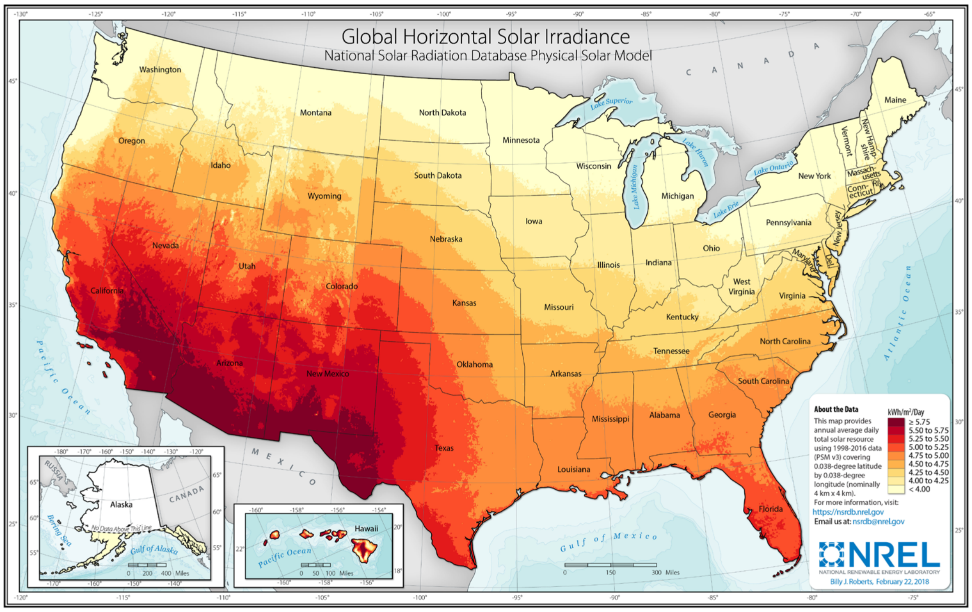
Q. Is solar potential high in Utah?

A. Yes. Figure 6, produced by the National Renewable Energy Laboratory ("NREL") shows that Utah is one of the top states for solar energy potential.[24] This potential is untapped. Note that states such as Massachusetts, New Jersey, and New York, with higher solar

[24] Sengupta, M., Y. Xie, A. Lopez, A. Habte, G. Maclaurin, and J. Shelby, *The National Solar Radiation Data Base (NSRDB)*, Figure U.S. Annual Solar GHI, Renewable and Sustainable Energy Reviews at the National Renewable Energy Laboratory, U.S. Annual Solar GHI, June 2018, https://www.nrel.gov/gis/solar.html; *see also Solar Energy Potential,* United States Department of Energy, https://www.energy.gov/maps/solar-energy-potential (Accessed Feb. 26, 2020).

installations than Utah, as shown above in Figure 4, have much lower solar energy potential.

Figure 6: Solar Energy Potential in the United States



Q. Are there workers to employ in the DG solar industry in Utah and are businesses interested in the Utah market?

A. Yes. Utah's population is growing by 2% annually (mostly in the Salt Lake City area), one of the highest growth rates in the nation.[25] There are currently 175 solar companies[26] doing business in Utah.

[25] Pamela S. Perlich, Mike Hollinghaus, Emily R. Harris, Juliette Tennert & Michael T. Hogue, *Utah's Long-Term Demograpic and Economic Projections Summary,* The Kem C. Gardner Policy Institute at the University of Utah, Table 5, p. 13, July 2017, https://gardner.utah.edu/wp-content/uploads/Projections-Brief-Final.pdf.

[26] *Utah Solar,* Solar Energy Industries Association, https://www.seia.org/state-solar-policy/utah-solar (data current through Q3 2019).

Q. Are Utahns interested in buying renewable energy including DG solar?

A. Yes. For example, the Utah Legislature, in 2019, passed the Community Renewable Energy Act (HB411) setting the framework for communities to achieve 100% clean electric energy by 2030. As of December 18, 2019, 20 communities have signed up,[27] showing overwhelming support for the development of additional renewable energy sources, of which DG solar is an important component. There also has been significant interest in RMP's Utah Subscriber Solar Program, which was fully subscribed the year after the program was announced in 2016.

Q. Is there a drawback to these programs?

A. Yes. Although the Community Renewable Act and the Utah Subscriber Solar Program clearly demonstrate strong customer support for renewables, the Community Renewable Act does not necessarily result in the development of more renewables within Utah. The renewable commitments in these programs can be fulfilled by ascribing out-of-state renewable resources, owned by or contracted to RMP, to Utah customers. RMP is planning big additions of renewable generation, mostly outside of Utah. These planned investments will further Utah's renewable goals, but they are costly for ratepayers because they require large investments in transmission infrastructure, the costs of which will be borne by RMP's customers. By comparison, DG solar investment is paid for by DG solar customers and does not require large investments in infrastructure to bring power across state lines. The

[27] These are Park City, Salt Lake City, Moab, Summit County, Cottonwood Heights, Holladay, Salt Lake County, Oakley, Kearns, Kamas, Millcreek, Francis, Ogden, Grand County, Orem, West Jordan, Springdale, Alta, Coalville and West Valley City.

state government has recognized the value of in-state resources in the Energy Resource and Carbon Emission Reduction Initiative (SB 202) signed into law by Governor Huntsman in 2008. In that law, in-state solar resources are valued much higher than out-of-state resources to assist solar development in the State of Utah.[28]

Q. What additional benefits can DG provide?

A. DG can provide very large savings, sometime unexpected, to electric consumers. As an example, during a 7-day heat wave in July 2018 in the Northeast United States, it is estimated that distributed solar saved the New England regional system operator nearly $20 million[29] and New York system operator over $10 million[30] by reducing peak load and displacing the most expensive generation. In March 2018, the California Independent System Operator, which oversees the state's electric power system, cancelled 20 transmission projects and revised 21 more because energy efficiency and DG solar have altered local load forecasts and the need for new transmission. As a result, California customers are projected to have saved approximately $2.6 billion.[31] In New York City, Consolidated Edison deployed a mix of DG solar and energy efficiency, rather than

[28] *2019 Integrated Resources Plan,* PacifiCorp, Volume I, p. 60, Oct. 18, 2019, https://www.pacificorp.com/energy/integrated-resource-plan.html.

[29] Pat Knight and Jamie Hall, *Wholesale Cost Savings of Distributed Solar in New England,* Synapse Energy Economics, Slide 4, Aug. 28, 2018, https://suncommon.com/wp-content/uploads/2018/08/Wholesale-Cost-Savings-of-Distributed-Solar-New-England-SunCommon.pdf; *see also*, Walton, Robert, *Distributed solar saved ISO-NE consumers $20M During July Heatwave, Report Says,* Utility Dive, Aug. 31, 2018, https://www.utilitydive.com/news/distributed-solar-saved-iso-ne-consumers-20m-during-july-heatwave-report/531336/.

[30] Knight and Hall, at Slide 4.

[31] Weaver, John, *Distributed solar and efficiency saves California $2.6 billion on power lines,* PV Magazine, March 27, 2018, https://pv-magazine-usa.com/2018/03/27/distributed-solar-and-efficiency-saves-california-2-6-billion-on-power-lines/.

investing in transmission facilities, to address a sharp increase in New York City's demand for power, avoiding the need for a conventional transmission solution (i.e., adding a substation) that would have cost more than $1.2 billion. The demand-side solution was estimated to cost only about $200 million.[32] These kinds of benefits are possible in Utah if it supports a vibrant DG solar industry.

VII. Value of CG Exports in RMP's Service Territory

A. Overview

Q. Is there a definition of the value of DG solar?

A. The value of DG solar in a big picture sense consists of the costs that the utility avoids because of DG solar, plus additional benefits, net of any incremental costs that DG solar imposes on the system. There is a generally recognized set of categories used for the quantification of costs and benefits. These categories include avoided energy costs; avoided system losses; avoided generation capacity costs; avoided transmission and distribution capacity costs; the provision of ancillary services; fuel price hedging benefits; improved reliability and resiliency; environmental benefits, including reduced emissions and improved public health; and economic benefits, such as job creation. The exact definitions used in studies and adopted by regulators vary.

[32] Walton, Robert, *The non-wire alternative: ConEd's Brooklyn-Queens pilot rejects traditional grid upgrades*, Utility Dive, Aug. 3, 2016, http://www.utilitydive.com/news/the-non-wire-alternative-coneds-brooklyn-queens-pilot-rejectstraditional/423525/.

Q. Why does the definition include benefits in addition to utility avoided costs?

A. It is widely recognized that the unique attributes of DG solar provide benefits beyond the utility perspective of cost. DG solar is small, geographically dispersed, and independently owned and operated outside the centrally dispatched system. It displaces fossil fuel-fired generation, providing environmental and health benefits to the wider community as a result of reduced emissions. DG solar is often deployed as part of a new "ecosystem" in which innovative in-home technologies and other complementary markets are growing. Thus, in addition to the utility cost perspective, valuation of DG solar must also consider the benefits created for solar customers, ratepayers, and society as a whole.

