



**Portland General Electric**  
121 SW Salmon Street · Portland, Ore. 97204

October 14, 2020

Public Utility Commission of Oregon  
Attn: Filing Center  
201 High Street, S.E.  
P.O. Box 1088  
Salem, OR 97308-1088

**RE: UM 2099 In the Matter of PGE's Request for Approval of Agreement for Net Metering and Interconnection Services**

Portland General Electric (PGE) hereby submits this filing into the UM 2099 Docket. The following attachments were presented by PGE in three workshops with Staff and Stakeholders between July and September 2020.

- Attachment A, UM 2099 Workshop Slide Deck presented on July 13, 2020
- Attachment B, UM 2099 Technical Workshop Slide Deck presented on August 4, 2020
- Attachment C, Two Meter Solution Technical Details Document presented on September 30, 2020
- Attachment D, Daytime Minimum Load Methodology presented on September 30, 2020

Please direct any questions regarding this filing to Chris Pleasant at (503) 464-2555.

Please direct your communications related to this filing to the following email address:  
[pge.opuc.filings@pgn.com](mailto:pge.opuc.filings@pgn.com).

Sincerely,

*\s\ Robert Macfarlane*

Robert Macfarlane  
Manager, Pricing & Tariffs

Enclosures

UM 2099  
In the Matter of PGE's Request for Approval of Agreement for Net  
Metering  
and Interconnection Services

Attachment A, UM 2099 Workshop Slide Deck  
presented on July 13, 2020

# **UM 2099 Workshop**

## **Agreement for Net Metering and Interconnection Services**

Portland General Electric

July 13, 2020



# Background

- With increasing amounts of distributed generation projects on PGE's distribution system, a small number of distribution feeders have reached the limit where additional generation cannot be added without harming the reliability of service for existing customers
- In short, during low load periods, generation may exceed load on these limited number of feeders
- Reliability issues include risk of dangerous voltage transients on substation transformers due to back feed, safety issues due to distributed generation sources attempting to feed an "island" following loss of a substation source, and voltage/frequency excursions for existing customers

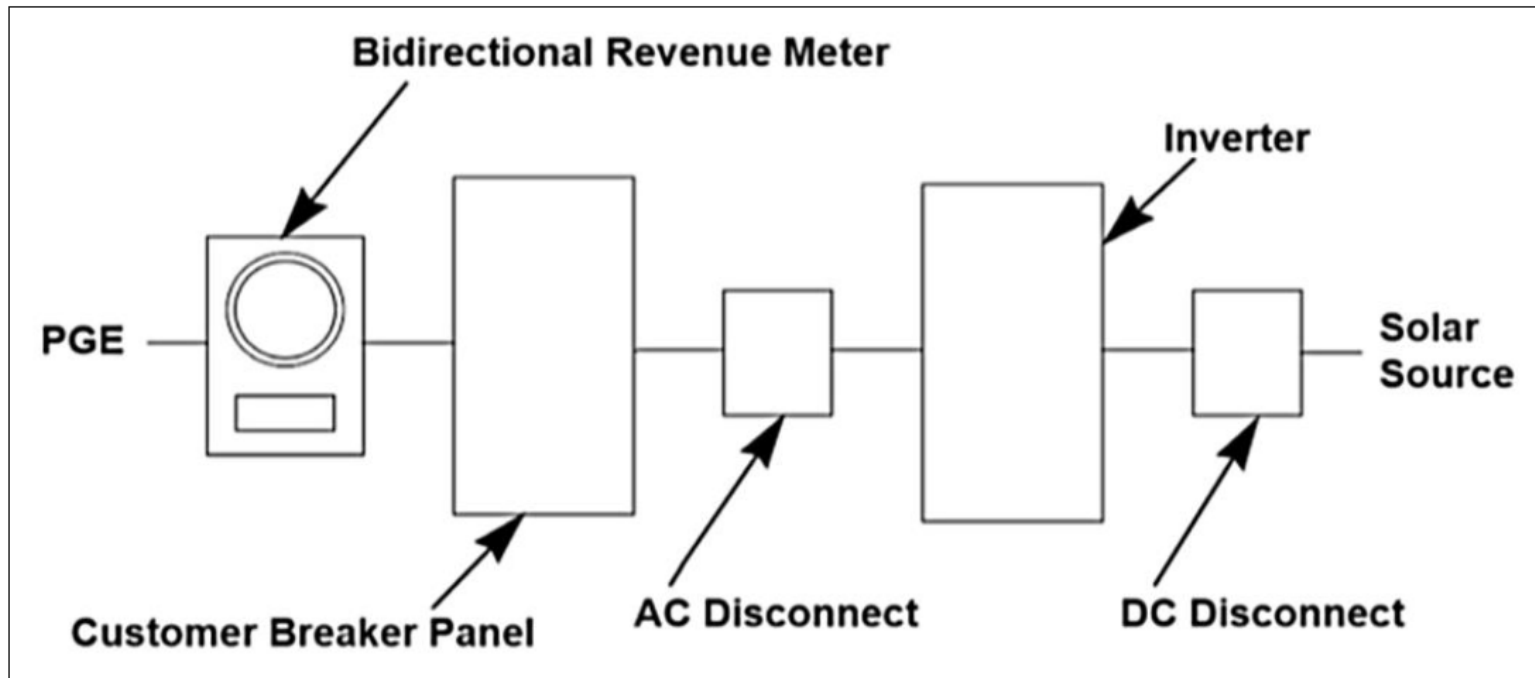
# Undesirable Alternative Solutions

- Assign significant substation transformer protection replacement costs to residential net metering projects that result in back feed onto the substation transformer
  - The scope of the costs involved would make net metering projects not economic
- Close generation limited feeders to additional residential net metering applications

