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September 23, 2020

E-FILING

Rosemary Chiavetta, Secretary
PA Public Utility Commission
Commonwealth Keystone Building
400 North Street
Harrisburg, PA 17105-3265

Re: PPL Electric – DER Management Plan – Docket No. P-2019-3010128
Sustainable Energy Fund Surrebuttal Testimony

Dear Secretary Chiavetta:

Enclosed please find SEF St. No. 1-SR (J. Costlow) and SEF St. No. 2-SR (R. Celentano) for filing in the above-referenced proceeding. Parties have been served in accordance with the Certificate of Service. Please contact me if you have any questions.

Sincerely,

Kenneth L. Mickens, Esquire
Attorney for Sustainable Energy Fund

KLM/bls
Certificate of Service
Enclosures

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Petition of PPL Electric Utilities Corporation for Approval of Tariff Modifications and Waivers of Regulations Necessary to Implement its Distributed Energy Resource Management Plan

Docket No. P-2019-3010128

SEF ST. 1-SR

SURREBUTTAL TESTIMONY

SUSTAINABLE ENERGY FUND

John M. Costlow

March 19, 2020

Testimony of John M. Costlow

Q. Please state your full name and business address.

A. My name is John M. Costlow. My business address is 4110 Independence Dr. Ste 100 Schnecksville, PA 18078.

Q. Have you previously testified in this proceeding?

A. Yes, SEF Statement No.1 and SEF St. No. 1 (Confidential/Highly Confidential), my Direct testimony.

Q. Are you sponsoring any exhibits in connection with this testimony?

A. I am not sponsoring an exhibit in connection with this Surrebuttal testimony.

Q. Do you agree with Mr. Salet's position concerning the turning off of DERs?

A. No. In short, I believe Mr. Salet's Rebuttal testimony[1] demonstrates a lack of understanding of the solar plus storage market. Solar plus storage customers use batteries and solar to provide off-grid power to their homes when there is a grid failure. PPL Electric acknowledges it will not shut off a source such as a battery or a fossil fuel generator[2] but still insists on shutting off the customer's DER (solar generation).[3] In fact, when using solar plus storage, the solar system recharges the

[1] PPL Electric St. 1-R, p.33.
[2] PPL Electric St. 1-R, p.33.
[3] PPL Electric St. 1-R, p.33.

batteries during the day. Consequently, there is no unintentional islanding since solar and battery inverters automatically disconnect from the grid in the case of a power outage. The disconnection is significant because PPL Electric's proposed action of shutting off DERs in case of a grid failure, such as a downed line, will place customers' property and health at risk.[4]

Q. If PPL Electric's Petition is approved by the Commission, should PPL Electric's DER Management Plan be monitored by the Commission and Stakeholders?

A. Yes. Although, in my opinion, the Commission should deny PPL Electric's Petition; if approved, I believe that PPL Electric should not be given the authority to modify, in any way, its DER Management Plan at Company discretion. Just as PPL Electric's EE&C Plans are approved by the Commission and modification requires Commission approval, any modification of PPL Electric's DER Management Plan should be subject to such approval. In addition, I recommend that the DER Management Plan be published on an *easily located* webpage that details DER monitoring and control.

Q. Do you agree with Mr. Salet that PPL Electric's petition is not premature[5]?

A. No. Nothing in PPL Electric's testimony disputes the fact that the smart

[4] SEF St. 1, p. 10.
[5] PPL Electric St. 1-R, pp.43-44.

inverters under the new IEEE and UL standards are not yet available. In fact, PPL Electric has proposed a *workaround* until these smart inverters are available.[6] In this regard, PPL Electric has currently approved two inverter manufacturers, Fronious and ABB[7]. However, this determination is, at best, premature since reputable inverter manufacturers such as Solar Edge, SMA and Sunny Boy are not even on the list. Moreover, PPL Electric's approach does not address micro-inverters, which may not even have a RS 485 port. Actually, solar installers often work with less than two inverter manufacturers in order to keep their costs down. However, if these installers do not work with one of PPL Electric's two approved inverter manufactures, they will now need to open accounts with this very limited market. As a result, PPL Electric will essentially be creating an oligopoly within its service territory. Such a circumstance severely limits the market and directly interferes with the marginal cost of solar systems. There is no reason that PPL Electric, given its vast resources, could not have previously tested and approved a litany of inverters if they are genuinely available. If the Commission decides to approve PPL Electric's Petition, I recommend that the effective date of such approval should be set in such a way that allows for significantly more smart inverters to become commercially available before the tariff is effective.

