SOLAR VALUATION STUDY

Special Contemporary Issue
Evergy Missouri West
Integrated Resource Plan
4 CSR 240-22.080
April 2021

evergy™

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1. Executive Summary

The "Order Establishing Special Contemporary Resource Planning Issues" issued on November 4, 2020 in EO-2021-0067 and EO-2021-0068 directed the Company to:

> "Conduct a Value of Solar study to inform efforts relating to integrated resource planning. A Value of Solar study is a comprehensive analysis of the cost avoided and benefits created for the grid, electricity customers, and society as result of the generation of solar energy. Because solar energy is often interconnected at the distribution level of the grid, such a study, done correctly, will capture distribution level benefits and costs that cannot be captured by wholesale level avoided cost estimates. The immediate benefit of such a study is to understand the contributions and costs related to distributed solar generation beyond simplistic and subjective allegations of cross subsidies. The utility's Value of Solar study should consider the National Association of Regulatory Utility Commission's Distributed Energy Resources Rate Design and Compensation manual, National Renewable Energy Laboratory's Value of Solar: Program Design and Implementation Considerations, and the National Energy Screening Project's National Standard Practice Manual for Distributed Energy Resources among any other industry guidance on value of solar study development and implementation."

To complete this effort, the Company relied on input from numerous internal subject matter experts as well as retained the services of The Brattle Group. In combination, this expertise and industry knowledge resulted in a solar valuation appropriate to inform the Company Integrated Resource Planning effort.

To inform Integrated Resource Planning, it is important that a Value of Solar study and the Integrated Resource Plan are aligned so that solar resources are evaluated on a consistent basis with other resources. A key principle in integrated utility planning is that all potential resources are evaluated on an equivalent basis with each other. Some approaches to complete a Value of Solar study do not follow this guideline. Some Value of Solar studies include generous amounts of external and societal benefits, some of which are not easily quantifiable and can vary considerably from study to study. While certain external considerations may be appropriate, it is important to note that any external factors used to override the resource selection based on minimization of revenue requirement will, by definition, increase customer electric bills. At this time, Evergy does not include external and societal benefits in its revenue requirement calculations in accordance with 22.010(2)(B). Thus, to be consistent with 22.010(2)(A) requiring resources be considered on an equivalent basis, these factors should also be excluded for distributed resources. In an effort to comply with the intention of this Special Contemporary Issue, Evergy has considered, to the extent possible, benefits and costs of distributed and utility scale solar relevant to the Integrated Resource Plan.

In developing this Solar Valuation Study, the Company relied upon the structure of the above Special Contemporary Issue by examining the Value of Solar approach used in the industry, examining its relationship to the Integrated Resource Planning process, and considering the three source documents identified by the Commission in its Order. Evergy utilized two primary steps in developing the its Solar Valuation Study, which include:

1. An evaluation of quantifiable benefits expressed through avoided costs, and
2. A review of subjective and conditional benefits identified in the Special Contemporary Issue source documents.

Basing the Solar Valuation on avoided cost provides focus on the "known and measurable" aspects of distributed solar generation. The Company asserts the potentially quantifiable benefits provided by distributed solar generation include:

- avoided energy costs
- avoided generation capacity
- avoided transmission and distribution (T&D) line losses
- avoided distribution infrastructure costs
- avoided transmission infrastructure costs

The Company performed an evaluation of the avoided costs associated with distributed solar generation in Missouri. A copy of the analysis is included as Appendix 1 to this report. A summary of the results is as follows:

Evergy Missouri Metro			
Avoided Cost Category	**Quantity**	**Value**	**Avoided Cost**
Energy	49,795,116 kWh	$0.0220 per kWh	$1,095,493
Capacity	7,122.35 kW	$3.99 per kW-month	$341,018
T&D Line Losses	5,150,558 kWh/yr	$0.0220 per kWh	$113,312
Distribution Costs	0	see narrative	$0
Transmission Costs	0	see narrative	$0
Total			**$1,549,823**

Evergy Missouri West			
Avoided Cost Category	**Quantity**	**Value**	**Avoided Cost**
Energy	72,508,944 kWh	$0.0220 per kWh	$1,595,197
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Capacity	17,493.53 kW	$3.99 per kW-month	$837,590
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Distribution Costs	0	see narrative	$0
Transmission Costs	0	see narrative	$0
Total			**$3,746,378**

If expressed as a $ per kWh value, the avoided cost associated with distributed solar generation is currently determined to be:

Missouri Metro	**$0.03113 per kWh**
Missouri West	**$0.03029 per kWh**
Missouri Total	**$0.03063 per kWh**

The Company notes the Commission's desire to look beyond avoided cost as evidenced by the wording of the Special Contemporary Issue and the reference to three documents for consideration, which include:

- National Association of Regulatory Utility Commission's Distributed Energy Resources Rate Design and Compensation manual
- National Renewable Energy Laboratory's Value of Solar: Program Design and Implementation Considerations
- National Energy Screening Project's National Standard Practice Manual for Distributed Energy Resources.

Each document provides some form of framework for the valuation of solar, inclusive of a wide range of potential value streams. As part of the consideration of these factors, the following summary was produced and enabled further consideration detailed later in Section 6.

COMPONENTS CONSIDERED WHEN ASSESSING VALUE/COST OF SOLAR

System	Component	Description	Acknowledged by Studies Cited in Order?			Unique to DG?	Addressed in Evergy Avoided Cost Analysis?
			NARUC	NREL	NESP		
Generation	Avoided Fuel Costs	Costs related to generation fuel	√	√	√		√
	Avoided VOM	Non-Fuel Variable Cost			√		√
	Avoided Generation Capacity Cost	Avoided or deferred capacity investments	√	√	√		√
	Avoided FOM	Fixed O&M costs			√		√
	Avoided Environmental Compliance Cost	Includes non-GHG or RES/CES environmental regulations	√		√		
	Avoided RES/CES Compliance Cost	Reduction in necessary clean energy to comply with RPS/CES			√		
	Fuel Hedging	Reduction in fuel price risks	√		√		
	Market Price Response	Change in wholesale market prices from reduced consumption			√		
	Ancillary Services	Services to maintain grid stability in wholesale system	√		√		
Transmission	Avoided Transmission Capacity	Avoided or deferred capacity investments	√	√	√		√
	Avoided Line Losses	Electricity lost through transmission resistance	√	√	√		√
Distribution	Avoided Distribution Capacity	Avoided or deferred increases in capacity investments	√	√	√	√	√
	Resiliency and Reliability	Impacts ability to withstand and recover from unanticipated events	√	√	√	√	√ **(Reliability)**
	Distribution O&M	Impacts O&M for the distribution system			√	√	√
	Distribution Voltage and Power Quality	Services to maintain grid stability in distribution system	√		√	√	
	Avoided Line Losses	Electricity lost through transmission resistance	√	√	√	√	√

System	Component	Description	Acknowledged by Studies Cited in Order?			Unique to DG?	Addressed in Evergy Avoided Cost Analysis?
			NARUC	NREL	NESP		
Other	Integration Costs	Any upgrade or other costs related to integrating DG	√	√	√	√	
	Lost Utility Revenue Costs	Lost revenue (if net metering)				√	
	Program and Admin. Costs	Includes all administration costs, including financial support programs		√	√	√	
	Risk	Includes operational, financial, regulatory/legal, reputational risk			√	√	
Societal	Avoided GHGs	Avoided GHG valued at social cost of carbon (SCC) estimate		√	√		
	Air Quality	Improved air quality and public health from reduction in fossil combustion		√	√		
	Other Environmental Benefits	Other air, land, water, waste and other impacts.		√	√		
	Economic Benefits	Incremental economic development and job impacts			√		
	Energy Security	Impact on energy imports and energy independence			√		

The Company has observed that these frameworks add numerous other potential benefits to the calculation of avoided costs. This approach can be problematic as many of these values are subjective, conditional or at minimum tend to vary widely depending on the individual utility, conditions of the grid or details of the individual solar installations (location, inverter capability, customer load, etc.). Our review also notes that the decision to include societal impacts—such as carbon emissions, criteria pollutants, economic development, or other values that accrue to society—can have a significant impact on the value of solar results, and agreement was not found across the studies. In some cases, a common rationale for excluding societal benefits is that they do not materialize as savings in the form of avoided costs to the utility, which means the benefits cannot be passed along to ratepayers. Regardless of these concerns, Evergy explores and offers critiques of the values and where appropriate, estimates values or value ranges for each.

Evergy notes that the Commission took special interest in the potential locational benefits of distributed solar generation and supports the theoretical and potential locational benefits of placing generation closer to loads; however, this benefit is elusive. In reviewing the Company circuits, sufficient saturation is not occurring to be a benefit to others beyond the system owner. Circuit saturation is defined as net metered solar capacity divided by total circuit capacity. On average, for the circuits with the highest saturation average circuit loading is 8.01%. These same circuits the majority have less than 1 MW of installed distributed solar generation on the circuit. As detailed in the Company's determination of avoided cost, these conditions do not support material locational benefit. Conversely, the Company would contend that utility scale solar can provide many of the locational benefits anticipated by the Commission more efficiently than distributed solar generation.

2. The Role of Value of Solar

In considering the directive of this SCI as described in the Executive Summary above, the Company observed the primary purpose of the special contemporary issue ("SCI") is to "inform" the IRP. The SCI goes on to offer a definition of "Value of Solar" and provides a narrative offering statements concerning approach and benefits. Finally, the SCI identifies three source documents to be considered. In producing this study, the Company mirrors this structure and offers an analysis of the potential costs avoided and potential benefits.

2.1. Value of Solar Definition

The definition of Value of Solar ("VOS") has proven to be a complex issue to address. The Order notes in part,

> "Value of Solar study is a comprehensive analysis of the cost avoided and benefits created for the grid, electricity customers, and society as result of the generation of solar energy. Because solar energy is often interconnected at the distribution level of the grid, such a study, done correctly, will capture distribution level benefits and costs that cannot be captured by wholesale level avoided cost estimates."

Under this definition one would presume the effort is a form of cost/benefit study. This is consistent with the approach defined by the National Standard Practice Manual ("Manual") offered by the National Energy Screening Project ("NESP"). The Manual addresses benefit-cost analysis for distributed energy resources, inclusive of DG and serving as a sort of proxy for VOS.

However, other sources, particularly those cited later in the SCI Order link VOS much more closely with procurement of resources or the compensation paid to customer generators for solar generation. In the Executive Summary of its report on Value of Solar, the National Renewable Energy Laboratory ("NREL") states,

> "The value of solar (VOS) is a relatively new mechanism for the purchase of distributed solar generation that is being considered in some locations. A VOS tariff is intended to be compensation for real value provided by the solar installations to the electric system."

The NREL report goes on to further explore VOS as an alternative to net metering.

The Company has observed numerous VOS studies completed across the industry and notes that the approaches, categories of costs and benefits and the resulting use of the results vary widely. A "meta" study by ICF on behalf of the U.S. Department of Energy in 2018[1] sought to examine individual studies for comparison and to uncover trends and supports the Company observation. A summary of the findings was offered in the following summary table[2].

[1] Steve Fine, Meegan Kelly, Surhud Vaidya, Patricia D'Costa, Puneeth MV Reddy, and Julie Hawkins, *Review of Recent Cost-Benefit Studies Related to Net Metering and Distributed Solar*. May 2018

[2] Ibid, p. ii.

Table 1: Review of Recent Cost-Benefit Studies

Included	●
Discussed but not monetized/quantified	○
Included/represented in another category	● (red)
For NY, included in VDER Phase One	○ (red)

		Arkansas - Crossborder Energy 2017	Nevada - E3 2016	Louisiana - Acadian Consulting Group 2015	South Carolina - E3 2015	Mississippi - Synapse 2014	Vermont - VT Public Service Dept 2014	Washington DC - Synapse 2017	Georgia - Southern Company 2017	Hawaii - Clean Power Research 2015	Maine - Clean Power Research 2015	Oregon - Clean Power Research 2015	Minnesota - Clean Power Research 2014	Utah - Clean Power Research 2014	New York - BCA Framework 2016 + VDER Phase One	California - LNBA Framework 2016	Total
Utility System Impacts																	
G	Avoided Energy Generation	●	●	●	●	●	●	●	○	○	●	○	○	●	○ (red)	○	15
G	Avoided Generation Capacity	●	●	●	●	●	●	●	○	○	●	○	○	●	○ (red)	○	15
G	Avoided Environmental Compliance	●	●			● (red)	●	●	○ (red)		● (red)	○		●		○ (red)	10
G	Fuel Hedging	●			●	●		●		○	●	○	● (red)	●			9
G	Market Price Response	●					●	●		○	●				○		6
G	Ancillary Services		●		●	○		○	○	○					○	○	8
T	Avoided Transmission Capacity	●	●	●	●	●	●	●	○	○	●	○	○	●	○ (red)	○	15
T	Avoided Line Losses	●	●		●	●	● (red)	●	○			○		● (red)	○ (red)	○	11
D	Avoided Distribution Capacity	●	●	● (red)	● (red)	● (red)	●	●		○	○	○	○	● (red)	○ (red)	○	14
D	Avoided Resiliency & Reliability	○				○		○							○	○	5
D	Distribution O&M			●					○						○	○	4
D	Distribution Voltage and Power Quality									○	○	○	○		○	○	6
C	Integration Costs	●	●	●	●	○		●	○	○	●	○	○		○	○	13
C	Lost Utility Revenues	●	●	●	●	●	●								○		7
C	Program and Administrative Costs		●	●	●	●	●	○							○		7
Societal Impacts																	
S	Avoided Cost of Carbon	●					●	●		○	●		○		○ (red)	○	8
S	Other Avoided Environmental Costs	●	●			○		○		○	●		○		○	○	9
S	Local Economic Benefit	●				○		○									3

Of the fifteen studies identified by ICF, each varied in some way. The authors provide further commentary stating,

> "The studies that are the focus of this meta-analysis have different objectives, ask different questions, and arrive at different results. In summary, the review demonstrates a historic lack of consensus around a preferred methodology for valuing the costs and benefits of distributed solar, and emphasizes how choices about input assumptions and the perspective from which value is assessed is a strong influencer of study results. The meta-analysis also demonstrates a shift toward more comprehensive and defined approaches to valuing distributed solar and DERs more broadly."[3]

2.2. VOS and the IRP

The SCI Order concerning a VOS study requests that the Company explore the relationship of a VOS study to inform integrated resource planning. The Company welcomes this question because this is a foundational issue now as the Company considers multiple Alternative Resource Plans ("ARP") with varying amounts of solar, and some ARPs with significant amounts of solar. If the VOS study is to properly inform the Integrated Resource Plan, it is important that the VOS and the Integrated Resource Plan are aligned so that solar resources are evaluated on a consistent basis with other resources. A key principle in integrated utility planning is that all potential resources are evaluated on an equivalent basis with each other. The Missouri IRP rules lay out three requirements in order to fulfill the "fundamental objective"[4] of the IRP process [Emphasis added]:

> "(A) **Consider and analyze demand-side resources, renewable energy, and supply-side resources on an equivalent basis**, subject to compliance with all legal mandates that may affect the selection of utility electric energy resources, in the resource planning process;

[3] Ibid. pg 2.
[4] 20 CSR 4240-22.010(2)

(B) **Use minimization of the present worth of long-run utility costs as the primary selection criterion** in choosing the preferred resource plan, subject to the constraints in subsection (2)(C); and

(C) **Explicitly identify and, where possible, quantitatively analyze any other considerations which are critical to meeting the fundamental objective** of the resource planning process, but which may constrain or limit the minimization of the present worth of expected utility costs. The utility shall describe and document the process and rationale used by decision-makers to assess the tradeoffs and determine the appropriate balance between minimization of expected utility costs and these other considerations in selecting the preferred resource plan and developing the resource acquisition strategy. These considerations shall include, but are not necessarily limited to, mitigation of:

1. Risks associated with critical uncertain factors that will affect the actual costs associated with alternative resource plans;
2. Risks associated with new or more stringent legal mandates that may be imposed at some point within the planning horizon; and
3. Rate increases associated with alternative resource plans."

