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April 15, 2025

Via E-Filing

Rosemary Chiavetta, Secretary
Pennsylvania Public Utility Commission
Commonwealth Keystone Building
400 North Street
Harrisburg, PA 17120

Re: Petition of PPL Electric Utilities Corporation for Approval of its Second Distributed Energy Resources Management Plan, Docket No. P-2024-3049223; **Joint Solar Parties' Reply Brief**

Dear Secretary Chiavetta:

Please find attached for filing the public version of the Joint Solar Parties' Reply Brief.

The HIGHLY CONFIDENTIAL version will be filed with the Commission using its Confidential ShareFile site and will only be served upon Adiminsitrative Law Judge John M. Coogan and counsel who have executed appropriate Non-Disclosure Certificates pursuant to an appropriate Stipulated Protective Agreement or the Protective Order entered in this proceeding.

Copies will be provided as indicated on the Certificate of Service.c filing,

If you have any questions, please contact me at (202) 213-1672.

Respectfully submitted,

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Attachments

cc: The Honorable John M. Coogan (via e-mail; w/attachments)
Service List

CERTIFICATE OF SERVICE

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Dated this 15th day of April, 2025 /s/ Bernice I. Corman

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

Petition of PPL Electric Utilities Corporation for Approval of its Second Distributed Energy Resources Management Plan	: : :	Docket No. P-2024-3049223

REPLY BRIEF OF JOINT SOLAR PARTIES

Before Administrative Law Judge John M. Coogan

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April 15, 2025

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I. INTRODUCTION

The Joint Solar Parties ("JSPs") continue to urge this Commission to decline approval of PPL Electric's ("PPL's" or the "Company's") Petition for Approval of its Second Distributed Energy Resources ("DER") Management Plan ("Plan"), and to immediately terminate and not extend PPL's First DER Management Plan ("Pilot").[1]

> Although the rates of solar penetration in Pennsylvania are still quite low, and
>
> … certainly not enough to cause the kind of voltage fluctuations, two-way power flows or "duck curve" energy supply-demand imbalances that are starting to disrupt power grids in Hawaii, California, Arizona and other solar-heavy states…,

PPL has sought to "plan ahead for managing its future growth," and "forestall the kind of solar integration problems other more PV-rich utilities have experienced."[2] But to do so, PPL's Plan would require as a condition of interconnection that every DER across its territory submit to monitoring and active control by PPL and use only PPL-approved smart inverters in which PPL has installed a PPL-owned DER Management Device ("Device").[3]

PPL has failed to show that the high costs of its program produce benefits that outweigh the serious harms it causes. There is no other program in the country that eliminates customer choice to this degree; mandates utility control; invades customers' property; and takes customers' property (their DERs) without compensation, all as a condition of interconnecting. PPL's program increases costs, causes delay, blocks market entry of new products, and blocks competition by third parties who could do what PPL is doing more cost-effectively. PPL's program requirements exceed

[1] The Joint Solar Parties respectfully oppose the recommendation of the Office of Small Business Advocate (Proposed Ordering Paragraph No. 3) that the Pilot be extended, and an extension or freezing of the program.
[2] *See* gtm[2] , Jeff St. John, Oct. 16, 2020, Smart Inverters vs. DER Management Systems: Pennsylvania Utility Pilot Runs Them Head-to-Head.
[3] PPL's First DER Management Plan (or "Pilot") required the same for the first 3,000 DERs each year seeking permission to interconnect.

national and Pennsylvania standards (specifically IEEE 1547-2018 and 52 Pa. Code § 75.22), and PPL's program implementation (in particular, its method of Device installation) damages customers' inverters, voids customers' warranties, and violates National Electrical Code ("NEC") requirements.[4]

PPL's Plan cannot be fixed and should not be approved; and its Pilot should stop forthwith and not be extended. Thus, the JSPs urge the Commission to deny the Plan and terminate the Pilot. The JSPs additionally urge the Commission to order PPL to immediately cease requiring that inverters be tested for compatibility with PPL's Device as a condition for use; and to immediately cease installing its Device in a manner that does not comport with inverter manufacturers' UL-approved installation instructions. The Commission should not approve the method PPL uses to install its Device in SolarEdge inverters, and should require PPL to either replace SolarEdge inverters in which it has installed its Device, or establish a $2,000,000.00 fund to be used for replacement of SolarEdge inverters that have thermal damage, and in which its Device has been installed.

II. THE COMMISSION SHOULD DENY APPROVAL OF PPL's PROPOSED SECOND DER MANAGEMENT PLAN AS WRITTEN, BECAUSE ITS COSTS DO NOT OUTWEIGH ITS BENEFITS; PPL'S PROPOSED MODIFICATION IS NOT READY FOR A COMMISSION RULING

[4] 34 Pa. Code § 403.21(a)(1), the Pennsylvania Uniform Construction Code, adopts and incorporates by reference, *inter alia*, chapter 27 of the International Building Code of 2018. Section 2701.1 of the Code states that "[t]he provisions of this chapter and NFPA 70 (which is the National Electric Code ("NEC")) shall govern the design, construction, erection and installation of the electrical components, appliances, equipment and systems used in buildings and structures governed by this code." Section 90.4 of the NEC (entitled "Enforcement") provides: "(A) Application. This Code is intended to be suitable for mandatory application by governmental bodies that exercise legal jurisdiction over electrical installations … (B) Interpretations. The authority having jurisdiction for enforcement of the Code has the responsibility for making interpretations of the rules, for deciding on the approval of equipment and materials, and for granting the special permission contemplated in a number of rules." Over 90% of Pennsylvania's 2,562 municipalities have elected to administer and enforce the UCC locally. *See* Commonwealth of Pennsylvania, Uniform Construction Code (UCC); Administration and Enforcement of the UCC.

As indicated above, the Joint Solar Parties oppose PPL's Second DER Management Plan principally because PPL has failed to show that the high costs of its program will outweigh any benefits it may yield, particularly when weighed against the significant harms it has caused and will continue to cause.[5] Indeed, the harms the Second Plan will cause will dwarf the harms the Pilot already caused, inasmuch as the reach of the Second Plan is so much broader: PPL has proposed that it be pervasive (the Pilot's limit to 3,000 devices/year would be eliminated); permanent (Pilot duration was limited to three years); and all-encompassing (the Second Plan will be prospective and retroactive, reaching back to capture all DERs previously excluded from the Pilot).[6]

The Joint Solar Parties also oppose the modification PPL purportedly proposed in its Main Brief.[7] Specifically, on page 29, PPL "indicate[s] its willingness to explore cloud-based communications in lieu of its DER Management devices," stating that doing so "would significantly reduce the largest driver of costs in the cost-benefit analysis [$69.8 million of the $81 million] and only increase the benefit-cost ratio projected by the Company."[8]

PPL argues that based upon its prior experience setting up servers with JSP member Enphase, it "could seamlessly incorporate cloud-based communications through the Enphase modems into its ADMS/DERMS." *Id*., p. 36. PPL further declares its use of cloud-based communications would hold down costs, as it "would not require the procurement, installation and maintenance of a DER Management device." *Id*.

Finally, PPL argues that if the Commission gives the JSPs' claims "any credence," the proper remedy is not to deny approval of PPL's Second DER Management Plan and order PPL to

[5] *See* Main Brief of Joint Solar Parties, filed March 25, 2024 (hereinafter JSP Br."), p. 7.
[6] *See* JSPs' Br., pp. 23 – 24, where the JSPs address PPL's Plan's retroactive application.
[7] PPL's Main Brief, filed March 25, 2024, shall hereinafter be referred to as "PPL Br.").
[8] PPL Br., p. 29, *citing* PPL St. No. 1-RJ at 4-5, 14-15; PPL St. No. 10-R, Table SWW-2.

cease installing its Device in SolarEdge inverters, but rather, it is to direct PPL to use a different device, method of installation, or mode of communication (such as cloud-based communications), which PPL claims can be done at this stage of this proceeding. *See*, *Id*., p. 59, *citing Frompovich v. PECO Energy Co.*, Pa. PUC Docket No. C-2015-2474602 (Order entered May 3, 2018), which in turn cites a Recommended Decision from *Petition of PECO Energy for Approval of its Smart Meter Technology Procurement and Installation Plan* ("*PECO*"), Pa. PUC Docket No. M-2009-2123944 (Recommended Decision entered July 12, 2013).

The JSPs applaud PPL's acknowledgement that employment of the Enphase modem and cloud-based communications would be far more cost-effective than would further use of PPL's Device. *Id*., p. 29. Unfortunately, however, PPL's proposed alternative remains unreasonable, and the *PECO* case fails to offer useful precedent.

PECO involved PECO's petition for approval of Phase II of its smart meter universal deployment plan. During Phase I deployment, PECO experienced "several" events of meter overheating.[9] PECO proactively undertook corrective action, which included its suspending installation of additional smart meters while it investigated the events; replacing the installed smart meters with meters manufactured by another entity, such that by the time its Phase II plan was initiated, it had completed the change-out from the earlier generation of meters; and deferring cost recovery efforts associated with the meter overheating events, while PECO resolved issues with the meter vendor. *Id*. Further, Administrative Law Judge Angela Jones' recommendation that PECO's plan be approved rested in part on her concluding that as a matter of law, PECO's plan as

[9] *Id*., p. 9, *citing* PECO Statement in Support of Joint Petition for Settlement ("PECO Stmt. In Support"), n. 5.

modified by a settlement[10] found by Judge Jones to be in the public interest, complied with relevant law and the Commission's Phase I order in that case. *Id*., Conclusions of Law ¶ 3.

Here, the parties have not separately agreed that PPL's alternative remedy, as PPL has tentatively fashioned it, is necessarily in the public interest; and no record has been developed in support thereof. Indeed, unlike in *PECO*, the intervenors were not consulted or invited to discuss with PPL how to make its proposed alternative remedy workable. Thus, there are simply too many questions still unanswered – and an insufficient record for the Commission to evaluate -- to allow for a simple, *PECO*-like, mid-docket technology swap out.

For example, PPL has failed to state whether it intends to remain the sole entity able to actively control customers' DERs, albeit through the cloud, rather than to allow for a third party to do so;[11] whether PPL will ultimately find cloud-based communications to be adequate substitutes for its Device;[12] whether customers would be compensated for their DERs' provision of grid services; whether PPL would procure something from someone, such as procuring modems from Enphase,[13] or for the service of sending signals to its customers' inverters; whether PPL would agree to use of any additional cloud-based communications technologies (*i.e.,* apart from, or in addition to, the Enphase modem), and if so what the technical requirements would be to do so; whether customers' participation would be mandatory; how PPL proposed modification would address the issues raised by JSPs regarding PPL's program being a deterrent for third party aggregators looking to participate in the PJM wholesale electricity market; and whether PPL would

[10] The parties' settlement in that case covered a wide variety of topics including stakeholder processes, PPL's recovery of smart meter costs, and preservation of rights to challenge future cost recovery related to AMI meter overheating events. *Id*., pp. 5 – 6, 12

[11] *See* JSP Br., pp. 33 – 34.

[12] *See*, *e.g.*, PPL St. 1-RJ, pp. 14 – 15, where PPL notes its concerns with the Enphase modems' availability and associated costs, inclusive of the device and any ongoing cellular charges, and who would pay for those costs.

[13] *See also* JSP St. No. 6-SR, p.10, providing pricing for package including Enphase modem that can be installed by the customers themselves, as well as a five-year cellular plan, which price would likely be lower than listed in a negotiated bulk purchase order.

still require testing to determine if inverters allow for active management by PPL through a non-Device mechanism.

Additionally, unlike in *PECO*, PPL has stated nothing about whether it intends to recover the costs of a Device installed in a manner that caused thermal damage already and continues to pose a fire hazard. Nor has PPL indicated any willingness to explore use of any other device, mode of communication or method in lieu of its Device, such as inverters with application programming interfaces ("APIs"),[14] nor whether a prior record of setting up servers would be a predicate to PPL's doing so. To the contrary, PPL refused to compare the costs and benefits of use of any alternatives,[15] and indeed testified that to the extent it indicated willingness to explore alternatives in the future, it may still find them to be inadequate.[16]

Accordingly, the JSPs remain encouraged by PPL's non-committal "willingness to investigate use of cloud-based communications as an alternative to the DER Management Devices," but unified in their opposition thereto as PPL has presently framed it.

III. PPL HAS NOT REBUTTED THE JSPs' ALLEGATIONS CONCERNING THE ADVERSE EFFECTS OF THE DER MANAGEMENT PILOT PROGRAM AND SECOND DER MANAGEMENT PLAN

In its Main Brief at pp. 41 - 53, PPL identifies five areas in which it claims it has fully rebutted the JSPs allegations concerning the adverse effects of its Program requirements.[17]

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[14] JSP witnesses from Tesla (JSP St. No. 4SR, pp. 22 – 25) and Enphase (JSP St. No. 6, p. 21) provided testimony on the attributes of APIs, and instances of their use to monitor, or for third-party control by, DERs. JSP witnesses from SolarEdge also provided testimony on the cost-savings to be obtained through use of its inverter, which can automatically communicate with its built-in modem, eliminating the need for a DER Device or an AMI network to talk to the Device; and eliminating the need for the truck rolls and equipment costs associated with these installations. JSP St. No. 7-SR, pp. 22 - 23.

[15] *See* JSP St. No. 4SR, p. 31, where Mr. Graham cites to a PPL discovery answer conceding that PPL's cost-benefit analysis made no attempt to compare alternative policies. *See also* PPL Br., p. 6, conceding same.

[16] *See* PPL St. No. 1-RJ at 4-5, noting PPL's concerns with relying on Wi-Fi and ethernet connections if the download and upload speeds are insufficient.

[17] These are: the JSPs' allegations that the Program restricts options for DER (PPL Br., p. 42); that the Program increases the costs of projects, installations, and servicing DERs (PPL Br., p. 42); that Program requirements caused losses of sales and delays (PPL Br., p 43); that PPL's actions have voided customers' warranties (PPL Br., p. 44); and that PPL's method of installation is unsafe (PPL Br., pp. 44 – 53).

Troublingly, however, PPL fails entirely to discuss five sets of allegations that are of critical importance to the JSPs, thus failing to meet the burden on it of persuading the Commission that its program is reasonable, just, and in the public interest.[18]

First, PPL fails to address the JSPs' allegations that PPL's Program is anti-competitive, as it blocks third party aggregators from being able to offer more cost-effectively the same grid services over which PPL has made itself the monopoly provider.[19] Indeed, PPL's Main Brief does not once use the words "aggregation" or "aggregator" or the term "third party," which is stunning, given not only that the JSPs have put this issue front and center since they filed their July 9, 2024 Protest, Answer, and Petition for Leave to Intervene,[20] but also because PPL is well aware that the Commission has commenced a proceeding to prepare the Commonwealth for the participation of DER Aggregations in wholesale, energy, capacity and ancillary markets.[21]

Indeed, the JSPs note that in PPL's comments in that docket, PPL has taken pains to ensure that the Commission will preserve PPL's ability to compete with third party aggregators in the wholesale energy, capacity and ancillary markets.[22] This is the height of irony, given that PPL's program effectively blocks third-party aggregators from competing in PPL's market, whether inadvertently or by design. *See* JSP Br., p. 16, highlighting PPL's unfounded conclusions that no market exists for the provision of reactive power, and that even if a market did exist, that PPL believes the rights to manipulate reactive power and distribution system voltage management lie

[18] *See Todd Elliott Koger v. Duquesne Light Company,* Pa. PUC, Docket No. C-2023-3038703, pp. 6 - 7 (Order entered January 28, 2025) ("*Koger*").
[19] *See* JSP Br., pp. 17 – 18, where the JSPs argue that PPL's assertion that it should control is inconsistent with IEEE 1547-2018; pp. 33 – 34, where the JSPs highlight that PPL's failure to have evaluated use of third parties deprives the Commission of being able to assess whether PPL's monopoly is in the public interest; and pp. 48 – 51, summarizing testimony put forth by the JSPs on the Program's impacts on third-party aggregators, and how it undermines one of the purposes of standards, which is to level the playing field and promote competition.
[20] *See* Answer by American Home Contractors, Inc., et al., p. 5; Protest, ¶ 14.d.; and Petition to Intervene, pp. 9 – 10.
[21] *See Distributed Energy Resources Participation in Wholesale Markets*, Pa. PUC Docket No. L-2023-3044115, 19 (PPL Comments entered May 29, 2024) ("PPL ANOPR Comments").
[22] *See* PPL ANOPR Comments, 19, 29 - 30.

exclusively with the utility and "are inappropriate commodities for aggregation by third parties." *See also* JSP Br., p. 17, explaining why PPL's program also interferes with third parties' ability to aggregate, and customers' ability to access, the owners' DERs' real power capabilities.

As PPL's failure to even raise the issue appears to constitute its concession that its Program does in fact block third-party competition, the JSPs will not reiterate herein the arguments stated in their Main Brief on the topic, but note that PPL's election to ignore the topic is highly emblematic of PPL's lack of understanding of, or lack of concern for, the serious impacts of its Program on the JSPs, their customers, and the public interest. Indeed, in their Main Brief at p. 49, the JSPs had already commented that PPL seems not to have taken seriously during the course of this proceeding the JSPs' argument and proofs on the topic. PPL's failure to do so in its Main Brief confirms the unreasonableness of PPL's myopic, and not fully conceived, proposed program.

Second, PPL's Main Brief accords the JSPs' allegations that PPL's Device interfered with customers' power production one sentence (PPL Br., p. 43); and the JSPs' allegations that its Device interfered with customers' communications, zero sentences. Absent discussion in PPL's Reply Brief, the JSPs will understand these omissions to mean, again, that PPL has conceded its Device caused and will continue to cause both types of interference, including the events' duration, and the resultant losses to customers of the values of their DERs.[23]

Third, PPL's Main Brief barely addresses the JSPs concerns that PPL's program has been and will be mandatory. On p. 57, PPL provides only a hypothetical – PPL asks what would happen if there were a feeder on which there is extensive DER penetration causing a system problem, but

[23] The JSPs showed that in the 27 Tesla systems with Zigbee installed, one or more inverters lost communications for 6,933 days, or an average of 256 days/system, JSP Br., p. 44; Enphase systems lost 617 cumulative days of solar production downtime and 609 days of communications downtime, amounting to a loss of 18,410 kWh of solar power generation. *Id*., p. 47. JSP witnesses Sun Directed and Green Way Solar also testified to customers experiencing communications losses. *See* JSP St. No. 3, pp. 5 – 6, and JSP St. No. 10, p. 8, respectively.

no voluntary participants on that feeder in the program who will contribute to the problem's resolution. PPL concludes it would have no choice but to invest in an expensive infrastructure upgrade.