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[6] PPL Electric St. 1-R, p. 6.
[7] PPL Electric St. 1-R, p.92.

Q. Are you concerned about potential revenue enhancement motives by PPL Electric?

A. Yes. Significantly, PPL Electric does not dispute the fact that implementation of the DER control strategy it has outlined in its Petition could decrease DER output, thereby increasing PPL Electric distribution revenue.[8] Consequently, whether or not that was a consideration on their behalf, it is a fact. Notably, Net Metering is in place to support the growth of DERs throughout Pennsylvania and any action by PPL Electric that would result in a decrease in net DER benefits is contrary to the Net Metering statute and regulations.

Q. Do you remain concerned that PPL Electric's communication strategy[9] would limit the ability of DER owners to control and monitor their DER inverters?

A. Yes. Although inverters are equipped with two (2) RS 485 connectors on multi-inverter systems, one port from the master inverter is used to communicate with the slave inverters. In AC Coupled solar plus battery storage solutions, the other port is used to communicate with the battery system or energy management system. This does not leave a port available for PPL Electric's proposed communication solution.

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[8] PPL Electric St. 1-R, pp. 72-73.
[9] PPL Electric St 1-R, pp.18-20.

Q. Why are DER plus storage systems critical to the future of the distribution system, expansion of solar and ultimately a carbon-free society?

A. As new solar systems are added to PPL Electric's distribution system, the overall system will be subject to the duck curve. The duck curve is a result of a decrease in solar production due to a reduction in sunlight at the end of the day and an increase in customer load. This decrease in solar production and the increase in load is already occurring on PPL Electric's distribution system.[10] This decline in production and increase in load leads to rapidly increased generation. Under normal circumstances, this condition would not be a significant issue. However, Pennsylvania's existing power plants are antiquated and do not have the ability to scale rapidly. This requires the use of marginal resources such as natural gas peaker plants that can ramp up rapidly. Unfortunately, these peaker plants tend to be higher priced generation resources than baseload plants. The duck curve can be flattened by the use of behind the meter storage. Solar plus storage, as an example, would reduce excess generation during the day when the battery system is charging and decrease the slope of the duck curve because as solar generation declines battery storage output increases to handle the customer's load. Consequently, DERs, such as solar plus storage, constitute the long-term remedy to the obstacles to a carbon-free electric system in Pennsylvania. In my opinion, this long-term

[10] Based on data provided by PPL Electric SEF Set I-6 Attachments 1 HC through SEF 1-6 Attachment 8 HC.

societal need far outweighs PPL Electric's desire for monitoring and control of DERs.

Q. Do you agree that PPL Electric's Rebuttal proposal decreases the overall costs for purchasers of DERs[11]?

A. No. The new Rebuttal proposal only decreases the cost relative to PPL Electric's initial proposal that substantially increased DER installation costs.

Q. Do you agree with PPL Electric witness Reder that your previous testimony concerning DER growth is too conservative[12]?

A. No. I have worked on the ground in Pennsylvania for the past 11 years and seen DERs grow with state incentives and then fall when state incentives were no longer available. As a result, the Pennsylvania market for DERs is growing at a slow pace and, I believe, will continue to do so for the foreseeable future. The purpose of my forecast was to demonstrate that with the low growth in DERs, PPL Electric will not be harmed by a rapid increase in renewables during the time required to convene a statewide proceeding. Respectfully, Ms. Reder is not on the ground in Pennsylvania and does not have a comprehensive understanding of the Pennsylvania market, as I do.

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[11] PPL Electric St. 1-R, pp.18-20.
[12] PPL Electric St. 2-R, p.3.