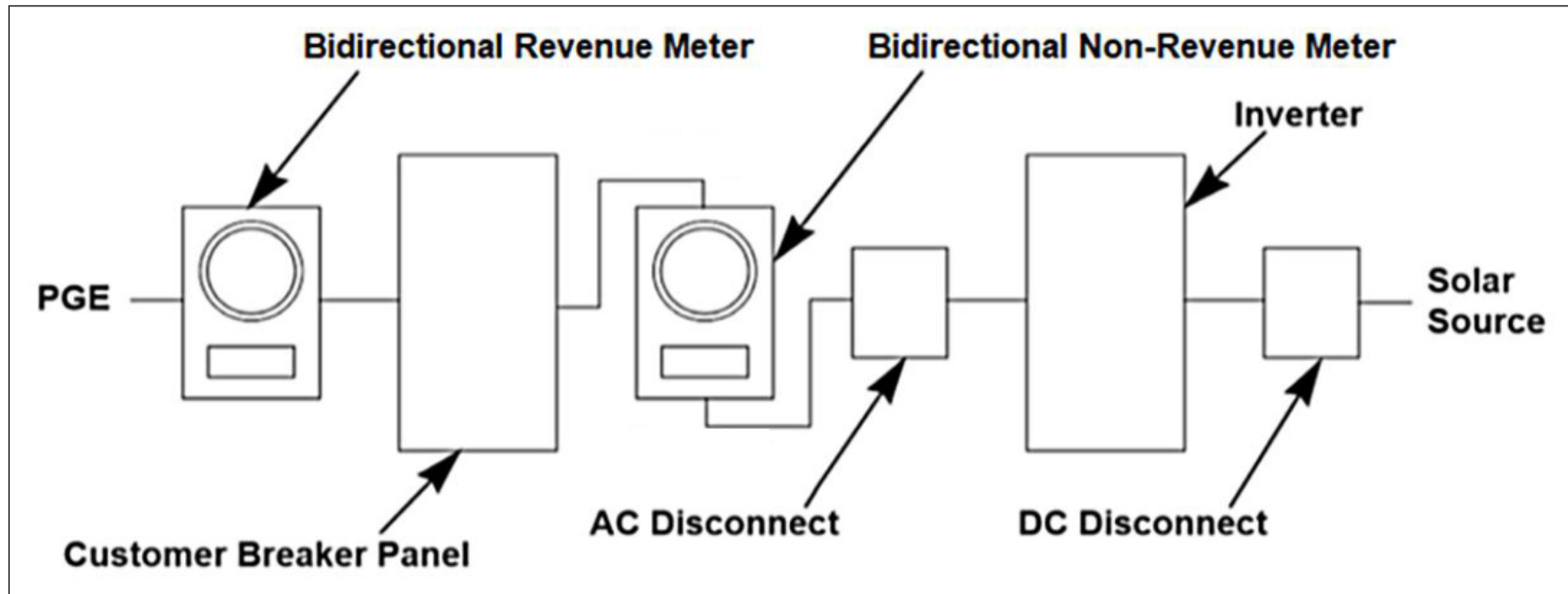
# Proposed Solution

- Install second non-revenue remote-disconnect meter upstream of the customer inverter – customer pays for meter base, PGE provides the meter
- Allows PGE to remotely stop back feed of solar production onto the system during times when low feeder customer demand is coupled with high solar output
- Likely to be exercised for only a few hours to days per year
- Allows PGE the ability to mitigate the effect of “islanding” on a feeder should there be a loss of source to a substation. Our goal is to maintain control of the voltage and frequency on all PGE lines (OPUC requirement). If we lose the source to a substation, the second meter allows us to prevent the “island” from forming
- Avoids significant capital costs for net metering customers and helps expand residential access to solar on limited feeders

# Typical Residential Net Metering Installation



# Typical Residential Installation w/Two-Meter Solution





# Proposed Language – Attachment A

## Exhibit 1

### (Applicable only to Net Metering Facilities on a Generation Limited Feeder)

As a condition of interconnecting this Net Metering Facility, Applicant is required to install a second meter base upstream of the inverter to accommodate a second PGE meter that will allow for temporary remote disconnection of the Net Metering Facility during periods of high generation and low customer demand on the feeder (“Feeder Minimum Load Conditions”). Applicant agrees to allow PGE to remotely disconnect the Net Metering Facility from PGE’s Electric Distribution System without notice to Applicant when PGE reasonably deems it appropriate during Feeder Minimum Load Conditions. Applicant is responsible for all costs of the secondary meter base.

# Future Solutions

- When substation protection systems are upgraded, second meters for net metering projects will no longer be required.
- Upgrading of residential inverters to UL standards. As inverters are improved, we anticipate controllable/switchable inverters which can be interrupted eliminating the need for a second meter.
- Technology advancements will continue to provide opportunities through storage, electric vehicle charging, etc.

# Questions?

The screenshot displays the PGE Net Metering Map website. The browser address bar shows the URL: [portlandgeneral.com/residential/power-choices/renewable-power/install-solar-wind-more/net-metering/net-metering-map](http://portlandgeneral.com/residential/power-choices/renewable-power/install-solar-wind-more/net-metering/net-metering-map). The page features the PGE logo and a search bar. A sidebar on the left lists navigation options under 'RENEWABLE POWER': Back, Choose Renewable, Green Source, Clean Wind, Green Future Solar, and Habitat Support. The main content area includes a text block: 'Metering application. To help avoid unexpected delays or costly design changes, please don't construct your project until we have approved your application.' Below this is a map titled 'PGE Generation Limited Feeders' showing various colored regions. A right-hand sidebar contains a list of links: Net Metering Rate Schedule, Oregon Public Utility Commission, and Net Metering Rules. The Windows taskbar at the bottom shows the time as 12:11 PM on 7/7/2020.



UM 2099  
In the Matter of PGE's Request for Approval of Agreement for Net  
Metering  
and Interconnection Services

Attachment B, UM 2099 Technical Workshop Slide Deck  
presented on August 4, 2020

# **UM 2099 Technical Workshop**

## **Agreement for Net Metering and Interconnection Services**

Portland General Electric

August 4, 2020





# PGE Participants

- Richard Goddard-Manager Interconnection Services
- Jason Zappe-Senior Interconnection Specialist
- Derrick Harris-Manager Planning Distribution Engineering
- Ken Spencer-Senior Distribution Operations Engineer
- Adam Yackley-Control Systems Meter Engineer
- Joe Boyles-Grid Products and Integration
- Chris Pleasant-Rates and Regulatory Affairs



# Recap of Proposed Solution

- Install second non-revenue remote-disconnect meter upstream of the customer inverter on a small number of distribution feeders – customer pays for meter base, PGE provides the meter
- Allows PGE to remotely stop back feed of solar production onto the system during times when low feeder customer demand is coupled with high solar output
- Allows PGE the ability to mitigate the effect of “islanding” on a feeder should there be a loss of source to a substation (fault condition) and maintain control of the voltage and frequency on all PGE lines (OPUC requirement).
- Avoids significant capital costs for net metering customers and helps expand residential access to solar on limited feeders

# Event Dispatch Considerations

## ■ Generation Limited Feeders

### • Ten PGE Feeders (out of ~650) Considered as Limited

- Periodic Updates to List – updates triggered by changes to the queue
- Developing Systemwide Semi-Annual Review – will enable communication of minimum load