Q. What factors impact the value of CG in RMP's service territory?

A. The value of CG in Utah stems from its unique locational, temporal, operational, environmental, and ownership characteristics in comparison with RMP's conventional centralized resources. The current adoption rate of CG solar in Utah is low. In 2019, the energy produced by Schedule 135 and Schedule 136 customers[33, 34] made up a very small fraction of total energy produced in RMP's service territory, just 1.7%.[35] Even small increases in DG solar can have disproportionate benefits in reducing needs for running expensive and inefficient marginal resources or purchasing higher cost on-peak power.[36]

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[33] Schedule 135 and Schedule 136 are the specific net metering classifications and schedules used by Rocky Mountain Power with regards to customers that own or lease a customer-operated renewable generating facility.

[34] Exhibit 2-CAB, Attach Vote Solar 9.8.xlsx, RMP's Response to Vote Solar 9th Set Data Request – Attachment 9.8 (Feb. 6, 2020).

[35] Vote Solar, *Affirmative Testimony of Volkmann*, line 289.

[36] Increases in CG at lower penetration levels impose almost no costs on the utility's system, but could, for example, obviate the need to start a generation unit saving a disproportionately large amount of costs.

Q. How do you categorize the value of CG in Utah?

A. Fully understanding the value of CG requires analyzing the local context, such as the local utility system's characteristics. Because the scope of this docket is limited to the evaluation of a just and reasonable rate to compensate customers for their exported DG, the value of CG analysis I conducted is limited to an analysis of the costs and benefits associated with exported CG only.[37] The energy that is produced and consumed onsite from a customer's DG system is not included in this analysis. To develop a long-term analysis of the value of CG exports and to inform the Commission's determination of just and reasonable compensation for exported CG that will be in effect beginning in 2021, I have analyzed the values on a levelized cost basis in 2021 dollars by examining a 20-year projection of values from 2021-2040.

To facilitate this study, Vote Solar witnesses have utilized inputs from RMP's own data and Vote Solar's Load Research Study ("Vote Solar LRS"), in conjunction with their own research and analysis, to determine various components of the value of CG. The value is associated with the following set of categories, all of which have been used in various studies examining the value of solar across the U.S. [38]

[37] The value of CG can increase dramatically when coupled with storage and other technologies. I have not included these benefits in the value of CG exports in my current testimony. Inclusion of these benefits would increase the value of CG exports to a higher level than I present here.

[38] *See* Steve Fine, Meegan Kelly, Surhud Vaidya, Patricia D'Costa, Puneeth MV Reddy, and Julie Hawkins, *A Review of Recent Cost-Benefit Studies Related to Net Metering and Distributed Solar*, ICF, May 2018, https://www.icf.com/insights/energy/value-solar-studies; Gideon Weissman and Bret Fanshaw, *Shining Rewards, The Value of Rooftop Solar Power for Consumers and Society*, Environment America and the Frontier Group, Oct. 18, 2016, https://environmentamerica.org/reports/ame/shining-rewards; and Lena Hansen and Virginia Lacy, *A Review of Solar PV Benefit & Cost Studies,* Rocky Mountain Institute, 2013, https://rmi.org/insight/a-review-of-solar-pv-benefit-and-cost-studies/.

Energy: Energy exported from DG solar provides benefits by reducing the amount of utility generation (or purchases) needed to serve regulated customers. The benefit includes the avoided cost of energy including avoided losses on the transmission and distribution systems.

Capacity: DG solar can delay or offset planned investments to maintain or expand the electric system. Capacity benefits include the avoided or delayed costs of investment in generation, transmission, and distribution assets, including the avoided fixed operation and maintenance costs associated with these investments.

Grid Support Services: DG solar can provide valuable services to the grid, including reactive supply, voltage control, regulation or frequency response, energy imbalance, or load-shaping services.

Financial Risk: Financial risk relates to hedging costs and market price effects. DG solar displaces fossil-fuel generation, reducing system reliance on fuels such as natural gas. The replacement of natural gas with solar energy, reduces the variations in fuel prices – a natural fuel price hedge. DG solar can impact market prices. DG solar reduces the utility's need for energy and natural gas. The reduction in demand for these commodities will lower their market price and reduce the utility's cost of energy and natural gas purchases.

Security Risk: Utilities frequently invest resources to ensure the resiliency and reliability of the grid. DG solar can lower these costs by reducing congestion along the transmission and distribution networks, increasing energy portfolio diversity, and providing reliable capacity. DG solar, especially when coupled with storage, can provide grid services such as reactive power, voltage control, operating reserves, and load shaping services.

Environmental: DG solar helps mitigate the negative impact of large, centralized fossil fuel-fired generation on the environment. These environmental benefits include avoided carbon and criteria pollutant emissions, as well as avoided fossil fuel lifecycle costs – water consumption costs, land use costs, and ecosystem impacts associated with the extraction, transportation, and burning of fossil fuels.

Societal: DG solar provides local economic benefits, including jobs, increased local economic activity, and tax revenue that benefit all local residents.

Q. Are all these categories relevant for the value of CG in Utah?

A. Yes. All these categories have been included in existing value of solar studies using well-accepted methodologies. While not every study includes all categories, all are nonetheless important to consider in determining the value of CG exports in Utah. Each of these categories is either explicitly quantified or considered by Vote Solar's witnesses.

B. Energy

Q. Please describe the energy benefits of DG solar exports in RMP's service territory.

A. Energy benefits include avoided system energy generation (or purchases) and avoided line losses.

Q. What is avoided energy generation, and what is its value related to DG solar exports in RMP's service territory?

A. Electricity generated from DG solar at the point of consumption reduces the electricity that RMP must generate from its power plants or purchase from the wholesale market. The value of this reduced generation is primarily driven by the variable costs of displaced marginal resources and fuel price forecasts.

Q. What value has been determined for avoided energy generation?

A. Dr. Milligan has done an analysis of avoided energy costs associated with CG exports and determined the value to be 3.65 ¢/kWh.[39]

Q. What are avoided transmission and distribution line losses, and what is their value related to DG solar in RMP's service territory?

A. When RMP generates or purchases energy, some of the energy is lost in transmission and distribution facilities (e.g., lines, substations, and transformers). Line losses occur when electricity is lost on the way from central generation power plants to consumers. As DG systems export electricity onto the distribution system, these systems cut down the total amount of electricity transmitted through the grid, reducing overall line losses. As line losses decrease, centralized generation facilities can produce less total electricity. Calculating line losses usually includes creating an average loss factor, which incorporates parameters including current size and resistance in the grid.

Q. What value has been determined for transmission and distribution line losses?

A. Mr. Volkmann has done an analysis of transmission and distribution line losses and determined loss factors for each portion of RMP's transmission and distribution system.[40]

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[39]Vote Solar, *Affirmative Testimony of Michael Milligan.*
[40] Vote Solar, *Affirmative Testimony of Curt Volkmann*, lines 364–76.

Dr. Milligan has used these loss factors to calculate transmission and distribution line losses and determined the value to be 0.31 ¢/kWh.[41]

C. Capacity

Q. Please describe the capacity benefits of DG solar exports in RMP's service territory.

A. The capacity benefits of DG solar in RMP's service territory represent the avoided or delayed costs of maintaining and upgrading generation, transmission, and distribution infrastructure – infrastructure that is no longer needed to produce and transport energy due to the supply of DG solar energy to the electric system at the point of consumption.

Q. What are avoided generation capacity costs, and what is their value related to DG solar exports in RMP's service territory?

A. DG solar export capacity can help RMP to defer or avoid additional investment in generation assets by reducing peak demand. To determine deferred or avoided generation investment, two key inputs are needed: (i) the effective capacity associated with DG solar exports and (ii) RMP's generation capacity costs. Effective capacity is the actual fraction of exported DG solar capacity that could reliably offset RMP's generation capacity at the system peak and is the appropriate measure to use when determining avoided generation capacity costs related to DG for purposes of informing an ECR.

[41] Vote Solar, *Affirmative Testimony of Michael Milligan.*

Q. What value has been determined for avoided generation capacity costs?

A. Dr. Milligan has done an analysis of avoided generation capacity costs and determined the value to be 1.60 ¢/kWh.[42]

Q. What is avoided transmission capacity investment?

A. Avoided transmission investment represents the costs that utilities and ratepayers can save from avoided or postponed transmission infrastructure upgrades. DG solar exports, at the current penetration levels in RMP's service territory, is produced and used by customers on the distribution system, reducing present and future electricity transmission needs. DG solar exports relieve RMP's requirement to supply power at a distant location using its transmission network, and thus effectively reduces transmission congestion, transmission losses, and the need for additional transmission capacity.

Q. What value has been determined for avoided transmission capacity investment?

A. Dr. Yang has done an analysis of avoided transmission capacity investment and determined the value to be 1.45 ¢/kWh.[43]

Q. What is avoided distribution capacity investment?

A. Avoided distribution capacity investment represents the costs that utilities and ratepayers can save from postponed distribution infrastructure upgrades. DG solar reduces the need

[42] Vote Solar, *Affirmative Affirmative Testimony of Michael Milligan.*

[43] Vote Solar, *Affirmative Testimony of Yang*.

for RMP distribution investments by providing power locally, reducing the power flow through the distribution grid.[44]

Q. What value has been determined for avoided distribution capacity investment?

A. Mr. Volkmann has computed a distribution deferral value and a distribution utilization weighting[45] and provided these values to Dr. Yang who has quantified the value of avoided distribution capacity investment of 0.56 ¢/kWh.[46]

D. Grid Support Services

Q. Please describe the grid support services of DG solar exports.

A. DG solar, especially when paired with energy storage, can provide different types of support services, also referred to as ancillary services, to the grid. These include reactive supply, voltage control, energy imbalance, and operating reserves.[47]

Q. What is the value related to DG solar exports in RMP's service territory?

A. DG solar has the potential to provide ancillary services to the grid, but the actual value of ancillary services has been difficult to quantify. There is an ongoing debate around whether DG solar will provide or require additional ancillary services at various penetration levels. This depends on whether DG solar reduces or increases RMP's needs for ancillary services.