The first of these requirements for meeting the fundamental objective is to "[c]onsider and analyze demand-side resources, renewable energy, and supply-side resources on an equivalent basis… ." In the context of this IRP, solar (whether distributed or utility scale) must be evaluated on an equivalent basis to other renewable, supply-side, and demand-side resources. The requirement to consider resources on an equivalent basis extends to all costs and benefits of the resources. For example, if a particular value stream (benefit) is included for one candidate resource option, e.g. avoided greenhouse gases ("GHG"), then it must be included for all candidate resource options on an equivalent basis. In this IRP, the Company has represented the value of GHG by modeling multiple levels of a carbon price (See Volume 4, Section 5.4 for more details).

The second of these requirements is to "[u]se minimization of the present worth of long-run utility costs as the primary selection criterion… ." This requirement limits the scope of costs and benefits included in the IRP to those that impact the utility revenue requirement and is sometimes referred to as least-cost planning. For example, a particular value stream (benefit) may exist, e.g. public health, but the economic benefits of such a value stream might not be included if it does not impact the electric utility's revenue requirement. Some exceptions to this may be accounted for in the third requirement.

Minimization of revenue requirement is the methodology that enables utilities to find the lowest cost way to serve customers. It is the most accurate way to determine the comparative value between different resources options because it takes into account all of the incremental benefits and costs of the differing resources. So, to determine how much value an additional 500 MW of a particular resource (e.g. solar) has for Evergy customers, two scenarios could be developed, one with and one without the 500 MW resource. The net present value of revenue requirement ("NPVRR") would then be calculated for these two scenarios. The difference in the NPVRR of these two scenarios would be the value (or cost) of that additional resource. So, while a VOS study is valuable in informing the proper inputs to use in the IRP, it is not the solar study determining the "value" rather, it is the IRP determining the "value" of solar.

The third of these requirements is to "[e]xplicitly identify and, where possible, quantitatively analyze any other considerations which are critical to meeting the fundamental objective… ." At this time, Evergy does not include external and societal benefits in the revenue requirement calculations in accordance with 22.010(2)(B) and thus to be consistent with 22.010(2)(A) requiring resources be considered on an equivalent basis these factors should also be excluded for distributed resources.

In addition to this Solar Valuation Study, Evergy also conducted a Behind-the-Meter ("BTM") Potential Study to gain insights on the adoption of Distributed Energy Resources ("DER"). The study provided a supplement to the Company's awareness of existing solar adoption known through the solar rebate program. More details on this study can be found in Volume 5 Section 2 and the full report in Appendix 5G. An analysis of the BTM average rate impacts for selected ARPs can also be found in Volume 6 Section 5(M).

Evergy has considered, to the extent possible, benefits and costs of distributed and utility scale solar relevant to the IRP. In the case of distributed solar generation, high initial cost relative to utility scale solar, inability to dispatch and lack of certainty to deployment limited consideration as a resource option through the screening processes. Evergy has demonstrated its commitment to determining the appropriate quantity of solar in this IRP filing by analyzing an extensive number of Alternative Resource Plans (ARPs) with varying amounts of solar. This is manifested by Evergy's preferred plan selection of 3,200 MW of utility scale solar.

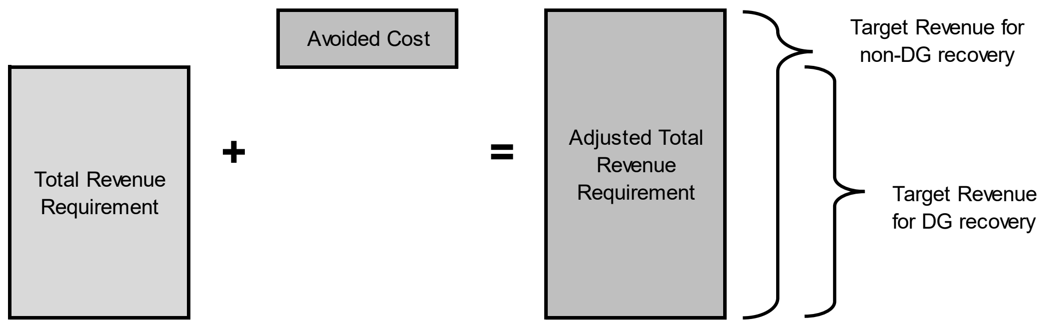
2.3. Linkage to Ratemaking

Given the NARUC Manual specifically identified in the SCI Order speaks significantly about rate making approaches, the Company is compelled to mention its opinions and concerns around VOS and rates. VOS is often considered as a successor rate design for net metering. Some jurisdictions have commissioned VOS studies specifically for the purpose of establishing a value to be applied to distributed solar generation. Additionally, many of these studies are commissioned as extensions of statute, seeking to subsidize investment in distributed solar generation.

Evergy approached this analysis with the intent of informing the IRP and not other uses such as ratemaking. Given Missouri statutes define net metering and clearly establish the value to be paid for energy from distributed solar generation, the Company did not fully incorporate ratemaking assumptions within the analysis. The Company did consider how benefits related to avoided cost might be recognized within the ratemaking process and has identified some concerns. The most primary concern is around "monetizing" the avoided costs. In order for customers to receive a reduction in rates, there must be costs identified in the costs to be recovered that can, in turn, be avoided.

Current ratemaking processes require costs to be identified and evaluated to determine revenue requirement. Traditionally, only costs incurred are represented in the revenue requirement treatment. If avoided costs are to be considered, these avoided costs must be recognized, or added to the revenue requirement. During the ratemaking treatment, recovery of the adjusted revenue requirement would be built into rate designs for non-generating customers. Distributed solar generation customers would have rates reflective of the adjusted revenue requirement less the avoided cost, thereby passing that benefit to the distributed solar generation customers. Expressed graphically, the process is as follows:

Figure 1: Revenue Requirement Example



Stated plainly, the value of the avoided cost of distributed solar generation will be recovered from the non-generating customer. Application of these costs will be reflected in the class cost of service study, particularly in as an adjustment to the Unbundled presentations of costs. Similar applications will be made in the rate design process to ensure the avoided costs are properly recognized.

2.4. Company Approach to Solar Valuation

In evaluating this directive of the SCI, Evergy is provided few details other than to analyze "the cost avoided and benefits created for the grid, electricity customers, and society as result of the generation of solar energy". Evergy has approached this solar valuation through two steps:

1. an evaluation of quantifiable benefits expressed through avoided costs, and
2. a review of subjective and conditional benefits identified in the SCI example source documents.

As described more fully in the following sections, this approach provides focus on the "known and measurable" aspects of valuation. It is Evergy's position that seeking a cost-basis is most compatible with traditional regulatory practice and better ensures balance for all utility stakeholders.

3. Quantifiable Benefits

The SCI asserts in part that,

> "a *Value of Solar study is a comprehensive analysis of the cost avoided and benefits created for the grid, electricity customers, and society as result of the generation of solar energy. Because solar energy is often interconnected at the distribution level of the grid, such a study, done correctly, will capture distribution level benefits and costs that cannot be captured by wholesale level avoided cost estimates.*"

The SCI further states that the "*immediate benefit of such a study is to understand the contributions and costs related to distributed solar generation beyond simplistic and subjective allegations of cross subsidies.*"

The Company observes that VOS studies have been used in numerous jurisdictions for varying purposes but does not believe that the purpose and application of these studies is clear. These concerns are explored more fully later in this study. For this analysis Evergy notes that most VOS studies begin with identification of avoided costs and supports that valuing distributed solar generation is best accomplished by establishing these quantifiable benefits derived from that generation source. “Quantifiable Benefits” represent actual costs (or avoided costs) defined by the market or another quantifiable cost basis. The Company asserts the potentially quantifiable benefits provided by distributed solar generation include:

- avoided energy costs
- avoided generation capacity
- avoided transmission & distribution (T&D) line losses
- avoided distribution infrastructure costs
- avoided transmission infrastructure costs

Adhering to quantifiable costs and benefits helps ensure that rates for all customers will be equitable while encouraging efficient use of resources and minimization of unnecessary cross-subsidization between customers. The manifestation of this subsidization is driven by the application of the VOS results and associated ratemaking choices more than the determination of the value itself.

The Company has observed that most value of solar studies seek to add numerous other potential benefits to the determination. This approach can be problematic as many of these values are subjective, conditional or at minimum tend to vary widely depending on the individual utility, conditions of the grid or details of the individual solar installations (location, inverter capability, customer load, etc.)

The Company performed an evaluation of the avoided costs associated with distributed solar generation in Missouri. The full analysis is in Appendix 1 of this report. A summary of the results is as follows:

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This analysis was completed by a team of internal subject matter experts representing Energy Resource Management, Distribution Engineering, Distribution Planning, Transmission Planning, Energy Solutions, Energy Accounting, and Regulatory Affairs. This team evaluated industry materials on distributed solar generation valuation, considered studies completed by other companies, and examined the distributed solar generation systems installed in the Missouri jurisdictions. The full analysis found in Appendix 1, is made up of five sections where each avoided cost category is detailed. For each, subject matter experts describe the methods used to quantify and value the impact of distributed customer generation. Further, these experts provide observations and comments concerning how the avoided costs are determined now and might be under higher penetrations, highlighting grid conditions that influence the impact of distributed customer generation, and consideration of technologies or practices that are developing around distributed customer generation.

The most consistent finding is with respect to the limited impact of intermittent distributed solar generation. Many of the avoided costs analyzed could be more significant if the resource were dispatchable or reflected the system load shape. Because customers require uninterrupted service, capable of powering all their load, utility systems from generation to the meter, must be designed to serve full customer load. Distributed solar generation systems, however, remain unable to provide continuous, uninterrupted service. As long as this fact holds true, the quantity and value of avoided cost from distributed solar generation will be potentially lower than other resources. Other notable findings include:

- To accurately determine avoided cost, detailed assumptions of production and output curves are required to provide some level of confidence for the utility planner that a solar installation will perform as expected, particularly at peak times. While generation meters and operational data from existing installations can, over time, provide improved estimates, the performance variability between systems, years and days is significant and thus complete certainty is impossible. As distributed solar generation penetration continues to be significant, this forecasting uncertainty will continue to be key in estimating and, ultimately, realizing avoided distribution costs. It could create risk for customers as a whole if Evergy defers distribution investments on the basis of distributed generation performance which ultimately does not perform as modeled.
- Smart Inverters and storage are potentially the next transformational technologies for distributed solar generation. Smart Inverters can allow solar photovoltaic systems to provide valuable, energy-related services such as voltage support, power factor compensation, or event ride-through capabilities. Storage

would allow alignment of the distributed solar generation production with the system loads and also has the potential to provide grid services. Some of Evergy's ongoing efforts on energy storage are detailed in the response to the SCI related to Integrated Distribution Planning (Volume 8, Section 4(h)).

- Distributed solar generation production, particularly from south-facing systems, aligns poorly with residential load. At the time of peak, solar generation provides an average of 20.29% of its generation with a worst-case level of 10.86%. Westward alignment provides some improvement but at a cost to overall annual production. (See SCI related to optimizing the direction solar panels face in Volume 8, Section 4(I))
- The value of capacity can vary depending on the application. Different values are currently used within resource planning and in evaluation of demand side measures such as energy efficiency or demand response. While these different values for capacity are related, one should not expect to see identical values between applications as the considerations for term, size, and other factors are unique to each.
- Reverse current flow on the utility system as a result of excess generation will generate additional losses. These losses would offset avoided line losses.
- Distributed solar generation systems can impact distribution system protection schemes and can cause significant, additional wear on voltage support devices. Protection schemes must be revised to account for reverse power flow and voltage support devices may require more frequent maintenance or replacement.
- Transmission projects are currently aimed at improving reliability with no transmission expansion projects designed to respond to load growth expected. Unless DG can be relied on to address reliability needs, benefits to the transmission system will be limited.

Before considering other potential benefits, it is important to understand the relationship between these avoided costs and current ratemaking practices. In some jurisdictions the VOS result has been used to establish compensation amounts for distributed solar generation. Although not clearly the intention of this SCI, it is worth noting that many of these avoided costs are already recognized and benefits returned to customers. Considering that avoided costs are not representative of actual costs but instead represent the potential for savings, proper representation of these savings must take into account the nature of the cost and the related revenue recovery. For example, variable costs such as energy are mainly a pass-through of cost. Energy costs, mainly represented by fuel costs, are identified in base rates and adjusted under the Fuel Adjustment Charge ("FAC"). Savings related to avoided energy would appear through a reduction in kWh consumed and a reduction in the cost paid through the FAC charge. Over time these reductions would appear in the base rate. This pass-through would ensure the savings are recognized and realized by those customers creating the savings.

Avoided costs that are associated with fixed costs such as transmission or distribution infrastructure are more complex. Infrastructure could not be removed as the result of intermittent generation. The same concern exists if the distributed solar generation were known at the time of design. Absent technologies to remove the intermittency, facilities must be designed and maintained as to carry the full customer load absent the distributed solar generation.

It should also be noted that the Company believes that as the amount of distributed solar generation deployed grows, it would be appropriate to include a recognition of the energy sales displaced by distributed solar generation energy production in the determination of quantifiable benefits. When a distributed solar generation system is deployed and customers begin generation of their own energy, recovery of utility costs is directly impacted, offsetting the benefits. During the ratemaking process, there is an expectation of energy sales built into the rates. If these expectations are not met, the utility can under-recover its approved revenue requirement. In the case of distributed solar generation, and similar to the avoided cost process, the amount of these lost sales can be identified. The amount can, in turn, be valued at the rate of the non-fuel, retail revenue rate.