The Commission need not buy into PPL's false dichotomy and believe itself compelled to choose between either mandating universal control or expecting customers to forfeit reliability. However, PPL has tried to force this choice by failing to provide the Commission with any basis for finding, e.g., that it could not attract the "needed" amount of DER owners with the provision of appropriate incentives (JSP Br., pp. 22 and 24). Indeed, PPL has failed to even identify the amount of DER owners that are in fact "needed" in order to achieve its objectives. See, *e.g.*, JSP Br., p. 3, *citing* PPL St. No. 1-R, p. 17 (where PPL states without offering any support that "… reli[ance] on voluntary participation by a self-selecting group of customers to respond to price incentives will likely not achieve the goals of the Second DER Management Plan."); and JSP Br. p. 22, *citing* Exhibit JSP-NZ-1SR, PPL's response to an Office of Consumer Affairs discovery request in which it acknowledges it did not even seek to identify such level, having found instead "that monitoring and active management have already become desirable and cost-effective and will provide significant benefits." The JSPs maintain that if PPL is capable of figuring out the value of its program, it is capable of figuring out the levels of incentives necessary to implement it. *See* JSP Br., p. 24.

PPL's discussion on pp. 58 – 59 of its Main Brief also demonstrates a lack of serious attention to a fourth set of JSP allegations – that PPL's is the only program in the country that has seized the services provided by customers' DERs without compensating them for same. As PPL's Brief raises little that is new, the JSPs respectfully refer the Commission to pp. 22 and 24 - 26 of the JSPs' Main Brief.

However, the JSPs take issue with PPL's comment that the JSPs purportedly failed to put forth an aligned compensation proposal. To be clear: first and foremost, and especially in light of PPL's steadfast opposition to including any compensation scheme in its proposed plan, the burden was not on the JSPs to put forth such scheme,[24] rather, the JSPs' burden – which they met, was to show that a plan lacking such scheme is not reasonable, just, or in the public interest,[25] and indeed, that PPL's premise – that it may "take" customers' property without compensation, amounts to an unconstitutional deprivation of customers' property interests.[26] Second, if PPL were to finally acquiesce to including a compensation component and to making customer participation voluntary – which the JSPs showed would finally bring PPL in line with every single other utility program of its kind in this country[27] – that the appropriate mechanism with which to define the scheme would be, at a minimum, by conducting a stakeholder process, as did PECO in making its mid-docket modification. Finally, notwithstanding the foregoing, the JSPs put forth ample evidence of compensation schemes – including an example of compensation to customers for their DERs' provision of reactive power,[28] as well as an example of compensation to DER owners who voluntarily submitted to active control by a utility.[29]

Finally, PPL's Main Brief says nothing in response to the JSPs' allegations that PPL's method of installation violates the NEC. Indeed, it says nothing at all about the NEC, except to state repeatedly that its expert is an expert in the NEC. Nevertheless, PPL's proposed conclusions of law ("COC") boldly ask that this Commission find as a matter of law that the Commission is

[24] *See Koger*, pp. 6 - 7.
[25] *See* JSPs' Br., p. 25, explaining that, *inter alia*, PPL's seizure of the DERs' reactive power to resolve grid voltage problems for which they are not the cause underscores that they are providing a grid service deserving of compensation.
[26] *See* JSP Br., pp. 15 – 16.
[27] *See*, *e.g.*, JSP St. No. 8-SR, p. 8, *citing* Green Mountain Power and Duke programs that are also voluntary and provide significant compensation for participating customers. *See also* JSP St. No. 9, p. 10.
[28] *See* JSP St. No. 7, p. 24.
[29] JSP St. 1, p. 24, *citing* a California program piloting active control using volunteers and providing compensation.

the authority that has jurisdiction over PPL's Management Devices and their installation (PPL COC ¶ 11); and that PPL's Devices need not comply with the NEC because they are authorized by the Commission (PPL COC ¶ 12). Further, its proposed ordering paragraphs request that the Commission approve PPL's Device and PPL's method of installation (PPL POP ¶ 3).

The JSPs will discuss below, why, as a matter of substance, the Commission should decline to make PPL's requested conclusions of law or issue the requested order. However, the JSPs urge the Commission to also find that, in light of PPL's failure to even state an argument on NEC compliance and/or Commission jurisdiction, PPL has failed to meet its burden on demonstrating NEC non-applicability. The JSPs strongly urge the Commission to be aware that even though PPL admitted it did not provide its installation instructions to the Commission in the prior docket,[30] it has nevertheless maintained that Commission approval of its Pilot meant that the Commission "approved" the very installation method that the JSPs maintain violate NEC requirements, cause customers' warranties to be voided, and most significantly, causes thermal damage to units installed in customers' homes. PPL St. No. 12-RJ, pp. 16; PPL St. No. 12-R, p. 6.

Turning now to the JSPs' allegations that PPL does address:

a. PPL's Pilot Restricted, and its Proposed Plan Will Restrict, Market Entry, and Constrict Customers' Choices

On p. 42, PPL erroneously identifies Tesla as the only inverter manufacturers it has blocked from market entry. However, PPL also has limited six manufacturers to single-inverter installs. In so doing, PPL either betrays its fundamental misunderstanding as to the way the IEEE standard operates or intentionally misleads the Commission as to the breadth of the adverse effects of its program.

[30] *See* Exhibit JSP-JB-13SR (PPL Vice-President Sal Salet's Answer to JSP-IX-3(a))); *and* JSP St. 7-SR, p. 10.

i. PPL Overstates the Abundance of Options on its Approved Smart Inverter List

PPL's denial that its Program has "restricted inverters and projects" on grounds, PPL claims, that it has approved 315 inverters for use in its territory[31] is misleading; out of touch with how the solar industry operates; inconsistent with Pennsylvania requirements; and simply false.

Critically, PPL fails to make clear that out of the 315 inverters on its Approved Smart Inverter List, PPL has restricted use of ***45*** of them to single-inverter installs. *See* PPL's Approved Smart Inverter List (Exhibit AD-1R), denoting in red font multi-inverter prohibitions on 41 inverters.[32] Thus, at best, PPL has permitted unrestricted use of only ***270*** inverters in its territory, not ***315***.

However, and leaving aside for the moment that PPL's restrictions on 45 inverter models are unreasonable (discussed immediately below and extensively in the JSPs' Main Brief),[33] PPL significantly misleads this Commission in arguing that it has only restricted use of 45 inverter models from ***6 manufacturers*** (EG4 Electronics; Fortress Power; Goodwe Technologies; Lux PowerTek; Mango Power; and Tigo Energy).

For example, PPL fails entirely to inform the Commission that on December 15, 2022, and March 21, 2023, PPL informed Tesla it would deny permission to operate ("PTO") to multi-inverter Tesla installations using inverters manufactured by ***two additional manufacturers,*** Delta and SolarEdge, respectively. *See* Exhibit JSP-JG-3 and PPL Exhibit AD-10R regarding Delta and Exhibit JSP-JG-4 (HIGHLY CONFIDENTIAL) regarding Delta and SolarEdge.[34] In other words,

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[31] PPL Br., pp. 41-42.

[32] Please note that PPL's Approved Smart Inverter List, PPL Exhibit AD-1R, which is dated "2024-10-14" restricted only 41 inverter models to single-inverter installations. On the current list available on PPL's website and dated February 17, 2024, the number of restricted inverters has grown to 45. A hard copy of PPL's current Approved Smart Inverter List is attached hereto as Appendix A.

[33] In Section III of their Main Brief, the JSPs discussed extensively that these restrictions exceed IEEE requirements, and Pennsylvania law that incorporates IEEE requirements, and are therefore unreasonable.

[34] JSP Br. n. 28 contained a typo. The reference to JSP-JG-3 should have been JSP-JG-4.

PPL restricted use of two more manufacturers' inverters than it has informed this Commission or the public by informing an installer it would deny PTO, rather than using the more visible channel of publishing restrictions on its Approved Smart Inverter List. PPL stated it would deny PTO because it claimed it was unable to make its Device communicate with Delta and SolarEdge multi-inverter installs using a Zigbee communications module,[35] even though these inverters were approved by PPL for unrestricted use. *See* PPL's Approved Smart Inverter List, PPL Exhibit AD-1R, showing the Delta and SolarEdge inverters without restrictions.

The JSPs again note that to this day, PPL has still failed to acknowledge that the Zigbee modules it alleged were interfering with its Device's communications were either installed by Delta and SolarEdge in, or were recommended for use by, the very manufacturers whose inverters it approved for use in its territory.[36] In other words, although the installer had done all it could to comply with PPL's Program (*i.e.,* purchased only those inverters PPL approved after PPL tested them for compatibility with its Device, and used only the components in the inverters that the PPL-approved manufacturers specifically intended be used), PPL could not in fact make its Device work with the inverters it approved. JSP Br., p. 45. This forced the installer to reduce the sizes of four systems from those which its customers had ordered.[37]

Further, due to PPL's informing it that it would deny PTO for multi-inverter projects, this installer also rejected or re-designed (i.e., down-sized) customers' orders not yet in the pipeline, in other words, the installer curtailed further multi-inverter projects permanently, resulting in

[35] *See e.g.*, PPL Electric Exhibit AD-10R (December 2022 and February 2023 emails re PPL limiting Tesla installations of multi-inverter solar systems using Zigbee in Delta and SolarEdge inverters).
[36] *See e.g.*, Exhibit JSP-JG-2 (photo of SolarEdge product label showing SolarEdge ships Zigbee modules to customers in the same package it ships its inverters). *See also* JSP St. No. 4, n. 4, providing Delta's product webpage, which lists Zigbee as a feature of Delta's M Series of solar inverters.
[37] Tesla showed that PPL's restrictions resulted in customers being forced to reduce the size of the solar systems compared to what they originally ordered, 4 systems, reduction by 37.6 kW-AC. JSP St. No. 4-SR, p. 15; FOF ¶ 190.

significantly less total solar being deployed in PPL territory,[38] losses in revenues as a result of restricting sales to smaller projects,[39] and customers who were displeased because they were unable to install the systems they wanted. JSP St. No. 4, p. 15.[40]

Thus, the addition of SolarEdge and Delta to the list of 6 manufacturers whose inverters are restricted for use in PPL territory brought the total to 8, not 6, or ***more than one third*** of all inverter manufacturers on PPL's approved list, making PPL's claim that it doesn't restrict inverters or projects ring hollow. And those are only the restrictions about which the JSPs have first-hand knowledge.

As explained in the JSPs' Main Brief at pp. 44 - 47, after between two and three years of effort – during which time customers were denied the full value of the systems they were permitted to install, PPL and the installer finally found ways to resolve the communications problems experienced in these systems using Delta and SolarEdge inverters. Thus, in addition to these data showing that PPL misleads in its claims as to numbers of inverter "options" available in its territory, these data also illustrate the complexities PPL's program poses of doing business in PPL's territory, largely due to PPL's not fully understanding the products it is attempting to regulate, or the full impacts of its program on how those products operate, in particular, in conjunction with PPL's

[38] Tesla testified that PPL's restrictions on multi-inverter installs effectively limited it to installing solar systems sized at the largest single SolarEdge and Delta inverters that Tesla sourced: 11.4 kW-AC output for SolarEdge and 9.6 kW-AC for Delta. JSP St. No. 4-SR, p. 15.

[39] JSP St. No. 4, p. 15.

[40] In rebuttal testimony, PPL disputed that Tesla's down-sizing of projects were driven by PPL's restrictions, arguing that Tesla did so after PPL lifted its restriction. PPL St. No. 2-R, pp. 23 – 24. As Tesla witness Jordan Graham responded in JSP St. No, 4-SR at p. 15, Tesla disputes that the restriction was in fact lifted, since it was contingent upon PPL's requiring that Tesla devise a bespoke software patch to fix the problem, which Tesla did not and could not do, because the interference with communications had not been resolved. Further, as may be seen in PPL Exhibit AD-10R, PPL's supposed narrowing of its restriction pertained to installations using Tesla inverters, not SolarEdge or Delta. As the JSPs explained in their Main Brief (JSP Br. pp. 44 – 47), PPL ultimately discovered solutions provided by the inverter manufacturers, which meant that PPL's conditions on Tesla installations were unnecessary from the start, and were certainly not due to any wrong-doing by Tesla.

Device. And this is but one example of why the JSPs argue that PPL should simply not be permitted to interfere on the customer side of the meter.

As importantly, PPL misunderstands how the solar industry operates, which also renders its purported abundance of installer "options" meaningless.

Critically, as the JSP installers testified, installers have long-established relationships with vendors and/or with the manufacturers themselves, who sell them products they use in multiple jurisdictions, making it infeasible for them to simply shift products just to meet PPL's bespoke program requirements. *See*, *e.g.*: JSP St. No. 5-SR, pp. 7-8, where Trinity Solar testified:

> [W]e generally obtain significantly reduced prices for our customers through direct negotiations with the manufacturers. But because we are limited by the Pilot requirements as to the purchases of the inverters that we're using in PPL's territory, we are paying more."

See also JSP St. No. 3-SR, p. 6, where Sun Directed testified it cannot shift to Delta inverters, which PPL argued were satisfactory alternatives (PPL St. No. 2-R, p. 22), because Sun Directed's suppliers don't carry them. Finally, *see* JSP Br., pp. 38 - 42, explaining, *e.g.*, that the increased labor and equipment costs required for PPL-approved inverters; that the approved inverters' non-American origin; and the PPL-approved inverters' lack of proven performance record, or comparable brand recognition,[41] also render use of PPL's purported abundant "options" illusory.

It is this standard installer business model – in which installers negotiate prices, buy in bulk, and pass those savings on to their customers, that PPL has made untenable in its territory. Again, the JSPs offer this as further evidence that PPL simply does not understand the impacts of its program on the customer side of the meter.

PPL also erroneously stated (PPL Br., p. 42) that the only inverter manufacturer blocked from market entry as a result of its Program, in addition to the 6 manufacturers discussed above,

[41] JSP St. No. 5, p. 3.

is Tesla.[42] However, this statement fails to account for the fact that PPL's pilot has also deterred solar installers from conducting business in its territory. As PPL itself noted in its testimony, Sunrun, Inc. ("Sunrun"), one of the major installers in the U.S. market, has also "opted out" of doing business in PPL territory. PPL St. No. 2-R, p. 33. PPL claimed Sunrun wouldn't have qualified to interconnect to PPL's grid anyway because it is not IEEE 1547-2018 compliant, but offered no evidence to support that damning assertion. Regardless, the JSPs highlight this aspect of PPL's testimony to point out PPL's awareness that at least two of the country's leading actors in the solar industry do not wish to do business in PPL territory. The JSPs respectfully submit more will follow suit if PPL's Plan is approved.

As to Tesla, Tesla witness Jordan Graham testified that Tesla bases its decisions as to where to sells its products based on the values, costs and customer experience associated with doing business in a given region or territory. *See* JSP St. No. 4, p. 22.

Whether or not PPL or this Commission agree with Tesla's and Sunrun's business decisions, the undeniable fact is that PPL's restrictions are causing solar installers to cease business in PPL's territory and preventing Pennsylvanians from being able to access products they may choose – which are cost-effective and innovative products that have been certified as meeting IEEE 1741 and UL 1547 SB,[43] in other words, that may be used everywhere else in the country, including everywhere else in Pennsylvania except PPL territory.

ii. The Restrictions that Are Visible on PPL's Smart Inverter List are Unreasonable

Regarding the six manufacturers, PPL purports to justify its restrictions thereon, stating:

[42] *See* PPL Br., p. 42.
[43] *See* JSP Br., pp. 43 – 44, summarizing AHC testimony as to reasons its customers choose products PPL has prohibited.

> [T]here is a clear reason why – as these manufacturers have publicly stated that these inverters cannot be networked, which would cause these inverters to be noncompliant with SunSpec Modbus Communication protocols.[44]

PPL's statement fundamentally misstates IEEE 1547-2018's compliance requirements, displaying either PPL's gross misunderstanding, or willful disregard, of the standard, or both.

A networked system is a multi-inverter system in which instead of PPL installing one of its Devices in each inverter and communicating with each inverter directly, PPL connects to all inverters in a "daisy chain" and requires that all the other inverters in the multi-inverter system respond to commands from the single PPL Device.

As was set forth previously, an ability to be networked is not a requirement of inverter certification to the IEEE standard. *See* JSP In. Br., pp. 8 - 9[45], 10[46] and 13[47], explaining that IEEE 1547-2018 requires that each inverter have an interface capable of communicating with someone or something, which can be either communicating with the utility, *or* communicating with another entity. IEEE does not require that inverters be able to be "daisy chained" so as to spare PPL from having to install one Device per inverter in a multi-inverter install in order for PPL to control each inverter.[48]

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[44] PPL Br., p. 42. *See also* JSP Br., p. 13, *citing* PPL's Smart Inverters and DER Pilot Management Requirements (Updated 2/17/2025), "Requirement for Networking Multiple Inverters." *See also* Hrg. Tr. p. 342 (where Ms. Dombrowski-Diamond explains that to be approved for use in PPL territory, inverters must "have a network system and be able to communicate to inverters along the chain with a mod ID of two plus."); *and* PPL St. No. 2-R, p. 24.

[45] *Citing* the IEEE 1547-2018, Sec. 3.1, definition of "interoperability" as "[t]he capability of two or more networks … to externally exchange and readily use information ... "

[46] *Citing* the 1547-2018, Section 3.1, definition of a local interface.