### • Limited Feeder Criteria

- Feeder does not have hot line blocking capabilities, e.g., when feeder is generating (DER generation exceeds load), PGE cannot protect customer or PGE equipment from damage, and
- Disaggregated generation to load ratio on feeder  $> 90\%$  - reduces PGE's ability to predict behavior and manage the feeder, potentially leading to equipment damage

OR

- Associated transformer does not have adequate protection, leading to transformer damage, and
- Disaggregated generation to load ratio on associated transformer  $> 100\%$  - reduces PGE's ability to predict behavior and manage the transformer, potentially leading to equipment damage

### • Future Generation is Considered



# Event Dispatch Considerations

## ▪ Event Parameters

### • Events will affect Customers with 2<sup>nd</sup> Disconnect Meter

- Events will be based on individual feeder conditions, e.g., conditions that trigger the Limited Feeder criteria, like a sunny day (lots of generation) with limited load (not a lot of consumption)
- Affected customers will be grouped by their associated feeders

### • Parameter Criteria (Predictive)

- Daytime Minimum (Net) Load
- Daytime Minimum (Disaggregated) Load
- Anticipated Generation

Time of Year

Hour of Day

Ambient Temperature

Cloud Cover

### • Customer Focus - Limit Number of Events

### • Continuous Monitoring and Refinement of Methodology

## Illustrative Example

-50 kW

500 kW

800 kW (80 NM customers on feeder, generating 10kW each)