4. Consideration of Specific Documents

As part of the SCI included in the Order, the Commission identified three distinct documents for consideration,

- the National Association of Regulatory Utility Commission's ("NARUC") Distributed Energy Resources Rate Design and Compensation manual,
- National Renewable Energy Laboratory's ("NREL") Value of Solar: Program Design and Implementation Considerations, and
- the National Energy Screening Project's ("NESP") National Standard Practice Manual for Distributed Energy Resources

In examining these documents, Evergy notes that the NREL and NESP documents are frameworks while the NARUC document is designed to address rate designs. All of the documents provide extensive discussion of issues and considerations around distributed solar generation/DG/DER. This study summarizes the three VOS documents referenced in the Order, as well as the ICF meta-study that served as the starting point for the research in this review.

4.1. NARUC's Manual on Distributed Energy Resources Rate Design and Compensation (2016)

This manual assists utilities and regulators regarding the rate design related to distributed energy resources ("DERs"). Concerning determining value of solar, the manual presents a "Value of Resource" framework to value DG resources. The manual notes that,

> "It is important that the costs and benefits under this strategy are similar to those afforded to traditional generation resources. If a jurisdiction identifies additional benefits, such a job creation, it should be considered outside the development of the rate itself and can be treated as an adder or compensated for in some other manner."[5]

With respect to how to approach the valuation, the manual notes:[6]

> "There is debate over the benefits of DER. Part of the disagreement is in quantifying benefits from DER and the effects of integrating DER into the grid and utility systems. Regulators are also increasingly interested in calculating benefits that have not traditionally been incorporated in rate design or are hard to quantify. Environmental benefits of distributed carbon-free generation and the ancillary services markets of many RTOs are examples of recent attempts at increased quantification of benefits."

[5] Manual on Distributed Energy Resources Rate Design and Compensation. NARUC. 2016. Pg. 133, Fn. 193
[6] Ibid. Pg. 71

In Section V.2., the study defines two main methods of determining the value: 1) value of resource ("VOR") and 2) value of service. However, the latter is a functional unbundling of distribution services and is thus not considered here.[7] VOR separates the costs of utility services and benefits that may occur from DER systems and attempts to value them separately, and attempts to recognize potential benefits to the grid, other customers, and society. The study notes that it is important that the costs and benefits under this strategy are similar to those afforded to traditional generation resources. Moreover, that if additional benefits are identified, such a job creation, it should be considered outside the development of the rate itself and can be treated as an adder or compensated for in some other manner.[8] To consider the positive and negative effects of DERs, the study notes the following components have been considered:

- Avoided energy/fuel
- Energy losses/line losses
- Avoided capacity
- Ancillary services (may include voltage or reactive power support)
- Transmission and distribution capacity (and lifespan changes)
- Avoided criteria pollutants
- Avoided CO_2 emission cost
- Fuel hedging
- Utility integration and interconnection costs
- Utility administration
- Other environmental factors
- Reliability factors and costs.

The study argues that value elements that are often overlooked can be quantified benefits in a transparent manner using this approach. The study notes that determinations of value should attempt to reflect the actual, market value of a trait as identified and valued by that jurisdiction. As such, a value for carbon avoidance should be based on market value, and should avoid alternative, non-market-based values.[9] As a specific example, the manual notes that "a value for carbon avoidance should be based on market value, and should avoid alternative, non-market-based values." This supports an argument that, absent a carbon market or regulation, one should not assign it a non-market value[10]. The authors note that one detriment to this method is that it often requires subjective judgments and may allow for values that are not quantified in a rigorous manner. Another is that a process to determine both the list of items to be valued as well as the values themselves may be highly contested and prolonged.

The study does not attempt to estimate any of the individual value components.

4.2. NREL Value of Solar: Program Design and Implementation Considerations (2017)

This report was written for utilities, regulators, and stakeholders regarding issues related to VOS program design and implementation. The report discusses and addresses VOS program design options and considers how a VOS rate may

[7] The study also considers a more "future-oriented" method known as Transactive Energy (TE). Given the necessary infrastructure for approach, we do not consider it here either.
[8] Manual on Distributed Energy Resources Rate Design and Compensation. NARUC. 2016. Pg. 133. Fn. 193.
[9] Ibid. Pg. 136.
[10] Ibid. Pg. 136

affect future development of distributed photovoltaic projects. The report presents a "range of options" for jurisdictions to consider as they contemplate their VOS program goals and design options best suited to meet its policy goals and priorities. It does not suggest which solar value components could be included as part of the VOS rate or how the components are calculated.[11]

The study states that the "VOS rate is determined by: 1) identifying the categories in which solar provides both benefit and cost to the utility and society, 2) calculating values of each of these categories (assigning positive and negative as appropriate), and 3) combining these components into a single rate. The VOS rate represents the real value of distributed solar to the utility, considering both costs and cost savings, which will be monetized in all ratepayers' electric bills over time.[12]" The study lists key themes that could be used to design a VOS rate:[13]

- Sufficient utility revenues for grid services provided to support solar growth;
- Recognize the VOS benefits and costs–not only to the utility system, but to society as well (to the extent the benefits are codified in utility financial structures)–and pay the project owner appropriately;
- Limit cost to customers, both those with solar and those without;
- Create a transparent VOS rate calculation methodology, including input assumptions and updates.

In the study's methodology, NREL included the following components in their VOS calculation:[14]

Table 3: NREL Component Considerations

Category	Low	Middle	High
Avoided fuel[20]	Natural gas prices from EIA Annual Energy Outlook 2013 "High Oil and Gas Resource" case	Natural gas prices from EIA Annual Energy Outlook 2013 "Reference" case	Natural gas prices from EIA Annual Energy Outlook 2013 "Low Oil and Gas Resource" case
Avoided capacity	No generation needed for 10 years	No generation needed for 5 years	Immediate capacity need
T&D Deferral	No T&D benefit is assumed	5 year T&D deferral based on ASCE average T&D expenditures from 2001-2010 and the retail sales from the same period (EIA 2013a)	Immediate T&D avoided investment based of ASCE average T&D spend from 2001-2010 and the retail sales from the same period (EIA 2013a)
Environmental	No environmental benefit is assumed	Non-greenhouse benefit of natural gas electric generation (NRC 2010)	Non-greenhouse and greenhouse (CO2) benefit of natural gas electric generation (NRC 2010)

Note: Value of Solar: Program Design and Implementation Considerations. NREL. 2017. Pg. 21.

[11] Value of Solar: Program Design and Implementation Considerations. NREL. 2017. Pg. 3.
[12] Ibid. Pg. 9.
[13] Ibid. Pg. 11.
[14] Ibid. Pg. 20.

Table 4. NREL Study VOS Rates (cents per kwh)

Category	Low	Middle	High
Avoided fuel	3.6	5.2	6.1
Avoided capacity	1.0	1.5	2.1
T&D deferral	0	0.14	0.19
Environmental	0	0.18	1.9
Losses	0.3	0.49	0.72
Total	**4.9**	**7.5**	**11.0**

Note: NREL Study, pg. 22.

The study's appendix also reviews several prior studies regarding the calculation of a VOS rate:

- Interstate Renewable Energy Council's ("IREC") *A Regulator's Guidebook: Calculating the Benefits and Costs of Distributed Solar Generation* published in 2013. In this study, IREC suggests that there are several main components required to properly calculate a VOS rate, including avoided energy benefits, system losses, avoided capacity, T&D capacity, grid support (ancillary) services, fuel price hedge or guarantee, market price response, reliability and resiliency, environmental services, and economic development. The study notes societal benefits of distributed solar generation policies, such as job growth, health benefits, and environmental benefits, can be included in valuations, as these were typically among the reasons for policy enactment in the first place.
- NREL's *Methods for Analyzing the Value of Distributed Photovoltaic Generation* published in 2014. This study considered seven VOS components: energy, emissions, T&D losses, generator capacity, T&D capacity, ancillary services, and "other costs and benefits."
- Rocky Mountain Institute's *A Review of Solar PV Benefit and Cost Studies: Second Edition*, published in 2013. This meta-study reviewed 16 benefit/cost studies done from 2005 to 2013. The study notes how the calculation methodology for distributed solar generation system value falls into two categories: monetized and inconsistently monetized. The monetized category includes energy, system loses, generation capacity, T&D capacity, grid support services, and technology and penetration costs. Inconsistently monetized components included financial services (fuel price hedge and market price response), security risk, greenhouse gas emissions, criteria pollutants/air quality, avoided renewable portfolio costs, and other customer services.

4.3. NESP's National Standard Practice Manual for Benefit-Cost Analysis of Distributed Energy Resources (2020)

NESP's manual provides industry guidance on benefit-cost analyses ("BCAs") of DERs. While such analyses are not perfectly synonymous with value of solar studies, we summarize the key points presented regarding the quantification of costs and benefits. The manual notes that BCAs should include all the electric system impacts, and may include other system impacts as well.

Utility system impacts are the “monetized” components often considered in other studies, summarized in Table 5. In addition to these components, the manual describes potential societal impacts that can be included, provided in Table 6. These societal impacts are the “non-monetized” components captured in some VOS studies, but not all.[15] Importantly, the manual distinguishes environmental compliance, which the utility will need to meet, and societal GHG emissions. The manual notes that GHG impacts do not affect customer rates, and therefore are not appropriate to include in rates.[16] While not explicitly stated for all the other societal impacts, this demarcation is likely implied for all societal impact components.

[15] Note that “resilience” is already included in the utility system benefits and care must be taken to avoid double counting.
[16] National Standard Practice Manual for Benefit-Cost Analysis of Distributed Energy Resources. NESP. 2020. Pg. 4-21.

Table 5. NESP Potential electricity utility system benefits and costs for distributed generation

Type	Utility System Impact	Benefit or Cost	Notes, or Typical Applicability
Generation	Energy Generation	●	Typically benefits because DG reduces electricity generation and system peak demands
	Generation Capacity	●	
	Environmental Compliance	●	
	RPS/CES Compliance	●	
	Market Price Response	●	
	Ancillary Services	●	A benefit or a cost, depending upon DG technology and system conditions; magnitude of benefits and costs may change with deployment rate of DG on particular parts of the distribution system
Transmission	Transmission Capacity	●	A benefit or a cost because DG can increase or decrease transmission peak demand
	Transmission System Losses	●	A benefit because DG reduces transmission volumes
Distribution	Distribution Capacity	●	A benefit or a cost because DG can increase or decrease distribution peak demand
	Distribution System Losses	●	A benefit because DG reduces distribution volumes
	Distribution O&M	●	May add to or relieve congestion and grid management costs
	Distribution Voltage	●	A benefit or a cost, depending upon location-specific grid conditions
General	Financial Incentives	●	A cost to the extent they are relevant
	Program Administration Costs	●	
	Utility Performance Incentives	●	
	Credit and Collection Costs	●	A benefit because customer savings make bill payment easier, especially for low-income customers
	Risk	●	DPV reduces some system risks but adds complexity to system operations
	Reliability	●	Variable DG can support reliability or impose reliability costs at high deployment levels
	Resilience	●	Grids with DG should be easier to restore; islandable systems or systems with ride-through capacity may have faster restoration and reduced recovery times

● = typically a benefit for this resource type; ● = typically a cost for this resource type; ● = either a benefit or cost for this resource type, depending upon the application of the resource; ○ = not relevant for this resource type.

Table 6. Potential societal impacts of DER

Type	Societal Impact	Benefit or Cost	Notes, or Typical Applicability
Societal	Resilience	●	Typically not relevant for renewable DG; potentially a benefit for CHP
	GHG Emissions	●	Renewable DG will typically reduce system emissions; CHP can also reduce system emissions depending upon fuel source and generation displaced
	Other Environmental	●	
	Economic and Jobs	●	Typically a net benefit
	Public Health	●	Renewable DG will typically offer benefits; CHP can also offer benefits depending upon fuel source and generation displaced
	Low Income: Society	●	A benefit, depending on siting and low-income participation
	Energy Security	●	A benefit for renewable DG; potentially a cost for non-renewable DG, depending on fuel source

● = typically a benefit for this resource type; ● = typically a cost for this resource type; ● = either a benefit or cost for this resource type, depending upon the application of the resource; ○ = not relevant for this resource type.

4.4. ICF's Review of Recent Cost-Benefit Studies Related to Net Metering and Distributed Solar (2018) (Sources Used in Addition to Documents Listed in Commission Order)

This paper provides a meta-analysis of 15 cost and benefit studies of distributed solar conducted from 2014 to 2018 across a diverse set of states. The paper considers 18 potential cost and benefit components[17]. Overall, all studies considered three value categories: avoided energy generation, avoided generation capacity, and avoided transmission capacity. Ten or more of the studies included value categories related to avoided environmental compliance costs, avoided line losses (including transmission and distribution), avoided distribution capacity, and integration costs (a negative value). Less common value categories tended to be those that are more challenging to quantify.

The study notes that the perspective used to assess value affects which value categories are included. The study notes that "Value of DER frameworks apply the value categories in a way that aligns compensation with system value and grid services provided, while also providing a method for integrating the value of DERs into utility system planning processes." While eight studies considered the avoided cost of carbon, but only three quantified it based on the Social Cost of Carbon. Nine studies included benefits from avoided criteria pollutants, but only three quantified it. Last of the societal impacts, economic development was only considered in three studies and quantified by one.

[17] Steve Fine, Meegan Kelly, Surhud Vaidya, Patricia D'Costa, Puneeth MV Reddy, and Julie Hawkins, *Review of Recent Cost-Benefit Studies Related to Net Metering and Distributed Solar*. May 2018. Pg. 19.

