For the 2021 Draft CEIP, PSE developed draft customer benefit indicators as seen in Figure H-1. With the help and guidance of the third-party consultant DNV, PSE has developed potential metrics and data sources for each customer benefit indicator. As of the draft CEIP, PSE is still evaluating data availability for the potential metrics, as well as other regulatory requirements and policies that would apply. These include SB 5126, passed by the Washington State Legislature in 2021, as well as WUTC and other rules around data collection and privacy.

These indicators will be used to forecast the distribution of benefits and measure progress over time. The purpose of this Appendix H is to outline each metric, an equation to calculate, the expected data source, and expected impact to customers. Data availability and relevancy will evolve over time, and period changes to how metrics are measured will be required.

Some of the metrics rely on customer data, which may be already held by PSE, publicly available, or available for purchase. Prior to establishing any measurements of customer information, PSE must carefully evaluate relevant privacy requirements, policies, regulatory requirements, and stakeholder perceptions.

Other metrics rely on data which PSE already reports, sometimes in multiple different ways depending on the reporting requirement or agency. Clarity in measurement and reporting will be important for these areas.

Finally, some of the potential metrics considered as options in the attached report are not in common use in the northwest region today, and further evaluation will be needed to identify if they are applicable or if better metrics are available.

Figure H-1: Draft customer benefit indicators and metrics

CETA Category	Draft customer benefit indicator	Metric
Energy benefits Non-energy benefits Burden reduction	Improved participation from named communities	Count and percentage of participation by PSE customers within named communities
Non-energy benefits	Increase in clean energy jobs	Number of jobs created by PSE programs by residents of named communities
Non-energy benefits	Improved home comfort	Dollar per kilowatt-hour in benefits for program calculated using indoor air temp, indoor air quality, and lighting quality
Burden reduction	Reduced cost impacts	Percentage of income spent on electricity bills for PSE customers in highly impacted communities and vulnerable populations
Cost reduction	Affordability of clean energy	Percentage of income spent on electricity bills for PSE customers
Environment	Reduced greenhouse gas emissions	Metric tons of annual CO2 emissions form PSE resources
Environment, risk reduction	Reduction of climate change impacts	Reduced peak demand

CETA Category	Draft customer benefit indicator	Metric
Public health	Improved outdoor air quality	Regulated pollutant emissions (Sox, NOx, PM2.5) from PSE resources Reduction of particulates from resources in non-attainment areas
Public health	Improved community health	Health factors like mortality, hospital admittance, work loss days
Energy security Resiliency	Decrease frequency and duration of outages	Number of outages, total hours of outages and total backup load served during outages
Risk reduction Energy security Resiliency	Increased resiliency	Number of customers who have access to emergency power (in home/at community center)