Summer

12pm-3pm

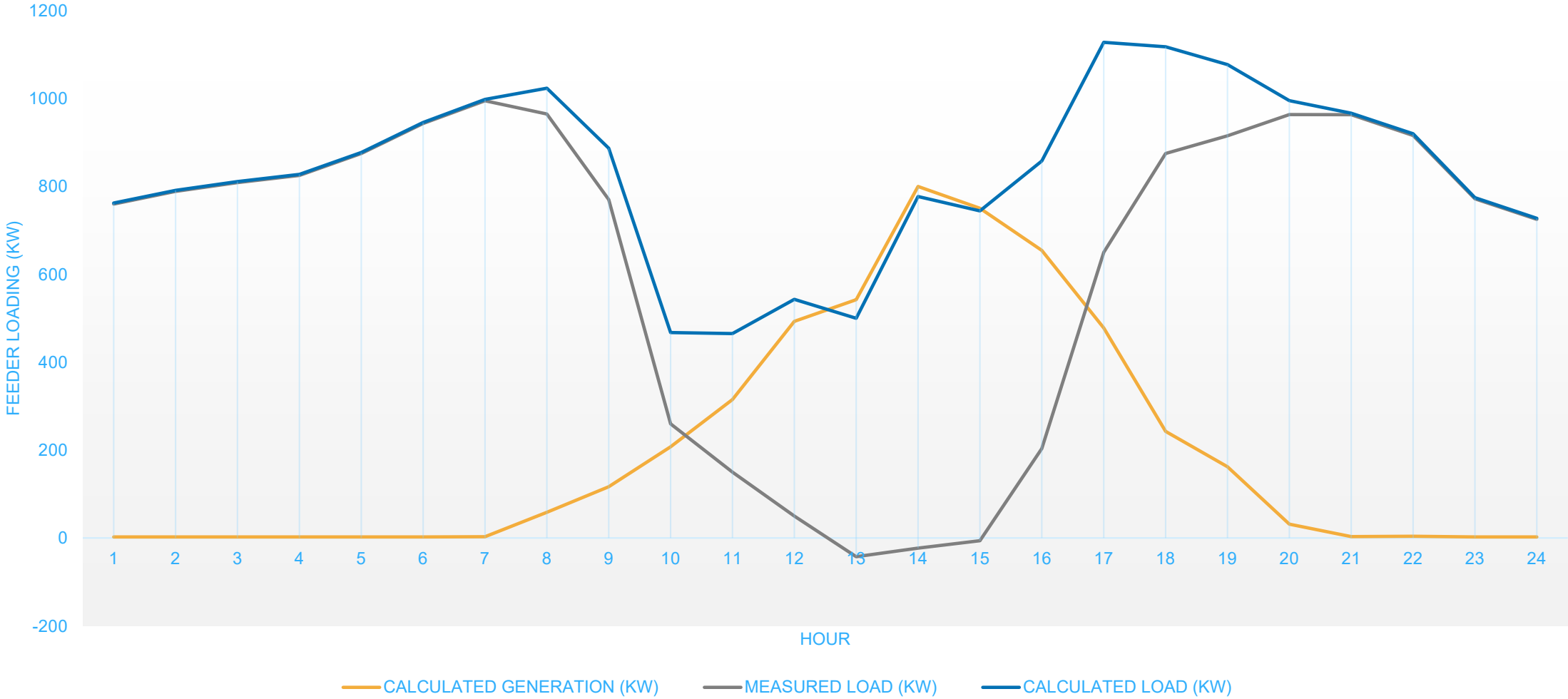
70 degrees

None

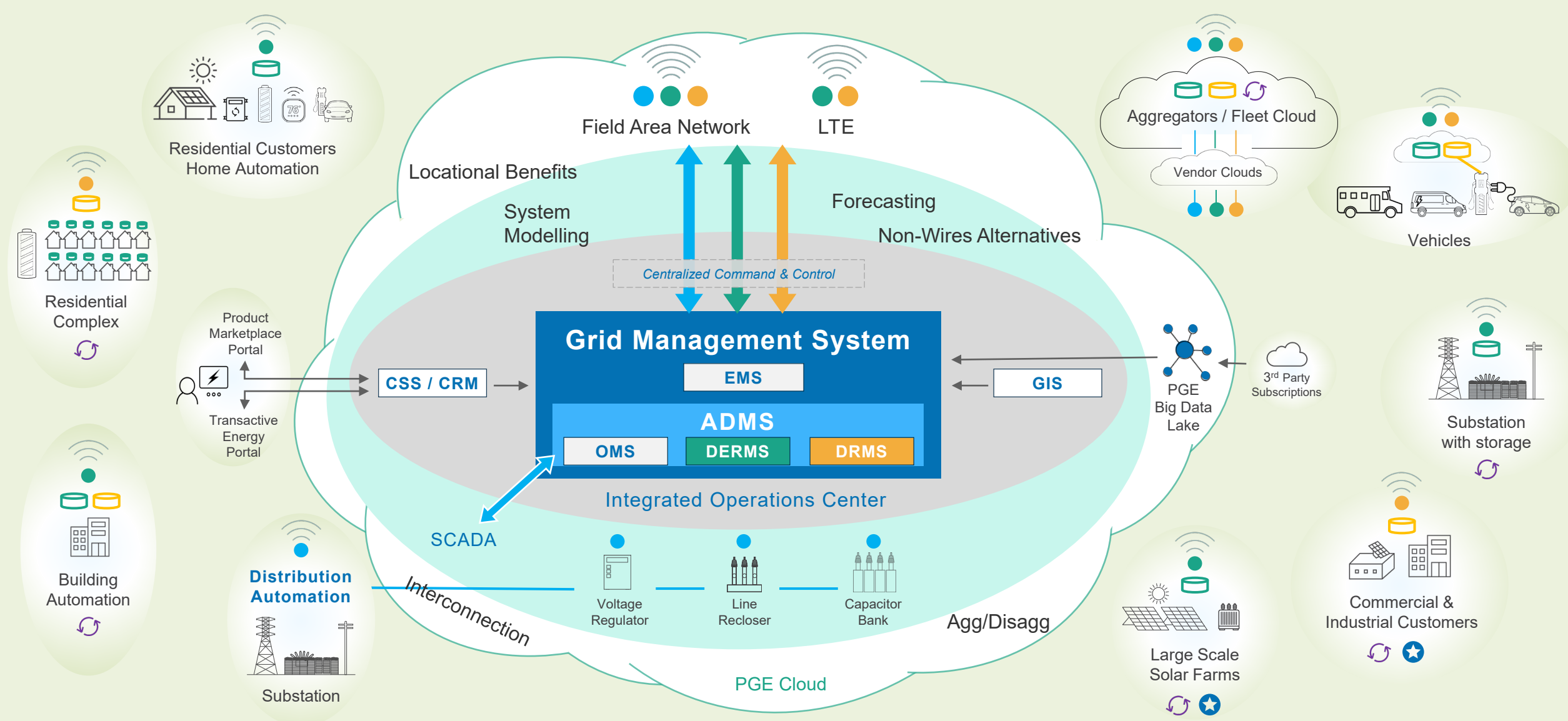


# Event Dispatch Considerations

SINGLE DAY LOAD/GENERATION CYCLE



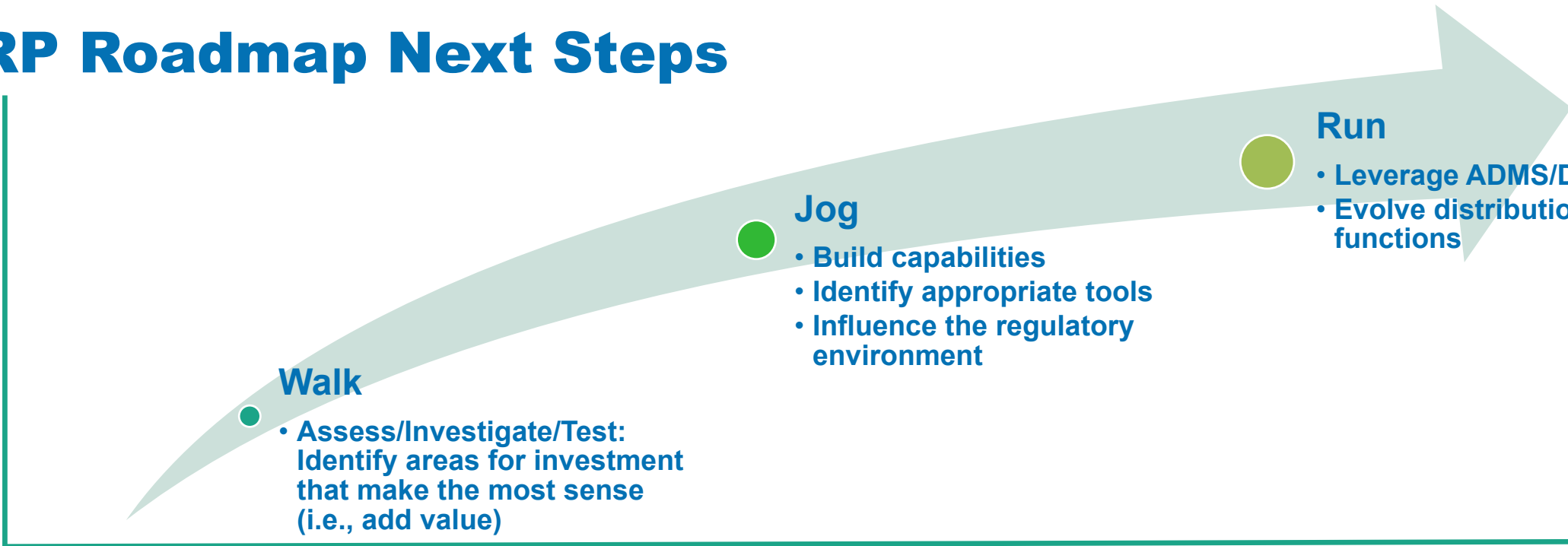
# PGE Grid Modernization – Conceptual Overview of the Grid





# DRP Roadmap Next Steps

DER Penetration & Grid Ops Maturity



## Walk

- Assess/Investigate/Test: Identify areas for investment that make the most sense (i.e., add value)

'20'21

## Jog

- Build capabilities
- Identify appropriate tools
- Influence the regulatory environment

'22'23

## Run

- Leverage ADMS/DERMS
- Evolve distribution market functions

'24'25

### Forecasting

- System & feeder level forecast
- Baselineing (e.g., market profiles)
- Development of internal forecasting tools
- Increase granularity/frequency based on learning
- Business as usual by utilizing advanced forecasting and system modeling

### Hosting Capacity Analysis (HCA)

- Adopt HCA in planning studies
- Develop roadmap for hosting capacity maturity
- Use HCA in distribution studies and investment planning, e.g., add capacity for DER penetration
- Increase granularity, data sharing, frequency

### Interconnection

- HCA as screening tool for developers
- Technical outreach & facilitation
- Visualization of hosting capacity in GIS
- Incorporate costs-to-upgrade for interconnection

### Valuation

- Use existing framework to develop locational value of DERs
- Assess cost-effectiveness methodology
- Broaden DER valuation categories
- Identify earning mechanisms/recovery for DERs
- Send market signals

### Other Initiatives

- Community engagement plan
- Planning support for regulatory filings, pilots, etc.
- Non-wires alternatives
- Integrate community engagement in day-to-day
- Transparency into grid needs
- NWA methodology development/testing





# Q&A

- Question: Does the solution outlined in Exhibit 1 mitigate the need for all of the modifications that were determined to be necessary through those impact studies or were there other solutions that were also employed to avoid substation modifications? Can PGE share the list of customers/trade ally contractors that they have been in coordination with to help avoid costly substation modifications and process their net metering applications.
- Answer: The proposed two-meter solution for net metering projects provides a means to mitigate the impact of additional net metering generation on limited feeders. The solution has been approved on eight net metering projects to date. We do have a couple larger commercial three-phase projects that will require a three-phase contactor in addition to the remote disconnect meter. PGE does not make customer information publicly available, but we can provide a list of installers that have marketing in PGE's service territory.