Q. Can you identify the unjust and unreasonable actions that are of concern in connection with PPL Electric's proposed DER Management Plan?

A. Yes. First, in this proceeding PPL Electric, a monopoly, requests the authority to control DERs pursuant to company policy. Although in Rebuttal testimony PPL Electric provides additional details related to its proposed control of DERs[13], the Company has not put forth a mechanism for Commission approval of any changes PPL Electric seeks authority to make. In addition, although PPL Electric witnesses reference *islanding* in connection with shutting down inverters and allowing battery backups to operate, the Company remains silent on allowing DERs to operate in parallel with the battery system. My concern is that PPL Electric will shut down the DER and when the battery is discharged people's property and health will be at risk.

Q. Is PPL Electric's web portal capable of handling requests for new construction interconnection applications?

A. No. Although PPL Electric witness Mr. Salet states that PPL Electric "worked hard on developing and implementing"[14] its interconnection software, the system's inability to handle new construction applications show a lack of forethought and is still a failure. In short, the Company's inability to handle new construction

[13] PPL Electric St. 1-R, pp.18-23.
[14] PPL Electric Statement 1-R, p.92.

interconnection requests may reflect the Company's lack of understanding of the DER market which will certainly impact the Company's ability to successfully manage DERs.

Q. Do you have a concern about the internal communications ability of PPL Electric's selection of ConnectDER?

A. Yes. I have personally investigated the ConnectDER device.[15] It is my understanding that the proposed communication protocol is still in testing and will involve WiFi communications between the dongle and the connect DER device. It appears that the goal for the communication distance is 100 feet, which is reasonably consistant with WiFi communications. However, although this may work in some installations, it will not work in all installations. For example, it would not work in SEF's installation since our meter base is significantly further than 100 feet from the inverters. Installers and DER owners should not be required to place their DERs within 100 feet of PPL Electric's meter just so PPL Electric can monitor and control the DER. The inverters should be placed where they are most efficient considering the significant losses associated with the transmission of DC power.[16]

[15] Information obtained from ConnectDER on March 12, 2020.
[16] DC power, unlike AC power experiences significantly greater loss over any distance given the same size conductor.

Q. Are you concerned about the ConnectDER device still being in testing?

A. Yes. This is yet another fact that speaks to PPL Electric's premature filing and the need for a statewide proceeding so inverter manufacturers as well as companies like ConnectDER, can speak to the capabilities and limitations of their devices.

Q. How do you propose that the Commission proceed?

A. I recommend that the Commission deny PPL Electric's Petition. However, if the Commission desires to approve PPL Electric's Petition, I recommend that the Commission only approve the Petition in the form of a *Pilot* Program as outlined below.

Q. How do you recommend the Pilot program be structured?

A. If the Commission does not deny PPL Electric's Petition, I recommend it be approved only as a pilot program with the following structure:

1. Pilot Period – 30 Months.
2. During this Pilot period, the Commission will engage a statewide proceeding **after** the adoption of IEEE 1547-2018 and UL 1741. At the conclusion of the initial statewide proceeding, the Commission should engage a second statewide proceeding to consider rules in connection with the monitoring

and control of DERs. (This process would eliminate the need for the waivers PPL Electric has requested in this proceeding).

3. The Pilot cannot commence until PPL Electric certifies 80% of the inverters in the market. Certified inverters should include, at minimum, five (5) inverter manufactures as well as micro inverters.
4. The DER Management Plan should be approved by the Commission, as modified below in items 11 and 12. Any modification to the DER Management Plan must first be approved by the Commission. The Parties to this proceeding and Stakeholders should have the opportunity to provide Comments and Reply Comments prior to the Commission's determination on the modifications.
5. PPL Electric can file a Petition to evaluate the Pilot program on or after it has produced and published its year two (2) report(s) as outline in Mr. Salet's testimony. This Petition should include an analysis as to the cost and benefits of the DER Management Plan to DER owners and the cost and benefits to non-DER owners. In addition, the analysis should identify any reductions in capital expenditures to the distribution system as a direct result of the Pilot program.
6. PPL Electric will provide monthly reports to Parties with the number of new DER customers connected, how many RS-485 ports are being used on the

master inverter and the function of each communication connection. In addition, PPL Electric will provide all the reports outlined in the Rebuttal testimony of Mr. Salet's at pages 85-87. Further, PPL Electric will provide the same reports to the Parties in an aggregated manner in an excel worksheet or similar format with a unique identifier for each customer that can be tracked throughout the Pilot program.