Table 7. Comparison of value categories across ICF's META-Analysis Studies

		Arkansas - Crossborder Energy 2017	Nevada - E3 2016	Louisiana - Acadian Consulting Group 2015	South Carolina - E3 2015	Mississippi - Synapse 2014	Vermont - VT Public Service Dept 2014	Washington DC - Synapse 2017	Georgia - Southern Company 2017	Hawaii - Clean Power Research 2015	Maine - Clean Power Research 2015	Oregon - Clean Power Research 2015	Minnesota - Clean Power Research 2014	Utah - Clean Power Research 2014	New York - BCA Framework 2016 + VDER Phase One	California - LNBA Framework 2016	Total
Utility System Impacts																	
G	Avoided Energy Generation	●	●	●	●	●	●	●	○	○	●	○	○	●	⭕	○	**15**
	Avoided Generation Capacity	●	●	●	●	●	●	●	○	○	●	○	○	●	⭕	○	**15**
	Avoided Environmental Compliance	●	●			🔴	●	●	⭕		🔴	○		●		⭕	**10**
	Fuel Hedging	●			●	●		●		○	●	○	🔴	●			**9**
	Market Price Response	●					●	●		○	●				○		**6**
	Ancillary Services		●		●	○		○	○	○					○	○	**8**
T	Avoided Transmission Capacity	●	●	●	●	●	●	●	○	○	●	○	○	●	⭕	○	**15**
	Avoided Line Losses	●	●		●	●	🔴	●	○			○		🔴	⭕	○	**11**
D	Avoided Distribution Capacity	●	●	🔴	🔴	🔴	●	●		○	○	○	○	🔴	⭕	○	**14**
	Avoided Resiliency & Reliability	○				○		○							○	○	**5**
	Distribution O&M			●					○						○	○	**4**
	Distribution Voltage and Power Quality									○	○	○	○		○	○	**6**
C	Integration Costs	●	●	●	●	○		●	○	○	●	○	○		○	○	**13**
	Lost Utility Revenues	●	●	●	●	●	●								○		**7**
	Program and Administrative Costs		●	●	●	●	●	○							○		**7**
Societal Impacts																	
S	Avoided Cost of Carbon	●					●	●		○	●		○		⭕	○	**8**
	Other Avoided Environmental Costs	●	●			○		○		○	●		○		○	○	**9**
	Local Economic Benefit	●				○		○									**3**

Included	●
Included/represented in another category	🔴
Discussed but not monetized/quantified	○
For NY, included in VDER Phase One	⭕

The study notes that the decision to include societal impacts—such as carbon emissions, criteria pollutants, economic development, or other values that accrue to society—can have a significant impact on study results, and agreement was not found across the studies. A common rationale for excluding societal benefits is that they do not materialize as savings in the form of avoided costs to the utility, which means the benefits cannot be passed along to ratepayers.

5. Subjective and Conditional Benefits

The Company retained the services of The Brattle Group ("Brattle") to further consider the NARUC, NREL and NESP documents and to assess the additional benefits that could be applicable to Evergy in this analysis. This work is performed in an effort to comply with the SCI. It should be noted that at this time, Evergy does not include external and societal benefits in the revenue requirement calculations in accordance with 22.010(2)(B) and thus to be consistent with 22.010(2)(A) requiring resources be considered on an equivalent basis these factors should also be excluded for distributed resources.

Table 8. Components considered when assessing value/cost of solar for Evergy

System	Component	Description	Acknowledged by Studies Cited in Order? NARUC	NREL	NESP	Unique to DG?	Addressed in Evergy Avoided Cost Analysis?
Generation	Avoided Fuel Costs	Costs related to generation fuel	√	√	√		√
	Avoided VOM	Non-Fuel Variable Cost			√		√
	Avoided Generation Capacity Cost	Avoided or deferred capacity investments	√	√	√		√
	Avoided FOM	Fixed O&M costs			√		√
	Avoided Environmental Compliance Cost	Includes non-GHG or RES/CES environmental regulations	√		√		
	Avoided RES/CES Compliance Cost	Reduction in necessary clean energy to comply with RPS/CES			√		
	Fuel Hedging	Reduction in fuel price risks	√		√		
	Market Price Response	Change in wholesale market prices from reduced consumption			√		
	Ancillary Services	Services to maintain grid stability in wholesale system	√		√		
Transmission	Avoided Transmission Capacity	Avoided or deferred capacity investments	√	√	√		√
	Avoided Line Losses	Electricity lost through transmission resistance	√	√	√		√
Distribution	Avoided Distribution Capacity	Avoided or deferred increases in capacity investments	√	√	√	√	√
	Resiliency and Reliability	Impacts ability to withstand and recover from unanticipated events	√	√	√	√	√ **(Reliability)**
	Distribution O&M	Impacts O&M for the distribution system			√	√	√
	Distribution Voltage and Power Quality	Services to maintain grid stability in distribution system	√		√	√	
	Avoided Line Losses	Electricity lost through transmission resistance	√	√	√	√	√
Other	Integration Costs	Any upgrade or other costs related to integrating DG	√	√	√	√	
	Lost Utility Revenue Costs	Lost revenue (if net metering)				√	
	Program and Admin. Costs	Includes all administration costs, including financial support programs		√	√	√	
	Risk	Includes operational, financial, regulatory/legal, reputational risk			√	√	
Societal	Avoided GHGs	Avoided GHG valued at social cost of carbon (SCC) estimate		√	√		

System	Component	Description	Acknowledged by Studies Cited in Order?			Unique to DG?	Addressed in Evergy Avoided Cost Analysis?
			NARUC	NREL	NESP		
	Air Quality	Improved air quality and public health from reduction in fossil combustion		√	√		
	Other Environmental Benefits	Other air, land, water, waste and other impacts.		√	√		
	Economic Benefits	Incremental economic development and job impacts			√		
	Energy Security	Impact on energy imports and energy independence			√		

6. VOS Component Descriptions and Values

To catalogue the range of components included in VOS studies and their value, Brattle reviewed recent VOS studies performed across the United States. The reviewed studies were identified in part by surveying two recent meta-analyses that summarized many individual VOS studies: ICF's 2018 "Review of Recent Cost-Benefit Studies Related to Net Metering and Distributed Solar" and LBNL's 2021 "Locational Value of Distributed Energy."[18] Brattle supplemented the studies in these reports with others that we identified through our own review of the literature. While not exhaustive, the resulting set of studies covers a wide range of jurisdictions and study vintages in order to present a broad and representative survey of existing studies in the United States.

Specifically, Brattle relied on the following 15 studies to summarize the range of solar value estimates provided:

1. *Net Metering in Mississippi*. Synapse Energy Economics. Prepared for the Public Service Commission of Mississippi. 2014.
2. *Minnesota Value of Solar: Methodology*. Clean Power Research. Prepared for Minnesota Department of Commerce, Division of Energy Resources. 2014.
3. *Evaluation of Net Metering in Vermont Conducted Pursuant to Act 99 of 2014*. Vermont Public Service Department. 2014.
4. *Value of Solar in Utah*. Clean Power Research. Prepared for Utah Clean Energy. 2014.
5. *Maine Distributed Solar Valuation Study*. Clean Power Research. Prepared for the Maine Public Utilities Commission. 2015.
6. *Joint Report and Recommendations of the Net-Metering Working Group*. Arkansas Public Service Commission. Docket No. 16-027-R. 2015.

[18] Manual on Distributed Energy Resources Rate Design and Compensation. NARUC. 2016. Value of Solar: Program Design and Implementation Considerations. NREL. 2017. National Standard Practice Manual for Benefit-Cost Analysis of Distributed Energy Resources. NESP. 2020.

7. *Valuation of Solar + Storage in Hawaii: Methodology*. Clean Power Research. Prepared for the Interstate Renewable Energy Council. 2015.

8. *South Carolina Act 236 Cost Shift and Cost of Service Analysis*. Energy and Environmental Economics. Prepared on behalf of the South Carolina Office of Regulatory Staff. 2015.

9. *Nevada Net Energy Metering Impacts Evaluation 2016 Update.* Energy Environmental Economics. 2016.

10. *Distributed Solar in the District of Columbia*. Synapse Energy Economics. Prepared for the Office of the People's Counsel for the District of Columbia. 2017.

11. *The Benefits and Costs of Net Metering Solar Distributed Generation on the System of Entergy Arkansas*. Crossborder Energy. 2017.

12. *Benefits and costs of utility scale and behind the meter solar resources in Maryland*. Daymark Energy Advisors. Prepared for the Maryland Public Service Commission. 2018.

13. *Value of Solar and Solar + Storage Study*. Energy Environmental Economics. Prepared for Sacramento Municipal Utility District. 2018.

14. *Net Energy Metering (NEM) Benefit-Cost Analysis*. Navigant. Prepared for NorthWestern Energy – Montana. 2018.

15. *Solar Savings in New England*. Synapse Energy Economics. 2020.

Values documented below represent the range of outcomes detailed in the studies above and are not strictly additive.[19] Some of the Value of Solar studies include generous amounts of external and societal benefits, some of which are not easily quantifiable and can vary considerably from study to study. As evidenced by the wide range of estimates, these estimates may be highly subjective, conditional or at minimum tend to vary widely depending on the individual utility, conditions of the grid or details of the individual solar installations (location, inverter capability, customer load, etc.). Further, the focus is specifically on describing and quantifying cost and benefits that are understood and not already addressed in the DG avoided cost analysis found in Appendix 1 of this study.

6.1. Generation

Avoided Energy Cost (Avoided Fuel Costs and VOM)

Considered in DG avoided cost analysis. Appendix 1, starting on page 35

Avoided Capacity Cost (Avoided CAPEX and FOM)

Considered in DG avoided cost analysis. Appendix 1, starting on page 39

Avoided Environmental Cost

This category includes the reduction or elimination of costs that the displaced marginal unit would incur from various existing and reasonably expected environmental regulations (e.g. the costs of scrubbers on fossil generators). Several of the reviewed studies include avoided environmental compliance within the avoided

[19] This is due to two reasons. First, studies vary in how they group benefits and which components are included in specific categories. Second, the numerical VOS values presented provide a range across all the studies. As such, one VOS might fall on the higher end of the range for one component and the lower end of the range for another component.

energy generation value category, which eliminates the need for this separate value category. Further, environmental costs that are fixed in nature may be included in avoided capacity cost estimates. Moreover, many studies bundle these in the same category as emission-related costs, discussed below, or includes avoided portfolio standard costs into this category. As such, one must be careful not to double count these avoided costs in multiple categories.

The environmental compliance costs related to this category are already included in Evergy's estimates of avoided energy and capacity costs.

VOS Range: No incremental benefit in Evergy's VOS, because already considered in estimates of avoided energy and capacity costs. Appendix 1, starting on page 35 for energy and starting on page 39 for capacity. In studies where this benefit has been reported separately, the value has ranged from $3-20/MWh.

Avoided RES/CES Cost

This category addresses the avoided cost of purchasing renewable energy to comply with State renewable portfolio standard (RPS) requirements. If generation from DERs is be eligible to fulfill a state's RPS, this would reduce the cost of procuring additional generation to meet the RPS. This benefit is specific to utilities in states with RPSs and who are clean energy supply-limited.

Evergy has met the requirements of Missouri's current RPS. As such, this category does not provide any cost savings for Evergy.[20]

VOS Range: No incremental benefit in Evergy's VOS

Fuel Hedging Cost Savings

This value category reflects the avoided costs to the utility based on reduced risk and exposure to the volatile fuel prices of conventional generation resources. Alternatively, solar generation has no fuel cost and therefore is not subject to fluctuations in fuel price.

The approach to quantifying fuel hedging cost savings varies by study. Some studies already include it in avoided energy costs by relying on gas price futures or gas contract price estimates that already account for the risk of fuel cost volatility. Other studies include this in a general "risk" category that bundles all risks into one component.

While this is a relatively common benefit category to include and quantify (nine of the 15 studies in the ICF meta-analysis included fuel hedging cost savings), the benefit is only applicable if utilities actually hedge their exposure to fuel price risk.

VOS Range: No incremental benefit in Evergy's VOS[21] ($0-40/MWh when quantified separately in other studies)

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[20] 2020 Annual Renewable Energy Standard Compliance Report in compliance with the Electric Utility Renewable Energy Standard Requirements, CSR 240-20.100. Case EO-2021-0346 and EO-2021-0347 both filed April 15, 2021

[21] Evergy discontinued hedging activity pending changes in the marketplace or other relevant factors. Non-Unanimous Partial Stipulation and Agreement. ER-2016-0285. Filed February 10, 2017.

Market Price Response

Market price response is relevant for jurisdictions within organized wholesale markets and refers to the impact that DERs can have on market prices and customer costs. Overall, as DER generation increases, demand for energy in the wholesale market decreases, and market prices decrease as a result (all else being equal).

Most studies approximate the market price suppression effect using methods established by Synapse in their analysis of the New England Market, which involves calculating a load-dependent predictive market price calculator using historical data, establishing a "but-for" load without DER generation, and calculating the impacts of DER generation.[22]

Ranges for the value of market price response vary dramatically over studies, as this depends on slope of a given market's supply curve and the extent to which a market is long or short on available supply. Market prices in SPP tend lack the variation observed in some other markets, suggesting that SPP prices may be less responsive to changes in load due to rooftop solar PV adoption.

There are two additional important caveats to note about this benefit. First, it is a temporary effect. The reduced market prices should be followed by generation retirements as more expensive units are pushed off the margin, causing the market to return to equilibrium at higher price levels. Second, from a societal perspective, market price response is neither a benefit nor a cost. It is simply a transfer payment from generators to consumers. For this reason, and due to challenges in estimating the value, the treatment of market price response in utility and regulator applications of the total resource cost (TRC) test is inconsistent. Some states have chosen to consider it a benefit, while others have not.[23]

VOS Range: Most studies range from \$1 to \$9/MWh, and Brattle recommends values in the lower half of this range based on the considerations mentioned above. In the reviewed studies, there are outliers as high as \$60-80/MWh. SPP-specific analysis could be used to refine these estimates for Evergy's market conditions.

Ancillary Services

This value category is related to the need for generation reserves to provide grid support services such as reactive supply, voltage control, frequency regulation, spinning reserve, energy imbalance, and scheduling. There are potentially two ways in which distributed solar could impact ancillary services costs.

In the first instance, distributed solar potentially could reduce ancillary services costs by reducing total load on Evergy's system. This reduction in load would translate into a reduction in the utility's obligation to procure the required quantity of ancillary services. While plausible, we are not aware of any precedent for attributing this benefit to other demand-side resources in Missouri. For example, avoided ancillary services costs are not included as a benefit in Evergy's energy efficiency and demand response filings.

In the second instance, distributed solar potentially could impose an ancillary services cost on the system, by increasing variability in power supply and therefore increasing the need to procure ancillary services in order to maintain a balanced power system. Many VOS studies have not assigned a significant ancillary services

[22] Solar Savings in New England. Synapse Energy Economics Inc, December 2020.
[23] Paul Chernick and Paul Plunkett, "Price Effects as a Benefit of Energy-Efficiency Programs." https://www.aceee.org/files/proceedings/2014/data/papers/5-1047.pdf.

cost to distributed solar separately, because it is included in another category (e.g. avoided energy cost) or not easily quantifiable.

VOS Range: Not applicable to Evergy; not included as benefit when evaluating other demand-side resources in Missouri.

6.2. Transmission

Avoided Transmission Capacity

Considered in DG avoided cost analysis. Appendix 1, starting on page 39.

Avoided Line Losses

Considered in DG avoided cost analysis. Appendix 1, starting on page 45.

6.3. Distribution

Avoided Distribution Capacity

Considered in DG avoided cost analysis. Appendix 1, starting on page 39.

Resiliency

Resiliency is often bundled with reliability benefits in VOS studies, but we distinguish the two here. As defined in this document, reliability refers to having sufficient supply to serve electricity demand and avoid widespread blackouts due to supply shortages. This reliability benefit is already captured in Evergy's estimate of avoided capacity costs, because in quantifying that benefit, rooftop solar is assumed to displace capacity that otherwise would be installed to serve peak demand and maintain resource adequacy.