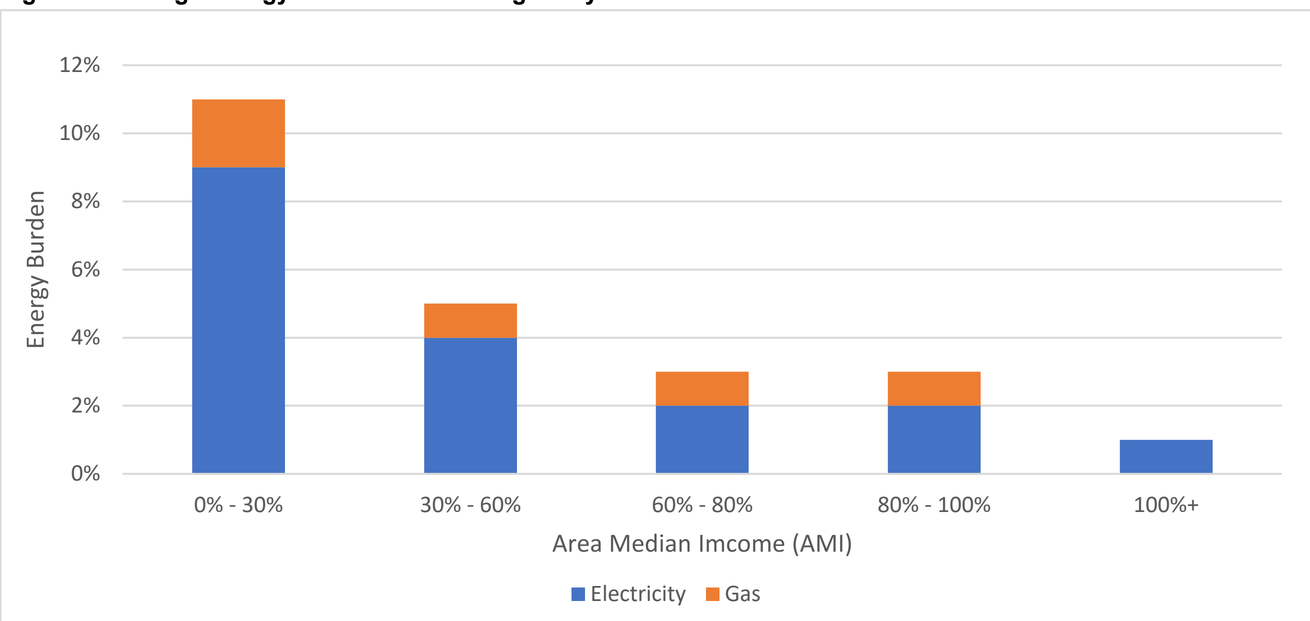
MEASUREMENT OF DRAFT CUSTOMER BENEFIT INDICATORS - OUTLINE

REDUCED COST IMPACTS

Customer Benefit Indicator Categories

Burden Reduction. The US Department of Energy defines energy burden as "the percentage of gross household income spent on energy costs."[1] For the purposes of this metric, we consider energy costs to include gas and electric, but will track them together (for true energy burden) and separately (to focus on clean energy). Figure 1 below presents the average energy burden in Washington by the five Area Median Income (AMI) bins. As demonstrated by these data, extremely low-income households in Washington have an energy burden around 11%, very low-income households have around a 5% Energy Burden and low-income households have a 3% energy burden. This metric will measure the extent to which PSE's programs are reducing the energy burden among customers in specific communities that are described further in the next section.

Figure 1. Average Energy Burden for Washington by Area Median Income Bins



Source: https://www.energy.gov/eere/slsc/maps/lead-tool

Applicable Population

In PSE's 2021 IRP, PSE identified a series of "named populations." These named populations include highly impacted communities and vulnerable populations which are represented as census tracts that meet specific criteria.[2] This metric will be calculated specifically for those vulnerable populations and highly impacted communities. As we discuss further below, this metric can be estimated as an average across all PSE customers within named populations, as the average across all PSE program portfolio participants within named populations, and/or across PSE customers within named populations who participated in a specific program.

Examples

Stakeholder Example Question: Does the program decrease the percentage of customers' income dedicated to energy costs?

[1] https://www.energy.gov/eere/slsc/low-income-community-energy-solutions

[2] As identified in in Appendix K, Figure K-6 in PSE's 2021 IRP (https://pse-irp.participate.online/2021-irp/reports)

Example: CACAP Program. In 2020, PSE filed tariff revisions to incorporate the Crisis Affected Customer Assistance Program (CACAP) into its low-income tariff.[3] CACAP is designed to provide bill assistance relief to residential customers facing financial hardship. This metric would be used to track the energy burden for those customers who participated in CACAP by comparing customer's energy burden before and after they signed up for the program.

Metric

This metric will measure a population's percent of income spent on electricity and gas bills. This metric should be calculated and presented separately for residential customers who are dual fuel and those who are electric only. The metric can be calculated and presented for the following populations:

- **All Residential PSE customers** in highly impacted communities and vulnerable populations
- **Residential PSE Portfolio Participants** in highly impacted communities and vulnerable populations
- **Residential PSE Single Program Participants** in highly impacted communities and vulnerable populations

Measurement

Table 1 below presents the energy burden calculation for an individual customer. To determine whether energy burden is decreasing over time, PSE should calculate this measurement for residential program participants over time. It is also important that PSE identify a pre-period measurement, ideally one year prior to program participation.

Table 1. Energy Burden Calculation

Title	Calculation	Notes
Energy Burden [%] [Individual Customer]	$EB = \frac{TEC_{(p,y)}}{HI_{(y)}}$	$TEC_{(p,y)}$ = *Total energy cost by participation and year* $HI_{(y)}$ = *Household income in year*
Number of High Energy Burdened Customers (HEB)	$N_{HEB} = \|HEB\|,$ $HEB = \{i : EB_i \geq 0.06\}$	N_{HEB} = *number of high energy burdened customers (i.e., size of the set HEB)* i = *i th customer for a given participation and year* HEB = *set of all customers with EB > 0.06*
Total Energy Assistance Need	$EAN = \sum_{i \in HEB} (TEC_i - 0.06 * HI_i)$	TEC_i = *Total energy cost for customer i* HI_i = *Household income for customer i*

Issues and Data Gaps

Issue 1: Energy burden ideally is calculated at a household level, but reliable household-level income data is difficult to obtain. PSE's billing records contain household level cost data for some energy sources – the numerator of energy burden. Household level income data – the denominator – is not as easy to obtain. Some data providers (e.g. Experian, Nielsen) sell household level income data imputed from census data and credit card activities. Public data from the US Census can be used to approximate household income at the census block group level. census block groups represent approximately 200 to 1000 households each. This is the most focused, free, public data available for income.