7. All new customers will receive a ConnectDER device that includes an RS-485 port. Customers who need access to both ports (e.g. for use in connection with slave inverters and solar PV plus battery storage) will be exempt from the DER communications and management device requirements until such time as PPL Electric develops a communications and control protocol that will not impact the customers' right to use the RS-485 ports for their own needs. At no time does PPL Electric possess a right to a communication port on a customer's DER and cannot make it a condition of interconnection.
8. PPL Electric can use the communications port, if available, to monitor DERs. This will allow PPL Electric to monitor the possibility of *masked load.*
9. PPL Electric must make a datapoint in its DERMs system to track DER systems with battery storage.
10. This Pilot does not include Electric Vehicle battery storage.

11. DER customers must opt-in for PPL Electric to control their inverter(s) and can opt-out at any time. The control is limited to:
    a. Volt/VAR, Constant Power Factor;
    b. Voltage Ride-through; and
    c. Frequency Ride-through.
12. DER customers can consent to activation of on/off function. The consent must be separate from the opt-in for control itemized in paragraph 11.
13. PPL Electric should be able to control new DER systems with capacities exceeding 1 MW AC without the customer electing to opt-in provided the DER owner has an RS-485 port available for PPL Electric and the inverter is within range of the ConnectDER device. However, the availability of an RS 485 port cannot be a condition of interconnection.
14. PPL Electric should create an educational webpage, agreed to by the Parties in this proceeding, that explains the monitoring and control of DERs and the implications of each.
15. PPL Electric will create a text alert system that will notify customers when PPL Electric modifies an inverter setting as well as a text alert when the system is restored to its previous settings.

16. If a connected DER unintentionally islands, PPL Electric may shut down the DER remotely but only if the Company can identify the individual DER that is unintentionally islanding.

17. PPL Electric will continue to provide data to the Parties in this proceeding so that they can independently verify the costs and benefits to DER owners.

Q. Does this conclude your Surrebuttal testimony?

A. Yes.

AFFIDAVIT

I, John M. Costlow, certify that I am President/CEO of the Sustainable Energy Fund and that, in said capacity, I am authorized to and do make this Affidavit for it, that the facts set forth in the foregoing SEF St. 1-SR are true and correct to the best of my knowledge, information and belief. I understand that false statements made herein are made subject to the penalties of 18 Pa. C.S. § 4904, relating to unsworn falsifications to authorities.

John M. Costlow

John M. Costlow
President/CEO
Sustainable Energy Fund

Dated: March 19, 2020

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

Petition of PPL Electric Utilities Corporation for Approval of Tariff Modifications and Waivers of Regulations Necessary to Implement its Distributed Energy Resource Management Plan	:	Docket No. P-2019-3010128

SEF Statement No. 2-SR

SURREBUTTAL TESTIMONY
RONALD E. CELENTANO

MARCH 19, 2020

Q. Please state your name

A. My name is Ronald E. Celentano.

Q. Have you previously submitted testimony in this proceeding?

A. Yes, I submitted SEF St. 2 (Direct Testimony) where I discussed my education, professional experience and employment background.

Q. Are you sponsoring an exhibit in this proceeding?

A. No.

Q. Do you agree with Mr. Salet's position with regard to PPL Electric using the "remote on/off" function for DERs if there is a grid outage[1]?

A. No. PPL Electric has provided no evidence that identifies solar PV systems installed in its territory as the culprits in the unintentionally islanding issue that may exist on the electric grid. In fact, the inverters rely on an alternating sine wave of 60 hz and a tight AC voltage range to operate – if that doesn't exist (i.e., if there is a grid outage) then the inverter simply shuts down automatically. In short, the inverters rely on the 60 hz sine wave to convert from DC to AC.