Resiliency refers to the ability of power grids to withstand extreme conditions and restart quickly after outages. For rooftop solar to provide this benefit, it would need to be installed as part of a microgrid application that is designed to provide backup power generation during outage conditions. Standard rooftop solar installations typically do not provide this benefit as they are not wired to provide energy to the host site during outages.

VOS Range: Not applicable to this study, as it requires a specific application of rooftop solar that is part of a package including other technologies, such as battery storage.

Distribution O&M

Considered in DG avoided cost analysis. Appendix 1, starting on page 47 and page 50.

Distribution Voltage and Power Quality

This category reflects the costs of maintaining voltage and frequency on the distribution system within acceptable ranges during electric service delivery, and/or to potentially improve power quality. Some studies attempt to quantify this category within a broader transmission and distribution ancillary services category, distribution O&M, or within the integration cost. While this category is included In the ICF meta-analysis, none of the reviewed studies quantify it.

VOS Range: No indicative range from studies due to lack of data.

Avoided Line Losses

Considered in DG avoided cost analysis. Appendix 1, starting on page 45.

6.4. Other Utility System Costs and Benefits

Integration Cost

Broadly, "integration costs" refers to the cost of any system upgrades necessary to reliably incorporate distributed solar into the power grid. Examples include investments to provide islanding protection or to support voltage regulation. To the extent that these costs have been quantified in VOS studies, the focus has been primarily on interconnection costs.

Integration costs increase with the level of distributed solar PV penetration. At low levels of penetration, distributed solar can be "absorbed" by the capabilities of the existing system. At higher levels of penetration, the challenge of managing two-way flows of intermittent energy resources potentially can impose meaningful costs on the power grid. Distribution resource plans can help to identify solar adoption thresholds at which these costs are a consideration, as well as to forecast when and where these thresholds will be reached.

Cost Range: $1/MWh to $5/MWh (ICF), with more extreme values in some cases (over $100/MWh).

Lost Utility Revenue Cost

This category captures the loss of revenues to the utility due to reduced retail customer loads associated with DERs. Lost revenues are the result of customers paying smaller electric bills and are equivalent to customer bill savings. While not a societal cost, this value represents a transfer payment with a potential cost-shift from DER customers to other customers. In the total resource cost (TRC) test, which is used to evaluate the system-wide benefits and costs of demand-side programs, lost revenues are regarded as a transfer payment and not counted as a net cost or benefit.

Cost Range: As distributed solar generation deployment grows, it would be appropriate to include a recognition of the energy sales displaced by distributed solar generation energy production in the determination of quantifiable benefits. When a distributed solar generation system is deployed and Customers begin generation of their own energy, recovery of utility costs is directly impacted, offsetting the benefits. During the ratemaking process, there is an expectation of energy sales built into the rates. If these expectations are not met, the utility can under-recover its approved revenue requirement. In the case of distributed solar generation and similar to the avoided cost process, the amount of these lost sales can be identified. The amount can, in turn, be valued at the rate of the non-fuel, retail revenue rate.

Program Administration Cost

This category reflects the costs incurred by the utility to administer DER programs. It can include both the cost of State incentive payments and the cost of administering them, compliance and reporting activities, personnel, billing costs, and other administrative costs to implement and maintain a formal program. Many studies do not separate this cost as an individual line item, but include it within a broader category of integration costs.

Cost Range: Not applicable to Evergy; Administration costs are addressed within the respective tariffs.

Other Risks

There are a number of risk reduction benefits that may fall into this category, ranging from operational risks to legal risks. The difficulties in assigning a value to these benefits lie in (1) quantifying the risks, (2) identifying the risk reduction effects of the resources, and (3) quantifying those risk reduction benefits. The most common practical approach to risk-reduction-benefit estimation has been to apply an adder to avoided costs rather than to attempt a detailed analysis. However, there is little consensus in the industry as to what the value of that adder should be.

VOS Range: Common avoided risk adders range from 0%-10% of avoided costs.

6.5. Societal Impacts

Avoided Emissions

This broad category refers to societal benefits of avoided emissions, including greenhouse gas (GHG) emissions and criteria pollutants that impact health. These categories can be combined into one component of a VOS study or treated separately. Below, we breakdown each category.

Total Avoided Emissions VOS Range: $5-80/MWh

> **GHGs:** This category calculates the avoided societal costs from reduced greenhouse gas (GHG) emissions. In markets with carbon prices or policies, some of the GHG cost savings will already be captured in other categories, such as avoided energy costs. This category, however, captures additional non-regulatory avoided costs that accrue to broader society from mitigating climate change. Given the potential overlap, calculating the additional avoided GHG benefits needs to account for cost savings already included in other categories. In the ICF meta-study, eight studies include this value category and three quantify it based on the Social Cost of Carbon developed by the U.S. Environmental Protection Agency. While not common, this category may also attempt to quantify the societal cost savings from reductions in methane leakage from reduced natural gas usage.
>
> In markets with carbon pricing, the avoided GHG costs can be partly calculated directly using market prices. To calculate this GHG reduction benefits in other markets, or the additional societal benefits of avoided GHG above regulatory cost savings, benefits are often calculated by estimating the GHG reductions from a DER, multiplying the emission reductions by a societal GHG cost that reflects long-term damages from GHG emissions, and netting out any benefits already accounted for in other

categories. Many studies also often incorporate air quality benefits or other environmental benefits into one component, and do not report the benefits of GHG reductions alone.

An example can provide context regarding the magnitude of these benefits: Assume a DER generated MWh reduces the generation from a combined cycle natural gas plant by an equivalent amount, which emits roughly 0.45 tonnes of carbon per MWh. This offset can be multiplied by the $54/tonne social cost of carbon provided by the EPA to arrive at an overall benefit $24/MWh.[24]

GHG VOS Range: $4-40/MWh, though assuming a higher cost of carbon may lead to higher values.

Air Quality: Reductions in fossil combustion from the deployment of DERs also reduces criteria pollutants that have adverse health costs. Often, these calculations include reductions in SO_x, NO_x, and $PM_{2.5}$ criteria pollutant emissions. Similar to GHG reduction benefits, calculating societal benefits of reduced criteria pollutant emissions should also net-out any cost-savings already included in other categories, such as the costs associated with scrubbers used to comply with environmental regulations at power plants included in avoided energy generation calculations.

Air quality benefits are not straightforward to calculate, as the benefits are highly dependent on the location of emission reductions (population density, population demographics, geography, weather patterns, etc.). Many studies estimate these benefits using the United States Environmental Protection Agency ("USEPA") Co-Benefits Risk Assessment ("COBRA") tool. While a range of values calculated is provided below, it must be stressed that this component is highly dependent on the location of the benefit.

Air Quality VOS Range: $1-65/MWh

Other Environmental Benefits

DER generation can also result in non-emission environmental benefits related to the reduced use and/or construction of fossil generation. These include, but are not limited to, reductions in water usage due to decreased thermal plant operation and avoided land use from reduced procurement of fossil or large-scale renewable resources. Generally, solar technologies use little, if any, water during operation (minimal amounts may be needed occasionally to wash the panels). Water consumption for fossil fuel fired power plants are substantial, particularly for coal fired facilities. Solar energy can potentially have a land use benefit if conventional generation sources are replaced with roof-mounted distributed solar generation systems.

These benefits are difficult to calculate and are rarely included quantitatively in a VOS analysis. Values below are taken from SMUD's 2020 VOS study.

VOS Range: $0-5/MWh

[24] The social cost of carbon is the 2020 value under the 3% societal discount rate, adjusted for inflation. We do not consider line losses here. The Social Cost of Carbon. United States Environmental Protection Agency. Accessed 4/19/2020.

Economic Benefits

Economic benefits are benefits to the broader economy that are not included in other categories, such as jobs in the solar industry, local tax revenues, or other indirect benefits to local communities resulting from increased distributed solar deployment. These impacts are nuanced and require careful accounting to determine their societal value. For example, an increase in solar industry jobs could come at the expense of decreased jobs in other parts of the economy, as workers transition into solar. Further, while job creation in particular may have societal and/or political value, it does not necessarily equate to lower costs for consumers. Sources of power generation for labor-intensive industries are not necessarily lower cost than power generation options for industries with lesser labor requirements.

These benefits are challenging to quantify and are heavily influenced by assumptions. In the ICF meta-analysis, three studies discussed the value and only one quantified it within a broader societal cost category. A more recent report in Maryland attempted to calculate the economic benefits of distributed solar using IMPLAN. IMPLAN is an input-output model that combines a set of databases of economic factors, multipliers, and demographic statistics to measure the economic impacts caused by investment or other actions that cause an increase in sales to local industries.

VOS range: $10-50/MWh

Energy Security Benefits

Energy security refers to risk of fuel supply shortages related to international trade. This does not refer to reliability related supply risks due to inadequate pipeline capacity or other planning deficits. Deployment of DERs can reduce the demand for fossil fuels to power fossil plants, which in turn reduces related energy security risks. The quantification of this risk is extremely uncertain, and often already accounted for in the price of long-term fuel contracts. However, the United States currently is a net-exporter of fossil fuels used for power generation and not at risk of fuel supply shortages. As a result, the energy security benefits related to rooftop solar are negligible.

VOS Range: Not applicable.

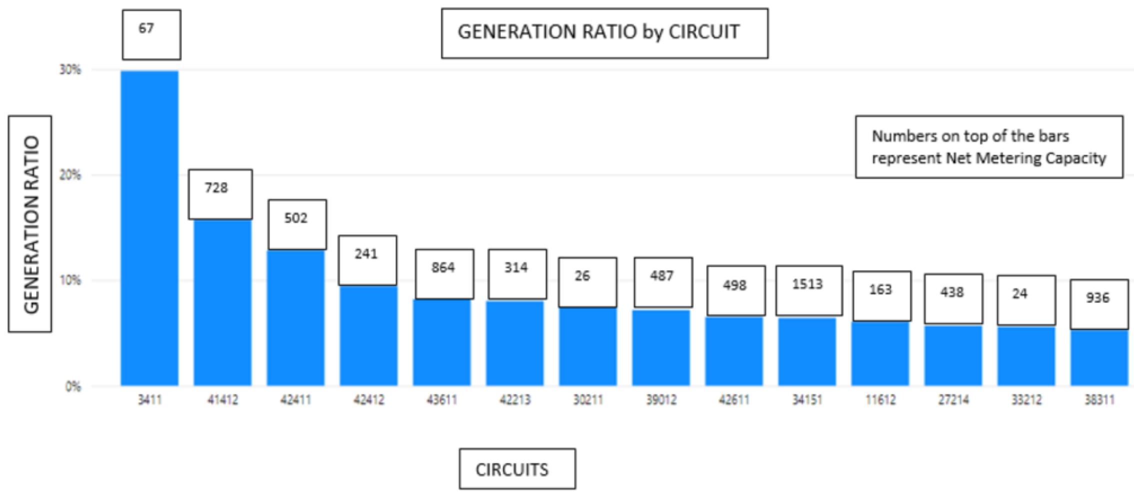
7. Contextual Comparison to Value of Utility Scale Solar

Evergy notes that the Commission took special interest in the potential locational benefits of distributed solar generation. The SCI contained the following,

> "Because solar energy is often interconnected at the distribution level of the grid, such a study, done correctly, will capture distribution level benefits and costs that cannot be captured by wholesale level avoided cost estimates."

In considering this language, Evergy supports the theoretical and potential locational benefits of placing generation closer to loads; however, this benefit is elusive. For distributed solar generation to be a benefit to others than the system owner, the distributed solar generation must be of suitable size and placement to exert beneficial conditions on the circuit to which it is connected. In reviewing the Company circuits, this saturation is not occurring. Review of the fourteen Missouri circuits with the highest levels of distributed solar generation installed reveals that absent one outlier circuit[25], all circuits are loaded with less than 16% of connected KVA. Excluding the outlier circuit, the average loading (defined as net metered solar capacity divided by total circuit capacity) is 8.01% with the lowest loading at 5.26%. The following chart summarizes the conditions for these circuits.

Figure 2: Distributed Solar Generation by Circuit (Top 14 loaded circuits)



Note: Boxes above the bars indicate the installed distributed solar generation on the circuit, expressed in kW.

Further review of these circuit details shows that nine of the top ten loaded circuits have less than 1 MW of installed distributed solar generation on the circuit. As detailed in the Company's determination of avoided cost, these conditions do not support material locational benefit.

Conversely, the Company would contend that utility scale solar can provide many of the locational benefits anticipated by the Commission more efficiently than distributed solar generation. Review of a paper prepared by Brattle can provide additional support for this point of view. The following bullets summarize the main takeaways from Brattle's "Comparative Generation Costs of Utility-Scale and Residential-Scale PV in Xcel Energy Colorado's Service Area" paper, which was prepared for First Solar in 2015:

- **Overall Costs:** In general, utility-scale solar is less costly than residential-scale systems due to (a) lower installed costs per KW and (b) greater output due to optimized panel placement and solar tracking axes.
- **Integration Cost**: We expect that residential-scale PV capacity will typically require slightly higher ancillary service needs than equal amounts of utility-scale PV capacity, all other factors being the same. Utility-scale systems that oversize the panel array relative to inverter capacity will likely have a better profile (less variability) than any given residential-scale system but the geographical diversity of residential-scale systems aggregated also contributes to reduced variability. However, other advantages of utility-scale include better location selection (higher insolation), better controllability and visibility by the system operator, and being able to provide downward ancillary services.

[25] Circuit 3411 is a circuit of unusually short length and small installed capacity. With three distributed solar generation systems installed, it deviates from the norm, reaching a 29.81% loading.