> **Risk mitigation recommendation:** PSE should continue to explore data availability and privacy issues with different data sources.

Issue 2: Energy Burden Impacted by non-program changes (such as weather and economy). Customer energy use will continue to rise with increasing extreme weather events like heat waves and polar vortexes. Similarly, changes in the economy will have an impact on energy burden beyond the program's control. This will conflate program and non-program impacts when comparing energy burden year over year.

[3] https://sec.report/Document/0001085392-21-000011/#i1854a55cb59b44598ac27f855328067a_28

Risk Mitigation Recommendation. PSE should look at the overall average energy burden year over year for named populations and all PSE customers. Furthermore, PSE should consider weather- and economic normalizing techniques.

Issue 3: Unknown Costs for Customers with Dual Providers. Calculating energy burden requires all energy expenditures. PSE will not know both customer electricity and gas expenditures for customers that receive one fuel (such as gas, electricity, wood or propane) from another provider.

Risk Mitigation Recommendation. Tracking the electric and gas energy burden separately is one way to address this issue. Or if true energy burden is required, proxy values may be developed by using publicly available data through the EIA form 861 for utilities, however the data will not be provided at the level of granularity required to calculate energy burden for specific populations. PSE relies on data collected from the Department of Energy (a 2018 analysis), which estimates the total energy costs related to Electric, Gas, and Other fuel sources, for customers in our service territory. PSE uses a methodology to match each of our customers to the best estimate value from the DOE data to impute energy costs for unknown fuels (i.e., gas and “other” fuel costs for electric only customers; electric and “other” fuel costs for gas only customers; and “other” fuel costs for combo customers).

Issue 4: Delay in Census Tract Data Availability. Census tract-level income data from the ACS 5-year rollup has about a 2-year lag in reporting.

Risk Mitigation Recommendation. Use purchased household income data. Or PSE would have to use slightly outdated income data for census tract.

Data Sources

Table 2 presents the data sources needed to calculate energy burden. Note that we present three possible data sources for household income. The first source is purchased household income data. The second is ACS data, which are easily accessible but do not provide individual household income. Nevertheless, ACS data would allow PSE to compare the average bill reduction and compare to the energy burden (average bill amount and income) by census tract to determine an average impact on energy burden. A third, more granular assessment of the metric, would include collecting customer self-reported income. One direct way that PSE can collect this information is to request it on the customer’s program application. Collection of customer data should be evaluated carefully and with stakeholder input in regards to privacy issues and regulatory requirements.

Other data sources may be available and PSE should continue to update data sources over time.

Table 2. Data Sources to Calculate Energy Burden

Category	Dataset	Source	Units	Source Reporting	Date of Release	Estimated Cost to Collect
Participant Identification	Program participation	PSE Program Tracking Database	T/F	Annually	TBD - PSE	$1,600 - $4,000
	Named populations	PSE 2021 IRP	Census Tracts	TBD - PSE	TBD - PSE	$1,600 - $4,000
Energy Costs and Assistance	Electricity cost	PSE Billing Data	$/year	Annually	TBD - PSE	$1,600 - $4,000
	Gas cost		$/year	Annually	TBD - PSE	$1,600 - $4,000
	CACAP Program Assistance		$/year	Annually	TBD - PSE	$1,600 - $4,000

Category	Dataset	Source	Units	Source Reporting	Date of Release	Estimated Cost to Collect
Household Income	Option 1. Household income	Data purchased by PSE	$/year	Annually	TBD - PSE	$4,000 - $8,000
	Option 2. Average and Median household income by census tract	ACS (American Community Survey) 5-Year Estimates Subject Table S1901	$/year	Annually	December 9 of following year	$1,600 - $4,000
	Option 3. Self-reported income	Collect During Program Sign Up	$/year	Annually	TBD-PSE	Unknown

Expected Program Impact on Metric

Energy assistance program such as CACAP are designed to provide bill assistance so we would expect the energy burden to decrease for customers enrolled in such a program. Energy efficiency programs are similarly designed to reduce energy burden for customers. Other programs such as Solar PV, battery may reduce energy burden if specifically designed to do so for highly impacted and vulnerable communities.