[44] Note that even without DG solar, RMP's distribution system requires replacement of aging equipment and upgrading of distribution-level transformers and wires to accommodate load growth and/or changes.

[45] Vote Solar, *Affirmative Testimony of Curt Volkmann*, lines 187–91.

[46] Vote Solar, *Affirmative Testimony of Spencer Yang.*

[47] Lena Hansen and Virginia Lacy, *A Review of Solar PV Benefit & Cost Studies,* Rocky Mountain Institute, 2013, https://rmi.org/insight/a-review-of-solar-pv-benefit-and-cost-studies/.

There are several methods for estimating the value of ancillary services, including estimating the change in ancillary services requirements for DG solar installations and applying cost estimates for the services.[48] Nevertheless, studies focusing on the value of solar in other states have found that DG solar at low penetration levels does not have a measurable impact on ancillary services.[49] Similarly, at this point in time DG solar has not reached the level of penetration in Utah that is necessary to accurately quantify an ancillary services value. However, if DG solar continues to grow, ancillary services may become an increasingly important component of the value of DG solar, especially when coupled with complementary technology, such as energy storage, smart inverters, and micro-grids. For example, Soleil Lofts, a new 600-unit all-electric apartment complex in Herriman, Utah, just outside Salt Lake City, equipped with solar panels, on-site in-unit battery storage, and more than 100 electric vehicle chargers, will provide grid support services consisting of demand response and emergency back-up power to RMP's system.

E. Financial Risk

Q. Please describe the value provided by DG solar exports related to financial risk.

A. There are two kinds of value that DG solar provides related to financial risk. First, DG solar replaces the marginal generation resource which is typically a natural gas-fired resource,

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[48] A study focusing on Arizona included a net benefit of DG solar due to reduced operating reserve requirements. *See* R. Thomas Beach, *The Benefits and Costs of Solar Distributed Generation for Arizona Public Service.* Crossborder Energy, May 8, 2013, https://www.seia.org/sites/default/files/resources/AZ-Distributed-Generation.pdf.

[49] *The Benefits and Costs of Utility Scale and Behind The Meter Solar Resources in Maryland*, Daymark Energy Advisors, p. 99, April 10, 2018, http://www.psc.state.md.us/wp-content/uploads/MD-Costs-and-Benefits-of-Solar-Draft-for-stakeholder-review.pdf .

and thus reduces the exposure of RMP's customers to natural gas price volatility providing a fuel price hedging benefit. Second, by lowering RMP's demand for natural gas and electricity purchases, DG solar can reduce the market prices of these commodities allowing RMP to purchase them at lower prices. This is a market price benefit.

Q. Can you further explain fuel price hedging benefits, and their value related to DG solar exports in RMP's service territory?

A. DG solar effectively provides a "hedge" against RMP's generation fuel price volatility, by adding a "fuel" with a stable price into the fuel mix. Several cost-benefit studies have quantified such hedging benefits, using NYMEX futures market prices as an indicator of fuel price volatility.[50] The resulting benefit estimates range from less than $5/MWh to nearly $40/MWh, depending on the methodology, input assumptions, and local market characteristics (e.g., the marginal resource and the affected utilities' exposure to fuel price volatility).[51] In a 2014 value of solar study, CPR has estimated a value of $26/MWh as a fuel hedging price benefit from NEM customers in Utah.[52]

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[50] *See, e.g.*, Bolinger, Mark A, and Wiser, Ryan. *The Value of Renewable Energy as a Hedge Against Fuel Price Risk: Analytic Contributions from Economic and Finance Theory,* Lawrence Berkeley National Lab, https://www.osti.gov/biblio/962658-value-renewable-energy-hedge-against-fuel-price-risk-analytic-contributions-from-economic-finance-theory.

[51] A study in Maine valued avoided fuel price uncertainty at $37/MWh. *See*. Norris, Benjamin L., et al., *Maine Distributed Solar Valuation Study,* Maine Public Utilities Commission, Clean Power Research, Sustainable Energy Advantage LLC, and the Pace Law School Energy and Climate Center, p. 6, April 14, 2015, https://digitalcommons.pace.edu/cgi/viewcontent.cgi?article=1002&context=environmental.

[52] Benjamin L. Norris, *Value of Solar in Utah,* Clean Power Research, p. 11, Jan. 7, 2014, https://pscdocs.utah.gov/electric/13docs/13035184/255147ExAWrightTest5-22-2014.pdf

Q. Does RMP hedge fuel-price risk?

A. Yes. As explained by PacifiCorp in its 2019 Integrated Resource Plan ("IRP"), its "ownership of gas-fired electric generation requires it to purchase large quantities of natural gas to generate electricity to serve its customers. PacifiCorp hedges its net energy (combined natural gas and power) position on a portfolio basis…."[53] "The goal of the hedging program is to reduce volatility in PacifiCorp's net power costs primarily due to changes in market prices. The goal is not to 'beat the market' and, therefore, should not be measured on the basis of whether it has made or lost money for customers. This reduction in volatility is calculated and reported in the company's confidential semi-annual hedging report which it began producing as a result of the hedging collaborative."[54]

Q. Has a value for the reduction in fuel price risk provided by DG solar already been determined for PacifiCorp?

A. Yes. In an extensively litigated value of solar proceeding at the Oregon Public Service Commission ("PSC") it was determined that a hedge value existed but that it was difficult to quantify. As explained by the Oregon PSC Staff, "[t]he hedge value represents the benefit provided by solar from the certainty of generation costs. Utilities employ hedging strategies to insulate themselves from risk by purchasing contracts for future deliveries at fixed prices. To do this, they are charged a premium over the expected price. If fuel prices rise[,] this strategy is seen in hindsight to have saved the utility money. However, if prices fall[,] the

[53] *2019 Integrated Resources Plan,* PacifiCorp, Volume I, p. 302, Oct. 2019. https://www.pacificorp.com/energy/integrated-resource-plan.html

[54] *Id*. at p. 303.

utility ends up paying a higher price than they otherwise would have had they just bought from spot markets. Given fuel price volatility, utilities generally are willing to pay to reduce their exposure to uncertainty, going so far as to pay a premium to take this bet. However, utilities get this benefit from solar for free. By generating without fuel, solar provides price certainty to the utilities. Instead of paying these hedge contract premiums, they know for 20 years exactly what the price of generation from solar resources will cost. As this reduction in exposure is a cost for which utilities are willing to pay, solar generation provides a quantifiable benefit to this avoided cost."[55] Acknowledging that a hedge value exists, and that it is difficult to quantify, the Oregon PUC adopted a value equal to 5 percent of avoided energy costs[56] based on a study by E3 Economics.[57]

Q. What hedge value do you recommend for DG solar exports in RMP's service territory?

A. I recommend the same value as adopted for PacifiCorp by the Oregon PUC, 5% of avoided energy costs. This results in a value of 0.20 ¢/kWh.

Q. Please describe the market price effect.

A. As the penetration of CG increases, it will displace the most expensive generation on the system which is typically natural gas-fired generation. The decrease in RMP's demand for

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[55] Andrus, Brittany, *Staff Exhibit 100,* Public Utility Commission of Oregon, Docket No: UM 1910/1911/1912, p. 45, March 18, 2018, https://apps.puc.state.or.us/edockets/docket.asp?DocketID=21118.

[56] *Order No: 19-021 In the Matter of PacifiCorp, dba Pacific Power, Resource Value of Solar,* Public Utility Commission of Oregon, Docket No. UM 1910, p. 20, Jan.22, 2019, https://apps.puc.state.or.us/orders/2019ords/19-021.pdf.**Error! Hyperlink reference not valid.**

[57] Andre DeBenedictis, David Miller, Jack Moore, Arne Olsen, & C.K. Woo, *How Big is the Risk Premium in an electricity Forward Price,* The Electricity Journal, Volume 24, Issue 3, p. 72, (April 2011).

both energy and natural gas will put downward pressure on the prices of these commodities. RMP will benefit through lower purchase prices. RMP is typically a seller of generation but is a large buyer of natural gas. Thus, the price effects attributable to CG exports may be positive for natural gas but negative for electricity. To determine a total market price effect the impact on RMP of changes in both electric and natural gas prices would need to be examined.

Q. What value did you find for the market price effect attributable to CG?

A. I did not quantify market price effects for RMP, but these effects can be significant. A study done by the Lawrence Berkeley National Lab, found a market price effect for natural gas in the range of 0.75-2.0 ¢/kWh.[58]

F. Security Risk

Q. What is reliability and resilience?

A. Reliability and resilience are closely related and overlapping concepts. Reliability relates to planning and running the electric system in a way that reduces the probability that the loss of a generator, or transmission or distribution line, will disrupt the flow of energy to consumers. Resilience is a broader concept that includes not only "the ability to withstand and reduce the magnitude and/or duration of disruptive events,"[59] but also "the capability

[58] Ryan Wiser, Mark Bolinger, and Matt St. Clair, *Easing the Natural Gas Crisis: Reducing Natural Gas Prices through Increased Deployment of Renewable Energy and Energy Efficiency*, Berkeley Lab Electricity Markets & Policy Group, Page ix, Jan. 2005. https://emp.lbl.gov/publications/easing-natural-gas-crisis-reducing.