Furthermore, it is unclear how the DERMs system is connected to a solar PV system with battery storage. There are Alternating Current (AC) and Direct Current (DC) coupled PV systems. The AC coupled system utilizes grid-tied inverters as well as a battery storage inverter or bimodal inverter. Mr. Salet states that it is not PPL Electric's intention to shut down battery storage systems.[2] However, in an AC coupled system, the grid-tied inverters must continue to operate on-site during a grid-outage, so that the solar PV modules can charge the

[1] PPL Electric St. 1-R, pp. 31-34.
[2] PPL Electric St. 1-R, p.33.

batteries, via the bimodal inverter. It's the grid side of the bimodal inverter that automatically disconnects from the grid when there is an outage, while the grid-tied inverters continue to operate from an AC sine wave created by bimodal inverter. During a grid outage, this entire backup system is separated from the grid and operates independently from the grid. With DC coupled systems, there is generally a single bimodal inverter, where a charge controller device is used to charge the batteries from the solar PV modules. During a grid outage, the input or grid side of the bimodal inverter automatically disconnects from the grid, while the output side of the inverter continues to supply power to the dedicated loads, from the batteries. Consequently, if PPL Electric remotely shuts down solar PV inverters during a power outage, the customer will lose the ability to re-charge their battery system, particularly for an AC coupled system.

Q. Does Mr. Salet's example of "Two-Way Power Flow"[3] make sense to you?

A. No. His example shows a diagram of five houses, three of which have solar PV exporting power to the two houses without solar, as well as exporting any excess power to the distribution system; probably to the non-solar houses on the next block. Many of the solar PV systems will likely export onto the grid at some time or another, such that "two-way power flow" will exist on the distribution line. However, in a residential neighborhood, even with high solar penetration (which is definitely not Pennsylvania), most - if not all - of the exported solar power will remain in the local neighborhood network. If there is a potential problem with voltage rise breaching the limit on the line, this should be determined during the interconnection application phase and engage the smart inverter functionality settings accordingly at the time of the installation, without the need to remotely change these settings. The concern raised by Mr. Salet of 8

[3] PPL Electric St. 1-R, pp.43-47.

kW of excess power from the solar PV systems[4] is insignificant, since it is the equivalent of three or four residential central AC units turning on or off at about the same time.

Q. Does Mr. Salet provide a sound argument for why Pennsylvania's solar penetration will surge in the near future[5]?

A. No. He states that the other parties fail to observe the substantial year-over-year decreases in costs for solar PV installations.[6] I acknowledge these cost reductions, but they are averaged across the nation. If these cost reductions were the only drivers, Pennsylvania would have far more solar capacity than it does today. In fact, Pennsylvania's solar market is significantly behind more than half the states in the nation. Twenty four states have a sales tax exemption (or no sales tax at all) and 33 states offer some sort of solar property tax exemption; Pennsylvania has neither (https://www.solarpowerrocks.com/solar-questions/what-are-tax-exemptions-for-solar/). First costs are not the only drivers of solar penetration. For example, Pennsylvania has lower electricity costs and much lower prices for the SRECs than neighboring states. In addition, the solar requirement under the Alternative Energy Portfolio Standard is far below that of other states and it will be capped by mid-2021.

Mr. Salet posits that because the solar penetration has increased substantially in other states, Pennsylvania will naturally follow at the same pace.[7] Unfortunately, he fails to recognize that most of this capacity is from grid-scale solar projects, which do not include the DER market and consequently is not applicable to this proceeding. Moreover, many of the states with increased solar

[4] PPL Electric St. 1-R, p. 46.
[5] PPL Electric St. 1-R, pp.44-48
[6] PPL Electric St. 1-R, p.49
[7] PPL Electric St. 1-R, p.54,55.

penetration, including most of them cited by Mr. Salet such as Missouri, South Carolina, Florida and New Mexico, have regulated electric utility markets, whereby the utilities can own and operate some or all of the solar facilities. Although there are plans for a few very large solar farm projects to be installed in Pennsylvania, these fall into the grid-scale solar category and do not apply to the DER market nor to this proceeding.