# Q&A

- **Question:** Does the [PGE Net Metering Map](#) show all feeders that meet the threshold for requiring a Level 3 net metering interconnection review? If not, what qualifies a feeder as "Generation Limited" and what data is used to determine that the feeders identified on the PGE Net Metering Map meet that threshold? Is there another resource that a solar trade ally contractor could refer to in order to determine if a project is on a feeder that requires a Level 3 net metering application? How often is the PGE Net Metering Map updated?
- **Answer:** The net metering map does provide a visualization of each feeder currently determined as having limited generating capacity. The qualification for these feeders to be placed on this list include the following:
  - Feeder does not have hot line blocking capabilities
  - Adequate transformer protection (3V0, or other related protection) is not acceptable
  - Disaggregated generation to load ratio on the associated feeder  $\geq 90\%$
  - Disaggregated generation to load ratio on the associated transformer  $\geq 100\%$
- Further efforts are underway to determine and issue daytime minimum load (DML) values for each distribution feeder and transformer in a consistent manner. Our intent is to refresh data as needed and provide updates for all distribution feeders and transformers on a semi-annual basis. At this point, we do not envision much deviation from the existing map.
- There is not currently an additional resource that a solar trade ally contractor could utilize other than materials from the UM2001 data request. UM2005 will be exploring options as to making additional related information more accessible.
- The net metering map is currently updated on an as-identified basis. We will be performing another comprehensive review of limited feeders in Q3.



# Q&A

- Question: If a customer located on a generation limited feeder was planning on installing a 6kW residential solar system with the required second meter base would the process they went through to apply for net metering be any different than is outlined in the Level 3 Net Metering Interconnection Review (860-039-0040)? Will the customer pay costs associated with the level 3 net metering application? Will PGE perform an impact study? Could the customer be responsible for additional substation modifications in addition to installing the second meter in order to interconnect their project?
- Answer: Customers planning to install a solar system on a generation limited feeder will be required to submit a Level 3 net metering application and PGE will review the project based on the Level 3 review criteria outlined in OAR 860-039-0040. All Level 3 net metering applications require an application fee of \$100 plus \$2 per kW of system size as outlined in the net metering rules. All customers who submit a Level 3 net metering application do receive an impact study. Customers who are offered the two-meter solution will not be required to pay for additional PGE substation upgrades.



# Q&A

- Question: Would the condition outlined in Exhibit 1 apply to all net metered facilities regardless of size or renewable resource that will be installed on a 'Generation Limited Feeder'? For example: Would this apply for a biopower or hydropower project? Would it apply for a three-phase commercial rooftop solar system?
- Answer: Our current proposal is to provide the two-meter solution to all net metering applications 25 kW and smaller on limited feeders. This would include projects other than solar (e.g. hydro, biomass) although most projects that apply for net metering are solar. Larger projects and three phase commercial projects will be reviewed on a case by case basis. As an example, we have provided a solution to a three-phase customer using the same remote disconnect meter combined with a three-phase contactor since our meters are not capable of disconnecting all three phases. This solution avoided a more expensive system modification that the customer would have been responsible for.



# Q&A

- Question: Are there requirements on the location of the second meter base described in Exhibit 1 that the contractor should be aware of in order to incorporate into their design?
- Answer: There is a requirement for the 2nd meter to be located within 10' of the revenue meter. The Distance is not described in Figure 1 or 2, but in the paragraph preceding Figure 2. See below:

The second meter is installed downstream of the customer breaker panel and upstream of generation system inverter. It will not be used for revenue or billing purposes. Upstream wiring enters on the line side (utility side) of the meter. Wiring from inverter enters on the load side (customer side) of the meter. The base for the second meter must be installed within 10 feet of the revenue (billing) meter on exterior of building. Meter socket must meet EUSERC 301 or 301A with 200 A maximum rating.

Figure 2 shows a typical residential net metering installation with a two-meter solution.

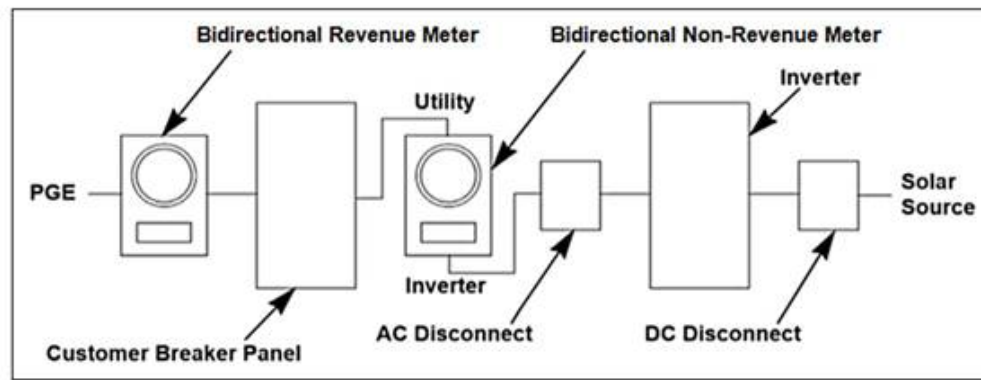


Figure 2: Typical Residential Net Metering Installation with a Two-Meter Solution



# Q&A

- Question: How will PGE determine that a 'Feeder Minimum Load Condition' has been reached in order to disconnect the net metering facility?
- Answer: A group has been formed to identify the appropriate criteria associated with PV curtailment of net metering customers. Factors that will influence this criteria include time of day, anticipated ambient temperature, anticipated cloud cover, day of week, type of day, and expected generation output as related to loading. In this evaluation, preliminarily, curtailment is expected to occur on a per feeder basis. This means that net metering customers served by a common feeder will be disconnected and reconnect concurrently. Analyses have been performed to identify risks; and per feeder, information is being generated to determine when feeders will need to begin curtailment if limited margin currently exists.
- During this exercise, the customer experience will be considered with the goal is to limit curtailment events and related durations as much as possible consistent with reliability needs and requirements. The technical team had just gotten together to speak on this issue this past Monday (July 27), and have identified factors for further consideration related to establishing a curtailment criteria. These factors include further (granular) identification of system states or configurations, customer behaviors, and identifying certain trends or patterns during time of year, time of day, within certain temperature ranges with varying levels of cloud cover. As this work develops, we will continue to keep you posted as we make progress.