[47] *Citing* the IEEE 1547-2018, Sec. 10.1, requirement that a system/inverter have at least one interface; and Section 1.4, that makes clear that "th[e] standard does not determine the communication network specifics nor the utilization of the DER provisions for a local DER interface ..."

[48] *See* JSP Br., p. 16, *citing* PPL's Smart Inverters and DER Pilot Management Requirements (Updated 2/17/2025) webpage, Frequently Asked Questions, which states that PPL's purpose in requiring networking is to limit the number of devices it needs to install so as to stay under the cap of 3,000/year, as well as "to keep installations as aesthetically viable as possible."

As PPL correctly notes,[49] IEEE 1547-2018 requires that inverters be able to follow one of three communications protocols, and SunSpec is one of those three. All the inverter models designed by the six manufacturers at issue were certified as compliant with IEEE 1547-2018, which means that each had at least one interface capable of communicating using at least one of the three communications protocols. Thus, all the inverter models meet Pennsylvania and IEEE standards, and are not "non-compliant with SunSpec Modbus Communication protocols," as PPL expressly stated in its Brief on page 42.

Nor have these inverter models' compliance status changed with passage of time, nor need they do so. In June, 2024, SunSpec issued a "Certification Specification" that PPL claims clarified whether an inverter needs to be capable of being networked in order to be compliant with SunSpec.[50] PPL's clear implication here is that as of June, 2024, PPL received official support for PPL's rejecting inverters that cannot be networked. *See* Hrg. Tr., p. 184, where PPL's expert, Jay Johnson, testified: "That has been added in June 2024 to make it clear to any DER vendors that they need to have that capability."

This is wrong. IEEE 1547.1 still does not require that an inverter receive certification by any of these protocol developers, such as SunSpec Certified™, or to any developer-produced test protocols, such as the SunSpec Modbus Conformance Test Procedures. *See* IEEE 1547.1 (2020), Section 2, identifying as one of the "Normative references" that are "indispensable for the application of [IEEE 1547.1(2020)," only the SunSpec DER Information Model Specification, published on July 15 of 2019, available at https://sunspec.org." *See also*, *Id*., at Section 6.8.1, entitled "SunSpec Modbus usage," which states:

[49] PPL Br., n. 21.
[50] The Certification Specification added a Broadcast test and Device Address write for RTU, single register write test, single register read test, and rejection tests.

> SunSpec information models are organized based on logical information content. The information models that contain the required IEEE 1547 content are described in [IEEE 1547.1] 6.8.1.1 through 6.8.10. The version of each SunSpec information model is represented by the information model ID. When a SunSpec information model is approved, the content associated with that information model ID will not change.

Thus, IEEE 1547.1 (2020) does ***not*** require certification to a later-issued SunSpec Certification such as the June 2024 Certification Specification; and PPL is wrong that the 46 inverter models' inability to be networked caused or causes them to be noncompliant with either SunSpec Modbus Communication protocols ***or*** with IEEE 1547-2018.[51] Indeed, this was admitted by Mr. Johnson in the Hearing. *See* Hrg. Tr., pp. 186 - 187, where he testified that an inverter retains its UL compliance certification, in other words, its UL 1741 certification that it has communication capabilities that conform to SunSpec's communications protocol, whether or not the IEEE 1547-2018 standard changes, or a protocol developer such as SunSpec later issues a new test procedure containing specific testing requirements.

Accordingly, PPL's prohibition on these manufacturers' inverters being used to interconnect multi-inverter installations exceeds Pennsylvania's requirements that they be certified to 1547 and UL 1741. Further, absent a change to IEEE 1547.1, no inverter model will ***ever*** be required to meet the June, 2024 SunSpec Certification in order to be compliant with IEEE 1547-2018 and UL 1741, and PPL will exceed Pennsylvania requirements if it continues to restrict additional inverter models to single-inverter installations on grounds that the inverter cannot meet PPL's requirement that it be able to be networked. Inverter manufacturers may opt to voluntarily certify to other items like the SunSpec Modbus June, 2024 Specification, but satisfaction of it is not required in order for an inverter to be NRTL-certified as IEEE 1547/UL 1741 SB compliant.

[51] *See* Hrg. Tr., p. 342, where PPL's Aliesha Dombrowski-Diamond testifies that PPL declines approval of inverters that cannot be networked not because they cannot comport with PPL's communication protocols, but because they do not comport with "the IEEE SunSpec Modbus communication protocols." As explained above, PPL is doing so erroneously.

In short, PPL's assertion it is justified in requiring that inverters be networked as a condition of approval is simply a misstatement of and misuse of IEEE 1547 requirements (and Pennsylvania law). It is precisely this feature that makes PPL's program unreasonable, and will continue to be unreasonable, so long as PPL is authorized to continue to assert that its interpretation of IEEE compliance (through its insistence on compatibility testing with its Device) trumps NRTL certifications. The danger is not hypothetical, as is illustrated by this real world example, as well as the fact that IEEE 1547-2018's communications requirements have many more gaps than the one that was at issue for these 6 manufacturers[52] that will be susceptible to differing interpretations as between PPL and the NRTLs.

b. PPL's Pilot Increased DER Costs in PPL Territory; its Second DER Plan Will Also Chill Investment in DERs in its Territory

PPL argues that the JSPs' allegations about increased costs due to its Program are unsupported and that their contentions about how approved inverters are not cost-effective were based on flawed and misleading analyses and were directly refuted by publicly available information about the inverter costs. PPL Br., p. 42.

To the contrary, the JSPs provided robust support for their position that PPL's program has increased costs. *See, e.g.*, Br., pp. 38 - 39, and 41, where the JSPs explain why, when demonstrating that the prices of approved inverters far exceeded the prices of non-approved inverters, neither Sun Directed nor Trinity compared the prices of like technologies; and pp. 40 - 42, explaining that Trinity's estimates of its substantial losses were based on the higher prices of the approved inverters and the higher labor costs associated with installing the approved inverters, as well as the additional man-hours, personnel and truck rollouts uniquely associated with installing and

[52] *See* JSP FOF ¶¶ 41 and 42, regarding the Electric Power Research Institute's identification of 26 gaps in the interoperability portion of IEEE 1547-2018, and PPL's own identification of gaps it discovered when testing inverters in its DER Lab for compatibility with its Device.

servicing installations containing or potentially containing PPL's Device; and pp. 41-42, explaining that Trinity's price comparisons employed assumptions based on Trinity's real-life experience sizing equipment for the "average installations" seen by Trinity in the field, as well as and the prices of "non-optional" components required to make the approved inverter operational. (PPL had inaccurately opined that Trinity had erroneously included the prices of "optional" components. PPL St. No. 2-RJ p. 22.)

Trinity also pointed out, and PPL has never refuted, that:

> …[b]ecause PPL is [Trinity's] largest territory, and to streamline and make less expensive [its] overall purchases, [Trinity] purchase[s] the same equipment for use in PPL territory that [it] will use as well elsewhere in Pennsylvania.

Id. Thus, because of the typical installer business model described by Trinity's Russell Pierson, PPL's restrictions are having the perverse effect of dictating Trinity's purchasing decisions outside of PPL territory, *see* JSP St. No. 5-SR, p. 3, which means that PPL's program is driving up the costs of Trinity's doing business outside of PPL territory as well as within it. *See* JSP St. No. 5-SR, pp. 7-8.

Under the rubric of "increased costs," PPL also argues that Enphase was not excluded from the PPL market for the four months the JSPs allege; that Enphase was excluded for only five weeks due to Enphase's purported failure to provide all the required documentation; and that PPL approved Enphase's inverters two days after receipt of Enphase's documentation. PPL Br., pp. 42 - 43. PPL also claims it helped Enphase develop "the IEEE 2030.5 Client" so Enphase inverters could be certified to the IEEE 1547-2018 2030.5 communication protocol standard, which, PPL claims, Enphase would have had to do anyway. PPL St. 2-R, p. 32.

PPL again grossly misstates the facts. In support of the JSPs' claim that Enphase was blocked from the market for four months, not five weeks, Enphase witness Marc Monbouquette testified that PPL's Pilot program requirements were not communicated effectively; that the short

turn-around time between the Commission's approval of the Pilot (November 17, 2020), and the Pilot's effective date (January 1, 2021) was inadequate for manufacturers to complete all testing and onboarding work with PPL to get on its Approved Inverter List in a timely manner, JSP St. No. 6, pp. 4 – 5; and most importantly, that PPL failed to convey the full extent of the barriers its program would impose on even a sophisticated manufacturer such as Enphase, which at the Pilot's inception, was seeking PPL approval of Enphase's 39 smart inverter product variants.

As explained in the JSPs' Main Brief,[53] and as Mr. Monbouquette explained in testimony, PPL initially demanded that all inverter products be capable of communicating through DNP3 or SunSpec Modbus, because PPL had not yet completely integrated IEEE 2030.5 into its own AMI network.[54] Thus, it took three months of lab work for PPL to eventually agree to using the IEEE 2030.5 interface Enphase had already productized per California's Rule 21 requirements. *Id*. But to assist PPL in launching its IEEE 2030.5 server, Enphase had to "sen[d] free equipment to PPL's lab and provid[e] remote support to PPL." Thus, the complete "approval" process took an additional three months of lab work, troubleshooting and debugging to ensure PPL's commands were working as intended, in other words, a full three months after PPL approved Enphase's inverters for inclusion on its Approved Smart Inverter List, before PPL would grant permission to interconnect to systems using those inverters.[55]

Further, PPL's claim it helped Enphase do what Enphase was required to do anyway to meet the IEEE 1547-2018 2030.5 standard is just patently false. Enphase had been in possession of Sunspec Common Start Inverter Profile ("CSIP") certification since December 17, 2019, which

[53] *See* JSP Br., pp. 42 – 44, providing 3 additional examples of PPL's program blocking market entry (as to SolarEdge, Tesla products, and the 46 inverters limited to single inverter installs.
[54] 1547-2018 requires that inverters be able to follow IEEE Std 1815 (DNP3) ***or*** SunSpec Modbus, ***or*** IEEE Std 2030.5. *See* PPL Electric St. No. 2-RJ at 37.
[55] *See Id*., pp. 5 – 6, JSP Br., pp. 42 – 43, and FOF ¶¶ 174 – 178, summarizing Enphase's losses during the four-month period.

means Enphase was certified as compliant with IEEE 2030.5 communications requirements more than a year before PPL even launched its IEEE 2030.5 server.[56]

In testimony, PPL cast aspersions on Enphase's purported inability to quantify the revenue impact of the four-month delay that had occurred three-and-a-half years prior to the date Mr. Monbouquette submitted his pre-filed testimony. PPL St. No. 2-R, p. 32. Enphase's inability to do so today has little bearing on Enphase's claim it incurred losses, as Enphase is not seeking today to prove and recover damages from PPL for its losses. Rather, Enphase made these allegations, as did the other JSP manufacturers, primarily to highlight that while they may have been able to withstand the losses inflicted by PPL's onboarding requirements, other, smaller manufacturers may not be able to do so as the price of doing business in PPL territory. JSP St. No. 6, p. 7.

More broadly, small and large manufacturers alike may conclude that PPL's expectation that manufacturers perpetually engage in lengthy and expensive troubleshooting as the price of operating under PPL's Program – which expectation continues to this day -- makes operating in PPL territory a losing business proposition. *See*, *e.g.*, JSP St. No. 4-SR, p. 11 (regarding Tesla's three years of troubleshooting communications problems in multi-inverter installs), *and* JSP St, No. 6-SR, pp. 2 – 3 (regarding another recent troubleshooting exercise required of Enphase this past summer to resolve newly occurring communications disruptions). Indeed, PPL's unrealistic expectation that the solar community should essentially bear the costs of PPL's engaging in its grand experiment – which PPL will rate-base -- have infected the program since its inception. *See*, *e.g.*, Joint Solar Parties' Findings of Fact ("FOF") ¶¶ 14 – 15, noting that PPL's Pilot approval rested on PPL's "proactively" requiring testing in accordance with a standard (UL 1741 Supplement B) that had yet to become effective. And DER manufacturers had to contort

[56] *See* JSP St. 5-SR, p. 9; *and* Exhibit JSP-MM-3SR (Enphase's CSIP certification).

themselves into demonstrating to PPL that they were already able to meet a standard that was not yet effective because otherwise, PPL would deny them an ability to do business in its territory, and/or deny their customers PTO.

The JSPs' Main Brief explained the significant resources SolarEdge dedicated on educating PPL that SolarEdge inverters already contained the capabilities that would be required in the then-not-yet-effective UL 1741 SB. *See* JSP Br., p. 43; and JSP St. No, 7, p. 4. However, the JSPs wish to respond herein to at best unsupported, and at worse, blatantly erroneous, charges made by PPL in testimony – that PPL's delay in approving SolarEdge inverters was due to "Solar Edge having done the minimum to be certified, but did not maintain the work needed for inverters to follow the protocols," or to "SolarEdge needing to bring its inverters back into compliance with UL 1741 SA." PPL St. No. 2-R, pp. 35 and 52. PPL's sole support for those incendiary statements was PPL Exhibit AD-22R (HIGHLY CONFIDENTIAL). However, that exhibit does *not* show that SolarEdge was ever non-compliant with UL 1741 SA. If anything, that document only shows that despite SolarEdge's having been certified to UL 1741 SA, PPL disbelieved it could rely on the NRTL certification, and kept asking SolarEdge to "re-prove" its compliance status.

In this regard, PPL's views have not changed (*see e.g.* Hrg. Tr., p. 369, where PPL is still stating its belief that NRTLs "g[e]t it wrong" when they certify inverters as meeting IEEE 1547-.1 and UL 1741 SB).[57] Again, this is a feature of PPL's program that makes doing business in PPL territory untenable – that PPL is subjecting inverters to its own DER Lab testing because PPL disbelieves or doubts the quality of NRTL certifications. Not only does PPL's approach block market entry in PPL territory, it turns the entire NRTL certification process on its head.[58]

[57] *See also* JSPs' Br., p. 14 for additional examples.
[58] *See* JSP Br., p. 15, explaining that the very purpose of NRTL certification (also a cornerstone of Pennsylvania requirements) is to ensure IEEE 1547-2018's uniform standards are met; and that the value of the certification system rests upon its reliance on testing and oversight by a NRTL.

The JSPs also note that PPL has essentially recanted its claim that it takes it on average two weeks to approve inverters. *See* PPL Petition, ¶ 25. On the JSPs showing that, based on PPL's own discovery responses, on average, it takes PPL roughly 4.6 months to approve inverters, and in some instances, up to 798 days,[59] PPL updated its position to state that on average, its approval takes 38.14 days, or about 1 and a half months (PPL St. No. 2-RJ, p 18), a timeframe the JSPs respectfully submit is still significantly understated.

The JSPs respectfully submit it is unreasonable of PPL to expect the whole DER community – manufacturers, installers, and customer/ratepayers, to lose value, let alone opportunities to deploy more solar and storage throughout the Commonwealth, so as to permit PPL to continue with its expensive and soon-to-be rate-based grand experiment.

c. PPLs' Program has Caused and Will Cause Delays, Resulting in Losses to Installers, Manufacturers and Customers

Third, PPL summarily dismisses AHC's, Sun Directed's, Tesla's, SolarEdge's and Green Way's claims that PPL's Program has resulted in delays that have caused installers and customers to endure losses, and installers to lose sales and revenues, citing only its rebuttal testimony. The JSPs' amply supported their claims on pp. 37 – 43 of their Main Brief.

However, presumably because PPL suspects it will not be able to counter the JSP witnesses' testimony and evidence that they lost sales and revenues, PPL attacks the JSP witness' credibility. *See*, *e.g.*, PPL Br., p. 43, where questions the "reliability" of AHC witness Nicolas Zavala's lost sales data based on PPL's disputing whether 6 of 52 lost sales were indeed in PPL territory (and effectively conceding that AHC lost 46 sales). *See also* PPL Br., p. 44, in which PPL continues to assert Mr. Stahlman's claims of delays in receipt of PTO were due to missing signatures on the

[59] JSP St. No. 7, p. 7.

certificates of inspection, despite the clear evidence showing the presence of all required signatures.[60]

PPL's commentary should be regarded as gratuitous, given that PPL has to date made no formal effort to disqualify these JSP witnesses, strike all or portions of their testimony, or ask for an offer of proof regarding their testimony.[61] Further, and most importantly, the findings of fact and conclusions of law related to whether PPL has shown its program is reasonable, just, and in the public interest will not turn on whether AHC lost 56 or 62 sales, or by how many days PPL delayed in granting PTO. Neither of these JSP witnesses nor any other JSPs are seeking damages from PPL for losses attributable to PPL's program, and thus, they are not needing to prove their harms with a preponderance of the evidence.[62] Thus, PPL's commentary as to these witnesses' credibility should be disregarded.

d. PPL Grossly Misleads in Claiming that SolarEdge has Inappropriately Denied Warranty Claims

In its latest recitation of this argument (p. 44), PPL again overlooks that although it was PPL's unauthorized, non-NEC compliant, and dangerous method of connecting its Device to SolarEdge inverters that voided SolarEdge's customers' warranties, SolarEdge has voluntarily replaced the inverters at no cost to its customers.[63] Thus, it is PPL's actions that have been unfair to SolarEdge customers and to SolarEdge, not the other way around.

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[60] JSP Br., p. 41.

[61] *See Application Nunc Pro Tunc of Artesian Water Pennsylvania, Inc. for Approval of Affiliated Interest Agreements and Certificate of Public Convenience Approving Transfer of Property from Artesian Resources Corporation Pursuant to Chapters 11 and 21 of the Public Utility Code, 66 Pa C.S. §§ 1102(a)(3), 1103(a) and 66 Pa. C.S. §§ 2101, 2102(a)-(b)*, Pa. PUC, Docket No. A-2017-2639994, *et al*., (Opinion and Order entered August 29, 2019) (denying exception to a Recommended Decision and request that certain testimony be disregarded or given no weight). *See also Commonwealth v. Griffin*, 65 A.3d 932, 939 (Pa. Sup. Ct. 2013) (an attack on "the credibility of the witness's testimony ... is not an attack on the sufficiency of the evidence, but an allegation of the weight it should have been afforded.)