The Pennsylvania solar DER market completely relies on economic drivers. Simple paybacks for residential solar projects today are well over 11 years in the best case scenario, to well over 16 years, assuming the business or residential customers tax liability is sufficient to account for the investment tax credit, which explains why solar is moving so slowly in Pennsylvania.

Q. Mr. Salet asserts that the national average residential cost for solar PV installations was $2.70/watt in 2018[8]. How does this cost compare to the residential solar PV installation cost in Pennsylvania?

A. Solar PV installation costs are definitely higher in Pennsylvania as compared to the national average. Mr. Salet references the $2.70/watt value from the article entitled "Costs Continue to Decline for Residential and Commercial Photovoltaics in 2018", NREL (December 17, 2018). However, I just surveyed 15 solar companies in Pennsylvania and asked them what is the average turnkey cost for installing a 10 kW residential rooftop solar PV system in 2020 in Pennsylvania. The average cost was $2.94/watt. Given that the national average cost of $2.70/watt is two years old, this confirms that Pennsylvania's 2020 costs are higher than the national average. Mr. Salet continues stating that "[a]nother NREL study shows that utility-scale battery costs will continue to decline, with

[8] PPL Electric St. 1-R, p.49.

projected decreases by 2025 of 10-52%..."[9] However, this statement is irrelevant to this proceeding, which is focused on the DER market.

Q. Mr. Salet claims that the Company's proposal will save DER installation costs by incorporating the ConnectDER DER management device because the DER can be directly plugged into the DER Management Device.[10] Do you agree?

A. No. It seems Mr. Salet assumes this scenario for a line-side connection, where the circuit breaker located on the ConnectDER DER management device serves as the AC overcurrent protection device for the inverter, as required by National Electric Code (NEC). The utility isolation switch is required for a load-side connection. However, Mr. Salet is incorrect in assuming that the circuit breaker located on the ConnectDER DER management device can be used in place of the utility isolation switch. Pursuant to the specific requirement of the isolation switch, as defined under the Pennsylvania Code Title 52 - Chapter 75: Alternative Energy Portfolio Standards:

§ 75.36. Additional general requirements.

> *(9) Small generator facilities **shall** be capable of being isolated from the EDC by means of a lockable, **visible-break isolation device** accessible by the EDC. The isolation device shall be installed, owned and maintained by the owner of the small generation facility and located between the small generation facility and the point of interconnection. A draw-out type circuit breaker with a provision for padlocking at the draw-out position can be considered an isolation device for purposes of this requirement.*

The circuit breaker in the ConnectDER DER management device is not a visible-break isolation device, nor is it a draw-out type circuit breaker. Consequently, the

[9] PPL Electric St. 1-R, p.50.
[10] PPL Electric St. 1-R, p.51.

latter disconnecting device must still be installed, yielding no installation cost savings. Moreover, Mr. Salet's estimated installation costs for the visible-break isolation device is grossly overstated. In my personal experience, this device should not cost more than $250 to install (i.e., materials and labor), so the anticipated cost savings would be minimal.

Q. In Mr. Wallace's rebuttal testimony, he describes a detailed breakdown of the Connector DER management device and how it would be installed.[11] Do you have any issues with his description?

A. Yes. I have two concerns. First, his *Figure 1 of PPL Electric Exhibit MW-1R – Typical Connection Diagram*[12] is hardly typical – I have seen and inspected many hundreds of solar installations in Pennsylvania and have rarely seen one like this, where the inverter is mounted on the outside wall, next to the utility meter and the inverter is connected on the load-side of the electric panel. Most inverters mounted outside like this would be connected on the supply side (otherwise known as a "line-side connection"), similar to what is shown in Figure 2.