[59] Federal Energy Regulatory Commission, *Order Terminating Rulemaking Proceeding, Initiating New Proceeding, and Establishing Additional Procedures*, 162 FERC ¶ 61,012, Jan. 8, 2018 (Dockets Nos. RM18-1-000, AD18-7-000).

to anticipate, absorb, adapt to, and/or rapidly recover from such an event." [60] For example, resilience is the ability of the electric system to withstand and quickly recover from a major weather or weather-related event, such as a hurricane, an earthquake, a major snowstorm, or wildfires. It is the ability to respond and adapt to major fuel shortages such as critically reduced supplies of natural gas. Resilience also includes cyber security or the ability of the electric system to anticipate and respond to a cyber-attack that disrupts electric system operations.

Q. How does DG solar make the electric system more reliable and resilient?

A. At the grid level, DG solar that is produced near end users can reduce outages, especially during times of peak demand, by reducing congestion on the transmission and distribution network. DG solar diversifies the generation portfolio, reducing system risk by reducing generator-specific fuel or operational risk. DG solar also has the potential to reduce large-scale outages by providing a more geographically dispersed generation portfolio. And DG solar equipped with smart inverters and storage can provide further benefits in the form of reactive power or back-up power to aid with system events. Although grid-related benefits have been widely recognized, they are difficult to quantify because assumptions must be made about the risk of extended blackouts, the costs to avoid the risk of those blackouts, and DG solar's ability to reduce those risks and costs.[61] However, at the individual customer level, DG solar benefits are tangible and real. During natural disasters, when access to

[60] *Id*.

[61] Jason B. Keyes and Karl R. Rabago, *A Regulator's Guidebook: Calculating the Benefits and Costs of Distributed Solar Generation*, Interstate Renewable Energy Council, Inc., p. 31, Oct. 2013, http://www.irecusa.org/wp-content/uploads/2013/10/IREC_Rabago_Regulators-Guidebook-to-Assessing-Benefits-and-Costs-of-DSG.pdf.

energy is critical, DG resources "allow hospitals to run medical equipment, let people charge phones and computers to communicate with the outside world, and power lifesaving air conditioning for the elderly and infirm."[62] A report done for Baltimore communities found that expanded use of solar panels with battery storage is the best way for low-income populations to benefit from long-term renewable energy savings, and it is the best way "to protect vulnerable populations from the damaging effects of power outages in severe weather events."[63] DG solar with storage is superior to diesel generators or other conventional back-up because the fuel supply does not run out and the generation equipment is used continuously rather than remaining idle for most of the time. The valuation of DG solar and customer's investments in DG solar largely ignores these benefits. Consideration of such benefits, however, can make otherwise uneconomic projects viable.[64]

Q. Has there been an increase in weather-related climate disasters in the last 40 years?

A. Yes. The National Oceanic and Atmospheric Administration (NOAA) tracks billion-dollar weather and climate disasters. There were 14 such events in 2019 as shown in Figure 7, and

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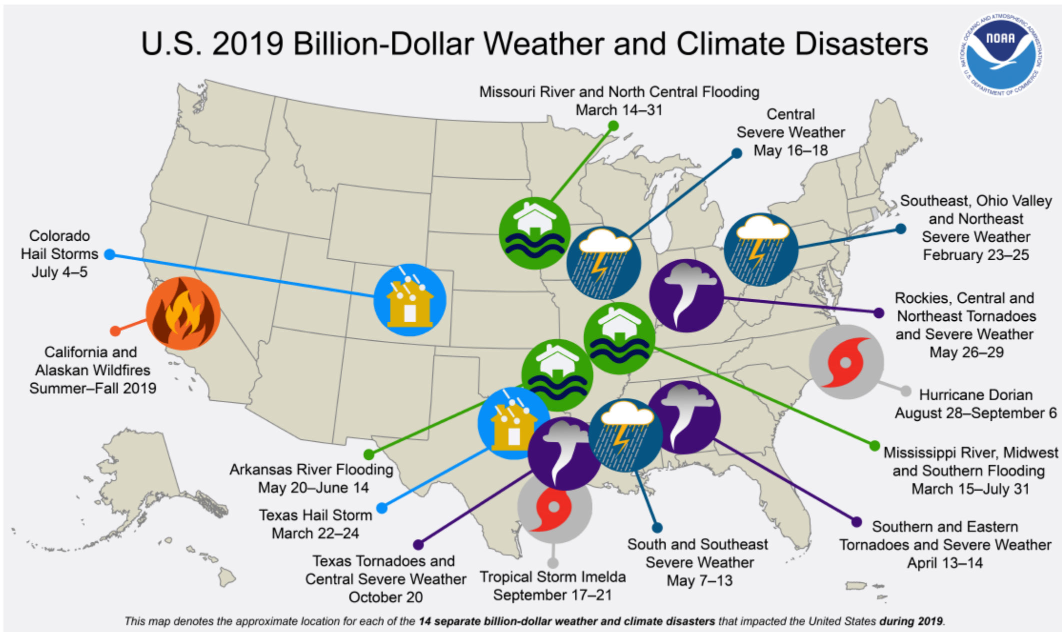
[62] Laurie Stone, *The Importance of Distribution-Scale Solar for Grid Resilience*, Rocky Mountain Institute, September 22, 2017, https://rmi.org/importance-distribution-scale-solar-grid-resilience/.

[63] Robert G. Sanders and Lewis Milford, *Clean Energy for Resilient Communities: Expanding Solar Generation in Baltimore's Low-Income Neighborhoods*", Clean Energy Group, p. 1, Feb. 2014, https://www.cleanegroup.org/wp-content/uploads/Clean-Energy-for-Resilient-Communities-Report-Feb2014.pdf.

[64] Nicholas D. Laws, Kate Anderson, Nicholas A. DiOrio, Xiangkun Li, and Joyce McLaren, *Valuing the Resilience Provided by Solar and Battery Energy Storage Systems*, National Renewable Energy Laboratory and the Clean Energy Group, p. 5, Jan. 2018, https://www.nrel.gov/docs/fy18osti/70679.pdf.

the annual average for the most recent five years is 13.8 events. The average of the last 40 years is 6.45 events.[65]

Figure 7: Billion-Dollar Weather and Climate Disasters, 2019



Q. Is there concern in Utah about weather and weather-related disasters and resiliency?

A. Yes. One primary concern is related to wildfires. Utah, like California, is exposed to the extreme threat of wildfires as shown in Figure 8. RMP has taken steps to improve monitoring and its response to mass outages by identifying areas that are vulnerable and areas where power can be shut off to protect public safety.[66] DG solar is an important piece

[65] *Billion-Dollar Weather and Climate Disasters: Overview,* National Ocean and Atmospheric Administration, https://www.ncdc.noaa.gov/billions/

[66] O'Donoghue, Amy Joi, *How Rocky Mountain Power is working to avoid mass outages like California*, Deseret News, , Nov. 4, 2019, https://www.deseret.com/utah/2019/11/4/20943714/california-wildfire-power-outages-rocky-mountain-power.

of the solution, as evidenced by the surge in the demand for DG solar coupled with storage in response to the wildfires in California.[67] [68]

Figure 8: Utah Areas Vulnerable to Wildfires

Q. Has progress been made in estimating the value of resilience?

A. A recent report prepared for the National Association of Regulatory Commissioners ("NARUC") provides an overview of current analytical practices.[69] There are various approaches to valuing avoided power interruptions which is used as the basis for the value

[67] Groom, Nichola, *U.S. solar firms see growth in fire-stricken California,* Reuters, Nov. 1, 2019, https://www.reuters.com/article/us-california-wildfire-solar/u-s-solar-firms-see-growth-in-fire-stricken-california-idUSKBN1XB3YD

[68] *See* Paulos, Bentham, *Resilient Clean Energy For California: Protecting Vulnerable Communities, Critical Facilities, And The California Economy With Solar + Storage*, Vote Solar, Feb. 2020, https://votesolar.org/files/8115/8203/7723/Resilient_Clean_Energy_for_California-REPORT.pdf

[69] *The Value of Resilience for Distributed Energy Resources: An Overview of Current Analytical Practices*, Prepared for The National Association of Regulatory Utility Commissioners, Prepared by Converge Strategies, LLC, April 2019, https://pubs.naruc.org/pub/531AD059-9CC0-BAF6-127B-99BCB5F02198.

of resilience. The approaches range from using surveys or interviews to elicit information about value to the use of sophisticated models.

Q. Has a value for reliability or resilience associated with DG solar been computed in any value of solar study?

A. Yes. A study prepared by Clean Power Research in 2012 examined seven locations in Pennsylvania and New Jersey and estimated that the value of avoided outages exceeds $20/MWh, based on the total cost of power outages to the U.S. each year and the ability of DG solar to decrease the incidence of outages at a capacity penetration of 15%.[70]

Q. What value for reliability and resilience do you recommend be applied to DG solar in Utah?

A. I have not quantified a specific reliability and resilience value for DG solar, although in my view, a value exists particularly related to the resource diversification value that DG solar provides. There is a growing consensus that the reliability and resiliency value of DG solar is positive and increasing. DG solar can play a critical role in protecting customers, especially vulnerable customers, during prolonged outages. The reliability and resiliency value of DG solar depends critically on the growth of the DG solar industry. The measurement of that value will become more accessible in time with industry experience and changing reliability and resiliency metrics that include DG solar.