AFFORDABILITY OF CLEAN ENERGY

Customer Benefit Indicator Categories

Burden Reduction. This metric tracks energy burden as in the previous metric, but **here it is applied to all residential utility customers**. The US Department of Energy defines energy burden as “the percentage of gross household income spent on energy costs.”[4] For the purposes of this metric, we consider energy costs to include gas and electric, but will track them together (for true energy burden) and separately (to focus on clean energy).

Applicable population

This metric applies to all residential PSE customers.

Examples

Stakeholder Example Question: Does the program decrease the percentage of customers’ income dedicated to energy costs?

Example: Energy Efficiency Rebate Program. In an example where PSE provides rebates to residential customers for purchases such as energy efficient furnaces, air conditioners, water heaters, etc., the installation of these efficient appliances would reduce the customer’s annual energy bill and would reduce the customer’s energy burden.

[4] https://www.energy.gov/eere/slsc/low-income-community-energy-solutions

Metric

This metric will measure a population's percent of income spent on electricity and gas bills. This metric should be calculated and presented separately for residential customers who are dual fuel and those who are electric only. The metric can be calculated and presented for the following populations:

- **All Residential PSE customers**
- **Residential PSE Portfolio Participants**
- **Residential PSE Single Program Participants**

Measurement

Table 3 below presents the energy burden calculation. To determine whether energy burden is decreasing over time, PSE should calculate this measurement for residential program participants over time. It is also important that PSE identify a pre-period measurement, ideally one year prior to program participation.

Table 3. Energy Burden Calculation

Title	Calculation	Notes
Energy Burden [%]	$EB = \frac{TEC_{(p,y)}}{HI_{(y)}}$	$TEC_{(p,y)} = Total\ energy\ cost\ by\ participation\ and\ year$ $HI_{(y)} = Household\ income\ in\ year$

Issues and Data Gaps

Issue 1: Energy Burden Impacted by non-program changes (such as weather and economy). Customer energy use fluctuates year to year depending on economic factors and the severity of summer and winter weather. Energy consumption for space conditioning will continue to rise with increasing extreme weather events like heat waves and polar vortexes. Similarly, changes in the economy will have an impact on energy burden beyond the program's control. This will conflate program and non-program impacts when comparing energy burden year over year.

> **Risk Mitigation Recommendation.** PSE should look at the overall average energy burden year over year for named populations and all PSE customers. Furthermore, PSE should consider weather- and economic normalizing techniques.

Issue 2: Unknown Costs for Customers with Dual Providers. Calculating energy burden requires all energy expenditures. PSE will not know both customer electricity and gas expenditures for customers that receive one fuel from another provider.

> **Risk Mitigation Recommendation.** Proxy values may be developed by using publicly available data through the EIA form 861 for utilities, however the data will not be provided at the level of granularity required to calculate energy burden at a household level.

Issue 3: Delay in Census Tract Data Availability. Census tract-level income data from the ACS 5-year rollup has about a 2-year lag in reporting.

> **Risk Mitigation Recommendation.** Use purchased household income data. Or PSE would have to use slightly outdated income data for census tract

Data Sources

Table 2 presents the data sources needed to calculate energy burden. Note that we present three possible data sources for household income. The first source is household income data purchased by PSE. The second is ACS data, which are easily accessible but naturally do not provide individual household income. Nevertheless, ACS data would allow PSE to compare the average bill reduction and compare to the energy burden (average bill amount and income) by census tract to determine an average impact on energy burden. A more granular assessment of the metric would include collecting customer self-reported income. One direct way that PSE can collect this information is to request it on the customer's program application. Collection of customer data should be evaluated carefully and with stakeholder input in regards to privacy issues and regulatory requirements.

Other data sources may be available and PSE should continue to update data sources over time.