# Q&A

- Question: How will PGE trigger the temporary remote disconnection of the second utility controlled meter? Would the customer be notified that a temporary remote disconnection had occurred?
- Answer: PGE is relying on our AMI communication infrastructure and head-end system to operate the 2nd remote connect/disconnect (RCRD) meters. This system is dependent on an employee initiating a connect/disconnect in real time, or scheduling one or both of those actions on a predetermined basis. We currently do not have a mechanism to reliably and consistently communicate to our Distributed Energy Resources (DERs) or Distributed Standby Generation (DSG) customers for generation connection/disconnection events, or to our Qualifying Facility (QF) customers when a system outage curtails their generation
- We are currently evaluating different systems and methodologies for when we would initiate an RCRD command, and would prefer to curtail the generation in real time. This would result in more frequent RCRD events, but would last for a short duration. For our SCADA-operated substations, we are evaluating an algorithm where we trigger an alarm to the grid operator when the generation exceeds the load on the substation transformer. For transformers with multiple feeders, more analysis is needed to determine whether we could operate meters on one feeder or would need to operate all feeders on the transformer. We still have more work to do to establish alarms in the SCADA system and procedures for operators to execute the command to operate the meters.
- We are also working with our Automated Distribution Management System (ADMS) implementation team to include automated system analysis and RCRD actions directly to the AMI head-end system as a future addition to the ADMS program. (Insert other ADMS/DERMS benefits here)
- For our non-SCADA or MV90 substation, the latency of data would likely require a more predictive method for operating the RCRD meters. The advantage of this method is it would give us the opportunity to provide advance notice to customers of upcoming RCRD events. The disadvantage is that this method may result in more hours of operation or possibly situations where we provide notice but don't actually operate the meters (longer duration, less frequency). We are also looking at historical PI data to determine if there are data elements such as hours of the day, temperature, days of the week, etc, that could be used to predict



# Q&A

- Question: In the net metering interconnection agreement there is a temporary disconnection clause that would seem to apply to the scenario described in Exhibit 1. What supporting documentation (highlighted section below) for the decision to trigger a temporary remote disconnection would PGE provide the customer?
- ***Temporary Disconnection (3.4.3)*** *If PGE determines that operation of the Net Metering Facility will likely cause disruption or deterioration of service to other customers served from the Electric Distribution System, or if operating the Net Metering Facility could cause damage to PGE's Electric Distribution System, then PGE may disconnect the Net Metering Facility. In such event, PGE shall provide the Applicant supporting documentation used to reach the decision to disconnect the facility upon the Applicant's request. - DAVID*
- Answer: PGE would provide the customer with information showing that conditions existed that warranted the decision to disconnect the net metering facility. The specific nature of the event and PGE's dispatch guidelines leading to the disconnection will dictate the specific type of information that would be provided to the customer.



# Q&A

- Question: During the presentation it was stated that battery storage technology was not currently able to mitigate the hazard identified in the same way that a utility-controlled meter could. PGE has displayed a level of comfort with new technology from the DSG program, to the Smart Battery Pilot being rolled out, and the microgrid projects currently being built . Can PGE go into any further detail on how battery storage equipment was evaluated and what limitations were of specific concern?
- Answer: There are a variety of issues and concerns surrounding the technical aspects of batteries that make them, especially residential batteries, an inadequate solution at this time. Batteries as a solution to generation-limited feeders display shortcomings when it comes to guaranteeing that a customer's solar installation will not cause backfeed onto the grid, often out of concern for inadequate power capacity and/or energy capacity, but also out of concern for the operation of the battery itself. These analyses were carried out looking at customer adoption of storage on PGE's system and the current landscape of batteries on the market and modeling their performance against an average solar installation in PGE territory using NREL's PVWatts tool. The Grid Edge Solutions team is still examining the potential of front-of-the-meter or large behind-the-meter batteries as a possible alternative



# Q&A

- Question: Customers that are interested in installing a new solar+ storage system currently submit a net metering application that includes information about the complete solar+storage system design. Does PGE consider the "Generation Capacity" of the net metering facility to be the combination of the maximum rating for the solar inverter plus the rating for the battery energy storage system? Would customers on a generation limited feeder with existing solar that are interested in adding battery storage need to submit a level 3 interconnection application reflecting additional capacity and retrofit their system with a second meter as outlined in Exhibit 1? Would customers on a generation limited feeder interested in a standalone battery storage system need to submit a level 3 net metering application?
- Answer: PGE evaluates solar+storage net metering applications based on the combined output rating of both components. It has been PGE's experience with standalone storage projects that they will export to the grid. PGE has two documented case of inadvertent export. The storage manufacturers literature indicates there may be inadvertent export under certain conditions.
- Customers wishing to add capacity to their existing net metering system would be required to submit a Level 3 net metering application if they are served by a generation limited feeder. PGE is still evaluating if the two-meter solution is appropriate for solar+storage projects. Many of the solar+storage net metering applications PGE receives indicate the storage is AC coupled and therefore the two-meter solution may not prevent energy from the storage being exported to the grid. PGE's technical team is current evaluating and discussing this issue.
- Customers who are interested in installing a standalone storage system cannot apply for net metering as storage by itself is not an eligible net metering technology. Customers with standalone storage projects would need to apply under the Small Generator Interconnection Rules. To date PGE has not received a standalone storage application on a generation limit feeder. PGE's technical team is discussing what the appropriate approach would be for such an application.

# Questions?

The screenshot shows a web browser window displaying the PGE Net Metering Map. The browser's address bar shows the URL: [portlandgeneral.com/residential/power-choices/renewable-power/install-solar-wind-more/net-metering/net-metering-map](http://portlandgeneral.com/residential/power-choices/renewable-power/install-solar-wind-more/net-metering/net-metering-map). The page content includes the PGE logo, a search bar, and a sidebar with navigation options: RENEWABLE POWER, < Back, Choose Renewable, Green Source, Clean Wind, Green Future Solar, and Habitat Support. The main content area features a map titled "PGE Generation Limited Feeders" with a search bar and a list of links: Net Metering Rate Schedule, Oregon Public Utility Commission, and Net Metering Rules. The map shows various colored regions (red, orange, yellow, green, blue, pink) representing different feeders, with labels for Hillsboro, Portland, Newberg, Salem, Mt. Hood National Forest, and Warm Springs Reservation. The map also includes a scale bar (30mi) and coordinates (-122.666 45.234 Degrees). The Windows taskbar at the bottom shows the time as 12:11 PM on 7/7/2020.