[70] Richard Perez, Benjamin L. Norris, and Thomas E. Hoff, *The Value of Distributed Solar Electric Generation to New Jersey and Pennsylvania,* Clean Power Research Table ES-2, p. 4, Nov. 2012, https://www.nj.gov/emp/pdf/cleanrenewablepower/MSEIA-Final-Benefits-of-Solar-Report-2012-11-01(1).pdf

G. Environmental

Q. Describe the environmental benefits of DG solar in RMP's service territory.

A. DG solar can provide meaningful benefits through reducing negative health and environmental impacts that result from the use of traditional fossil-fueled generation resources, such as natural gas or coal.

I.G.1. Health Benefits from Reduced Air Pollution

Q. Please describe the health impacts from fossil generation emissions.

A. Fossil fuel-based generation emits dangerous air pollutants including nitrogen oxide (NOx), sulfur dioxide (SO_2), fine particulate matter ($PM_{2.5}$), and mercury. These pollutants present a distinct threat to public health. NOx, SOx, and $PM_{2.5}$ contribute to premature mortality, non-fatal heart attacks, and respiratory illnesses including asthma and chronic bronchitis.[71,72] Mercury can harm motor and cognitive skills, especially in children. As documented in the Gardner Institute's recent policy report, "The Utah Roadmap,"[73] Utah's topography creates unique air quality challenges. Especially in winter, emissions may be

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[71] *Overview of the Human Health and Environmental Effects of Power Generation: Focus on Sulfur Dioxide (SO2), Nitrogen Oxides (NOx), and Mercury (Hg)*, Environmental Protection Agency, June 2002, https://archive.epa.gov/clearskies/web/html/benefits.html.

[72] *Public Health Benefits per kWh of Energy Efficiency and Renewable Energy in the United States: A Technical Report*, Environmental Protection Agency, July 2019, https://www.epa.gov/statelocalenergy/public-health-benefits-kwh-energy-efficiency-and-renewable-energy-united-states; *see also* Emma Zinsmeister, Nancy Seidman, Jim Lazar, *Value Added: Measuring the Health Benefits of Energy Efficiency and Renewables,* Regulatory Assistance Project (RAP), Dec.5, 2019, https://www.raponline.org/event/value-added-measuring-the-health-benefits-of-energy-efficiency-and-renewables/.

[73] Kem C. Gardner Policy Institute, *The Utah Roadmap: Positive Solutions on Climate and Air Quality*, University of Utah, p. 4, Jan. 31, 2020, https://gardner.utah.edu/utahroadmap/.

trapped in valleys for weeks and reach levels that can harm citizens. Research conducted in Utah found that child asthma, pneumonia, miscarriage, and heart disease are worsened due to emissions, while "…hospitals along the Wasatch Front see a 40% increase in emergency room visits when pollution ranks as unhealthy."[74]

Q. Have the health benefits associated with the reduction in air pollutants due to renewable energy resources been quantified?

A. Yes. The U.S. Environmental Protection Agency has done a quantification of these benefits and provided the results in a recent technical report.[75] The EPA 2019 Report was written with the express purpose of helping state and local governments quantify the health benefits of energy efficiency ("EE") and renewable energy ("RE"). "The goal of these estimates is to create credible and comparable values (i.e., factors) that stakeholders, such as state and local governments, EE/RE project developers, and nongovernmental organizations (NGOs), can use to estimate health benefits of EE/RE projects, programs, and policies."[76] The Report uses a robust peer-reviewed methodology and tools to develop a dollar value of benefits per kWh for EE and renewables, including solar generation. The values are developed for each type of resource on a regional basis. Utah is part of the Northwest Region as shown in Figure 9[77].

[74] *Id.* at p. 4.

[75] *Public Health Benefits per kWh of Energy Efficiency and Renewable Energy in the United States: A Technical Report*, Environmental Protection Agency, July 2019, https://www.epa.gov/statelocalenergy/public-health-benefits-kwh-energy-efficiency-and-renewable-energy-united-states.

[76] *Id.* at p. 5.

[77] *Id.* at p. 4.

Figure 9: Health Benefit Regions

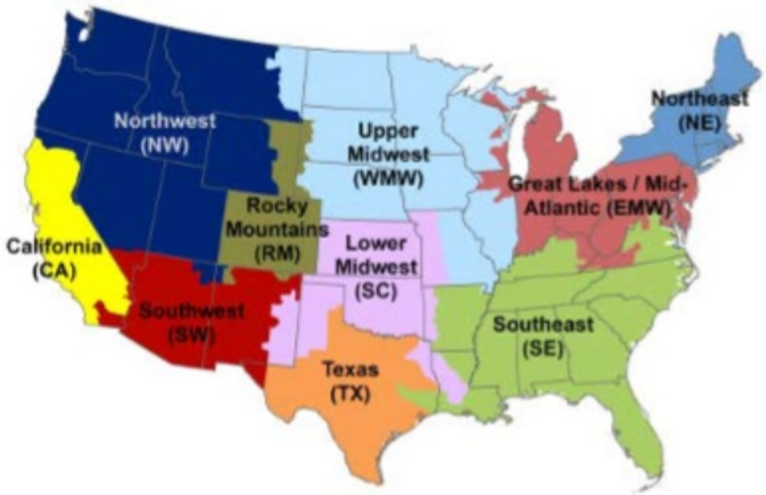

Figure ES.1. AVERT Regions.

Q. Have the estimates in the EPA 2019 Report been used in actual proceedings?

A. Yes. Even though the report has only been out since July 2019, there are several examples of its results being used. The Oklahoma Sustainability Network used EPA's benefits per kWh values in formal comments submitted to the Oklahoma Corporation Commission to support the health benefits of a proposed 1,485 MW wind facility.[78] The Maryland Public Service Commission's Energy Storage Working Group proposed a metric, based on EPA's benefits per kWh values, to assess the health benefits from using energy storage.[79] And the California Public Utilities Commission developed their own air quality adder, using the

[78] *Oklahoma Sustainability Network's Statement Of Position*, Corporation Commission of the State of Oklahoma, Docket No. PUD 201900048, p. 4, Nov. 7, 2019, http://imaging.occeweb.com/AP/CaseFiles/occ30301300.pdf.

[79] Public Utility Law Judge Division, *Submission of the PC 44 Energy Storage Working Group*, Public Service Commission of Maryland, Case No. 9619, p. 5, Dec. 31, 2019, https://www.psc.state.md.us/search-results/?q=9619&x.x=0&x.y=0&search=all&search=case.

EPA's models, to estimate the health benefits of reducing power plant emissions and obtained results nearly identical to those in the EPA 2019 report.[80]

Q. Does 2019 EPA report take into account the unique attributes of solar?

A. Yes. For example, the analysis takes into account the fact that solar only generates electricity during the daytime.

Q. What health benefits does the 2019 EPA Report quantify?

A. The 2019 EPA Report quantifies the health benefits from the reduction in $PM_{2.5}$ from primary electric generation emissions and from secondary emissions created from SO_2 and NOx emissions as they undergo chemical reactions in the atmosphere.

Q. What methodology is used in EPA's analysis?

A. The overall methodology consists of six steps: (1) an estimate is made of the change in fossil-fuel electric generation as a result of the EE/RE project; (2) an estimate is made of the changes in air pollution emissions as a result of the reduction in fossil-based generation; (3) an estimate is made of changes in ambient concentrations of air pollution due to changes in emissions; (4) an estimate is made of changes in public health impacts due to changes in ambient concentrations of $PM_{2.5}$; (5) an estimate is made of the monetary value of the changes in public health impacts; and finally, (6) the dollar value of health benefits is divided by the change in generation to determine the health benefits per kWh.[81]

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[80] *Administrative Law Judge's Ruling Seeking Responses To Questions And Comment On Staff Amended Proposal On Societal Cost Test*, Public Utilities Commission of the State of California, Rulemaking 14-10-003, p. 12, Mar. 14, 2018, http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M212/K023/212023660.PDF.

[81] *Id.* p. 7–8.

Q. What is the value of the health benefit obtained for solar?

A. Four values are determined based on low and high estimates of the social discount rate and on the high and low sensitivities of adult mortality and non-fatal heart attacks to changes in ambient $PM_{2.5}$ levels. The range of values is 1.04¢/kWh to 2.64¢/kWh (in 2017 USD).

Q. What value do you propose for DG solar in RMP's service territory?

A. I propose a value based on an average of the health sensitivities and a low estimate of the social discount rate. I choose an average of the health sensitivities based on documented health problems in the Salt Lake City area. I chose the low discount rate based on a survey of 197 experts that found that 92% of them are supportive of a social discount rate in the range of 1-3%.[82] This results in a health benefit value associated with CG exports of 2.09 ¢/kWh.