- **Avoided Fuel Costs:** Fuel cost savings are higher for utility-scale, as higher output (capacity factor) leads to more fuel saved.
- **Fuel Price Hedge:** The quantity of power produced by solar may vary and therefore the price hedge value, if any, cannot be easily quantified.
- **Avoided Losses:** Residential-scale PV is closer to the load and therefore reduces transmission losses.
- **Avoided Generation Capacity Costs:** All other things equal, utility-scale PV has higher effective load carrying capacities due to their ability to generate at higher capacity factors for longer using tracking technologies. This is offset by more losses for utility-scale PV. Overall, utility-scale solar can provide slightly more avoided generation capacity costs.
- **Avoided Transmission Capacity Costs:** Because residential-scale solar is located at the point of use, there is potentially a reduction in the need for transmission capacity to serve system load, all other factors being the same. Utility-scale solar relies on the bulk transmission system to reach load and therefore transmission is not avoided. Thus, at least in concept, residential-scale systems saves transmission capital costs relative to utility-scale systems. The exact amount of transmission that can be avoided by residential-scale solar capacity, and the cost of this transmission, can be estimated only in the context of actual systems conducting thorough planning exercises.
- **Avoided Distribution Costs:** It is unclear whether one type of solar results in more or less avoided distribution costs due to offsetting factors. Distribution line power losses would be reduced in the residential-scale PV alternative because the residential-scale solar generation reduces the inflow of power needed to supply end load, and thus reduces the need for distribution capacity. However, it should be noted that with higher penetration level of residential-scale PV systems, the losses could increase, particularly for the secondary circuits. Moreover, increasing distributed generation could potentially stress the existing distribution system and create the need for upgrades.
- **Resiliency:** In some configurations, distributed generation could be less vulnerable to electric system supply disruptions. However, most residential-scale PV systems installed today are set up so that these PV systems will not generate during outages to avoid potential accidents caused by reverse flows into a downed wire. Installing smart inverters or combining distributed PV systems with storage facilities could potentially increase resiliency, however the exact contribution of the PV system to this benefit cannot be easily calculated, and achieving this resiliency would carry the additional attendant cost of deploying storage and other protection systems on distribution systems.
- **Greenhouse Gas Emissions:** All things equal, the higher generation output, even after accounting for offsetting greater losses, from utility-scale solar leads to greater GHG reductions.
- **Air Quality:** Same as GHGs.
- **Other Environmental Benefits:** Same as GHGs**.**
- **Job Creation:** In general, the installation of residential-scale PVs is thought to create more jobs than installing utility-scale PV systems. However, the respective impact of each PV type to jobs associated with researching, developing and producing the PV equipment (panels, inverters, etc.), is unknown. Moreover, job creation is

an extremely difficult externality to quantify because, when measured properly, it must incorporate the net effects of all economic changes between the two scenarios studied, including in this instance the impact of customer bill differences.

Appendix 1: Distributed Generation Avoided Cost Analysis

ANALYSIS SUMMARY: This analysis seeks to quantify and value the benefit of distributed generation ("DG") to Evergy in its Evergy Missouri Metro ("EMM") and Evergy Missouri West ("EMW") jurisdictions (collectively referred to as "Evergy" or "Company"). Evergy has examined clearly quantifiable, market-based benefits associated with DG. These benefits are represented by the following avoided cost categories:

- Avoided Energy
- Avoided Generation Capacity
- Avoided Transmission & Distribution Line Losses
- Avoided Distribution Infrastructure Costs
- Avoided Transmission Infrastructure Costs

To complete this analysis, a team of subject matter experts representing Energy Resource Management, Distribution Engineering, Distribution Planning, Transmission Planning, Energy Solutions, Energy Accounting, and Regulatory Affairs was assembled. This team evaluated industry materials on DG valuation, considered studies completed by other companies, and examined the DG systems installed in the EMM and EMW jurisdictions. The following analysis summaries detail these considerations through a common framework for analysis.

Below is a summary of the quantifications, valuations, and total avoided cost resulting from this analysis:

Table 1: Annual Avoided Cost Summary

Evergy Missouri Metro			
Avoided Cost Category	**Quantity**	**Value**	**Avoided Cost**
Energy	49,795,116 kWh	$0.0220 per kWh	$1,095,493
Capacity	7,122.35 kW	$3.99 per kW-month	$341,018
T&D Line Losses	5,150,558 kWh	$0.0220 per kWh	$113,312
Distribution Costs	0	see narrative	$0
Transmission Costs	0	see narrative	$0
Total			**$1,549,823**

Evergy Missouri West			
Avoided Cost Category	**Quantity**	**Value**	**Avoided Cost**
Energy	72,508,944 kWh	$0.0220 per kWh	$1,595,197
Capacity	10,371.18 kW	$3.99 per kW-month	$496,572
T&D Line Losses	4,763,020 kWh	$0.0220 per kWh	$104,786
Distribution Costs	0	see narrative	$0
Transmission Costs	0	see narrative	$0
Total			**$2,196,556**

Evergy Missouri - Total			
Avoided Cost Category	**Quantity**	**Value**	**Avoided Cost**
Energy	122,304,035 kWh	$0.0220 per kWh	$2,690,689
Capacity	17,493.53 kW	$3.99 per kW-month	$837,590
T&D Line Losses	9,913,578 kWh	$0.0220 per kWh	$218,099
Distribution Costs	0	see narrative	$0
Transmission Costs	0	see narrative	$0
Total			**$3,746,378**

If expressed as a $ per kWh value, the avoided cost associated with DG is,

Missouri Metro	**$0.03113 per kWh**
Missouri West	**$0.03029 per kWh**
Missouri Total	**$0.03063 per kWh**

Evergy observes that DG proliferation is increasing as the result of positive economic value to the customer driven by declining cost of entry and the availability of additional incentives. This analysis acknowledges the current quantifiable benefits based on current penetration levels and the current technology. The Company's challenge going forward will be to balance the interests of DG customers, non-DG customers, and distribution system impacts as DG installations become more numerous. The Company recognizes that it will need to develop more robust distribution planning tools to handle higher levels of DG penetration, but also acknowledges these developments will come at increased costs to the Company and thereby its customers. As DG penetration levels increase, Evergy will make prudent judgements concerning investments in systems, personnel, and other resources in order to serve our customers interests and maintain a safe and reliable system.

DISTRIBUTED GENERATION AVOIDED COST ANALYSIS

COST CATEGORY: **Avoided Energy**

COST DESCRIPTION: Avoided energy costs provide benefit to the utility by reducing the amount of energy the utility would otherwise need to produce. This distributed energy is consumed at the point of generation and any excess energy is delivered to the grid.

QUANTIFICATION: Primarily, distributed generation occurs in the form of net metering. Under net metering the Company tracks two data points concerning the customer generation, the energy delivered by the utility to the customer and the energy delivered by the customer generator to the grid. There is currently no widespread, specific tracking of energy produced and consumed on-site by the customer generator. Therefore, to determine the total generation achieved by customer net metering systems, an engineering calculation must be used. For this analysis, the Company used the PVWatts[26] calculator provided by the National Renewable Energy Laboratory ("NREL").

Using PVWatts, the Company modeled the AC generation capability of the entire population of residential net metered systems under the default parameters[27] of the calculator based on a typical meteorological year ("TMY") data for Kansas City. Using the same data as the 2020 annual net metering report[28], the Company identified a total of 86,217.51 kW of customer generation capacity. Of that capacity, 35,102.77 kW was associated with the EMM jurisdiction and 51,114.74 kW was associated with EMW. According to the engineering calculation of the PVWatts system, the population of residential net metered systems is expected to produce the following levels of monthly energy.

[26] http://pvwatts.nrel.gov/

[27] NREL PVWatts Default values: Standard Module Type, Panel Losses of 14%, Fixed array with 20-degree tilt, at azimuth of 180 degrees, DC to AC ratio of 1.2, and Inverter efficiency of 96%.

[28] Submitted pursuant to 20 CSR 4240-20.065 (10)(A)

Table 2. Estimated kWh Output Based on Current Missouri Solar Penetration

	Missouri Metro	Missouri West	Missouri Total*
	AC Energy	AC Energy	AC Energy
	(kWh)	(kWh)	(kWh)
January	3,076,964	4,480,507	7,557,473
February	3,355,944	4,886,742	8,242,685
March	4,404,734	6,413,933	10,818,665
April	4,643,087	6,761,013	11,404,099
May	4,895,552	7,128,640	12,024,188
June	4,974,831	7,244,077	12,218,898
July	5,298,167	7,714,905	13,013,070
August	4,852,937	7,066,584	11,919,523
September	4,543,801	6,616,435	11,160,235
October	3,842,087	5,594,637	9,436,721
November	3,215,237	4,681,852	7,897,089
December	2,691,775	3,919,619	6,611,389
Annual	49,795,116	72,508,944	122,304,035

*Missouri Total calculated individually in PVWatts instead of derived mathematically from the Missouri Metro and Missouri West totals.

VALUATION: To establish the value for the customer energy, the Company considered and accepted that the energy value is defined by Missouri statutes and State Regulation. Within the Missouri Net Metering Easy Connect Act, particularly MO Rev Stat § 386.890., the value of energy from customer systems is set an amount at least equal to the avoided fuel cost per kilowatt hour. In the Code of State Regulation, under 20 CSR 4240-20.065 Net Metering, establishes a net metering rate paid for excess energy generation that is the same rate as the utility's cogeneration rate. The cogeneration rate under 20 CSR 4240-20.060, is established as no more than the avoided costs for purchases. As of the date of this report, the rate paid for excess generation in the EMM and EMW jurisdictions is $0.0220 per kWh. This value is applied to energy received from all net metering systems and parallel generation systems within both Missouri jurisdictions.

IDENTIFIED AVOIDED COST: To determine the avoided cost of the energy quantified, the Company multiplies the estimated kWh production from the net metered systems by the utility's rate for excess energy per kilowatt hour. The product of this multiplication represents the avoided cost of energy.

Table 3. Estimated Value of Energy Produced

	Missouri Metro		Missouri West		Missouri Total*	
	AC Energy (kWh)	Avoided Cost	AC Energy (kWh)	Avoided Cost	AC Energy (kWh)	Avoided Cost
January	3,076,964	$ 67,693	4,480,507	$ 98,571	7,557,473	$ 166,264
February	3,355,944	$ 73,831	4,886,742	$ 107,508	8,242,685	$ 181,339
March	4,404,734	$ 96,904	6,413,933	$ 141,107	10,818,665	$ 238,011
April	4,643,087	$ 102,148	6,761,013	$ 148,742	11,404,099	$ 250,890
May	4,895,552	$ 107,702	7,128,640	$ 156,830	12,024,188	$ 264,532
June	4,974,831	$ 109,446	7,244,077	$ 159,370	12,218,898	$ 268,816
July	5,298,167	$ 116,560	7,714,905	$ 169,728	13,013,070	$ 286,288
August	4,852,937	$ 106,765	7,066,584	$ 155,465	11,919,523	$ 262,230
September	4,543,801	$ 99,964	6,616,435	$ 145,562	11,160,235	$ 245,525
October	3,842,087	$ 84,526	5,594,637	$ 123,082	9,436,721	$ 207,608
November	3,215,237	$ 70,735	4,681,852	$ 103,001	7,897,089	$ 173,736
December	2,691,775	$ 59,219	3,919,619	$ 86,232	6,611,389	$ 145,451
Annual	49,795,116	1,095,493	72,508,944	1,595,197	122,304,035	$ 2,690,689

*Missouri Total calculated individually in PVWatts instead of derived mathematically from the Missouri Metro and Missouri West totals.

Current rate for energy as prescribed by 20 CSR 4240-20.060 Cogeneration	$ 0.0220

ADDITIONAL OBSERVATIONS:

- Certain generalizations were used to complete this determination of avoided cost. In particular, reliance on the engineering calculation to determine energy production may be suitable for current levels of production and at the current point in the lifecycle of DG, particularly solar photovoltaic systems.

    - As the penetration levels of DG increase and the installed systems begin to age, it would become increasingly important to utilize some other method to determine the actual energy produced and validate these estimates with actual data. The use of production meters is one way to make this actual generation data available.
    - Increased number of DG systems will introduce higher levels of diversity to the DG “fleet”, meaning the systems will become less homogeneous and less suitable for generalized calculations like those used here.
    - Concerning age, it is reasonable to expect that system performance will begin to degrade as photocell surfaces become cloudy and components wear out. Further, particularly for residential systems that may not benefit from regular maintenance, it is reasonable to expect that photocells will fail and not be replaced. Generalized calculations presume all systems are operational at full capability. This assumption may not prove reliable into the future.

- Future determinations of avoided energy may need to be revised to address changes in technology. In particular, deployment of Smart Inverters may change the way this element of avoided cost is defined. Today, solar photovoltaic systems produce energy only. When Smart Inverters are deployed, solar photovoltaic systems could be used to provide valuable, energy-related services such as voltage support, power factor compensation, or event ride-through capabilities. These services provide benefit to the grid but would result in reduced measured energy output from the customer's system. Quantification and valuation methodologies would need to be expanded to include these elements. Further, substantial DG and Smart Inverter proliferation would benefit from remote sensing and remote coordination/control at the utility level to help mitigate power quality issues associated with high levels of DG saturation. Thus, the utility may need to incur additional control systems costs.

- From another perspective, the energy produced by DG sources can contribute to a negative effect for non-DG customers. As current utility cost recovery is dependent on energy sales, reductions in sales can have the effect of increasing the average price paid for energy. That condition is not incorporated in this evaluation, but under high DG penetration levels and if the dependence on volumetric sales cannot be addressed, there may need to be a consideration of the impact in the determination of avoided cost. More specifically, if there is high penetration of DG and the Company must deploy higher levels of fast-start generation or rely more heavily on the hourly energy market for supporting the DG, it is reasonable to expect the costs to provide energy will increase. To the extent this increase is driven by DG, it may be appropriate to reflect this increase as an offset, or reduction to the calculation of avoided cost.

DISTRIBUTED GENERATION AVOIDED COST ANALYSIS

COST CATEGORY: **Avoided Generation Capacity**

COST DESCRIPTION: Avoided Generation Capacity Costs are avoided expenditures attributed to DG additions that would otherwise be required by a utility to meet capacity requirements.

QUANTIFICATION: To quantify the avoided capacity provided by DG, the amount of currently installed DG capacity in the Missouri jurisdictions was determined. The Company then developed an estimate of the effect the installed DG capacity has on the peak load observed for EMM and EMW.

Using data prepared for the 2020 annual net metering report[29], the Company identified a total of 86,217.51 kW of customer generation capacity. Of that capacity, 35,102.77 kW was associated with the EMM jurisdiction and 51,114.74 kW was associated with EMW.

To determine the effect or coincidence of production from the DG capacity on the system loads, the Company used the PVWatts[30] calculator provided by the NREL to obtain the hourly production estimated for each jurisdiction's identified DG capacity. This production was compared to load data obtained from Company load research sources. Aligning the hours, the Company compared the capacity factor attributable to DG generation to the system load factor. Figure 1 details that result for the annual system coincident peak ("CP") day, observed on July 17, 2020, and for the six highest peak days in July.