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Attachment C, Two Meter Solution Technical Details Document  
presented on September 30, 2020



## Background

In 2019, PGE began to identify multiple areas of PGE's system that are no longer able to accommodate additional net-metering projects without major system upgrades. The constraint in each area of the system is based on PGE's determination that existing and planned generators will with new distributed generation in these areas exceed local load during periods of high solar generation and low customer demand (referred to as the minimum daytime load). As required by current Oregon Administrative Rules, a customer (or net-metering facility) seeking to interconnect to PGE's system is responsible for the interconnection upgrades. Beginning in late 2019, PGE began working with Oregon Public Utility Commission (OPUC) Staff and stakeholders to identify a technical solution that would allow Customers to connect to PGE's system without incurring cost prohibitive upgrades. Through this stakeholder process, PGE recommended a solution that will allow Customers to proceed with their projects on Limited Feeders and avoid the cost of distribution system upgrades that would otherwise be necessary to accommodate additional generation.

## Purpose

The purpose of this request is to allow Customers to proceed with their projects on Limited Feeders and avoid the cost of distribution system upgrades that would otherwise be necessary to accommodate additional generation and be borne by the Customers. The solution requires an applicant on a Limited Feeder to install a second meter base upstream of the inverter (see Figure 1 below) to allow temporary remote disconnection of the net-metering facility during periods of high generation and low customer demand on the feeder. PGE also met with OPUC staff to explain the generation limitations and the proposed, near-term, two-meter solution. PGE also developed a searchable map of the areas that are served by Limited Feeders and posted this map on [PortlandGeneral.com](http://PortlandGeneral.com) along with additional customer resources and frequently asked questions to help Customers identify whether their project could potentially be impacted.

The proposed updates allow the Company to clearly communicate with Customers on the limited number of constrained feeders that PGE may remotely disconnect net-metering systems for reliability and safety reasons when local generation is predicted to exceed local load. Other provisions of the standard net-metering agreement already allow PGE to remotely disconnect the customer's facility due to reliability and safety concerns. This new language provides Customers with more information regarding the possibility of such disconnects for Customers that are connected to constrained feeders.

## Applicability

PGE's net-metering solution will apply to all Customers that are within an area that is constrained. Constrained areas are defined on a per feeder basis as areas in which sufficient levels of protection are not present at the attached substation transformer or feeder level, and (1) associated feeder aggregate daytime generation (kW) is greater than or equal to 90% of its minimum daytime consumption load; or (2) associated transformer aggregate daytime generation (kW) is greater than or equal to 100% of its minimum daytime consumption load.

## Requirements

For Net-Metering Facilities connected to a feeder identified as generation-limited, an option is presented for the customer to add an additional meter base designated to connect to their internal PV generation system. A lockable, manual load break disconnect switch that will disconnect the net-metering facility from PGE's Electric Distribution System will be installed. PGE will install an additional (non-revenue) meter and will have the option to remotely disconnect that meter resulting in disconnecting the customer's PV system. The switch must plainly indicate whether it is in the open or closed position and be located within ten (10) feet of PGE's meter. The disconnect switch may be located more than ten (10) feet from PGE's meter provided the net-metering facility obtains PGE approval of the location of the switch, and permanent instructions are posted at the meter indicating the location of the switch.

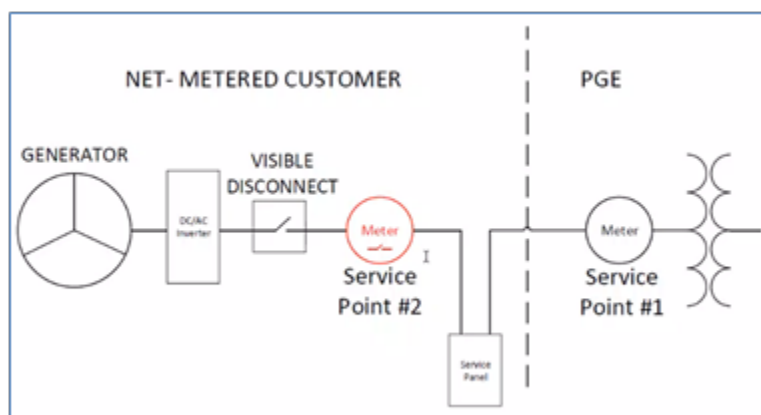


Figure 1: One Line diagram detailing proposed two-meter solution. Service Point #2 is a non-revenue meter that shall be controlled by PGE.

## Event Criteria

Net-metering facilities with the additional (non-revenue) meter will have their PV system disconnected under circumstances when PGE deems there is potential (future) risk of backfeed at the feeder level or transformer level. The following circumstances would trigger the need to disconnect the net metering facility:

1. Feeder breaker does not have hot line blocking enabled and feeder is at risk of backfeeding the substation transformer, and/or
2. Substation transformer does not have adequate protection (3V0), and attached feeders are at risk of generating to a level that the substation transformer will experience reverse current flow.

For either of these events, all non-revenue meters attached to the related (1) feeder or (2) transformer will be disconnected for a duration until it is deemed safe to reconnect. Meters that are not attached to these corresponding feeders or transformers will not be disconnected. Curtailment will only occur when a feeder or associated transformer is predicted to potentially experience reverse current flow.

## Curtailment Event

The following describes how we will determine when there is sufficient risk that the Event Criteria will be met and remote disconnection required. Screening hours are between 9am and 5pm. Curtailment shall occur within those hours only. Curtailment will occur only during certain periods throughout the year as analyzed on a month-to-month basis. Curtailment will be considered during months which expected generation/load percentage exceeds 95%. Feeders will be analyzed to determine whether curtailment will occur during weekdays only, weekends and holidays only, or seven days per week. A suggested temperature range at time of proposed curtailment will dictate whether curtailment is applicable. Curtailment will occur on days in which the forecasted weather for those curtailment hours is “sunny.”

Determination of when to curtail Net-Metering Facilities will be predictive. Factors included in this prediction will include time of day, time of year, day of week (weekends versus weekdays), and forecasted temperature. Additional factors (e.g., forecasted cloud cover) may be included in this process as system datasets mature. For each Limited Feeder, historical hourly data will be used in analysis to determine overall likelihood that a feeder or transformer may experience reverse flow.

PGE will monitor the conditions below, which may influence a curtailment event:

### **Time of Day**

In Oregon, summer peak sun hours have been determined to be about six hours, with winter peak sun hours to be about two hours per day. For the interconnection study process, daily hours examined are from a start hour of 0900-1000 to an ending hour of 1600-1700. These hours will be screened when determining curtailment. Generation curtailment will not be activated outside of hours 0900 – 1700. For the screening process, each feeder will be examined to determine conditions as to which hours are most likely to produce backfeed. Within the specified bandwidth, actual hours of curtailment will be narrowed to reflect this characteristic.