[82] Moritz Drupp, Mark Freeman, Ben Groom and Frikk Nesje, *Discounting disentangled: an expert survey on the determinants of the long-term social discount rate*, Centre for Climate Change Economics and Policy Working Paper No. 195 Grantham Research Institute on Climate Change and the Environment Working Paper No. 172, p. 38, May, 2015, http://piketty.pse.ens.fr/files/DruppFreeman2015.pdf.

I.G.2. Avoided Carbon Emissions (CO_2)

Q. Describe the benefits of reduced carbon emissions as a result of DG solar exports.

A. Generation of electricity with coal and natural gas is a major contributor to climate change. In 2018, carbon dioxide emissions from the electric power sector made up about 28 percent of all emissions in the United States.[83] Although coal makes up the vast majority of CO_2 emissions, the process of natural gas extraction and processing emits methane. Methane traps heat in the earth's atmosphere at a greater rate than CO_2.[84] DG solar provides a relatively quick and decentralized way of helping to reduce such emissions. Solar energy produces no emissions, can be deployed within months, and is flexible enough to be used in a variety of contexts. This is especially relevant with the release of the Gardner Institute's Utah Roadmap, which specifies a variety of negative effects on Utah from air pollution and climate change. These effects include declining snowpack, warmer and drier conditions, stronger wildfires, and more common extreme weather events, such as flash floods.[85]

Q. What are avoided environmental compliance costs, and what is their value related to DG solar in Utah?

A. RMP does not currently have a mandate to reduce carbon emissions. However, a January 2020 report from the Gardner Policy Institute at the University of Utah provides

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[83] *Sources of Greenhouse Gas Emissions*, Environmental Protection Agency, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions (Accessed Jan 16, 2020).

[84] Marielle Saunois et al, *The Global Methane Budget 2002-2012*, Global Carbon Project, Dec 2016, Accessed January 16, 2020, https://www.globalcarbonproject.org/methanebudget/16/hl-compact.htm.

[85] Kem C. Gardner Policy Institute, *The Utah Roadmap: Positive Solutions on Climate and Air Quality*, University of Utah, p. 7, Jan. 31, 2020, https://gardner.utah.edu/utahroadmap/ .

recommendations to Utah policymakers to reduce air emissions. At its broadest level, the Utah Roadmap seeks to reduce CO_2 emissions statewide to 25% of 2005 levels by 2025; 50% of 2005 levels by 2030; and 80% of 2005 levels by 2050. To do so, the report outlines a variety of policy options, including promoting and incentivizing of clean distributed generation and storage, allowing third-party power supply options outside regulated utility[86], and putting "an economy-wide price on greenhouse gas emissions through resolution or legislation."[87] In its most recent 2019 IRP, RMP provides estimates of the potential risk of future CO_2 compliance costs. RMP estimates "Medium" and "High" CO_2 prices – i.e., (i) Medium: $10/ton in 2025, reaching roughly $57/ton in 2040; and (ii) High: about $22/ton in 2025, reaching roughly $100/ton in 2040.[88] In addition, RMP provides a social cost of carbon price beginning in 2019 and increasing through 2040.

Q. What is the value of reduced carbon emissions related to CG exports in RMP's service territory?

A. I have computed two separate values for reduced carbon emissions based on RMP's prices for (a) RMP's CO_2 "High" compliance costs and for (b) the social cost of carbon. I chose the "High" prices based on (1) the carbon allowance price trend in the Western Carbon Initiative[89] which reflects a marginal cost of reducing carbon more consistent with the "High" compliance costs, (2) the movement toward cap and trade programs in Oregon and

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[86] *Id*. at p. 16.

[87] *Id*. at p. 2.

[88] *2019 Integrated Resources Plan,* PacifiCorp, Volume I, p. 180, Oct. 18, 2019, https://www.pacificorp.com/energy/integrated-resource-plan.html.

[89] *Western Carbon Initiative Carbon Allowances,* California Air Resources Board, December 20, 2019, https://ww3.arb.ca.gov/cc/capandtrade/wcicarbonallowanceprices.pdf

Washington and the business support for these programs[90], and (3) the broader worldwide trend toward programs to reduce carbon with 57 separate initiatives around the world that currently price carbon up to $125/ton.[91] As part of his testimony, Dr. Milligan has computed yearly avoided carbon emissions (in lbs.) associated with the reduced production of fossil-fuel generation due the CG exports.[92] Using RMP's prices and Dr. Milligan's avoided carbon amounts, I determined a yearly value for RMP's avoided compliance costs multiplying an average of RMP's high CO_2 prices by the amount of avoided carbon emissions. Then, I calculated the net present value of these avoided costs using a discount rate of 6.92%.[93] Finally, I determine a levelized value (a value with the same NPV) for RMP's avoided CO_2 compliance costs. I use the same method to compute the social benefits from CO_2 emissions reductions but in this case using a social discount rate of 3%.[94] I find an avoided compliance cost of carbon of 2.80 ¢/kWh and a social benefit of reduced carbon emissions of 6.57¢/kWh. Compliance costs and social benefits are two distinct value components. The costs of installing emissions control equipment or retiring a generation facility to reduce carbon emissions are separate and distinct from the benefits to the environment and human health from reduced carbon. For this reason, I include both these costs in the value of CG exports.

[90] Withycombe, Claire, *Businesses voice support for cap and trade in West Coast states,* East Oregonian, February 1, 2020, https://www.eastoregonian.com/news/business/businesses-voice-support-for-cap-and-trade-in-west-coast/article_84dc6b86-42c9-11ea-840c-6f71dd8a0066.html

[91] *Carbon Pricing Dashboard,* The World Bank, Launched May 2017 Updated 2019, https://carbonpricingdashboard.worldbank.org/map_data.

[92] Vote Solar, *Affirmative Affirmative Testimony of Michael Milligan.*

[93] *2019 Integrated Resources Plan,* PacifiCorp, Volume I, p.401, Oct. 18, 2019, https://www.pacificorp.com/energy/integrated-resource-plan.html.

[94] A 3% social discount rate is consistent with that rate I chose for the health benefits associated with reduced air pollution ($PM_{2.5}$).

I.G.3. Avoided Fossil Fuel Lifecycle Costs

Q. What are avoided fossil fuel lifecycle costs?

A. Expanded use of solar power, including DG solar, reduces the need for fossil fuels to power centralized energy generation plants. In addition to the reduction of emissions resulting from the extraction, processing, and transportation of these fossil fuels, large amounts of water resources are saved that would otherwise be used in obtaining fossil fuels such as coal and natural gas. Processing fossil fuels also has negative side-effects such as creation of coal ash that can contaminate water systems, destroy natural environments, and lead to disease among humans and wildlife.[95] And fossil fuel generation can negatively impact land values. These effects are difficult to quantify and I have not attempted to do so here. Nonetheless, DG solar by reducing the need for fossil fuel generation prevents or reduces these fossil fuel lifecycle costs and this benefit should be recognized when evaluating the value of DG solar in this proceeding.

H. Societal

Q. What benefits of DG solar exports do you quantify in this category?

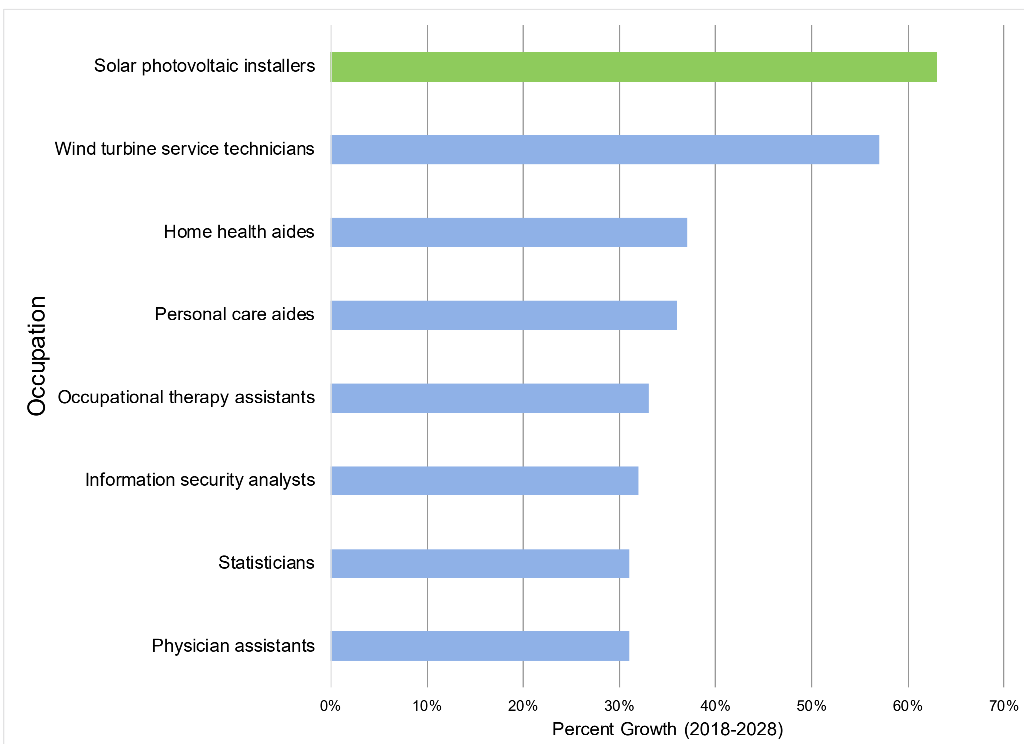
A. I quantify the local economic benefits created by DG solar exports for local communities.