Table 4. Data Sources to Calculate Energy Burden

Category	Dataset	Source	Units	Source Reporting	Date of Release	Estimated Cost to Collect
Participant Identification	Program participation	PSE Program Tracking Database	T/F	Annually	TBD - PSE	$1,600 - $4,000
	PSE Customers	PSE Customer Database	Utility meter	Annually	TBD - PSE	$1,600 - $4,000
Energy Cost	Electricity cost	PSE Customer Billing Data	$/year	Annually	TBD - PSE	$1,600 - $4,000
	Gas cost		$/year	Annually	TBD - PSE	$1,600 - $4,000
Household Income	Option 1. Household income	Data purchased by PSE	$/year	Annually	TBD - PSE	$4,000 - $8,000
	Option 2. Average and Median household income by census tract	ACS (American Community Survey) 5-Year Estimates Subject Table S1901	$/year	Annually	December 9 of following year	$1,600 - $4,000
	Option 3. Self-reported income	Collect During Program Sign Up	$/year	Annually	TBD-PSE	Unknown

Expected Program Impact on Metric

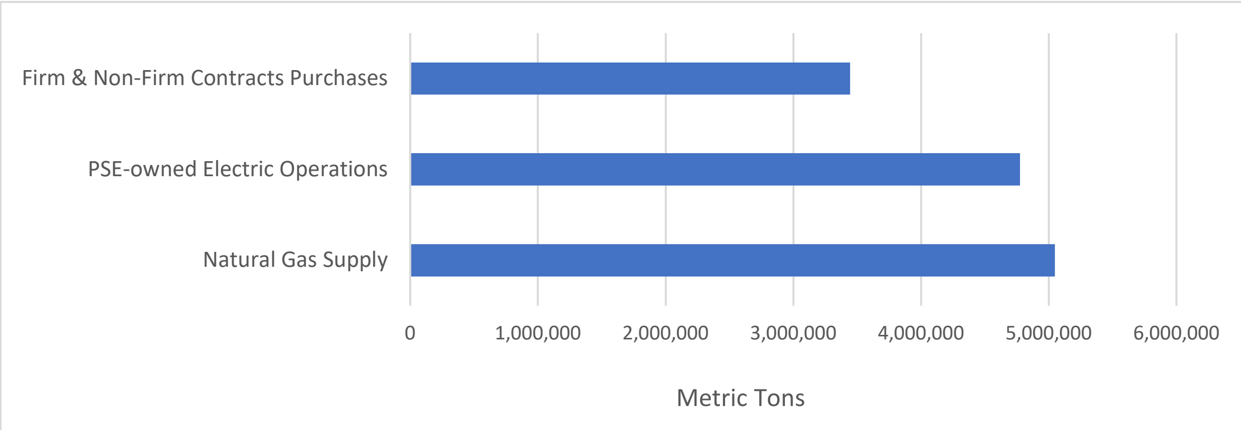
Overall, CETA is expected to increase customers' bills, but other factors such as income levels will also impact this measurement.

REDUCED GREENHOUSE GAS EMISSIONS

Customer Benefit Indicator Categories

Environment. This metric will measure the extent that PSE's programs are impacting greenhouse gas (GHG) emissions. The resulting reduction of GHGs will directly support the environment and are in synergy with Washington's larger umbrella climate policies such as the Clean Energy Transformation Act (CETA). As established by CETA, PSE will be eliminating coal-fired electricity by or before 2025, reach carbon neutrality by or before 2030, and eventually deliver 100% renewable or nonemitting electricity by 2045. While PSE is transforming its supply, it will need to simultaneously accommodate added load due to buildings and transportation electrification efforts. Figure 3 presents PSE's CO_2 emission inventory by emissions source for 2020, which totaled just over 13 million metric tons. Ultimately, this metric will measure the GHG impacts of each PSE program individually and in aggregate.

Figure 2. PSE 2020 CO_2 Emissions Inventory



Source: PSE Greenhouse Gas Inventory, 2020 (https://www.pse.com/en/pages/greenhouse-gas-policy)

Applicable Population

GHG emissions and resulting climate change affect the entire planet, and although there may be differences in the effect of climate change in localized areas, this metric will not track those downstream effects of climate change. PSE can use this metric to measure GHG impacts from all customers, all PSE program portfolio participants, and/or participants of a single PSE program.

Examples

Stakeholder Example Question: Does the program reduce air pollution by decreasing carbon emissions?

Example: DER + Storage with Remote Dispatch Program. In an example where PSE administers a program that incentivizes customers to give PSE the ability to charge and dispatch their distributed storage capacity to support PSE's energy/demand costs and GHG impacts, this metric will calculate the impact that the program's remote dispatch activities had on GHG emissions by quantifying the impact using marginal emission rates.