[62] *See Koger*, pp 6-7.

[63] JSP Br., p. 56. *See* also JSP St. No. 7, pp. 9 – 11, and Exhibit JSP-JB-2 (REDACTED), Slides 5 – 13.

e. PPL's Method of Connecting to SolarEdge Inverters is Unsafe, Unauthorized, and Violative of the NEC

The parties have litigated extensively the propriety of PPL's method of connecting its Device to SolarEdge inverters to power the PPL Device;[64] and whether PPL's improper method has caused thermal damage to SolarEdge inverters.[65, 66] Presumably because it knows it has neither facts nor law on its side,[67] again, PPL instead challenges JSPs witnesses' credibility on these issues. The JSPs respond herein to PPL's attacks and refer the Commission to the JSPs' Main Brief at pages 51 – 60 on these topics.

First, PPL engages in some throat-clearing in which it lauds its own efforts to ensure adherence to safety standards. Specifically, PPL claims it has "taken several steps to ensure the safety of its DER Management Devices and their installation," which include "the DER Lab work[ing] closely with the DER system manufacturer." PPL Br., p. 45.

The Commission should accord little weight to PPL's purported evidence on these topics. Per the NEC (whose "purpose … is the practical safeguarding of persons and property from hazards arising from the use of electricity"), the entity charged with determining safety of the method of installation is a Nationally Recognized Test Lab ("NRTL"). *See*, *e.g.*, 52 Pa. Code § 75.22 (defining a NRTL). PPL has admitted its DER Lab is <u>not</u> a NRTL. Hrg. Tr. pp. 362-363. *Id*. Thus, PPL's DER Lab safety test results and "steps taken" are not persuasive evidence that PPL's method of installation to power its Device is in fact "safe."

[64] *See* JSP Statement Numbers 7, 7-SR, 10, 10-SR, 11-SR, 12-SR, 14-SR and 1-SRJ. We note that the question of propriety
[65] *See* JSP Statement Numbers 7, 7-SR. 12-SR and 13-SR.
[66] As to both, *see* JSP Br., pp. 51 – 60.
[67] While the NEC is not itself a law, as it has been adopted and enforced by the Commonwealth, Code violations of it carry the force of law. *See supra*, n. 4.

Even if PPL's safety test results would have value, PPL admits it did not provide them for the record in this proceeding. *See*, *e.g.*, Hrg. Tr. pp. 361 – 362, where PPL witness Dombrowski-Diamond concedes that PPL did not provide any information on the testing it purportedly performed "using fork connectors underneath the [SolarEdge] AC screw terminal," *Id*., pp. 361 – 362, one of the very issues PPL has made central to this case.[68]

Moreover, PPL cannot show that in conducting this alleged safety testing, it consulted with either SolarEdge, the manufacturer of the inverters at issue (despite PPL's claim that it did so, *see* immediately above), or with any NRTL (whose certification is the OSHA-approved mechanism for determining safety).[69] *See* Hrg. Tr., p. 362, where when asked if PPL consulted with SolarEdge on its testing process, Ms. Dombrowski-Diamond answered: "I was not here at that time. I do not know if they specifically consulted with SolarEdge at that point for the AC testing." *See also*, *Id*., where, when asked if PPL consulted with a NRTL, Ms. Dombrowski-Diamond answered: "It was with a certified electrician, our safety department, our standards department and the lab." *Id.* In other words, Ms. Dombrowski-Diamond effectively conceded that PPL did not consult with a NRTL on its safety testing processes.

PPL next argues its Device installations in SolarEdge inverters are safe because they are done by PPL's Electric Meter technicians, who follow step-by-step installation instructions prepared by PPL. PPL Br., p. 45. Performance by PPL's Electric Meter Technicians is not persuasive evidence that PPL's installations are NEC-compliant, as both the NEC and Pennsylvania Code require inspection by an electrical inspector to ensure safety. *See* JSP Br., p. 52; and 34 Pa. Code § 195(b). Further, whether PPL's Electric Meter technicians comply with

[68] *See* PPL Br., pp. 47 and 52 – 53, and PPL FOF ¶¶ 209 and 211.
[69] *See Board-Tech Elec. Co. v. Eaton Elec. Holdings LCC*, Docket 17-CV-5028 (S.D. N.Y. 2017), *2. The *Board-Tech* decision was appended to the JSPs' Main Brief.

PPL's installation instructions (contained in what PPL calls a Distribution Device Instruction ("DDI")) is also not persuasive, as PPL admits it is not a NRTL, that no NRTL lab reviewed PPL's instructions,[70] and that PPL did not consult with SolarEdge in developing its instructions for installing its Device in SolarEdge inverters.[71]

Thus, PPL seeks to attack the JSP witnesses' credibility.

i. Then-SolarEdge Employee Bobruk Credibly Showed that PPL's Method of Powering its Device was Unauthorized, Dangerous, and Non-Compliant with the NEC

Starting with then-SolarEdge employee Jason Bobruk, PPL calls his testimony about the 8 instances of thermal damage recorded in SolarEdge's "PPL Case Review" "uncredible" because Mr. Bobruk "admitted" he did not know who photographed the damage, or "the knowledge of necessarily the timeline of the case," or of the decisions as to whether the damage is covered by SolarEdge's warranty. PPL Br., pp. 46 - 47. However, these details have no bearing on Mr. Bobruk's ability to credibly testify as to SolarEdge's observations of occurrences of thermal damage, and Mr. Bobruk's role in associating those with PPL's code violations. SolarEdge has produced the names of the photographers;[72] the case timelines;[73] and information on warranty decisions,[74] in short, all "business records" underlying SolarEdge's Case Review, which did not

[70] *See* PPL's Response to JSP-V-11(e) in Exhibit JSP-JB-10SR, in which PPL effectively concedes it did *not* submit its installation instructions to a NRTL. The NRTL-approved document referenced in the Answer is the NRTL certification for PPL's Device (a ConnectDER product) that says nothing about installations in a SolarEdge inverter.
[71] *See* PPL's Response to JSP-V-11(c) in Exhibit JSP-JB-10SR, in which PPL effectively concedes it did *not* submit its installation instructions to SolarEdge for approval. Rather, HIGHLY CONFIDENTIAL JSP-V-11 Attachment 6 referred to therein and attached hereto as Appendix B shows SolarEdge forwarded its guidelines to PPL.
[72] Mr. Bobruk was a witness to JSP discovery responses attaching Ex. PPL to JSP-II-22 Att. JB-2, and HC Ex.'s PPL to JSP-II-22 Att's JB-4-11.
[73] Exhibit JSP-DF-7SR, was first produced as a response to a discovery request witnessed by Mr. Bobruk.
[74] *See* Exhibit JSP-JB-2, Slides 5 - 13. *See also* Exhibit JSP-JIG-5SR, showing SolarEdge employee Jacob Geller's participation in the warranty determination.

require that Mr. Bobruk himself have first-hand knowledge of the contents of the Review, nor memory of the details of same some six months later during cross-examination.[75]

PPL next spends significant effort trying to get Mr. Bobruk to admit that he or SolarEdge had "actual or constructive notice" of PPL's method for installing its Devices in SolarEdge prior to August 2024, the timeframe Mr. Bobruk identified as that when SolarEdge became aware of PPL's incorrect configuration. (Mr. Bobruk testified that the awareness resulted from SolarEdge's receiving a call from a customer on August 22, 2024 whose inverter had started smoking, and an installer sending a photo showing the presence of PPL equipment in a part of the inverter SolarEdge intends that no human touch.[76]) Hrg. Tr., pp. 399 - 400; JSP St. No. 7-SR, p. 13. Nothing PPL cites impeaches Mr. Bobruk's credibility as to the date he and SolarEdge became "aware" of PPL's unauthorized, non-compliant and dangerous method of installing its Device: Thus, on p. 47 of its Main Brief:

1. PPL cites the date it filed and served the undersigned with its Petition (May 20, 2024) which contained a copy of PPL's DDI, as a date on which Mr. Bobruk should have been aware. However, as PPL's service list shows, SolarEdge was not yet a JSP, nor was it yet represented by the undersigned. Mr. Ryan served the Joint Solar Parties as they were constituted in *Petition of PPL Electric Utilities Corporation for Approval of Tariff Modifications and Waivers of Regulations Necessary to Implement its Distributed Energy Resources Management Plan*, Pa. PUC Docket P-2019-3010128, not the entities who became JSPs in this docket. *See* JSP FOF ¶ 11; *and* Mr. Ryan's May 20, 2024 Letter to Secretary Chiavetta enclosing the Petition.

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[75] *See Melvin Williams v. Pittsburgh Water and Sewer Authority*, Pa. PUC Docket No. C-2020-3019223, p. 9 (Opinion and Order entered Aug. 5, 2021) ("The witness does not have to be the person who made the entries, the custodian of the record at the time the entries were made, or an individual having personal knowledge of the facts reported in the business records. Rather …, a presumption of trustworthiness of the business records of a company can be established by an authenticating witness who can provide sufficient information relating to the preparation and maintenance of the records.") *See also* Exhibit JSP-JB-18SR (the standard operating procedure used by SolarEdge in the regular course of business when it opens up an investigation.

[76] *See* JSP St. No. 7, p. 14 and JSP St. No. 7SR, p. 10, explaining that the area where PPL is installing its Device ***to power it*** is "in a place … where it was not intended." (emph. added.) *See also* JSP St. No. 7-SR, pp. 4 and 5, explaining that connections to screw terminals in that area are "designed and intended only for factory wires connected to the inverter and factory-torqued in a controlled environment." Finally, *see* JSP St. No. 7-SR, pp. 4 – 5 and Exhibit JSP-JB-3SR, in which Mr. Bobruk distinguished the area in the inverter where PPL is (improperly) connecting its Device's wires to power its Device (the upper compartment), from an area in the inverter's lower compartment, in which the field terminals are designed for an installer to connect the inverter to external premises wiring.

2. PPL cites August 31, 2023, the date PPL sent a copy of a version of its installation instructions to SolarEdge employee Brett Hallgren, as another date on which Mr. Bobruk should have been aware of PPL's method of installation. However, Mr. Hallgren testified that as he had received PPL's manual two days after he had already overridden a field tech's warranty denial, having determined, based on the case notes (Exhibit JSP-BH-3SRJ), that the installer was not at fault for the interruptions to the inverters' communications, and that it was more likely that PPL's communications installation rather than the installer's inverter installation caused the interruptions, his review was only "quick." JSP St. No. 1-SRJ, p. 3.

3. Last, PPL cites a January 26, 2022 conversation between PPL employee Matthew Wallace and SolarEdge employee Alex Dinh in which Mr. Wallace claims Mr. Dinh told him he "saw no issues" with PPL's method of installation. PPL Br., pp. 47 – 48. However, Mr. Dinh testified in JSP St. No. 11-SR at pp. 2 and 5 - 6 that he has no recollection of so stating; that he did not and would not have "approved" PPL's method of installing its Device for purposes of powering it; and that as a software communications specialist, all his conversations with PPL have focused exclusively on ways PPL could connect its Device to SolarEdge inverters for purposes of allowing its Device to communicate with the inverters.

It bears noting that as to this final alleged example of "notice or constructive notice" to SolarEdge, Ms. Dombrowski-Diamond has testified: "I don't know exactly what happened in those calls, but I know there was instruction by Mr. Dinh on certain items," Hrg. Tr., pp. 358-359. Thus, PPL's own witness has undermined PPL's credibility, not Mr. Bobruk's, as to whether the Wallace/Dinh conversation provided early "notice" to SolarEdge of PPL's improper method of installation.

PPL then tries to impugn Mr. Bobruk's credibility by stating he "sidestepped" on the date of his awareness of PPL's instruction manual, until "pressed on cross-examination." PPL Br., p. 48. A review of the transcript makes clear that the cross-examiner was not clear on which "manual" he was cross-examining Mr. Bobruk, as both PPL and SolarEdge identify their installation instructions as "manuals."[77]

[77] During the Hearing, Attorney Ryan testified that the PPL Electric manual sent to Mr. Hallgren in 2023 is the same as that PPL attached to its Petition in 2024, "and [] also is attached [Mr. Bobruk's] testimony." Hrg. Tr., p. 403. The documents are not the same. For example, the photograph in PPL Exhibit AD-6, on which Mr. Ryan extensively cross-examined Mr. Bobruk (*see* Hrg. Tr., pp. 406 - 407), is not included in the set of instructions sent to Mr. Hallgren a year earlier.

Regardless, PPL misses the point. All of its examples of supposed "notice" or "constructive notice" to SolarEdge on its method of installation to power its Device, occurred after-the-fact, *i.e.*, after PPL developed its "manual" and commenced installations in accordance therewith. Had PPL sought SolarEdge buy-in (or wished to pursue a waiver from SolarEdge or the NRTL that certified the SolarEdge inverter safety requirements), it could certainly have asked SolarEdge before it developed and implemented its method.[78]

PPL next seeks to impeach Mr. Bobruk's credibility on grounds he purportedly failed to review Mr. Geller's surrebuttal testimony, which PPL alleges conflicts with Mr. Bobruk's. PPL Br., pp. 46, 48. Mr. Bobruk testified that PPL's Device caused 8 instances of thermal damage about which SolarEdge was aware, JSP St. No. 7, p. 14; JSP St. No. 7-SR, p. 11, while PPL characterizes Mr. Geller's testimony as stating that "there was no conclusive evidence to determine PPL Electric's DER Management device caused or contributed to 3 of those alleged thermal events." PPL Br., p. 46.

PPL has consistently misrepresented Mr. Geller's testimony, Mr. Geller's and Mr. Bobruk's testimony do not conflict, and neither Mr. Geller nor Mr. Bobruk have impeached one another's credibility. In his Surrebuttal Testimony, Mr. Geller unequivocally testified:

> In my opinion in all 8 cases we had clear evidence of thermal damage to the inverters, all of which have or had PPL's device installed. The ability to identify causation varies, but it is clear that in each case, the thermal damage arose from PPL's[79] installations reducing spacing; over-torquing, cross-threading, or not sufficiently tightening screws; leaving behind contamination; or from leaving bare wire exposed and in contact or in proximity with the circuit board, all of which could cause thermal arcing. Or, the thermal damage

[78] *See* JSP Br., p. 56, stating that the SolarEdge warranty protections will not apply if there has been a modification that was not pre-authorized by SolarEdge in writing.

[79] To be clear, PPL did not apprise the JSPs until its February 4, 2025 Rejoinder Testimony (developed six months after SolarEdge first produced its PPL Case Review) of its unsupported theory that an installer, Sunnova, was responsible for the Device installation in one of the instances of thermal damage. The point remains – no one, neither PPL nor Sunnova, was supposed to intervene in that portion of the inverter, and certainly, was not authorized to connect wires to the inverter to power PPL's Device.

> arose as a result if the installer causing mechanical damage to components during installation, which can also cause thermal damage.

JSP St. No. 13-SR, p. 5 (emphasis added). In short, it is Mr. Geller opinion, with which Mr. Bobruk does not disagree, that in all 8 instances, whether caused by PPL's [or a third party's] installations themselves (for example, by installing equipment in the inverter that reduced spacing), or by "mechanical damage to components during installation (for example, by dropping a tool), and/or whether PPL subsequently disconnected its Device, thermal damage had occurred in an area of the inverter that SolarEdge intends never be touched by humans[80] after the inverter is assembled in and leaves the SolarEdge factory. *Id*. Thus, as to the three Cases on which PPL alleges Mr. Geller backtracked (PPL Br., p. 46, *citing* JSP St. No. 13-SR at 8), Mr. Geller did nothing of the sort.

In the JSPs' Main Brief at p. 59, they countered PPL's Rejoinder Testimony pertaining to Cases 4141508[81] and 3456567.[82] As to the third case (Case 3884887), in which Ms. Dombrowski-Diamond argues that "Mr. Geller concedes he 'could not form an opinion to this case, and the photo from the field service tech … was too far out" and he "cannot attribute" the damage to PPL's work," PPL St. 2-RJ, p. 53, the JSPs wish to make clear that Mr. Geller's complete statement, and complete testimony, counter Ms. Dombrowski-Diamond's assertion. Mr. Geller's remaining sentences state that while he cannot attribute the thermal damage to PPL's work (e.g., the PPL's addition of a wire), it is his testimony that the photos show thermal damage, and that a piece of equipment (the AC relay) had internal failure. JSP St. No. 13-SR, p. 8. That failure is precisely the type of "mechanical damage to components during installation" to which Mr. Geller also testified,

[80] *See supra*, n. 76.
[81] As to PPL's contention re Case 4141508, which, per photographs, showed that the inverter sustained catastrophic thermal damage, the JSPs' Brief highlighted that Mr. Geller still was able to opine that the damage originated in the location where PPL improperly connects its wires to SolarEdge's inverter.
[82] As to PPL's contention that a photo offered by Mr. Geller showed the wrong inverter, the JSPs' Brief pointed to the portion of Mr. Geller's opinion that was not based on such photo, and in which Mr. Geller testified there was evidence of thermal damage.

see supra, p. 33, that can "can also cause thermal damage" and can occur, for example, if a technician dropped a tool that damaged circuitry associated with the relay. It is PPL's expert who "sidestepped" this issue, testifying that "… workmanship, such as dropping a screwdriver or dropping the part" would not "cause a short circuit or fault" because "the inverter is deenergized" during the work. Hrg. Tr., p. 293. The JSPs are hard-pressed to believe Mr. Floyd would opine that damage to circuitry occurring when the inverter is de-energized would not show up when the inverter is re-energized.

The JSPs note as well that PPL consistently fails to mention an additional event PPL disclosed in discovery. *See* JSP Br., p. 59. That, plus the additional 3 PPL erroneously excludes, brings the total number of thermal events to 9 that we know about in the portion of the inverter SolarEdge intends no human touch (*see supra*, n. 76) and in which PPL, or a surrogate, connected PPL's Device to power it.

More importantly, PPL fails to indicate what number of events would prompt its concern. *See* Hrg. Tr., p. 233, where PPL's expert testifies that "eight is small in the context of 6,878" but offers no opinion as to what number would be "large."