[95] Gideon Weissman, Emma Searson and Rob Sargent, *The True Value of Solar: Measuring the Benefits of Rooftop Solar Power*, Environment America and the Frontier Group, p.8, July 2019, https://environmentamerica.org/sites/environment/files/resources/AME%20Rooftop%20Solar%20Jul19%20web.pdf.

Q. Describe the local economic benefits created by DG solar exports.

A. DG solar creates local jobs, local economic growth, and higher tax revenue. These benefits are significant. According to the Bureau of Labor Statistics, the fastest growing occupation in the U.S. is solar PV installer, with expected growth of 63% from 2018 to 2028 and an expected median pay of $42,680 per year.[96] Figure 10[97] below shows the projected fastest-growing jobs in the United States through 2028 with solar PV installer on top followed by wind turbine service technicians. Since DG solar is local, most of the jobs created by the DG solar industry in RMP's will likely be in the state of Utah.

Figure 10: Fastest Growing Occupations in the United States



[96] *Occupational Outlook Handbook: Fastest Growing Occupations,* U.S. Bureau of Labor Statistics, https://www.bls.gov/ooh/print/fastest-growing.htm (Accessed January 16, 2020).

[97] *Id*.

In addition to solar installation jobs, DG solar creates jobs in manufacturing, wholesale trade and distribution, operation and maintenance, and jobs in companion industries such as storage and technology. The Solar Foundation estimates that in the U.S. as of 2019, 344,532 workers spend all or part of their time in solar and that Utah ranks 9th for solar jobs nationwide.[98] An ECR that is set at a level that supports rather than discourages DG solar growth will create local economic benefits in Utah.

Q. In addition to jobs, what other local economic benefits does DG solar create?

A. DG solar provides stimulus to the local economy when materials and services needed for the installation, maintenance, and operation of DG solar are purchased locally. Additionally, DG solar economic activity generates tax revenues for the State of Utah.

Q. How are local economic benefits associated with DG solar quantified?

A. To get an accurate assessment of the benefits it is necessary to model the local economy and then to assess the economic impact of DG solar investment relative to a case with no DG solar investment. In a recent study done for the Maryland Public Service Commission,[99] a comprehensive analysis of local economic benefits was done using an input-output model that measures and tracks all monetary flows associated with a specified activity.[100] Other

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[98] *National Solar Job Census Press Release,* The Solar Foundation, Feb. 19, 2020, https://www.thesolarfoundation.org/national/.

[99] *The Benefits and Costs of Utility Scale and Behind The Meter Solar Resources in Maryland*, Daymark Energy Advisors, p.108, April 10, 2018, http://www.psc.state.md.us/wp-content/uploads/MD-Costs-and-Benefits-of-Solar-Draft-for-stakeholder-review.pdf.

[100] The input-output model combines data on economic factors and demographic statistics with assumptions about how those elements interact. The model then measures how changes in solar investment affect sales of local industries.

studies have looked at the local costs of DG solar to derive the local economic benefit by estimating the monetary flow into the local economy.[101]

Q. How have you quantified the local economic benefits of DG solar in Utah?

A. Yes. I use monetary flows to calculate a gross local economic benefit and then I determine what portion of this benefit would have otherwise been achieved and subtract that amount to derive a net local economic benefit. I first calculate the benefits that DG solar provides to the local economy as equal to the payments made by DG solar companies to local businesses and employees. This represents the monetary flow into the local economy. Since I do not have a benchmark to compare the monetary flows without DG solar, I used an alternative approach based on a comparison of DG solar investment relative to RMP investment or procurement. I have developed an estimate of the portion of retail load growth served by RMP from generation resources located outside the state of Utah. This fraction represents the loss in local economic benefits when load is served from RMP resources as opposed to DG solar resources, or the net local economic benefits associated with DG solar.

Q. How did you estimate the monetary flow into the local economy?

A. The National Renewable Energy Laboratory ("NREL") tracks the cost of residential and commercial DG solar installations.[102] Those costs can be divided into two categories: (1) costs related to the purchase of equipment which are generally non-local in nature and (2)

[101] R. Thomas Beach and Patrick G. McGuire, *The Benefits and Costs of Solar Distributed Generation for Arizona Public Service,* Crossborder Energy before the Arizona Corporation Commission, Docket No. E-00000J-14-0023, Exhibit 2, Page 21, February 25 2016.

[102] Ran Fu, David Feldman, and Robert Margolis, *U.S. Solar Photovoltaic System Cost Benchmark: Q1 2018*, National Renewable Energy Laboratory, Nov. 2018, https://www.nrel.gov/docs/fy19osti/72399.pdf.

"soft" costs related to marketing and installation which are incurred locally. The soft costs are the relevant local costs for my analysis. Table 2 shows the benchmark costs of DG solar per watt taken from the NREL study.[103]

Table 2: Total Capital Cost of DG Solar

Residential PV		Commercial PV	
Cost Category	**2018 USD per Watt dc**	**Cost Category**	**2018 USD per Watt dc**
Equipment Costs		**Equipment Costs**	
Module	0.47	Module	0.47
Inverter	0.21	Inverter	0.08
Structural BOS	0.10	Structural BOS	0.12
Electrical BOS	0.21	Electrical BOS	0.14
Supply Chain Costs	0.30	EPC Overhead	0.18
Sales Tax	0.09	Sales Tax	0.05
Total Equipment Costs	**1.38**	**Total Equipment Costs**	**1.04**
Local Soft Costs		**Local Soft Costs**	
Install Labor	0.27	Install Labor & Equipment	0.16
Permitting, Inspection, Interconnection	0.06	Permitting, Inspection, Interconnectior	0.10
Sales & Marketing (Customer acquisition)	0.35	Contingency (4%)	0.05
Overhead (General & Admin.)	0.32	Developer Overhead	0.36
Net Profit	0.33	EPC/Developer Net Profit	0.12
Total Local Soft Costs	**1.32**	**Total Local Soft Costs**	**0.79**
Total Cost	**2.70**	**Total Cost**	**1.83**

Source: U.S. Solar Photovoltaic System Cost Benchmark Q1 2018, https://data.nrel.gov/submissions/103

Q. How do the soft costs of $1.32/Watt for residential solar and $0.79/Watt for commercial solar translate into total costs?

A. In 2019, 35.5 MW of residential and 11 MW of commercial DG solar was installed on RMP's distribution system.[104] Total soft costs or monetary flow into the local Utah

[103] Costs obtained from accompanying data file to the 2018 NREL Cost Benchmark study. Ran Fu, David Feldman, and Robert Margolis, *U.S. Solar Photovoltaic System Cost Benchmark Q1 2018 Data File,* National Renewable Energy Laboratory, Tab "Figure 14", November 2018, https://dx.doi.org/10.7799/1503848

[104] Exhibit 2-CAB, Attach Vote Solar 9.8.xlsx, RMP's Response to Vote Solar 9th Set Data Request – Attachment 9.8 (Feb. 6, 2020)..

economy associated with this investment based on the NREL cost estimates[105] was just under $57 million.

Q. What were the soft costs or monetary flow into the local Utah economy before the implementation of the Transition Export Rate?

A. In 2017, 67.8 MW of residential and 16.9 MW of commercial DG solar was installed on RMP's distribution system – 82% more than the MW installed in 2019. Total monetary flow into the local Utah economy associated with this investment based on the NREL cost estimates was over $100.7 million. The economic benefit for Utah in 2019 has declined by over $43.7 million relative to the 2017 benefit.

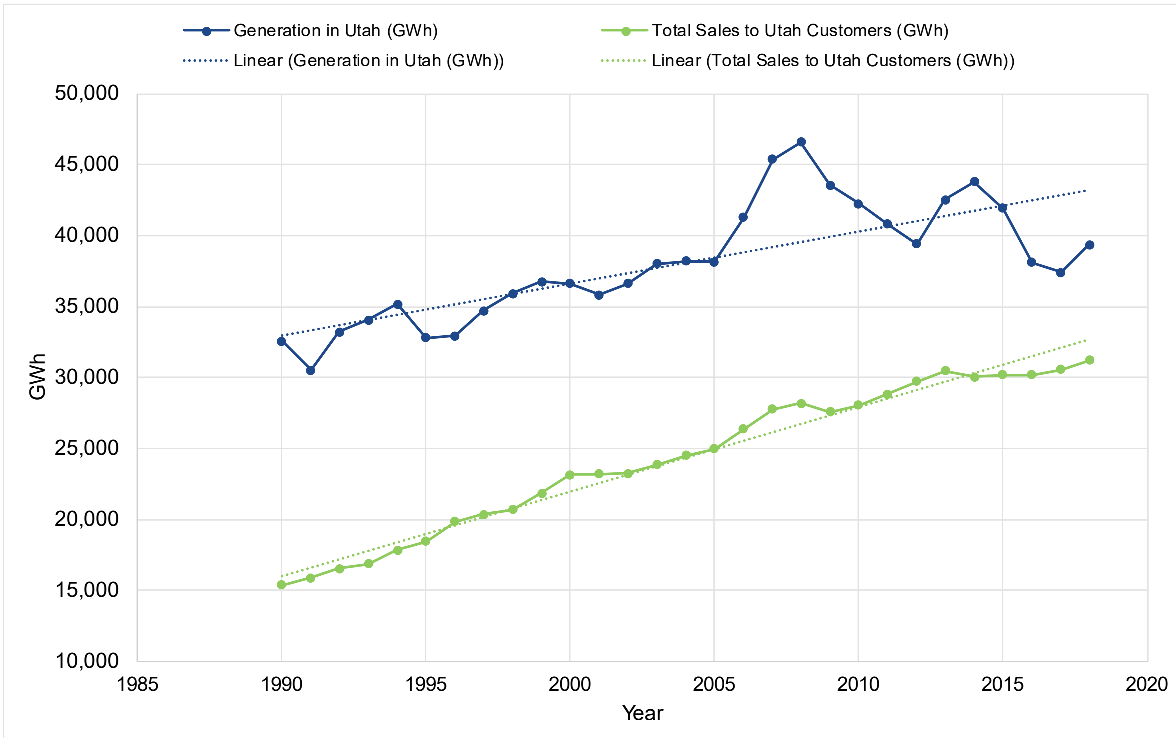
Q. How did you calculate the local economic benefit of DG solar relative to the local economic benefit that would accrue if the investment was made by RMP?