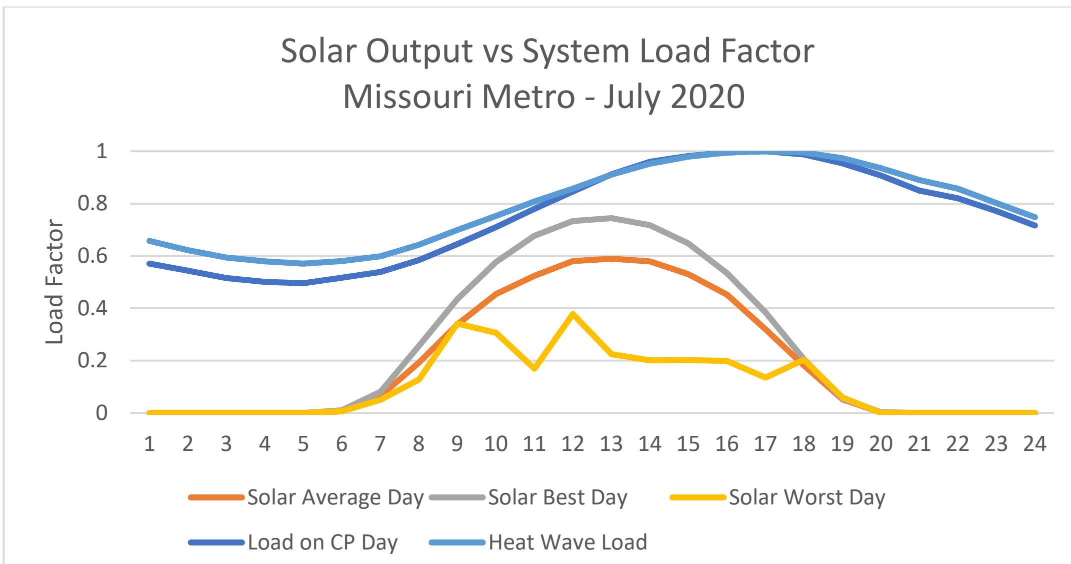


Figure 1

[29] Filed in compliance with 4 CSR 240-20.065
[30] http://pvwatts.nrel.gov/

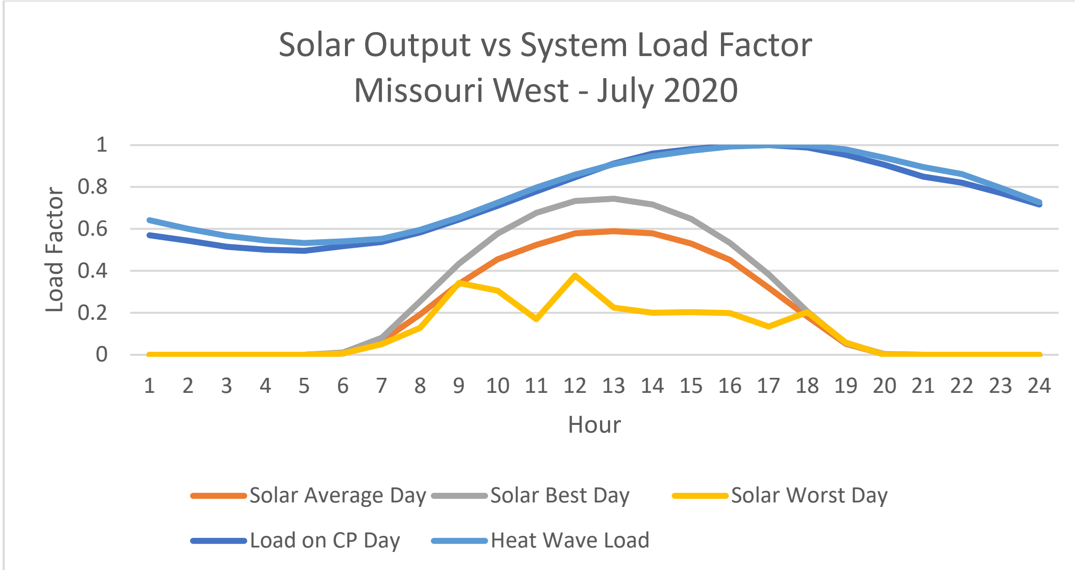


Figure 2

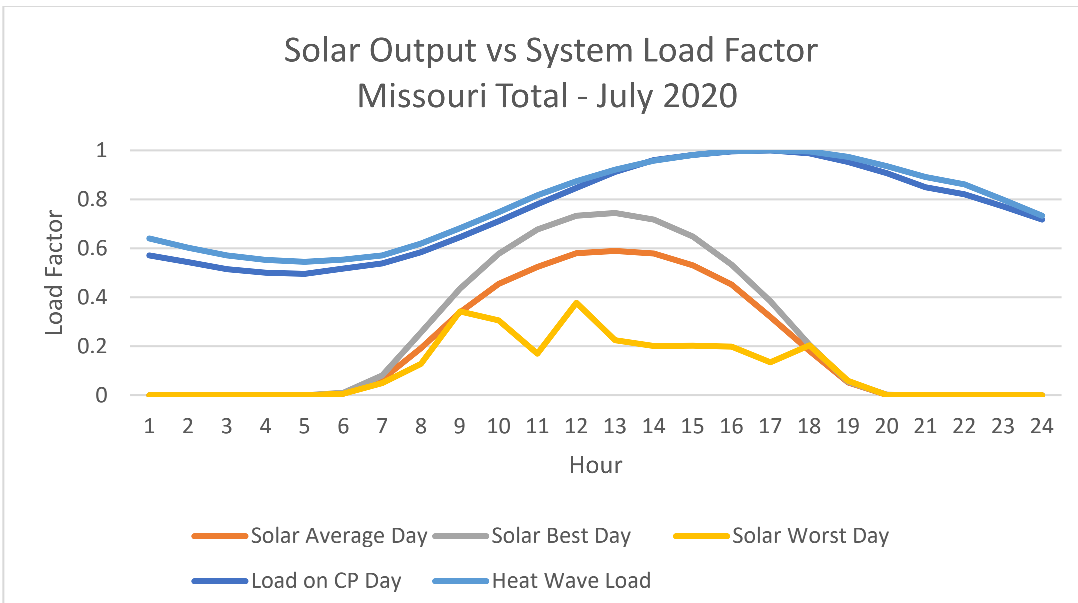


Figure 3

Two lines, the "Load on Coincident Peak ("CP") Day" and "Heat Wave Load", represent the measured customer load factor during the system peak day and the six days with the highest daily peaks and highest daily maximum temperatures in the month. On the vertical axis, a comparison of the load factors is presented. The system peak hour for each line was assigned a load factor of 1.0, and the other hours were assigned a factor based on a ratio of the hourly load to the peak load.

The "Solar Average Day" line represents the capacity factor for solar expressed as the ratio of the average hourly alternating current ("AC") output divided by the installed direct current ("DC") capacity. The AC output measures the usable energy delivered by the system, while the DC value expresses the capacity rating of the solar panels. For purposes of this analysis, the solar output was determined using the default settings of PVWatts for the installed DG systems. Two additional lines, "Solar Best Day" and "Solar Worst Day" reflect the hourly output for the July days with the highest and lowest production estimated by PVWatts. For the purpose of identifying the effective capacity factor for the DG capacity, the Company considered the four hours, starting with hour ending 16 (4pm) and produced an average value for that four-hour period. This period is thought to capture the peak and allow for a level of variability in aligning the data. The resulting average capacity factor for the "Solar Average" line in this period was **20.29%**. For comparison, the capacity factor for the "Solar Best Day" in that same period was 25.26% and the "Worst Solar Day" was 10.86%. Under higher DG penetrations, use of the "Worst Solar Day" capacity factor would be appropriate. However, under these smaller penetrations and to allow for some generalizations within the calculation process, the Solar Average is used here.

Using these values, the Company quantified the capacity provided by DG systems to be:

DG Capacity × DG Capacity Factor = Capacity Provided

Missouri Metro: 35,102.77 kW × 20.29% = 7,122.35 kW (7.12 MW)

Missouri West: 51,114.74 kW × 20.29% = 10,371.18 kW (10.37 MW)

Missouri Total: 86,217.51 kW × 20.29% = 17,493.53 kW (17.49 MW)

This calculation does not account for any variation, positive or negative, in production due to system installation (orientation, tilt, photocell type, inverter capability, or system losses), conditions of equipment (panel age, inverter settings), or other elements associated with individual installations (shading, wiring interconnection).

VALUATION: Company research would indicate there are no less than five methods commonly used to establish the value of capacity.[31] Those methods commonly used are:

- Simple avoided generator ("CT") - Assumes DG avoids construction of a new CT. also known as the Cost of New Entry ("CONE") of a Combustion Turbine.
- Weighted avoided generator - Assumes DG avoids a mix of generators based on avoided fuel.
- Capacity market value - Uses cost of capacity in restructured markets. The cost of capacities in these types of markets generally represent a short-term perspective such as in the PJM capacity market where capacity is priced and auctioned in one-year blocks. In markets without capacity elements, competitively bid capacity procurements could serve as an equivalent source.
- Screening curve - Uses system load and generation data to estimate avoided generation mix based on capacity factor.
- Complete valuation of DG versus alternative technologies - Estimates the type or mix of generators avoided in subsequent years using a capacity-expansion model.

In reviewing the environment around DG, including the amount of generation, the generation characteristics of common DG systems, and the time frame associated with the analysis, the

[31] Paul Denholm, Robert Margolis, Bryan Palmintier, Clayton Barrows, Eduardo Ibanez, Lori Bird, and Jarett Zuboy (2014). Methods for Analyzing the Benefits and Costs of Distributed Photovoltaic Generation to the U.S. Electric Utility System. NREL Report No. NREL/TP- 6A20-62447. Golden CO: National Renewable Energy Laboratory. Page 32

Company identified the market-based rate method as the appropriate means to value capacity under these short-term perspectives. The Company does acknowledge that the simple avoided generator method of CONE method has merit, but believes that it would be more representative of the equivalent cost and term of capacity agreements under higher penetrations of DG (levels approaching 100MW, a common size for capacity procurement) or if valuation methods are revised to consider long-term or forward-looking cost projections. It would be reasonable to expect the methodology used to value capacity to change as levels of DG penetration also change.

To determine a proxy market-based rate for capacity, the Company turned to the costs used in the current IRP filing. These costs reflect an average of prior request for proposal (RFP) capacity offers received from developers to satisfy capacity needs in for Evergy Missouri West. This RFP provided an opportunity for capacity producers to competitively bid to provide capacity service. Reviewing the range of responses received, the Company determined that **$3.99/kW-month** was representative. This rate is not reflective of the low bid received, but provided a liberal value, based on a ten-year average of capacity prices. The ten-year period was selected as it aligns with other terms used within the net metering and solar rebate programs.

IDENTIFIED AVOIDED COST:

To calculate the annual avoided cost the Company used the following equation:

Capacity Provided × Capacity Value = Avoided Cost of Capacity

Missouri Metro: 7,122.35 kW × ($3.99/kW-month × 12 months) = $341,018.12

Missouri West: 10,371.18kW × ($3.99/kW-month × 12 months) = $496,572.10

Missouri Total: 17,493.53kW × ($3.99/kW-month × 12 months) = $837,590.22

ADDITIONAL OBSERVATIONS:

- The Missouri Metro jurisdiction currently does not need capacity to satisfy customer loads.
- Utilities normally build or otherwise procure capacity in relatively large increments (≈100MW). As such, it is common to have excess capacity at any given time.
- In estimating the capacity factor for DG generation, the Company utilized an average level of production as estimated by PVWatts. For this effort, particularly given the limited amount of DG generation installed, this approach was deemed appropriate. However, the Company recognizes that if a relatively high level of DG penetration were incorporated on the Company's generation system in the future and absent data from production metering, use of the lower, "Worst Day Solar" capacity factor assumption would be prudent to ensure sufficient capacity resources are deployed to meet Southwest Power Pool-mandated capacity responsibility. This change would better parallel other system planning approaches and recognize capacity factors more in-line with known utility scale alternatives.

- As DG penetrations increase the avoided cost of generation capacity will be reduced.[32]
- Estimated capacity factors can vary dramatically from day to day. Using data from PVWatts assuming the system peak month in July, shows an average DG-based capacity factor of 20.29% with variations in daily capacity factors ranging from 10.86% to 25.26%. Figure 2 details these results.

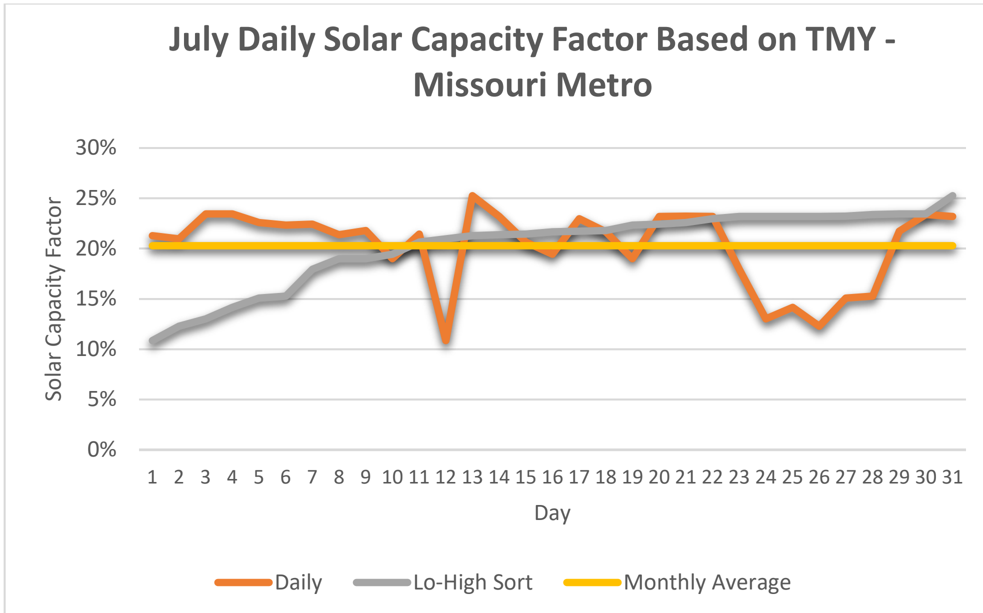


Figure 4

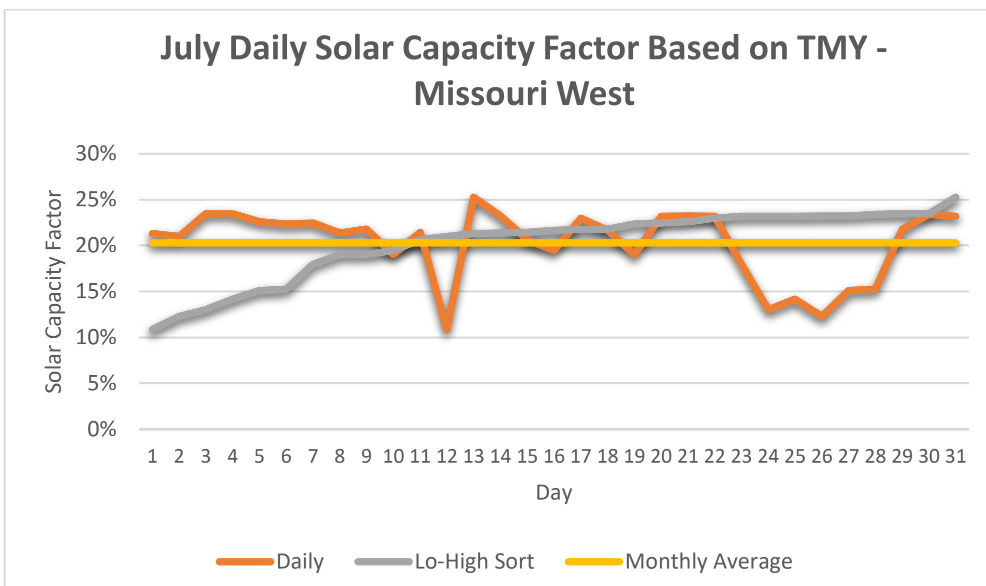


Figure 5

[32] "Changes in the Economic Value of Variable Generation with Increasing Penetration Levels: A Pilot Study of California", Andrew Mills and Ryan Wiser, Lawrence Berkeley National Laboratory, CREPC/SPSC Pre-Meeting Webinar, March 21, 2012.