The JSPs respectfully submit that a responsible utility that prides itself on putting safety first would affirmatively take measures to ensure that no more instances of thermal damage had occurred and/or would occur. It would not go in the other direction as has PPL and ask for Commission sign-off on a method which witnesses have attested is dangerous. Indeed, in *PECO*, discussed above, and cited by PPL, PECO did just that – voluntarily and proactively undertook a technology swap-out, and held in abeyance any action to recover costs incurred in installing the flawed device.

Finally, PPL complains it suffered "undue prejudice" resulting from Mr. Bobruk's purportedly failing to present all of Mr. Geller's analyses "in support of their direct case" in response to a discovery request, "forcing PPL to respond to Mr. Geller's analyses in the 13 days between the receipt of his surrebuttal testimony and the due date for the Company's rejoinder testimony. PPL Br., p 50. The JSPs' responses are the same as stated in their Answer to PPL's unsuccessful Motion in Limine and/or to Strike the testimony of Geller and others – first, that intervenors do not put on a direct case (the petitioning party does); and second, and more importantly, that there were no further analyses. As Mr. Geller stated in his August 23, 2024 e-mail (Exhibit JSP-JIG-5SR), the photographic evidence was so clear that PPL's tampering with the inverter was the cause of the smoking, there was simply "No need for a failure analysis."[83]

ii. The Other JSP Witnesses Have Also Credibly Shown that PPL's Method of Installing its Device Was Unauthorized, Dangerous, and Non-Compliant with the NEC

PPL also seeks to impeach the credibility of other JSP witnesses. PPL claims (on p. 50) that SolarEdge employee Alex Dinh lacks credibility because he asked PPL "where you get power," while at the same time states that "if PPL asked for [his] opinion as to its method of installing its Device for purposes of powering it, [he] would have referred PPL to the correct persons in SolarEdge who are authorized to review such request." JSP St. 11-SR, p. 6.

There is nothing inconsistent in Mr. Dinh's statements, especially given Mr. Dinh's area of expertise (software communications) (*see supra*, p. 31), and the fact that his numerous conversations with PPL focused exclusively on communications. It is PPL that lacks credibility in seeking to transform Mr. Wallace's memory of an unrecorded conversation with Mr. Dinh on seven separate subjects into a purported SolarEdge authorization of PPL's method of powering its

[83] The January 30, 2025 Order issued by Your Honor denying PPL's Motion found PPL was not prejudiced by Mr. Geller's filing of surrebuttal testimony.

Device. *See* PPL Br., p. 47 (enumerating the seven topics). Further, as noted above, on cross-examination, even Ms. Dombrowski-Diamond could not or would not testify as to the contents of the Wallace/Dinh exchange. *See supra*, p. 31.

Accordingly, PPL's characterization of Mr. Dinh's testimony should be rejected.

Nor should the Commission give heed to PPL's characterization of testimony by Green Way Solar witness William Stahlman. PPL asserts that Mr. Stahlman lacks credibility because he "admitted" he did not review the UL listing of PPL's Device. PPL Br., p. 50. In even asserting this challenge, PPL again shows it does not understand the NEC. The UL listing of PPL's Device is not at issue. What matters is whether SolarEdge's installation instructions authorized PPL's manner of installing PPL's Device in the SolarEdge inverter. And with regard to the correct question – whether SolarEdge's UL-listed instructions authorize PPL's installation (they do not) – Mr. Stahlman's testimony is unimpeachable. *See*, JSP St. No. 10, pp. 6 – 8, and JSP St. No. 10-SR, pp. 2 and 7 – 9.

iii. PPL's Expert Witness' Opinions as to the Soundness of PPL's Method of Installation are Incredible

Finally, PPL seeks to challenge the credibility of the JSPs' position – that PPL's Device installation causes electric arcing – by providing the opinions of its expert, Landis Floyd. PPL Br., p. 51. As we shall explain, it is Mr. Floyd's opinions that are utterly incredible.

PPL offers that first, Mr. Floyd opined that "PPL's devices, including the way in which they are installed, are well-designed and well-engineered and are consistent with electric industry best practices." PPL Br., p. 51. The JSPs have consistently shown that PPL is installing its Device for purposes of powering it in an area of the inverter that SolarEdge does not intend that there be any human intervention; [84] that PPL's decision to do so flouts SolarEdge's NRTL-approved

[84] *See supra*, n. 76.

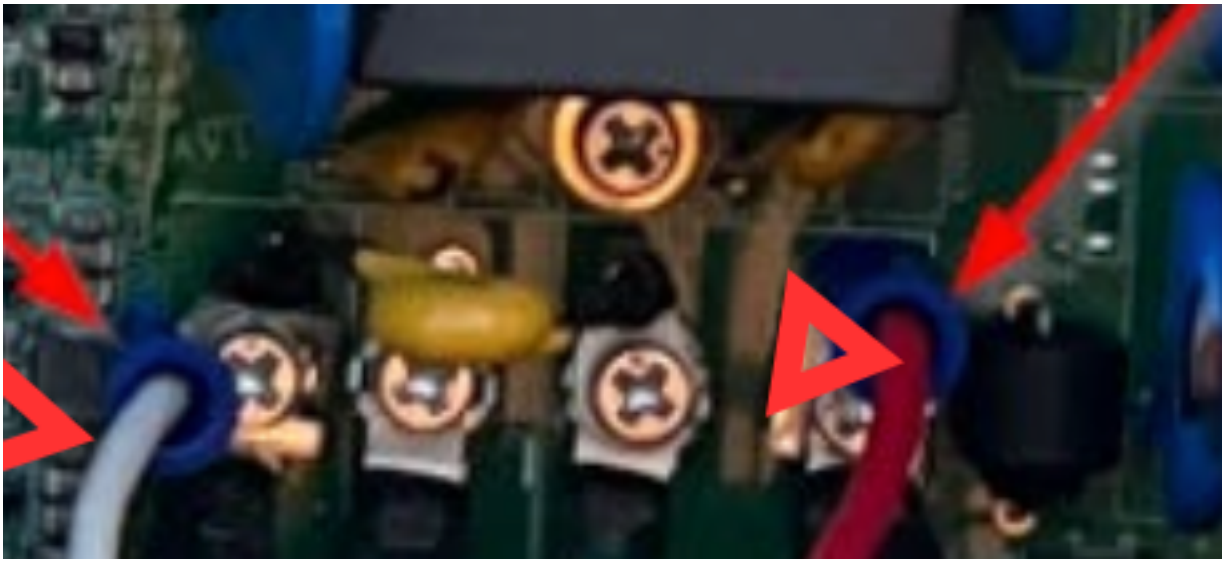
instructions;[85] and that in flouting SolarEdge's instructions, PPL has violated the NEC.[86] Moreover, Mr. Floyd cannot overcome the fact that PPL could not support its claims its installation method is safe, inasmuch as PPL failed to provide the results of safety testing its lab purportedly performed on its method of installation. *See*, *supra*, p. 28. Surely, these omissions by PPL counter its assertion that its method of installation is well-designed, well-engineered, or consistent with electric industry best practices.

PPL then offers that Mr. Floyd opined that "there is no credible evidence to support that PPL Electric's DER Management devices are creating an electric arc within the inverters," PPL Br., p. 50,[87] and that, based on his review, "PPL Electric is, in actuality, maintaining consistent spacing when it installs its DER Management Device." PPL Br., p. 52, *citing* PPL St. No. 12-R at 17.

Mr. Floyd's opinion simply defies photographic evidence and common sense. For example, as may be seen in the photograph below from Case 508192,[88] the manner with which PPL has inserted a "crimp type fork terminal," or "spade" terminal, as referred to by Mr. Floyd, the square shape that is surrounding the screw on the left, has clearly reduced the space between that left-most screw terminal and the screw terminal to its immediate right.[89] Compare the reduced spacing between the left-most screw terminal and the screw terminal to its immediate right with the far

[85] *See* Hrg. Tr., p. 382, where Ms. Dombrowski-Diamond admits that the SolarEdge Manual does not contain an instruction on powering a third-party device.
[86] *See*, *infra*, p. 42, quoting NEC 110.3's requirement that all installations and uses of listed or labeled equipment must conform to any of the NRTL's instructions included in the listing or labeling.
[87] As explained by Mr. Bobruk: "An electric arc occurs when a discharge from an electrical current travels through the air between conductors as a plasma. In short, it creates an electrical current and the associated heat through the air and through an area where it was not intended. That can cause various problems, including thermal issues." JSP St. No. 7, p. 14.
[88] Exhibit JSP-JB-2, Slide 5.
[89] *See* JSP St. No. 7-SR, p. 10, where Mr. Bobruk attests to same.

more generous spacing between the two screw terminals in the middle, as well as between the two screw terminals on the right.)



To compound the incredibility of Mr. Floyd's opinion, as Mr. Geller observed on p. 9 of his Surrebuttal Testimony (JSP St. No. 13-SR, p. 9), PPL's Installation Instructions provide no spacing protocol, which, in Mr. Gellers's opinion, is dangerous and underscores PPL's inattention to spacing. *See* PPL Exhibit AD-6 (stating nothing); *and* JSP St. No. 13-SR, p. 9. By contrast, SolarEdge's torquing protocol for installation in its factory requires that proper spacing between the screw terminals be secured before the inverter leaves the factory. *See* Exhibit JSP-JIG-12SR (stating: "Make sure the capacitor feet are facing forward as shown. Hold in place."), which is achieved through use of calibrated equipment in the factory assembly.[90]

In his Rejoinder Testimony at pp. 9 and 11 (to which the JSPs had no opportunity to respond), and in the Hearing, Mr. Floyd opined that since the white wire is insulated, spacing is not a concern. Hrg. Tr. pp. 284 – 285. The JSPs request that this testimony be struck, or that they be permitted to respond herein, to which they would state: the fact that PPL inserted insulated

[90] JSP St. No. 13-SR, p. 4.

wires in no way excuses PPL from having to be attentive to spacing concerns in the SolarEdge inverter: it is irrefutable that the screw terminals are metal, are clearly not insulated, and have been manipulated in a way that has reduced spacing.

PPL offered that Mr. Floyd also opined, PPL Br., pp. 51 – 52, that when a component causes thermal damage, damage should appear at the component, not near it. Mr. Geller directly rebutted this opinion, providing real-life examples of thermal damage both at AND near the component resulting from PPL's intervention. *See* JSP St. No. 13-SR, pp. 13 – 14, where he testified:

> In Case 4457839 (Exhibit JSP-JIG-4SR) the thermal damage has been initiated EXACTLY at the component PPL installed (the white wire with the green jacket). In Case 4705589 (Exhibit JSP-JIG-4SR), the sole location of damage is at the intervention point where PPL removed the inverter's screw to install its external device (the red wire) under the screw intended to hold the black wire. These are at least two examples of thermal events occurring at the area of PPL's connection. As for damage "near" the connection, PPL has used tools to perform modifications. Based upon PPL's Installation Instructions, and the physical damage we can see, I see no evidence that would lead me to believe that their interventions have not caused damage (such as bent wires, or dropping a tool onto the circuit board), which could cause damage in remote locations.

PPL argues that Mr. Floyd criticized Mr. Geller's opinions on grounds he purportedly did not conduct a proper root cause analysis, which, per Mr. Floyd, "identifies all possible causes of failure and, using scientific and engineering methods, rules out possible causes [sic] of failure and, using scientific and engineering methods, rules out possible causes that could not have caused the failure being investigated." PPL Br., p. 52.

Mr. Geller's analysis was a root cause analysis, because as Mr. Geller testified, he could determine the cause because "the evidence was so clear that our equipment had been tampered with, and that tampering caused or contributed to thermal events." JSP St. No. 13-SR, p. 14. *See also* Exhibit JSP-JIG-5SR, where on reviewing the photographs of the smoking inverter, Mr. Geller quickly opined: "This is clearly an installer issue, look at all the extra wires in the top compartment along with the crimps. No need for FA and please denies warranty."

PPL offers that both Mr. Floyd and Ms. Dombrowski-Diamond opined that PPL's connections cannot reduce spacing between the AC terminals and the board because:

> PPL Electric uses specific fork connectors to make sure the 5 mm of clearance is not affected by the Company's installation. Moreover, SolarEdge's inverters use ring terminals for the yellow AC capacitor leads. Therefore, it is impossible to reduce the spacing because the location for the AC capacitor leads is a permanent fixture on the circuit board. Thus the Company's use of fork connectors cannot reduce the spacing between the AC terminals and the board.

PPL Br., pp. 52 – 53.

PPL is wrong, and the Commission should reject PPL's proposed Findings of Fact ¶¶ 207 – 211. The fact of ring terminals for the yellow AC capacitor is a complete non sequitur, and has no bearing on the spacing between the screw terminals, and/or between the wires under the screw terminals and the circuit board.

Said "ring terminals for the yellow AC capacitor leads" are visible on the photo provided above on p. 38. The yellow capacitor is the yellow knob above the second screw from the left. The ring terminals are the legs that protrude from either side of it. These do nothing to prevent PPL's fork connectors from reducing spacing between the screw terminals, as is plainly shown with the two screw terminals on the left in the photo.

Finally, PPL has provided no support for its contention that it maintained "the 5 mm of clearance" standard (it provided no proof that it took measurements or that it met such standard). Moreover, neither Mr. Floyd nor Ms. Dombrowski-Diamond provided any support for their opinion that "the 5 mm clearance" governs.[91] Indeed, cross-examination revealed that Ms. Dombrowski-Diamond may not be aware of which standard governs. When asked who authored "the 5 mm clearance" standard she cited in her testimony (quoted above), she answered that it is

[91] *See* PPL St. 2-RJ, p. 57.

an NEC standard. Hrg. Tr., p. 382. However, to the JSPs' knowledge, the standard is a UL standard, not an NEC standard, and the minimum spacing is 6.4 mm, not 5 mm.[92,]

The JSPs note this is not the only instance in which Mr. Floyd and Ms. Dombrowski-Diamond have misconstrued NEC standards. For example, in their testimony they argued that PPLs' method of installing its Device in SolarEdge inverters is sound, because PPL technicians hand-tighten the screws using the amount of torque they claim SolarEdge specified for use with its inverters. PPL St. No. 12-SRJ, p. 4, *citing* PPL St. No. 2-RJ, p. 58, and PPL Exhibit AD-19RJ, p. 2. However, when pressed on cross-examination, Mr. Floyd admitted that the screws that were the subject of the specs were those SolarEdge installs in the inverter cover, not the screws that are factory-installed in the inverter; and that the specs pertain to hex screws (which are the type used with the inverter cover), not Phillips screws, which are the type that are factory-installed in the inverter. Hrg. Tr. pp. 298 – 303. The JSPs offer this example to highlight another instance of PPL demonstrating its lack of familiarity with the product it is regulating, as well as the safety regime that applies.

Most importantly, both Mr. Floyd and Ms. Dombrowski-Diamond have missed the point – that the question of which standard and how many standards apply – again – in a portion of the inverter SolarEdge does not intend be accessed by PPL -- will be trumped by any more protective, and/or the totality of, NRTL requirements that applied to certification of this piece of equipment. *See* JSP Br., p. 58. *See also* NEC 110.3, which unambiguously states that "Listed or labeled equipment shall be installed and used in accordance with any instructions included in the listing or labeling." Finally, *see* NEC Section 90.4, which provides:

> For specific items of equipment and materials referred to in this Code, examinations for safety made under standard conditions provide a basis for approval where the record is

[92] The UL Standard, set forth in Section 26, Table 26.1 (providing minimum spacings), is copyrighted, so a copy cannot be produced herein.

> made generally available through promulgation by organizations properly equipped and qualified for experimental testing, inspections of the run of goods at factories, and service-value determination through field inspections. This avoids the necessity for repetition of examination by different examiners, frequently with inadequate facilities for such work, and the confusion that would result from conflicting reports on the suitability of devices and materials examined for a given purpose.
>
> It is the intent of this Code that ***factory-installed*** internal wiring or the construction of equipment need not be inspected at the time of installation of the equipment, except to detect alterations or damage, ***if the equipment has been listed by a qualified electrical testing laboratory that is recognized as having the facilities described in the preceding paragraph and that requires suitability for installation in accordance with this Code. Suitability shall be determined by application of requirements that are compatible with this Code.***

(emphasis added).

Accordingly, PPL's purported compliance with a phantom NEC requirement ("the 5 mm clearance standard") does ***not*** mean that PPL's method of installation is safe. Nor does it mean that PPL is authorized to install its Device in that portion of the inverter, as doing so is still inconsistent with SolarEdge's NRTL-approved installation instructions. Nor is it a practice that this Commission should, or can, authorize, as it is not the authority that has jurisdiction, contrary to PPL's proposed Conclusion of Law ¶ 11.[93]

Based on the foregoing, Mr. Floyd's opinions do not impeach Mr. Bobruk's credibility. Rather, as the JSPs have shown, it is Mr. Floyd's opinions that are not credible.

[93] The JSPs do not dispute that the Commission has authority over PPL and installations on the utility side of the meter per 66 Pa.C.S. §§ 102 and 1501. Rather, as they argued in their Main Brief at p. 52, it is the JSPs' position that once PPL crosses the line and does work in public and private premises (defined by the NEC as "[t]he land and buildings located on the user's side of the point of demarcation between the communications service provider and the user,"), it becomes subject to the NEC, not the Commission. *See*, *e.g.*, *Robert J. Balint v. Verizon Pennsylvania Inc.*, Pa. PUC Docket No. C-20078508, p. 9 (Initial Decision entered May 19, 2008) (finding in the telecommunications context that the utility's responsibility ends at the "point of demarcation," beyond which wiring is labeled "inside wiring" not regulated by the Commission). Again, *see* NEC Section 90.2(C), providing that the Code covers the installation and removal of electrical … equipment for … (1) public and private premises, including buildings [and] structures [and… (4) installations used by the electric utility, such as … garages." By contrast, NEC Section 90.2(D) makes clear that the Code does not cover "… (4) Installations of communications equipment under the exclusive control of communications utilities <u>located outdoors or in building spaces used exclusively for such installations</u>." (emphasis added)

IV. JSPs' CONCLUSIONS AND RECOMMENDATIONS

The JSPs have shown that PPL's draconian, one-size-fits-all, mandatory, territory-wide, anti-competitive, active utility control program that provides no compensation to DER customers, is premature, as the levels of solar penetration in PPL territory simply do not justify PPL's crisis-level response at this time. The JSPs have also shown that PPL failed to provide the Commission with an analysis of any alternatives against which the Commission can weigh the costs and benefits of PPL's program as proposed. The JSPs have shown that the program, as designed, significantly overreaches, as it requires that DERs exceed national and Pennsylvania standards (specifically, IEEE 1547-2018) if they wish to be interconnected, and violates the NEC (as it calls for installing its Device in residential inverters in a manner not authorized by the inverter manufacturers' instructions). Finally, the JSPs have shown that the purported benefits (which the JSPs maintain in any event are overstated), do not outweigh the costs, particularly when evaluated against the harms the program has done and will do to the DER community in PPL territory and to the Commonwealth's interests in advancing DER.