A. Using EIA generation and consumption data for Utah, I estimated the fraction of the growth in electric consumption that is served by imports rather than in-state generation resources. Figure 11 shows the growth in consumption compared to the growth in generation in Utah for the period 1990-2018. As can be seen, consumption is growing faster than generation, the difference being supplied by imports.[106] I estimate the amount of incremental consumption supplied by imports to be 38%.

[105] Ran Fu, David Feldman, and Robert Margolis, U.S. Solar Photovoltaic System Cost Benchmark Q1 2018 Data File, National Renewable Energy Laboratory, Tabs "Figure 14" and "Figure 20", November 2018, https://dx.doi.org/10.7799/1503848.

[106] By definition, for state-level data, total generation minus total consumption equals net exports.

Figure 10: Net Energy Generation, Sales, and Exports in Utah 1990-2018 (GWh)



Q. Why do you use state level data to compute the fraction of imports for RMP?

A. RMP serves roughly 75% of the load in Utah, thus state-level data provides a good estimate for changes in RMP's net imports.[107]

[107] PacifiCorp's resource expansion plan in its 2019 IRP shows that just 35.1% of PacifiCorp's planned expansion resource expenditures in PacifiCorp East will be spent in the state of Utah. This supports my findings using the state-level data.

Q. How did you convert the $/Watt soft costs shown in Table 2 to a cents/kWh benefit for the value of DG solar exports?

A. I first converted the $/Watt to $/kW, and then multiplied that amount by costs by the fraction attributable to DG solar exports and then divided by a kWh/kW yield factor.[108] Next, multiplied the benefit by the fraction not otherwise achievable by RMP resources to determine the net local benefit. And lastly, I levelized this benefit over an expected DG solar lifetime of 20 years.

Q. What is the result?

A. I find that the local economic benefit for residential solar is 3.64 ¢/kWh and the local economic benefit for commercial solar is 2.17 ¢/kWh, and that the weighted average based on a split of 81% residential/19% commercial results in a total local economic benefit of 3.37 ¢/kWh.[109]

I. Costs of Customer Generation in RMP's Service Territory

Q. Please describe the additional system costs associated with CG in RMP's service territory.

A. At current penetration levels, CG exports does not impose any additional costs to the system, such as the need for upgrades to infrastructure such as transformers or potential need for increased operating reserves. The amount of such integration costs, if any, will depend not

[108] The yield factor is based on the Load Research Study and was provided by Dr. Lee.
[109] The small amounts of irrigation and industrial solar are valued at the commercial rate.

only on the level of penetration of CG, but also the density of those CG resources on a utility's distribution network. In a 2015 Lawrence Berkeley National Laboratory report, the authors find DG does not raise any distribution operational issues until levels of penetration are greater than 5% of distribution grid peak loading system-wide and that California and Hawaii are the only states in which operational issues are a concern based on DG adoption and public policy decisions.[110] Mr. Volkmann has analyzed RMP integration costs associated with CG and found that they are *de minimus*.[111]

VIII. Summary of Value of Customer Generation Exports

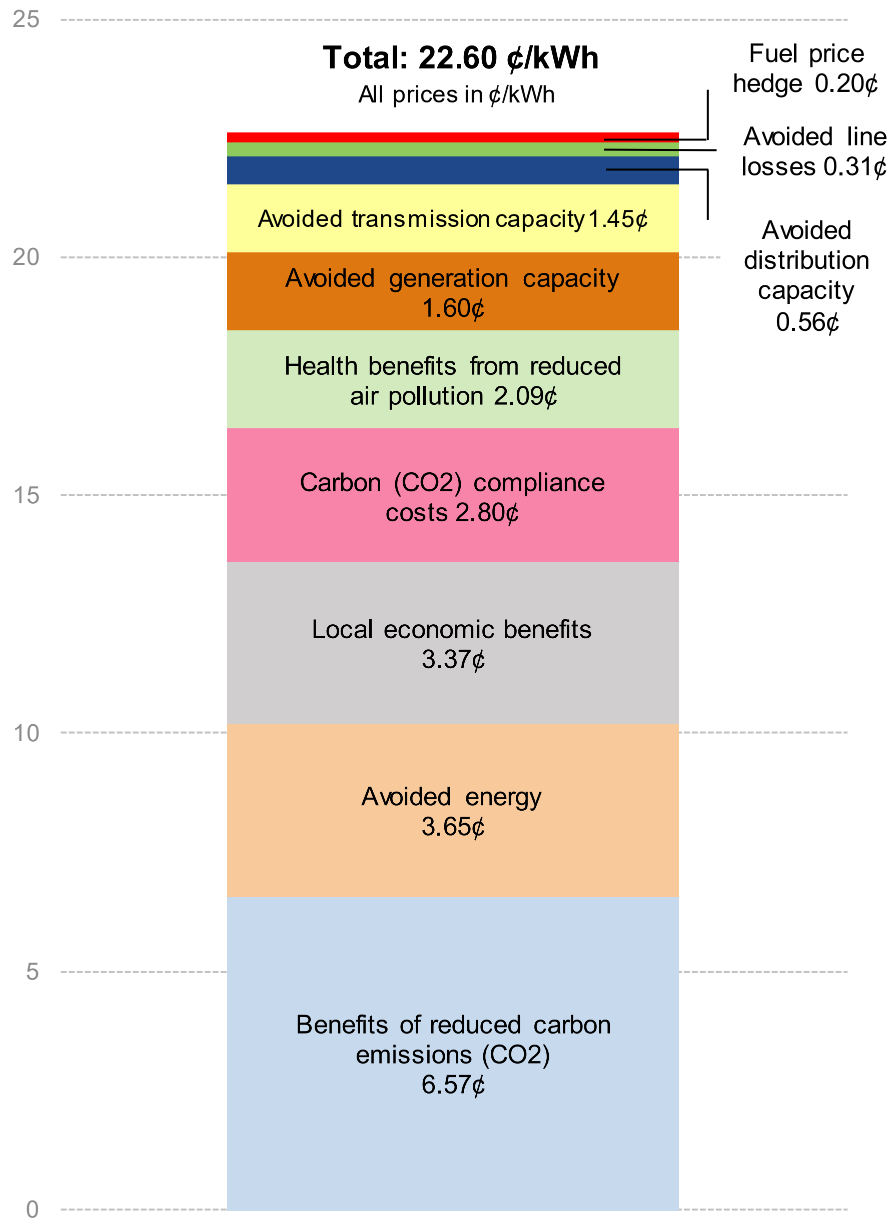
Q. Please summarize the value of CG exports in RMP's service territory.

A. Based on the amounts that we have been able to specifically quantify, I estimate that the 20-year levelized value of CG exports is 22.60¢/kWh. Figure 12 below shows the value stack of the components. I have not quantified some categories of benefits, but their value should also be weighed and considered. Excluding these categories would necessarily understate the value CG exports.

[110] Paul De Martini and Lorenzo Kristov, *Distribution Systems in a High Distributed Energy Resources Future: Planning, Market Design, Operation and Oversight*, p. 9, Oct. 2015. https://eta-publications.lbl.gov/sites/default/files/lbnl-1003797.pdf.https://emp.lbl.gov/publications/easing-natural-gas-crisis-reducing

[111] Vote Solar, Affirmative Testimony of Curt Volkmann, lines 360–63.

Figure 12: Value Stack of CG Exports



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Q. Are there other factors that the commission should consider when making its decision regarding just and reasonable compensation for CG exports?

A. Yes. The CG industry is part of a wider grid edge economic community that includes electric vehicles, battery storage, new and innovative energy management systems and software, and new devices to share energy and measure energy use. CG is a critical piece of this community and its growth is crucial to the achievement the synergies, technological advances, and consumer engagement than will provide new opportunities at lower costs to energy consumers. The compensation mechanism approved by the Commission will not only compensate CG customers for the energy and services they provide but also serve as a lever available to the Commission to achieve its energy policy goals. Ratemaking in general reflects the Commission's policy decisions, and compensation for exported CG is no different. The choice of CG export compensation will set the path to Utah's CG future and to the benefits that future can bring.

CERTIFICATE OF SERVICE

I hereby certify that on this 3rd day of March, 2020 a true and correct copy of the foregoing was served by email upon the following:

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