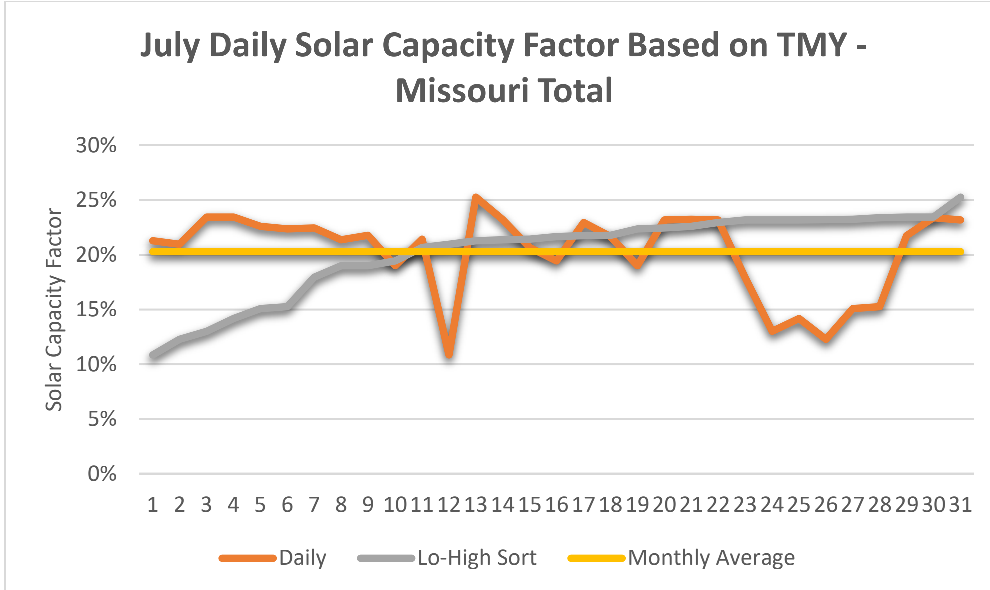


Figure 6

- It has been observed that orienting solar panels in a more westerly direction can result in higher levels of generation during the later afternoon/early evening peak hours, better aligning with the system peak usage period, but reducing the overall annual energy produced by the systems.

- The analysis completed here does not address considerations for reserve capacity costs or benefits associated with deferral of capacity. As higher levels of DG are deployed, particularly levels approaching the normal capacity of utility peaking generation, these factors may become more relevant and may be included in the determination of avoided capacity.

- The value of capacity can vary depending on the application. Different values are currently used within resource planning and in evaluation of demand side measures such as energy efficiency or demand response. While these different values for capacity are related, one should not expect to see identical values between applications as the considerations for term, size, and other factors are unique to each.

- With the implementation of FERC Order 2222 (where system owners, for example, can choose to participate in wholesale market activities as part of an aggregation), the Company may not be able to claim any benefit for the capacity of distributed solar generation but would be required to provide service in support of those installations.

DISTRIBUTED GENERATION AVOIDED COST ANALYSIS

COST CATEGORY: **Avoided Transmission and Distribution Line Losses**

COST DESCRIPTION: Costs associated with a reduction in line current relating to I^2R losses. Transmission and Distribution ("T&D") losses are the energy expended on the lines and transformers due to current flow through line and wire impedance. These losses are calculated by multiplying the square of the current flow through the line by the line resistance, hence I^2R.

QUANTIFICATION: To estimate the avoided line losses as a result of DG, the Company determined the amount of installed DG capacity in the EMM and EMW jurisdictions. Using the 2020 annual net metering report, EMM reported a total of 35,102.77kW of customer owned DG capacity and EMW reported a total of 51,114.74kW of customer owned DG capacity.

To estimate the DG avoided line losses, the Company used the PVWatts calculator provided by the NREL to obtain the annual energy production estimated for the identified DG capacity per jurisdiction. Default NREL suggested input values were assumed for this calculation. The estimated annual energy output for EMM was 49,795,116 kWh. The estimated annual energy output for EMW was 72,508,944 kWh. This nominal output was then multiplied by a combined T&D energy loss factor of 1.103435 for the EMM system and 1.065685 for the EMW system, calculated in a *P084-18 Electric Losses Study for KCP&L and GMO for 2016_R3*[33] by Siemens Industry, Inc. The resulting product is the total demand plus losses. Subtracting the DG output then leaves the total avoided losses per year, 160,331 kWh of avoided losses.

Evergy Metro Missouri Quantification

Output for a solar capacity of 35,102.77 kW = **49,795,116 kWh/year**

Evergy Metro Missouri System Energy Loss Factor = **1.103435**

Demand Output = Energy Loss Factor x Annual Energy Output for a solar capacity of 35,102.77 kW = **54,945,674 kWh/year**

Avoided Energy Loss due to Solar DG = Demand Output - Annual Energy Output for a solar capacity of 35,102.77 kW = **54,945,674 kWh/year - 49,795,116 kWh/year = 5,150,558 kWh/year**

Evergy Missouri West Quantification

Output for a solar capacity of 51,114.74 kW = **72,508,944 kWh/year**

Evergy Missouri West System Energy Loss Factor = **1.065685**

Demand Output = Energy Loss Factor x Annual Energy Output for a solar capacity of 51,114.74kW = **77,271,694 kWh/year**

Avoided Energy Loss due to Solar DG = Demand Output - Annual Energy Output for a solar capacity of 51,114.74kW = **77,271,694 kWh/year - 72,508,944 kWh/year = 4,763,020 kWh/year**

[33] Loss factors were provided in a 2018 update to the 2016 Line Loss study. The update, provided by Siemens as an addendum, was to Appendix F of the *P084-18 Electric Losses Study for KCP&L and GMO for 2016_R3*.

Total Avoided Energy Loss due to Solar DG

Avoided Energy Loss due to Solar DG for Evergy Metro Missouri + Avoided Energy Loss due to Solar DG for Evergy Missouri West = **5,150,558 kWh/year + 4,763,020 kWh/year = 9,913,578 kWh/year**

VALUATION: To establish the value for avoided T&D line losses due to DG, the Company used a marginal combined loss rate. This method is outlined in section five of NREL's *Methods for Analyzing the Benefits and Costs of Distributed Photovoltaic Generation to the U.S. Electric Utility System*. As identified in the Avoided Energy section of this report, the EMM and EMW system wide average cost of energy for DG solar in the test year period is $0.0220/kWh.

The Company's existing design standards account for line losses, in terms of voltage drop and current limits. Because of this, there is no additional valued benefit beyond that of the average cost of energy. Evergy will continue to evaluate ways that customer owned DG could provide value and improve grid performance.

IDENTIFIED AVOIDED COST: To determine the avoided cost of T&D line losses, the EMM and EMW Avoided Line Losses were multiplied by the average energy cost of $0.0220/kWh.

Cost of Energy × Total Avoided Line Losses = Total Estimated Value ($)

Missouri Metro: $0.0220/kWh x 5,150,558 kWh/year = $ 113,312.28/year

Missouri West: $0.0220/kWh x 4,763,020 kWh/year = $ 104,786.44/year

Missouri Total: $0.0220/kWh x 9,913,578 kWh/year = $218,098.72/year

ADDITIONAL OBSERVATIONS: None.

DISTRIBUTED GENERATION AVOIDED COST ANALYSIS

COST CATEGORY: **Avoided Distribution Infrastructure Costs**

COST DESCRIPTION: Avoided costs associated with maintaining existing or building new distribution infrastructure associated with DG.

QUANTIFICATION: Savings on distribution infrastructure improvement costs due to DG requires these conditions to be met:

1) The DG is available during the utilities' peak demand.
2) The DG is of sufficient quantity during peak to meaningfully impact the system.

Complications with each of these requirements are noted below.

Assuming future DG sizing is standard in accordance with existing Schedule NM, the existing infrastructure (wires and transformers) generally supports DG additions. Infrastructure upgrade situations often occur where multiple DG sites are connected to one distribution transformer. These transformers sometimes require upsizing to accommodate situations where customer loads are low, but generation is high. This situation has been particularly identified in the spring and fall (low customer loads) where multiple solar DG sites cumulatively contribute more capacity than the original transformer size. Additionally, "back-feeding" transformers not designed for reverse flow can cause increased losses due to the impedance characteristics of a transformer's primary and secondary coil.

As new customer growth occurs, infrastructure expansions and improvements must be made to keep the system operational. Unfortunately, it is unknown what future DG may exist and whether it will reduce our peak demand. The utility infrastructure will be designed, built, and maintained to support full peak demand.

As previously mentioned, utilities must design the distribution infrastructure to ensure reliable service during all conditions, and especially during peak usage situations. DG dependent infrastructure must be supported by uninterrupted generation. Without reliable and efficient energy storage devices, Solar DG cannot provide reliable uninterrupted service. Figure 3, following, illustrates that distribution infrastructure must be designed for Solar Generation Worst Day production, in the case of solar DG.

Further, Figure 7, illustrates the challenge with DG generation peaks not coincident with customer demand peak usage[34]. Peak solar generation (12 p.m. – 3 p.m.) occurs prior to the hours of peak residential demand (6 p.m. – 9 p.m.). Thus, DG dependent infrastructure cannot rely on solar to support its peak demand.

[34] Customer load data acquired from KCP&L-KS Residential General Use customer energy profile, provided by KCP&L Regulatory Department. Solar generation data acquired from Figure 3-145 of the KCP&L Green Impact Zone SmartGrid Demonstration Final Technical Report, DOE-KCP&L-0000221. Page 578.

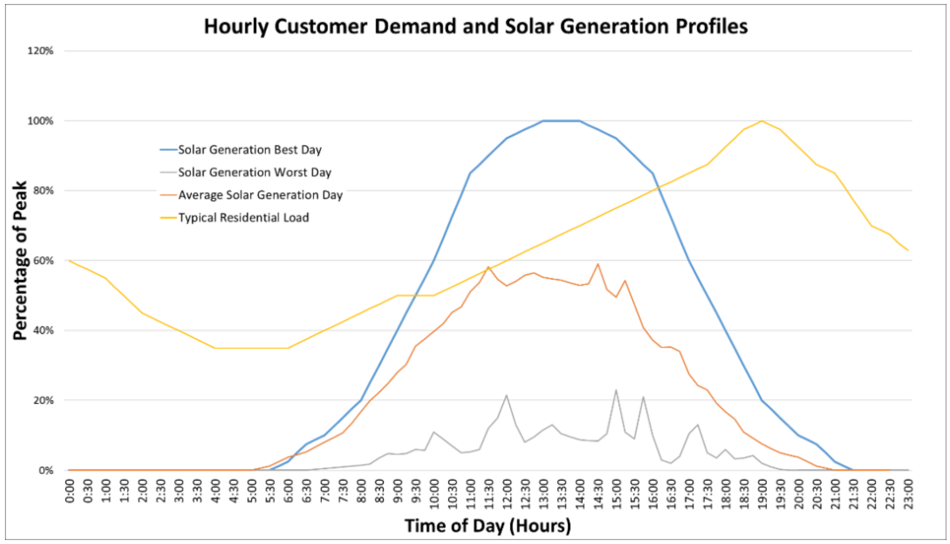


Figure 7

VALUATION: The valuation approach used for this study is that DG capacity is limited to current hosting capacity, outlined in section eight of NREL's *Methods for Analyzing the Benefits and Costs of Distributed Photovoltaic Generation to the U.S. Electric Utility System*. Current DG and storage systems do not offset the customer demand peaks with certainty. Utilities are required to build distribution infrastructure to ensure peak loads are met. No distribution infrastructure savings are present.

As technologies continue to advance and the prevalence of DG and efficient storage in our territory continues to grow, there could be a benefit observed in the future. At that time, a more advanced method of valuation could be considered, such as the Average Deferred Investment for Peak Reduction, mentioned in NREL's document noted above.

IDENTIFIED AVOIDED COST: Due to the intermittent nature of current DG sources, and the need to maintain a full capacity distribution source, there are no measurable avoided costs.

ADDITIONAL OBSERVATIONS:

- Another concern with net generation is its effect on distribution system protection schemes. These protection schemes are typically not intended to operate in reverse flow, though some have the appropriate settings to allow for it. In the case of fuses and many reclosers, operation in reverse power flow situations can lead to miscoordination and the potential for a dangerous extended fault. Additionally, DG can dramatically increase available fault current on distribution systems leading to a higher arc flash potential.

- Excessive voltage fluctuations can occur due to large changes in DG energy production. These fluctuations can cause significant, additional wear on voltage support devices such as capacitors, voltage regulators, and load tap changers, which are designed to automatically respond to voltage fluctuations. This could lead to noticeably shorter life expectations for these types of equipment, as well as additional labor hours spent inspecting devices for signs of eminent failure.

DISTRIBUTED GENERATION AVOIDED COST ANALYSIS

COST CATEGORY: **Avoided Transmission Infrastructure Costs**

COST DESCRIPTION: Avoided Transmission Infrastructure Costs are costs associated with expanding transmission infrastructure to meet demand and reliability needs.

QUANTIFICATION: EMM and EMW are currently forecasting load to remain relatively flat, thus transmission projects are primarily aimed at improving reliability. Given the current load characteristics, transmission expansion projects are generally geared toward individual commercial and industrial installations. Additionally, examination of the output of solar generation absent storage solutions provides limited reduction to peak load, resulting in no change to required transmission capacity. Finally, the Southwest Power Pool ("SPP") is responsible for transmission capacity expansion upgrades on the Bulk Electric System, and current levels of DG have not caused any projects issued to EMM or EMW to be deferred or omitted from the SPP project portfolio.

VALUATION: In the event of a large increase in the amount of residential DG on the EMM and EMW systems, it is possible that the benefits could be calculated using locational marginal prices from Southwest Power Pool's Integrated Marketplace, as suggested in *Methods for Analyzing the Benefits and Costs of Distributed Photovoltaic Generation to the U.S. Electric Utility System by* NREL. However, because locational marginal prices are location specific, absent a quantification of avoided cost, the value cannot be identified or reasonably estimated.

IDENTIFIED AVOIDED COST: Due to no observed reduction in cost and no current valuation, the identified avoided cost is zero.

ADDITIONAL OBSERVATIONS: None