To summarize, the harms shown by the JSPs include:

That PPL's Program Has Dramatically Increased and Will Increase the Costs of DER in PPL Territory:

- The average larger-size single-phase commercial project costs nearly $40,000, or 15% more, in PPL territory than it does in neighboring territories.[94]
- A larger size single-phase residential project cost $[redacted] more as a result of PPL program requirements.[95]
- A smaller project cost $[redacted] more as a result of PPL program requirements.[96]

That PPL's Program Significantly Delays Customers' Receiving Permission to Operate their Systems While They Await PPL's Installing its Device in Their Inverters

[94] JSP St. No. 3, p. 4.
[95] JSP FOF ¶ 153 and n. 12; Exhibit JSP-SD-1SR (HIGHLY CONFIDENTIAL).
[96] JSP FOF ¶ 153 and n. 12; Exhibit JSP-SD-2SR (HIGHLY CONFIDENTIAL).

- Some grants of PTO have taken up to 47 days following the date of the electrical inspection.[97]

- Delays in grants of PTO has harmed and will harm customers' ability to obtain financing.[98]

That Servicing Customers' Systems Takes Substantially Longer, As PPL is the Only Entity Authorized to Remove and Replace its Device

- On average, servicing an inverter now takes an additional 14 days, due to PPL's being the only entity that can remove and reinstall its Device.[99]

- In some cases, completion of a service job has taken up to 75 days.[100]

That PPL's Program Restrictions Have Resulted in Lost Sales, Smaller or Fewer Clean Energy Projects, and Limits on Customer Choice

- AHC testified that it denied sales to at least 52 customers over roughly a two year period, as the products the customers requested, mainly the Tesla Solar Roof, cannot be sold in PPL territory.[101] AHC estimated that a little more than half that many lost sales would have amounted to 512.13 kW of clean energy and 114 batteries in the Commonwealth.[102] During that same time frame, AHC has seen Tesla Solar Roof sales increase in the rest of Pennsylvania by [redacted], and generating slightly less than [redacted] to [redacted], suggesting that sales and revenues would increase by that amount in PPL territory as well, but for PPL's restrictions.[103]

- As a result of PPL's restricting multi-inverter installs, Tesla reduced the sizes of 4 solar systems it installed in PPL territory compared to what the customers originally ordered, resulting in a loss of 37.6 kW-AC of solar system sales and a reduction in clean energy for the Commonwealth.[104] The totals are understated, as Tesla declined new multi-inverter projects or downsized them at the time customers placed orders, in anticipation of PPL denying PTO.[105] Tesla also ultimately ceased doing business in PPL's territory due to the burdens associated with the Pilot.

That PPL's Program Restrictions Have Resulted in Lost Profits

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[97] JSP FOF ¶ 167.
[98] *See* JSP Br., p. 41.
[99] JSP FOF ¶ 163.
[100] JSP FOF ¶ 164.
[101] JSP FOF ¶ 146; JSP St. No. 2-SR, p. 11; Exhibit JSP-NZ-6SR (REDACTED).
[102] JSP FOF ¶ 156; JSP St. No. 2, p. 5.
[103] JSP St. No. 2, p. 5 (HIGHLY CONFIDENTIAL).
[104] JSP FOF ¶ 190; JSP St. No. 4-SR, p. 15.
[105] JSP St. No. 4, p. 15.

- Because of the higher costs associated with purchasing, installing and servicing PPL-approved equipment, Trinity Solar estimates it lost approximately [redacted] in revenues in 2023.[106]

That the Presence of PPL's Device in Customers' Inverters has Disrupted Customers' Power Generation, Depriving the Customers of the Full Value of the Systems They Own

- In 13 instances, PPL's Device's interference with Enphase inverters halted power production from the customers' solar systems,[107] resulting in a loss to the Commonwealth of at least 18,410 kWh of solar power generation,[108] and a total of 617 cumulative days of solar power production downtime.[109]

That the Presence of PPL's Device in Customers' Inverters has Disrupted Customers' Communications, Depriving the Customers of the Full Value of the Systems They Own

- In 18 instances, PPL's Device interfered with Enphase inverters' communications,[110] resulting in 609 cumulative days of communications downtime;[111] losses of at least $1,851 worth of net energy metering credits, as well as lost SREC values.[112]

- In 27 instances, PPL's Device proved incompatible with Tesla multi-inverter systems using Zigbee communications modules, resulting in communications losses from one or more inverters for 6,933 cumulative days, or an average of 256 days/system.[113]

- Sun Directed and Green Way Solar customers also experienced communications losses.[114]

That the Program Has Harmed and Will Harm the DER Market in PPL Territory

- **PPL's Program has Denied or Delayed Market Entry**

    - It took four months for PPL to approve and then grant PTO to Enphase inverters, resulting in losses to Enphase during that time (lost sales; expenditures of labor),[115] and customers switching to competitors' products.[116]

    - It took PPL one month to approve SolarEdge inverters, during which time it lost or experienced delays in sales and required the expenditure of labor.[117]

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[106] JSP FOF ¶ 162; JSP St. No. 5, pp. 3 - 4 (HIGHLY CONFIDENTIAL).
[107] JSP St. No. 6, p. 8; Exhibit JSP-MM-3.
[108] JSP FOF ¶ 206; JSP St. No. 6, p. 9.
[109] JSP FOF ¶ 205; JSP St. No. 6, p. 8.
[110] JSP St. No. 6, p. 8; Exhibit JSP-MM-3.
[111] JSP FOF ¶ 205; Exhibit JSP-MM-3.
[112] JSP FOF ¶ 207; JSP St. No. 6, p. 9.
[113] JSP FOF ¶¶ 186 – 187; JSP St. No. 4-SR, pp. 4 – 5; JSP Exhibit JG-2SR (HIGHLY CONFIDENTIAL).
[114] *See* JSP St. No. 3, pp. 5 – 6, and JSP St. No. 10, p. 8, respectively.
[115] JSP FOF ¶¶ 174 – 176; JSP St. No. 6, pp. 5 – 6.
[116] JSP FOF ¶ 177; JSP St. No. 6, p. 5.
[117] JSP FOF ¶¶ 179 – 183; JSP St. No. 7, pp. 4 – 5.

- PPL's approvals limiting 45 inverter models manufactured by six manufacturers to single-inverter use restricts those manufacturers' market entry.[118]
- PPL's denials of PTO to Tesla installations of inverter models manufactured by two more manufacturers to single-inverter use restricted those manufacturers' participation in the market.[119]
- PPL's program restrictions have caused 2 of the country's leading solar and storage companies to opt out of the PPL market.[120]

- **PPL's Program Has Blocked and Will Block Third Party Aggregators from Doing what PPL is Doing More Cost-Effectively**
  - PPL's physical occupation of the DER's communications port and/or its tariff requirement that DER control cede to PPL blocks or impedes third parties' aggregations.[121]

That PPL's Device Installation Has Caused and Will Cause Fire Risk

- PPL's method of powering its Device in SolarEdge inverters has caused 9 instances of thermal damage.[122]
- Although PPL's actions voided SolarEdge's customer warranties, SolarEdge has replaced the inverters at its own expense in 7 of the 8 instances about which it was aware, costing SolarEdge about $12,350.[123]
- The fact that PPL has installed its Device in the fashion described herein in nearly 8,000 SolarEdge inverters, means the potential for additional damages events and incurrence of expenses is substantial.[124]

PPL has called all these harms shown by the JSP "de minimis," PPL St. No. 10-R, p. 36, or "relatively small," *Id.*, p. 38; and declared that they "pale[] in comparison" to the benefits provided by PPL's program. *Id*., p. 37. While the above-listed impacts may not seem great to a large investor-owned utility, they can be dispositive to a smaller business' ability to stay in business,

[118] JSP FOF ¶ 60; Hrg. Tr. pp. 342 – 343.
[119] *See* JSP St. No. 4, p. 15.
[120] JSP FOF ¶ 161; PPL St. No. 2-R, p. 33.
[121] JSP Br., n. 15.
[122] *See* Exhibit JSP-JB-2 (REDACTED AND PUBLIC) containing SolarEdge's "PPL Case Review" re 8 cases, and JSP St. No. 13-SR, Section III re the 9th event.
[123] JSP FOF ¶ 263; JSP St. No. 7, p. 15; Exhibit JSP-JB-2 (REDACTED AND PUBLIC), Slide 15.
[124] PPL Br., p. 8.

or to a customer's interest in "going solar." Moreover, the cumulative effects of all these harms add up, as can be seen by the fact that two major players in the DER community (Tesla and Sunrun) have opted out of doing business in PPL territory at all. PPL's expectation that businesses (and customers) engage in endless and expensive "troubleshooting" while PPL learns of the impacts of its Program is not an acceptable solution.

For the foregoing reasons, the JSPs respectfully urge the Commission to deny PPL's plan, to terminate PPL's Pilot and not extend it, to order the immediate termination of any requirement to subject inverters to requirements beyond those clearly imposed by national standards as a condition of their use, to order that PPL immediately cease installing its Devices in SolarEdge inverters, to order that PPL replace SolarEdge inverters in which it has installed its Device or establish a fund to pay for replacements of SolarEdge inverters with thermal damage and PPL's Devices installed therein, and to declare as a matter of law that PPL's installation of its Devices on the customer side of the meter is subject to NEC requirements, including inspection by a local electrical inspector, and compliance with manufacturers' NRTL-approved installation instructions.

Respectfully submitted,

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APPENDIX A

PPL Electric Utilities - Approved Smart Inverter List

The most recent version of this list can be found by visiting www.pplelectric.com/DERManagement. ***Google Chrome users:*** *clear your browser cache if you encounter issues viewing the most recent list.*

Last updated: 2025-2-17							
Manufacturer	**Model #**	**Required Equipment for Compatibility**	**Nameplate (kW)**	**Phase(s)**	**Maximum Continuous Output Current (A)**	**Voltage (V)**	**Communication Type**
Chint Power Systems (CPS)	SCA25KTL-DO/US-208		25	Three	69.5	208	Serial (Modbus)
CPS	SCA25KTL-DO/US-480		25	Three	30.5	480	Serial (Modbus)
CPS	SCA36KTL-DO/US-480	"V2" model only	36	Three	43.5	480	Serial (Modbus)
CPS	SCA50KTL-DO/US-480		50	Three	66.2	480	Serial (Modbus)
CPS	SCA60KTL-DO/US-480		60	Three	79.4	480	Serial (Modbus)
CPS	SCH100KTL-DO/US-480		100	Three	126.7	480	Serial (Modbus)
CPS	SCH100KTL-DO/US-600		100	Three	106.8	600	Serial (Modbus)
CPS	SCH125KTL-DO/US-600		125	Three	127	600	Serial (Modbus)
CPS	SCH275KTL-DO/US-800		275	Three	198.5	800	Serial (Modbus)
Delta	E4-TL-US		3.33	Single	16	208	Serial (Modbus)
Delta	E4-TL-US		3.84	Single	16	240	Serial (Modbus)
Delta	E6-TL-US		4.99	Single	24	208	Serial (Modbus)
Delta	E6-TL-US		5.76	Single	24	240	Serial (Modbus)
Delta	E8-TL-US		6.66	Single	32	208	Serial (Modbus)
Delta	E8-TL-US		7.68	Single	32	240	Serial (Modbus)
Delta	M4-TL-US		3.32	Single	16	208	Serial (Modbus)
Delta	M4-TL-US		3.84	Single	16	240	Serial (Modbus)
Delta	M5-TL-US		4.16	Single	20	208	Serial (Modbus)
Delta	M5-TL-US		4.8	Single	20	240	Serial (Modbus)
Delta	M6-TL-US		4.99	Single	24	208	Serial (Modbus)
Delta	M6-TL-US		5.76	Single	24	240	Serial (Modbus)
Delta	M8-TL-US		6.65	Single	32	208	Serial (Modbus)
Delta	M8-TL-US		7.68	Single	32	240	Serial (Modbus)
Delta	M10-TL-US		8.32	Single	40	208	Serial (Modbus)
Delta	M10-TL-US		9.6	Single	40	240	Serial (Modbus)
Delta	M10-4-TL-US		8.32	Single	40	208	Serial (Modbus)
Delta	M10-4-TL-US		9.6	Single	40	240	Serial (Modbus)
Duracell Power Center	Max Hybrid 15	COMM version 1442 or newer; MCU version 7224 or newer	15	Single	62.5	208/240	Serial (Modbus)
EG4 Electronics	IV-8000-HYB-AW	Requires FW Version FAAB-1A1A or newer. One EG4 Inverter per Application - Multiple EG4 Inverters Will Be Rejected	8	Single	38.5	208	Serial (Modbus)
EG4 Electronics	IV-8000-HYB-AW	Requires FW Version FAAB-1A1A or newer. One EG4 Inverter per Application - Multiple EG4 Inverters Will Be Rejected	8	Single	33.3	240	Serial (Modbus)
EG4 Electronics	18KPV-12LV	Requires FW Version FAAB-1A1A or newer. One EG4 Inverter per Application - Multiple EG4 Inverters Will Be Rejected	10.4	Single	50	208	Serial (Modbus)
EG4 Electronics	18KPV-12LV	Requires FW Version FAAB-1A1A or newer. One EG4 Inverter per Application - Multiple EG4 Inverters Will Be Rejected	12	Single	50	240	Serial (Modbus)
EG4 Electronics	IV-16000-HYB-AW-FX *(a.k.a. FlexBOSS21)*	Requires FW Version FAAB-1A1A or newer. One EG4 Inverter per Application - Multiple EG4 Inverters Will Be Rejected	12	Single	66.7	208	Serial (Modbus)
EG4 Electronics	IV-16000-HYB-AW-FX *(a.k.a. FlexBOSS21)*	Requires FW Version FAAB-1A1A or newer. One EG4 Inverter per Application - Multiple EG4 Inverters Will Be Rejected	16	Single	66.7	240	Serial (Modbus)
Enphase	IQ7-60-2-US	IQ Gateway ENV2-IQ-AM1-240	0.24	Single	1.15	208	Ethernet (2030.5)
Enphase	IQ7-60-2-US	IQ Gateway ENV2-IQ-AM1-240	0.24	Single	1	240	Ethernet (2030.5)
Enphase	IQ7PLUS-72-2-US	IQ Gateway ENV2-IQ-AM1-240	0.29	Single	1.39	208	Ethernet (2030.5)
Enphase	IQ7PLUS-72-2-US	IQ Gateway ENV2-IQ-AM1-240	0.29	Single	1.21	240	Ethernet (2030.5)
Enphase	IQ7A-72-2-US	IQ Gateway ENV2-IQ-AM1-240	0.29	Single	1.39	208	Ethernet (2030.5)
Enphase	IQ7A-72-2-US	IQ Gateway ENV2-IQ-AM1-240	0.349	Single	1.45	240	Ethernet (2030.5)
Enphase	IQ7PD-72-2-US	IQ Gateway ENV2-IQ-AM1-240	0.19	Single	0.92	208	Ethernet (2030.5)
Enphase	IQ7PD-72-2-US	IQ Gateway ENV2-IQ-AM1-240	0.19	Single	0.8	240	Ethernet (2030.5)
Enphase	IQ7PD-84-2-US	IQ Gateway ENV2-IQ-AM1-240	0.21	Single	1.06	208	Ethernet (2030.5)
Enphase	IQ7PD-84-2-US	IQ Gateway ENV2-IQ-AM1-240	0.21	Single	0.88	240	Ethernet (2030.5)
Enphase	IQ7X-96-2-US	IQ Gateway ENV2-IQ-AM1-240	0.315	Single	1.51	208	Ethernet (2030.5)
Enphase	IQ7X-96-2-US	IQ Gateway ENV2-IQ-AM1-240	0.315	Single	1.31	240	Ethernet (2030.5)