Second, there would be no need to route the conductors from the inverter through the wall at all. In fact, over recent years, most inverters are installed on the outside wall and are line-side connected to the service. However, in regard to this, sometimes it is impractical or impossible to mount the inverter on the outside wall near the utility meter and in fact it could be mounted far away from the utility meter, either inside or outside the facility. Consequently, I question how far the dongle can effectively communicate via Wi-Fi to the meter collar. In any event, in my opinion, PPL Electric should pay for the enclosure and the labor for installing the dongle if it does not fit inside the inverter housing. Issues like these

[11] PPL Electric St. 6-R, p.7.
[12] PPL Electric St. 6-R, p.7.

further support SEF's position that PPL Electric's Petition is premature.

Q. In Ms. Johnson's Rebuttal Testimony – Non-Propriety Version, she states, *"Further, the Company's use of the smart inverters' Volt/VAR, Constant Power Factor, Voltage Ride-through, and Frequency Ride-through functions is estimated to reduce the net metering load for a typical 6 kW residential solar system by only 8.9 kWh, resulting in an annual customer credit reduction of approximately $1.04…".*[13] Do you agree with this credit reduction estimate?

A. Not at this time. I would like to see more detail concerning how these values were determined. There are many factors and variations that go into power factor or volt/var settings, since they are not the same. More specifically, I would want to know the assumed settings used and other conditions considered to yield these results. I recognize that voltage and frequency ride-through functionalities are valuable to both PPL Electric on the distribution side, as well as the customer-generator , because it keeps the inverters connected during minor grid instabilities (i.e., enough of a slight change in service voltage or frequency to shut down the inverter). However, I believe that the vast majority of inverters are currently not temporarily shutting down too often without engaging voltage and frequency ride-through.

Q. In Mr. Salet's rebuttal, he implies that the sudden increases of solar power output due to dynamic weather changes or the re-energizing of service after an outage will cause power quality issues such as flicker or spikes in voltage.[14] Are his concerns warranted?

A. No. As I mentioned in my direct testimony[15], the impact on substations from

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[13] PPL Electric St. 7-R (Public Version), p.12.
[14] PPL Electric St 1-R, p.97.
[15] SEF St. 2, pp.12-13.

changes of the solar system power output due to clouds passing in front of the sun, will not be substantial. The transition of the increased solar irradiance occurs in a sweeping fashion across a solar array or many small solar arrays, such that the increased power output will happen over many seconds, if not minutes. In addition, the impacts regarding flicker are also overrated, according to Electric Power Research Institute's (EPRI) Technical Update report, "Flicker Measurements at Photovoltaic Plants," September 2018.[16] The EPRI study of five solar photovoltaic (PV) plants across the United States found that their contribution to flicker was insignificant. The study concluded that cloud-induced changes in PV generation occur too slowly to contribute to flicker.

In regard to the solar system impacts when the grid is re-energized after an outage, a solar system begins to synchronize with the grid after about 5 or more minutes, whereas it takes about 5 to 10 seconds or more for the inverter to reach its relative full power output. With many small inverters connected to a substation's distribution line, the powering up sequence would naturally be slightly staggered over several minutes. This would seem similar, but in reverse, with HVAC and refrigeration equipment and motors starting up in a staggered fashion after the grid is re-energized.

Q. Does this conclude your Surrebuttal testimony?

A. Yes.

[16] https://eprijournal.com/can-variable-solar-generation-cause-lights-to-flicker/.

AFFIDAVIT

I, Ron Celentano, certify that I am a consultant testifying on behalf of the Sustainable Energy Fund in this proceeding and that, in said capacity, I am authorized to and do make this Affidavit for it, that the facts set forth in the foregoing SEF St. 2-R are true and correct to the best of my knowledge, information and belief. I understand that false statements made herein are made subject to the penalties of 18 Pa. C.S. § 4904, relating to unsworn falsifications to authorities.

Ronald E. Celentano
Consultant

Dated: March 19, 2020

CERTIFICATE OF SERVICE
(Docket No. P-2019-3010128)

I hereby certify that a true and correct copy of the foregoing SEF Surrebuttal Testimony (SEF St. 1-SR & SEF St. 2-SR) have been served upon the following persons, in the manner indicated, in accordance with the requirements of 52 Pa. Code § 1.54 (relating to service by a participant).

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Date: September 23, 2020