### **Time of Year**

Time of year (monthly) in which curtailment may be activated will be determined. This data is to be gathered via PI Processbook and set at hourly intervals. In the event that there is known PV that has been added to the feeder, but not yet included in a full year’s worth of data in PI, generation outputs from these additional devices will need to be added to the dataset in the areas that they were not previously included. The process to collect this data and determine time of year curtailment may be activated is detailed below:

1. Gather monthly Daytime Minimum Net Load (Utilize DML Methodology) for the Limited Feeders
2. Utilize generation reduction factors to determine expected PV generation on a per-month basis
3. For each month, add generation value to Daytime Minimum Net Load to determine disaggregated feeder load
4. For each month, divide generation value by disaggregated feeder load to determine generation/load percentage.
5. If generation/load percentage > 95%, then net-metering curtailment may need to be enabled for those months

6. For limited transformers without adequate protection, this activity will need to be repeated at either the transformer level, or at the level of the corresponding feeders' monthly coincidental daytime minimum load.

### **Day of Week**

Feeder characteristics will dictate whether curtailment shall occur on a seven-day cycle or on a weekend cycle.

### **Forecasted Temperatures**

Feeders will be screened to determine a likely temperature range at time of highest solar penetration to factor in individual feeder curtailment. The temperature range for the curtailment period duration will be determined based on the month and time a feeder will likely experience reverse current flow. Historical occurrences will be analyzed to determine the anticipated temperature range.

### **Forecasted Cloud Cover**

Cloud cover is included in the calculation that determines generation output for daytime minimum load. This information is based on historical loading information. As datasets mature, forecasted cloud cover as a percentage will be further integrated in analysis. Currently, the recommendation is to enable feeder curtailment only if the forecasted weather for those curtailment hours is "sunny."

## Evaluation

PGE will evaluate retrospectively dispatched events twice annually. Evaluation of data will include:

1. Event duration
2. Number of affected facilities
3. Lessons learned
4. Identification of alternative solutions

## Definitions

**Interim Solution:** Interim solution is defined as a two-year solution that aims to identify either a more permanent solution or PGE requests continuation of the interim solution.

**Net-Metering Facility or Customer:** Any new or existing net-metering facility with a generation capacity of up to two (2) mega-watt (MW), that qualify for Level 1, 2 or 3 applications for net-metering facility interconnection that will interconnect to PGE's electric distribution system.

**Limited Feeder:** If sufficient levels of protection are not present at the associated substation level, a limited feeder is defined as having aggregate daytime inverter-based generation (kW) greater than 90% of its minimum daytime consumption load (kW).

This is in accordance with PGE's current Protection Design Practices. When determining whether a feeder is limited, previously queued net-metering projects and qualified facility projects are to be factored into this calculation.

**Day Time Minimum Load:** See Attachment D.

UM 2099  
In the Matter of PGE's Request for Approval of Agreement for Net  
Metering  
and Interconnection Services

Attachment D, Daytime Minimum Load Methodology  
presented on September 30, 2020

## **Introduction**

This document describes the methodology used for determining daytime minimum load on Portland General Electric's distribution feeders and distribution power transformers.

## **Generation**

Inverter-based generation utilizes an inverter to convert DC to AC output. This includes battery/energy storage (BB), Solar Generation (S or XLS), or wind generation (W).

Non-Inverter based generation is generally machine based and includes Distributed Standby Generation (DSG), Fuel Cells (FC), Hydro Generation (H), and Methane Gas (MG or MG/S).

## **Net Minimum Load Output**

PI data historian is utilized to generate the previous year's loading data (real power measured in megawatts) for each distribution feeder and distribution power transformer. Loading data is determined on an average hourly basis, therefore, 8760 points of loading data are available for analysis. From this dataset, any system condition considered to be "abnormal" will not be used. Abnormal conditions include any known load shifts from preferred to alternate feeder or the utilization of intermittent distributed generation such as DSG or non-solar inverter-based resources. After abnormal conditions are removed, the lowest hourly loading value is used. A timestamp for this loading value will be depicted at the "start" hour of this occurrence. If a minimum load must be determined during an abnormal condition, or if prolonged abnormal system configuration results in insufficient data to determine daytime minimum load via the data historian; modeling tools, such as CYME, can be utilized to determine an estimated minimum load value.

For networked distribution systems, coincidental minimal load values shall be collected for each network system or grouping of feeders to determine a "net" minimum loading value (e.g., feeders associated with Canyon Network #1). Associated coincidental loading values of those feeders shall be recorded as their minimum load. A similar method shall be utilized for distribution power transformers that normally operate in parallel. A timestamp for these loading values will be depicted at the "start" hour of this occurrence. If a minimum load is determined during an abnormal condition; modeling tools, such as CYME or PowerWorld, can be utilized to determine an estimated minimum load value.

Recorded reactive demand shall be within the coincidental timeframe of the recorded minimum load output for their corresponding feeders or transformers.

## **Daytime Minimum Load Output**

Methodology to obtain net daytime minimum load is similar to obtaining the net minimum load output with exception to available annual dataset. Specified daily "start" hours range from 9:00 to 16:00, rendering 2920 points of available loading data. Associated reactive demand and "start" hour timestamp shall be captured and recorded accordingly.

### **Disaggregated Daytime Minimum Load Calculation**

To calculate gross or pure demand, flowing into the distribution system, the following assumptions are made:

- Large Solar PV (~500kW or greater) is operating and calculated at a percentage of nameplate output depending on the month which daytime minimum load is determined.
- Small Solar PV (~< 500kW) is operating at and calculated at a percentage of nameplate output depending on the month which daytime minimum load is determined.
- Large Solar PV and Small Solar PV reduced outputs are added to net power output to determine gross load (kW).
- Only PV-related output is factored into this calculation. Other common DGs (storage, DSG, wind, etc.) are not included in this calculation.

### **Future/Speculative Data**

Future data regarding the addition of solar generation and the resultant future net daytime minimum load shall be reviewed on a continual basis and factored into overall daytime minimum load when performing related interconnection studies.

### **Frequency of Analysis**

Systemwide analysis shall be performed twice annually. The analyses and compilation of this data shall occur during the winter (beginning in January) and summer (beginning in July) of each year. Datasets utilized for winter shall include January 1 of the previous year up to and including December 31 of that year. Datasets utilized for summer shall include June 1 of the previous year up to and including June 30 of the analysis year.