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Last updated: 2025-2-17							
Manufacturer	**Model #**	**Required Equipment for Compatibility**	**Nameplate (kW)**	**Phase(s)**	**Maximum Continuous Output Current (A)**	**Voltage (V)**	**Communication Type**
Enphase	IQ7AS-66-ACM-US	IQ Gateway ENV2-IQ-AM1-240	0.29	Single	1.39	208	Ethernet (2030.5)
Enphase	IQ7AS-66-ACM-US	IQ Gateway ENV2-IQ-AM1-240	0.349	Single	1.45	240	Ethernet (2030.5)
Enphase	IQ7XS-96-ACM-US	IQ Gateway ENV2-IQ-AM1-240	0.315	Single	1.51	208	Ethernet (2030.5)
Enphase	IQ7XS-96-ACM-US	IQ Gateway ENV2-IQ-AM1-240	0.315	Single	1.31	240	Ethernet (2030.5)
Enphase	IQ8-60-2-US	IQ Gateway ENV2-IQ-AM1-240	0.24	Single	1	240	Ethernet (2030.5)
Enphase	IQ8-60-M-US	IQ Gateway ENV2-IQ-AM1-240	0.24	Single	1	240	Ethernet (2030.5)
Enphase	IQ8PLUS-72-2-US	IQ Gateway ENV2-IQ-AM1-240	0.29	Single	1.21	240	Ethernet (2030.5)
Enphase	IQ8PLUS-72-M-US	IQ Gateway ENV2-IQ-AM1-240	0.29	Single	1.21	240	Ethernet (2030.5)
Enphase	IQ8M-72-2-US	IQ Gateway ENV2-IQ-AM1-240	0.325	Single	1.35	240	Ethernet (2030.5)
Enphase	IQ8M-72-M-US	IQ Gateway ENV2-IQ-AM1-240	0.325	Single	1.35	240	Ethernet (2030.5)
Enphase	IQ8A-72-2-US	IQ Gateway ENV2-IQ-AM1-240	0.349	Single	1.45	240	Ethernet (2030.5)
Enphase	IQ8A-72-M-US	IQ Gateway ENV2-IQ-AM1-240	0.349	Single	1.45	240	Ethernet (2030.5)
Enphase	IQ8H-240-72-2-US	IQ Gateway ENV2-IQ-AM1-240	0.38	Single	1.58	240	Ethernet (2030.5)
Enphase	IQ8H-240-72-M-US	IQ Gateway ENV2-IQ-AM1-240	0.38	Single	1.58	240	Ethernet (2030.5)
Enphase	IQ8H-208-72-2-US	IQ Gateway ENV2-IQ-AM1-240	0.36	Single	1.73	208	Ethernet (2030.5)
Enphase	IQ8H-208-72-M-US	IQ Gateway ENV2-IQ-AM1-240	0.36	Single	1.73	208	Ethernet (2030.5)
Enphase	IQ8HC-72-M-US	IQ Gateway ENV2-IQ-AM1-240	0.36	Single	1.73	208	Ethernet (2030.5)
Enphase	IQ8HC-72-M-US	IQ Gateway ENV2-IQ-AM1-240	0.38	Single	1.58	240	Ethernet (2030.5)
Enphase	IQ8HC-72-M-DOM-US	IQ Gateway ENV2-IQ-AM1-240	0.36	Single	1.73	208	Ethernet (2030.5)
Enphase	IQ8HC-72-M-DOM-US	IQ Gateway ENV2-IQ-AM1-240	0.38	Single	1.58	240	Ethernet (2030.5)
Enphase	IQ8MC-72-M-US	IQ Gateway ENV2-IQ-AM1-240	0.31	Single	1.49	208	Ethernet (2030.5)
Enphase	IQ8MC-72-M-US	IQ Gateway ENV2-IQ-AM1-240	0.32	Single	1.33	240	Ethernet (2030.5)
Enphase	IQ8AC-72-M-US	IQ Gateway ENV2-IQ-AM1-240	0.345	Single	1.66	208	Ethernet (2030.5)
Enphase	IQ8AC-72-M-US	IQ Gateway ENV2-IQ-AM1-240	0.349	Single	1.49	240	Ethernet (2030.5)
Enphase	IQ8X-80-M-US	IQ Gateway ENV2-IQ-AM1-240	0.36	Single	1.73	208	Ethernet (2030.5)
Enphase	IQ8X-80-M-US	IQ Gateway ENV2-IQ-AM1-240	0.38	Single	1.58	240	Ethernet (2030.5)
Enphase	IQ8X-80-M-DOM-US	IQ Gateway ENV2-IQ-AM1-240	0.36	Single	1.73	208	Ethernet (2030.5)
Enphase	IQ8X-80-M-DOM-US	IQ Gateway ENV2-IQ-AM1-240	0.38	Single	1.58	240	Ethernet (2030.5)
Enphase	IQ8P-72-2-US	IQ Gateway ENV2-IQ-AM1-240	0.475	Single	1.98	240	Ethernet (2030.5)
Enphase	IQ8P-3P-72-E-US	IQ Gateway ENV2-IQC2-AM3-3P	0.475	Three	2.28	208	Ethernet (2030.5)
Enphase	IQ8P-3P-72-E-DOM-US	IQ Gateway ENV2-IQC2-AM3-3P	0.475	Three	2.28	208	Ethernet (2030.5)
Enphase	IQ8H-3P-72-E-US	IQ Gateway ENV2-IQC2-AM3-3P	0.38	Three	1.83	208	Ethernet (2030.5)
Fortress Power	FP-ENVY-8K	Requires FW Version FAAB-1A1A or newer. One Fortress Power Inverter per Application - Multiple Fortress Power Inverters Will Be Rejected	8	Single	38.5	208	Serial (Modbus)
Fortress Power	FP-ENVY-8K	Requires FW Version FAAB-1A1A or newer. One Fortress Power Inverter per Application - Multiple Fortress Power Inverters Will Be Rejected	8	Single	33.3	240	Serial (Modbus)
Fortress Power	FP-ENVY-10K	Requires FW Version FAAB-1A1A or newer. One Fortress Power Inverter per Application - Multiple Fortress Power Inverters Will Be Rejected	10	Single	48	208	Serial (Modbus)
Fortress Power	FP-ENVY-10K	Requires FW Version FAAB-1A1A or newer. One Fortress Power Inverter per Application - Multiple Fortress Power Inverters Will Be Rejected	10	Single	41.6	240	Serial (Modbus)

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Manufacturer	**Model #**	**Required Equipment for Compatibility**	**Nameplate (kW)**	**Phase(s)**	**Maximum Continuous Output Current (A)**	**Voltage (V)**	**Communication Type**
Fortress Power	FP-ENVY-12K	Requires FW Version FAAB-1A1A or newer. One Fortress Power Inverter per Application - Multiple Fortress Power Inverters Will Be Rejected	12	Single	50	240	Serial (Modbus)
Fronius International GmbH	Primo GEN24 3.8 208-240	Includes "Plus" models	3.8	Single	18.13	208	Serial (Modbus)
Fronius International GmbH	Primo GEN24 3.8 208-240	Includes "Plus" models	3.8	Single	15.8	240	Serial (Modbus)
Fronius International GmbH	Primo GEN24 5.0 208-240	Includes "Plus" models	5	Single	24	208	Serial (Modbus)
Fronius International GmbH	Primo GEN24 5.0 208-240	Includes "Plus" models	5	Single	20.8	240	Serial (Modbus)
Fronius International GmbH	Primo GEN24 6.0 208-240	Includes "Plus" models	5.74	Single	27.6	208	Serial (Modbus)
Fronius International GmbH	Primo GEN24 6.0 208-240	Includes "Plus" models	6	Single	25	240	Serial (Modbus)
Fronius International GmbH	Primo GEN24 7.7 208-240	Includes "Plus" models	7.68	Single	36.9	208	Serial (Modbus)
Fronius International GmbH	Primo GEN24 7.7 208-240	Includes "Plus" models	7.68	Single	32	240	Serial (Modbus)
Fronius International GmbH	Primo GEN24 10.0 208-240	Includes "Plus" models	9.45	Single	45.45	208	Serial (Modbus)
Fronius International GmbH	Primo GEN24 10.0 208-240	Includes "Plus" models	10	Single	41.7	240	Serial (Modbus)
Ginlong Technologies	Solis-1P3.6K-4G-US	Requires FOMware DG-E*S-SG module. Set Grid Standard to UL-208-18 during commissioning	3.6	Single	17.3	208	Serial (Modbus)
Ginlong Technologies	Solis-1P3.6K-4G-US	Requires FOMware DG-E*S-SG module. Set Grid Standard to UL-240-18 during commissioning	3.6	Single	15	240	Serial (Modbus)
Ginlong Technologies	Solis-1P5K-4G-US	Requires FOMware DG-E*S-SG module. Set Grid Standard to UL-208-18 during commissioning	5	Single	24	208	Serial (Modbus)
Ginlong Technologies	Solis-1P5K-4G-US	Requires FOMware DG-E*S-SG module. Set Grid Standard to UL-240-18 during commissioning	5	Single	20.8	240	Serial (Modbus)
Ginlong Technologies	Solis-1P6K-4G-US	Requires FOMware DG-E*S-SG module. Set Grid Standard to UL-208-18 during commissioning	6	Single	28.8	208	Serial (Modbus)
Ginlong Technologies	Solis-1P6K-4G-US	Requires FOMware DG-E*S-SG module. Set Grid Standard to UL-240-18 during commissioning	6	Single	25	240	Serial (Modbus)
Ginlong Technologies	Solis-1P7.6K-4G-US	Requires FOMware DG-E*S-SG module. Set Grid Standard to UL-208-18 during commissioning	7.6	Single	36.5	208	Serial (Modbus)
Ginlong Technologies	Solis-1P7.6K-4G-US	Requires FOMware DG-E*S-SG module. Set Grid Standard to UL-240-18 during commissioning	7.6	Single	31.7	240	Serial (Modbus)
Ginlong Technologies	Solis-1P10K-4G-US	Requires FOMware DG-E*S-SG module. Set Grid Standard to UL-208-18 during commissioning	10	Single	43.3	208	Serial (Modbus)
Ginlong Technologies	Solis-1P10K-4G-US	Requires FOMware DG-E*S-SG module. Set Grid Standard to UL-240-18 during commissioning	10	Single	41.7	240	Serial (Modbus)
Ginlong Technologies	S6-GC25K-US	Requires FOMware DG-E*S-SG module. Set Grid Standard to IEEE1547-2018 during commissioning	25	Three	33.1	480	Serial (Modbus)
Ginlong Technologies	S6-GC30KLV-US	Requires FOMware DG-E*S-SG or E*X2-S + FCB-60 modules. Set Grid Standard to UL-208-18 during commissioning	30	Three	91.6	208	Serial (Modbus)
Ginlong Technologies	S6-GC33K-US	Requires FOMware DG-E*S-SG or E*X2-S + FCB-60 modules. Set Grid Standard to IEEE1547-2018 during commissioning	33	Three	43.7	480	Serial (Modbus)
Ginlong Technologies	S6-GC36K-US	Requires FOMware DG-E*S-SG or E*X2-S + FCB-60 modules. Set Grid Standard to IEEE1547-2018 during commissioning	36	Three	47.6	480	Serial (Modbus)
Ginlong Technologies	S6-GC40K-US	Requires FOMware DG-E*S-SG or E*X2-S + FCB-60 modules. Set Grid Standard to IEEE1547-2018 during commissioning	40	Three	52.9	480	Serial (Modbus)
Ginlong Technologies	S6-GC50K-US	Requires FOMware DG-E*S-SG or E*X2-S + FCB-60 modules. Set Grid Standard to IEEE1547-2018 during commissioning	50	Three	66.2	480	Serial (Modbus)

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Ginlong Technologies	S6-GC60K-US	Requires FOMware DG-E*S-SG or E*X2-S + FCB-60 modules. Set Grid Standard to IEEE1547-2018 during commissioning	60	Three	79.4	480	Serial (Modbus)
Ginlong Technologies	S5-GC75K-US	Requires FOMware DG-E*S-SG or E*X2-S + FCB-100 modules. Set Grid Standard to IEEE1547-2018 during commissioning	75	Three	90.2	480	Serial (Modbus)
Ginlong Technologies	S5-GC80K-US	Requires FOMware DG-E*S-SG or E*X2-S + FCB-100 modules. Set Grid Standard to IEEE1547-2018 during commissioning	80	Three	96.2	480	Serial (Modbus)
Ginlong Technologies	S5-GC90K-US	Requires FOMware DG-E*S-SG or E*X2-S + FCB-100 modules. Set Grid Standard to IEEE1547-2018 during commissioning	90	Three	108.3	480	Serial (Modbus)
Ginlong Technologies	S5-GC100K-US	Requires FOMware DG-E*S-SG or E*X2-S + FCB-100 modules. Set Grid Standard to IEEE1547-2018 during commissioning	100	Three	120.3	480	Serial (Modbus)
Ginlong Technologies	Solis-125K-EHV-5G-US-PLUS	Requires FOMware SE-A2 or SE-C1 module. Set Grid Standard to IEEE1547-2018 during commissioning	125	Three	132.3	600	Serial (Modbus)
Ginlong Technologies	Solis-185K-EHV-5G-US-PLUS	Requires FOMware SE-A2 or SE-C1 module. Set Grid Standard to IEEE1547-2018 during commissioning	185	Three	178	600	Serial (Modbus)
Ginlong Technologies	Solis-255K-EHV-5G-US-PLUS	Requires FOMware SE-A2 or SE-C1 module. Set Grid Standard to IEEE1547-2018 during commissioning	255	Three	184	800	Serial (Modbus)
GoodWe Technologies	GW5000-ES-US20	Requires FW Version DSP: 4, ARM: 8, or newer. One GoodWe Inverter per Application - Multiple GoodWe Inverters Will Be Rejected	5	Single	20.8	240	Serial (Modbus)
GoodWe Technologies	GW7600-ES-US20	Requires FW Version DSP: 4, ARM: 8, or newer. One GoodWe Inverter per Application - Multiple GoodWe Inverters Will Be Rejected	7.6	Single	31.7	240	Serial (Modbus)
GoodWe Technologies	GW9600-ES-US20	Requires FW Version DSP: 4, ARM: 8, or newer. One GoodWe Inverter per Application - Multiple GoodWe Inverters Will Be Rejected	9.6	Single	40	240	Serial (Modbus)
GoodWe Technologies	GW11K4-ES-US20	Requires FW Version DSP: 4, ARM: 8, or newer. One GoodWe Inverter per Application - Multiple GoodWe Inverters Will Be Rejected	11.4	Single	47.5	240	Serial (Modbus)
GoodWe Technologies	GW5000-MS-US30	Requires FW Version DSP: 2.x.1.x, ARM: 7, or newer. One GoodWe Inverter per Application - Multiple GoodWe Inverters Will Be Rejected	4.33	Single	20.8	208	Serial (Modbus)
GoodWe Technologies	GW5000-MS-US30	Requires FW Version DSP: 2.x.1.x, ARM: 7, or newer. One GoodWe Inverter per Application - Multiple GoodWe Inverters Will Be Rejected	5	Single	20.8	240	Serial (Modbus)
GoodWe Technologies	GW6000-MS-US30	Requires FW Version DSP: 2.x.1.x, ARM: 7, or newer. One GoodWe Inverter per Application - Multiple GoodWe Inverters Will Be Rejected	5.2	Single	25	208	Serial (Modbus)
GoodWe Technologies	GW6000-MS-US30	Requires FW Version DSP: 2.x.1.x, ARM: 7, or newer. One GoodWe Inverter per Application - Multiple GoodWe Inverters Will Be Rejected	6	Single	25	240	Serial (Modbus)

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GoodWe Technologies	GW7700-MS-US30	Requires FW Version DSP: 2.x.1.x, ARM: 7, or newer. One GoodWe Inverter per Application - Multiple GoodWe Inverters Will Be Rejected	6.65	Single	32	208	Serial (Modbus)
GoodWe Technologies	GW7700-MS-US30	Requires FW Version DSP: 2.x.1.x, ARM: 7, or newer. One GoodWe Inverter per Application - Multiple GoodWe Inverters Will Be Rejected	7.68	Single	32	240	Serial (Modbus)
GoodWe Technologies	GW9600-MS-US30	Requires FW Version DSP: 2.x.1.x, ARM: 7, or newer. One GoodWe Inverter per Application - Multiple GoodWe Inverters Will Be Rejected	8.32	Single	40	208	Serial (Modbus)
GoodWe Technologies	GW9600-MS-US30	Requires FW Version DSP: 2.x.1.x, ARM: 7, or newer. One GoodWe Inverter per Application - Multiple GoodWe Inverters Will Be Rejected	9.6	Single	40	240	Serial (Modbus)
GoodWe Technologies	GW11K4-MS-US30	Requires FW Version DSP: 2.x.1.x, ARM: 7, or newer. One GoodWe Inverter per Application - Multiple GoodWe Inverters Will Be Rejected	9.88	Single	47.5	208	Serial (Modbus)
GoodWe Technologies	GW11K4-MS-US30	Requires FW Version DSP: 2.x.1.x, ARM: 7, or newer. One GoodWe Inverter per Application - Multiple GoodWe Inverters Will Be Rejected	11.4	Single	47.5	240	Serial (Modbus)
LuxPowerTek	LXP-LB-US 5K	Requires FW Version FAAB-1A1A or newer. One LuxPowerTek Inverter per Application - Multiple LuxPowerTek Inverters Will Be Rejected	5	Single	24	208	Serial (Modbus)
LuxPowerTek	LXP-LB-US 5K	Requires FW Version FAAB-1A1A or newer. One LuxPowerTek Inverter per Application - Multiple LuxPowerTek Inverters Will Be Rejected	5	Single	20.8	240	Serial (Modbus)
LuxPowerTek	LXP-LB-US 7.6K	Requires FW Version FAAB-1A1A or newer. One LuxPowerTek Inverter per Application - Multiple LuxPowerTek Inverters Will Be Rejected	7.6	Single	36.5	208	Serial (Modbus)
LuxPowerTek	LXP-LB-US 7.6K	Requires FW Version FAAB-1A1A or newer. One LuxPowerTek Inverter per Application - Multiple LuxPowerTek Inverters Will Be Rejected	7.6	Single	31.7	240	Serial (Modbus)
LuxPowerTek	LXP-LB-US 8K	Requires FW Version FAAB-1A1A or newer. One LuxPowerTek Inverter per Application - Multiple LuxPowerTek Inverters Will Be Rejected	8	Single	38.5	208	Serial (Modbus)
LuxPowerTek	LXP-LB-US 8K	Requires FW Version FAAB-1A1A or newer. One LuxPowerTek Inverter per Application - Multiple LuxPowerTek Inverters Will Be Rejected	8	Single	33.3	240	Serial (Modbus)
LuxPowerTek	LXP-LB-US 9.6K	Requires FW Version FAAB-1A1A or newer. One LuxPowerTek Inverter per Application - Multiple LuxPowerTek Inverters Will Be Rejected	9.6	Single	46	208	Serial (Modbus)
LuxPowerTek	LXP-LB-US 9.6K	Requires FW Version FAAB-1A1A or newer. One LuxPowerTek Inverter per Application - Multiple LuxPowerTek Inverters Will Be Rejected	9.6	Single	40	240	Serial (Modbus)

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LuxPowerTek	LXP-LB-US 10K	Requires FW Version FAAB-1A1A or newer. One LuxPowerTek Inverter per Application - Multiple LuxPowerTek Inverters Will Be Rejected	10	Single	48	208	Serial (Modbus)
LuxPowerTek	LXP-LB-US 10K	Requires FW Version FAAB-1A1A or newer. One LuxPowerTek Inverter per Application - Multiple LuxPowerTek Inverters Will Be Rejected	10	Single	41.6	240	Serial (Modbus)
LuxPowerTek	LXP-LB-US 11.4K	Requires FW Version FAAB-1A1A or newer. One LuxPowerTek Inverter per Application - Multiple LuxPowerTek Inverters Will Be Rejected	11.4	Single	47.5	208/240	Serial (Modbus)
LuxPowerTek	LXP-LB-US 12K	Requires FW Version FAAB-1A1A or newer. One LuxPowerTek Inverter per Application - Multiple LuxPowerTek Inverters Will Be Rejected	12	Single	50	208/240	Serial (Modbus)
Mango Power	M Hybrid Inverter 12kW	Requires FW Version FAAB-1A1A or newer. One Mango Power Inverter per Application - Multiple Mango Power Inverters Will Be Rejected	10.4	Single	50	208	Serial (Modbus)
Mango Power	M Hybrid Inverter 12kW	Requires FW Version FAAB-1A1A or newer. One Mango Power Inverter per Application - Multiple Mango Power Inverters Will Be Rejected	12	Single	50	240	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 3000-TL-XH-US		2.6	Single	12.5	208	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 3000-TL-XH-US		3	Single	12.5	240	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 3800-TL-XH-US		3.29	Single	16	208	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 3800-TL-XH-US		3.8	Single	16	240	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 3800-TL-XH-US(S)		3.29	Single	16	208	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 3800-TL-XH-US(S)		3.8	Single	16	240	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 5000-TL-XH-US		4.33	Single	21	208	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 5000-TL-XH-US		5	Single	21	240	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 6000-TL-XH-US		5.2	Single	25	208	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 6000-TL-XH-US		6	Single	25	240	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 7600-TL-XH-US		6.58	Single	32	208	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 7600-TL-XH-US		7.6	Single	32	240	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 7600-TL-XH-US(S)		6.58	Single	32	208	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 7600-TL-XH-US(S)		7.6	Single	32	240	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 8200-TL-XH-US		7.28	Single	35	208	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 8200-TL-XH-US		8.2	Single	35	240	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 9000-TL-XH-US		7.9	Single	38	208	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 9000-TL-XH-US		9	Single	38	240	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 10000-TL-XH-US		8.73	Single	42	208	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 10000-TL-XH-US		10	Single	42	240	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 11400-TL-XH-US		9.88	Single	48	208	Serial (Modbus)
Shenzhen Growatt New Energy	MIN 11400-TL-XH-US		11.4	Single	48	240	Serial (Modbus)
SMA	SBSE3.8-US-50	ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	3.32	Single	16	208	Ethernet (Modbus)
SMA	SBSE3.8-US-50	ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	3.84	Single	16	240	Ethernet (Modbus)
SMA	SBSE4.8-US-50	ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	4.16	Single	20	208	Ethernet (Modbus)
SMA	SBSE4.8-US-50	ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	4.8	Single	20	240	Ethernet (Modbus)
SMA	SBSE5.8-US-50	ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	4.99	Single	24	208	Ethernet (Modbus)
SMA	SBSE5.8-US-50	ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	5.76	Single	24	240	Ethernet (Modbus)
SMA	SBSE7.7-US-50	ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	6.65	Single	32	208	Ethernet (Modbus)
SMA	SBSE7.7-US-50	ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	7.68	Single	32	240	Ethernet (Modbus)
SMA	STP 20-US-50	Firmware V03.02.08.R or newer, ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	20	Three	24	480	Ethernet (Modbus)

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SMA	STP 25-US-50	Firmware V03.02.08.R or newer, ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	25	Three	30	480	Ethernet (Modbus)
SMA	STP 30-US-50	Firmware V03.02.08.R or newer, ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	30	Three	36	480	Ethernet (Modbus)
SMA	STP 33-US-41	Firmware V04.01.05.R or newer, ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	33.3	Three	40	480	Ethernet (Modbus)
SMA	STP 50-US-41	Firmware V04.01.05.R or newer, ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	50	Three	64	480	Ethernet (Modbus)
SMA	STP 62-US-41	Firmware V04.01.05.R or newer, ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	62.5	Three	80	480	Ethernet (Modbus)
SMA	SHP 125-US-21	Firmware V04.02.03.R or newer, ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	125	Three	151	480	Ethernet (Modbus)
SMA	SHP 150-US-21	Firmware V04.02.03.R or newer, ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	150	Three	151	600	Ethernet (Modbus)
SMA	SHP 165-US-21	Firmware V04.02.03.R or newer, ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	165	Three	151	630	Ethernet (Modbus)
SMA	SHP 172-US-21	Firmware V04.02.03.R or newer, ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	172	Three	151	660	Ethernet (Modbus)
SMA	SHP FLEX-US-21	Firmware V04.02.03.R or newer, ModbusTCP Enabled, Comission using Grid Code US-IEEE 1547/2018-Cat III	172	Three	151	200-660	Ethernet (Modbus)
SMA	SC 2660 UP-US		2667	Three	2566	600	Ethernet (Modbus)
SMA	SC 2800 UP-US		2800	Three	2566	630	Ethernet (Modbus)
SMA	SC 2930 UP-US		2933	Three	2566	660	Ethernet (Modbus)
SMA	SC 3060 UP-US		3067	Three	2566	690	Ethernet (Modbus)
SMA	SC 4000 UP-US		4000	Three	3850	600	Ethernet (Modbus)
SMA	SC 4200 UP-US		4200	Three	3850	630	Ethernet (Modbus)
SMA	SC 4400 UP-US		4400	Three	3850	660	Ethernet (Modbus)
SMA	SC 4600 UP-US		4600	Three	3850	690	Ethernet (Modbus)
Sol-Ark	SA-8K-48-ST	COMM version 1442 or newer; MCU version 5224 or newer	8	Single	33.3	208/240	Serial (Modbus)
Sol-Ark	SA-12K-P	COMM version 1442 or newer; MCU version 6224 or newer	9	Single	37.5	208/240	Serial (Modbus)
Sol-Ark	Limitless 15K-LV *(a.k.a. 15K-2P-N)*	COMM version 1442 or newer; MCU version 7224 or newer	15	Single	62.5	208/240	Serial (Modbus)
SolarEdge	SE3000H-US		3	Single	12.5	240	Serial (Modbus)
SolarEdge	SE3800H-US		3.3	Single	16	208	Serial (Modbus)
SolarEdge	SE3800H-US		3.8	Single	16	240	Serial (Modbus)
SolarEdge	SE5000H-US		5	Single	21	240	Serial (Modbus)
SolarEdge	SE5700H-US		5	Single	24	208	Serial (Modbus)
SolarEdge	SE5700H-US		5.76	Single	24	240	Serial (Modbus)
SolarEdge	SE6000H-US		5	Single	24	208	Serial (Modbus)
SolarEdge	SE6000H-US		6	Single	25	240	Serial (Modbus)
SolarEdge	SE7600H-US		7.6	Single	32	240	Serial (Modbus)
SolarEdge	SE10000H-US		10	Single	42	240	Serial (Modbus)
SolarEdge	SE11400H-US		10	Single	48.5	208	Serial (Modbus)
SolarEdge	SE11400H-US		11.4	Single	47.5	240	Serial (Modbus)
SolarEdge	SE10KUS		10	Three	27.8	208	Serial (Modbus)
SolarEdge	SE10KUS		10	Three	12	480	Serial (Modbus)
SolarEdge	SE14.4KUS		14.4	Three	40	208	Serial (Modbus)
SolarEdge	SE17.3KUS		17.3	Three	48.25	208	Serial (Modbus)
SolarEdge	SE30KUS		30	Three	36.5	480	Serial (Modbus)
SolarEdge	SE33.3KUS		33.3	Three	40	480	Serial (Modbus)
SolarEdge	SE40KUS		40	Three	48.25	480	Serial (Modbus)
SolarEdge	SE43.2KUS		43.2	Three	120	208	Serial (Modbus)
SolarEdge	SE50KUS		50	Three	139.5	208	Serial (Modbus)
SolarEdge	SE66.6KUS		66.6	Three	80	480	Serial (Modbus)
SolarEdge	SE80KUS		80	Three	96.5	480	Serial (Modbus)
SolarEdge	SE100KUS		100	Three	120	480	Serial (Modbus)
SolarEdge	SE120KUS		120	Three	144.3	480	Serial (Modbus)
SunPower	Enphase IQ7HS-66-M-US	PV Supervisor 6 (PVS6)	0.369	Single	1.77	208	Ethernet (2030.5)
SunPower	Enphase IQ7HS-66-M-US	PV Supervisor 6 (PVS6)	0.384	Single	1.6	240	Ethernet (2030.5)

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SunPower	Enphase IQ7XS-96-2-US	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	Enphase IQ7XS-96-2-US	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPR-E19-320-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	SPR-E19-320-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPR-E19-320-BLK-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	SPR-E19-320-BLK-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPR-E20-327-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	SPR-E20-327-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPR-E20-327-BLK-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	SPR-E20-327-BLK-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPR-X20-327-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	SPR-X20-327-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPR-X20-327-BLK-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	SPR-X20-327-BLK-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPR-X21-335-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	SPR-X21-335-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPR-X21-335-BLK-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	SPR-X21-335-BLK-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPR-X21-345-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	SPR-X21-345-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPR-X21-345-BLK-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	SPR-X21-345-BLK-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPR-X21-350-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	SPR-X21-350-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPR-X21-350-BLK-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	SPR-X21-350-BLK-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPR-X22-360-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	SPR-X22-360-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPR-X22-360-BLK-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	SPR-X22-360-BLK-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPR-X22-370-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	SPR-X22-370-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPR-X22-370-BLK-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.51	208	Ethernet (2030.5)
SunPower	SPR-X22-370-BLK-E-AC	PV Supervisor 6 (PVS6)	0.315	Single	1.31	240	Ethernet (2030.5)
SunPower	SPWR-A4	PV Supervisor 6 (PVS6)	0.349	Single	1.45	240	Ethernet (2030.5)
SunPower	SPR-A390-G-AC	PV Supervisor 6 (PVS6)	0.349	Single	1.45	240	Ethernet (2030.5)
SunPower	SPR-A400-G-AC	PV Supervisor 6 (PVS6)	0.349	Single	1.45	240	Ethernet (2030.5)
SunPower	SPR-A390-BLK-G-AC	PV Supervisor 6 (PVS6)	0.349	Single	1.45	240	Ethernet (2030.5)
SunPower	SPR-A400-BLK-G-AC	PV Supervisor 6 (PVS6)	0.349	Single	1.45	240	Ethernet (2030.5)
SunPower	SPR-A410-G-AC	PV Supervisor 6 (PVS6)	0.349	Single	1.45	240	Ethernet (2030.5)
SunPower	SPR-A415-G-AC	PV Supervisor 6 (PVS6)	0.349	Single	1.45	240	Ethernet (2030.5)
SunPower	SPR-A420-G-AC	PV Supervisor 6 (PVS6)	0.349	Single	1.45	240	Ethernet (2030.5)
SunPower	SPR-M410-BLK-H-AC	PV Supervisor 6 (PVS6)	0.369	Single	1.77	208	Ethernet (2030.5)
SunPower	SPR-M410-BLK-H-AC	PV Supervisor 6 (PVS6)	0.384	Single	1.6	240	Ethernet (2030.5)
SunPower	SPR-M415-BLK-H-AC	PV Supervisor 6 (PVS6)	0.369	Single	1.77	208	Ethernet (2030.5)
SunPower	SPR-M415-BLK-H-AC	PV Supervisor 6 (PVS6)	0.384	Single	1.6	240	Ethernet (2030.5)
SunPower	SPR-M420-H-AC	PV Supervisor 6 (PVS6)	0.369	Single	1.77	208	Ethernet (2030.5)
SunPower	SPR-M420-H-AC	PV Supervisor 6 (PVS6)	0.384	Single	1.6	240	Ethernet (2030.5)
SunPower	SPR-M425-BLK-H-AC	PV Supervisor 6 (PVS6)	0.369	Single	1.77	208	Ethernet (2030.5)
SunPower	SPR-M425-BLK-H-AC	PV Supervisor 6 (PVS6)	0.384	Single	1.6	240	Ethernet (2030.5)
SunPower	SPR-M425-H-AC	PV Supervisor 6 (PVS6)	0.369	Single	1.77	208	Ethernet (2030.5)
SunPower	SPR-M425-H-AC	PV Supervisor 6 (PVS6)	0.384	Single	1.6	240	Ethernet (2030.5)
SunPower	SPR-M430-H-AC	PV Supervisor 6 (PVS6)	0.384	Single	1.6	240	Ethernet (2030.5)
SunPower	SPR-M430-H-AC	PV Supervisor 6 (PVS6)	0.369	Single	1.77	208	Ethernet (2030.5)
SunPower	SPR-M435-H-AC	PV Supervisor 6 (PVS6)	0.369	Single	1.77	208	Ethernet (2030.5)
SunPower	SPR-M435-H-AC	PV Supervisor 6 (PVS6)	0.384	Single	1.6	240	Ethernet (2030.5)
SunPower	SPR-M440-H-AC	PV Supervisor 6 (PVS6)	0.369	Single	1.77	208	Ethernet (2030.5)
SunPower	SPR-M440-H-AC	PV Supervisor 6 (PVS6)	0.384	Single	1.6	240	Ethernet (2030.5)
Tigo Energy	TSI-3.8K-US	Software version 3.6.3-ct or newer. One Tigo Inverter per Application - Multiple Tigo Inverters Will Be Rejected	3.29	Single	16	208	Serial (Modbus)
Tigo Energy	TSI-3.8K-US	Software version 3.6.3-ct or newer. One Tigo Inverter per Application - Multiple Tigo Inverters Will Be Rejected	3.8	Single	16	240	Serial (Modbus)
Tigo Energy	TSI-7.6K-US	Software version 3.6.3-ct or newer. One Tigo Inverter per Application - Multiple Tigo Inverters Will Be Rejected	6.58	Single	32	208	Serial (Modbus)
Tigo Energy	TSI-7.6K-US	Software version 3.6.3-ct or newer. One Tigo Inverter per Application - Multiple Tigo Inverters Will Be Rejected	7.6	Single	32	240	Serial (Modbus)
Tigo Energy	TSI-11.4K-US	Software version 3.6.3-ct or newer. One Tigo Inverter per Application - Multiple Tigo Inverters Will Be Rejected	9.88	Single	48	208	Serial (Modbus)

PPL Electric Utilities - Approved Smart Inverter List

The most recent version of this list can be found by visiting www.pplelectric.com/DERManagement. ***Google Chrome users:*** *clear your browser cache if you encounter issues viewing the most recent list.*

Last updated: 2025-2-17							
Manufacturer	**Model #**	**Required Equipment for Compatibility**	**Nameplate (kW)**	**Phase(s)**	**Maximum Continuous Output Current (A)**	**Voltage (V)**	**Communication Type**
Tigo Energy	TSI-11.4K-US	Software version 3.6.3-ct or newer. One Tigo Inverter per Application - Multiple Tigo Inverters Will Be Rejected	11.4	Single	48	240	Serial (Modbus)
Yaskawa Solectria Solar	PVI 25TL-208		25	Three	69.5	208	Serial (Modbus)
Yaskawa Solectria Solar	PVI25TL-480-R		25	Three	30.5	480	Serial (Modbus)
Yaskawa Solectria Solar	PVI-36TL-480-V2		36	Three	43.5	480	Serial (Modbus)
Yaskawa Solectria Solar	PVI 50TL-480		50	Three	60.2	480	Serial (Modbus)
Yaskawa Solectria Solar	PVI 60TL-480		60	Three	72.2	480	Serial (Modbus)
Yaskawa Solectria Solar	XGI 1500-125/125-UL		125	Three	120	600	Ethernet (Modbus)
Yaskawa Solectria Solar	XGI 1500-125/125-UL-A		125	Three	120	600	Ethernet (Modbus)
Yaskawa Solectria Solar	XGI 1500-125/150-UL		125	Three	144	600	Ethernet (Modbus)
Yaskawa Solectria Solar	XGI 1500-125/150-UL-A		125	Three	144	600	Ethernet (Modbus)
Yaskawa Solectria Solar	XGI 1500-150/166-UL		150	Three	160	600	Ethernet (Modbus)
Yaskawa Solectria Solar	XGI 1500 150/166-UL-A		150	Three	160	600	Ethernet (Modbus)
Yaskawa Solectria Solar	XGI 1500-166/166-UL		166	Three	160	600	Ethernet (Modbus)
Yaskawa Solectria Solar	XGI 1500-166/166-UL-A		166	Three	160	600	Ethernet (Modbus)
Yaskawa Solectria Solar	XGI 1500 175-480		175	Three	210.5	480	Ethernet (Modbus)
Yaskawa Solectria Solar	XGI 1500-175-480-DCG		175	Three	210.5	480	Ethernet (Modbus)
Yaskawa Solectria Solar	XGI 1500 200/200-480		200	Three	240.6	480	Ethernet (Modbus)
Yaskawa Solectria Solar	XGI 1500-200/200-480-DCG		200	Three	240.6	480	Ethernet (Modbus)
Yaskawa Solectria Solar	XGI 1500 225-600		225	Three	216.5	600	Ethernet (Modbus)
Yaskawa Solectria Solar	XGI 1500-225-600-DCG		225	Three	216.5	600	Ethernet (Modbus)
Yaskawa Solectria Solar	XGI 1500 250/250-600		250	Three	240.6	600	Ethernet (Modbus)
Yaskawa Solectria Solar	XGI 1500-250/250-600-DCG		250	Three	240.6	600	Ethernet (Modbus)

APPENDIX B

HIGHLY CONFIDENTIAL