Metric

This metric can be calculated at three levels of granularity as follows:

- **All PSE Customers.** Metric tons of annual CO_2 emissions from PSE distributed and utility-scale electric resources
- **PSE Portfolio Participants.** Clean energy program portfolio impacts on CO_2 emissions
- **PSE Single Program Participants.** Individual program impacts on CO_2 emissions

Measurement

Table 5 below presents two approaches to calculate program impacts on greenhouse gases. The first approach presented is a high-level annual GHG approximation that uses EPA's AVERT model based on annual avoided generation user inputs. The second approach is a more granular and more intensive calculation that uses historical hourly marginal emissions data to quantify hourly GHG reductions or increases through hourly avoided generation.

The first equation shown in Table 5 represents the less granular annual method of quantifying emissions reductions and is generally applicable to resources such as energy efficiency or solar that reduce net grid-supplied kWh consumption. The first step is to estimate the amount of energy the clean energy programs saved or generated over the course of the program year. The second step is to use the AVERT tool to provide annual GHG reductions based on avoided conventional energy production.

The second equation in Table 5 estimates impacts on an hourly basis using hourly savings or generation profiles and hourly PSE-wide GHG emissions profiles. These vary because marginal emissions rates of power plants vary depending on their merit order of dispatch, fuel type, and levels of efficiency. Therefore, programs that reduce generation requirements at the time of regional peak demand will have higher impacts per kWh on overall emissions because marginal generators in the region are natural-gas fired. The hourly method is more appropriate for resources that do not necessarily reduce net grid-supplied kWh consumption but rather shift consumption from peak to off-peak periods, such as demand response programs and energy storage. Emission impacts from these resource types may not be able to be quantified using the AVERT tool. When summed over all the hours in a year, the hourly approach should provide the same result as the annual approach.

With the passage of the Climate Commitment Act in Washington in 2021, rulemaking will define potentially different emissions measurement approaches. In addition, PSE already reports greenhouse gas emissions as required under EPA and Washington State regulations. There are options presented here, but as the regulatory requirements of different programs become clearer, the measurement and reporting should align with these regulatory requirements.

Table 5. Reduced Greenhouse Gas Emissions Calculation

Title	Calculation	Notes
Annual Avoided Emissions [CO_{2e}/year]	$GHG_{(p,y)} = AVERT\langle AG_{(p,y)}\rangle$	*AVERT = EPA tool that estimates annual CO_{2e} reductions based on Avoided Generation input* $AG_{(u,y)}$ = Avoided Generation by Participant, Program, and/or PSE per Year
Hourly Avoided Emissions [CO_2/hour]	$GHG_{(p,h)} = AG_{(p,h)} \times ME_{(p,h)}$	$AG_{(p,h)}$ = Avoided Generation by Participant, Program, and/or PSE per Hour $ME_{(p,h)}$ = Marginal Emissions by Participant, Program, and/or PSE per Hour

Issues and Data Gaps

Issue 1: Potentially Limited Site-Level Distributed Resource Hourly Data Availability. Sufficient time series (hourly or more granular) data may not be available from all program resources or regional generation.

> **Risk Mitigation Recommendation.** In setting up conditions of program engagement, PSE should require that program implementers and participating customers agree to share individual resource data streams. PSE should also investigate data availability – hourly data may not be available from generating resources.

Issue 2: Calculating Hourly Avoided Generation is Time-Intensive. Calculating GHG impacts for all participants is likely to be intensive unless clean data is provided across resource types in a common timestamped format.

> **Risk Mitigation Recommendation.** Create an analytic module that utilizes specified data frames to automatically calculate GHG program impacts. PSE should request vendors who are implementing a tracking program for this metric to provide data within this specified format for most efficient analysis. PSE should continue to evaluate if generation data sources are available with similar granularity.

Data Sources

Table 6 below presents data sources for both annual and hourly approaches to calculate GHG reductions. As shown, the annual approach can be calculated using tracking data while the hourly approach requires activities such as coordinating with battery vendors, setting up metering equipment on customer resources, and/or performing AMI load analytics. We also suggest PSE uses their annual greenhouse gas inventory report to use as a benchmark to the results of this calculation.

Table 6. Data Sources for Calculating Reduction in Greenhouse Gas Emissions

Category	Dataset	Units	Source	Source Reporting	Date of Release	Cost
Annual Avoided Generation	Renewable Energy Generated	MWh/year	PSE Program Tracking Data	Annually	TBD - PSE	\$1,600 - \$4,000
	Energy Storage Dispatched	MWh/year		Annually	TBD - PSE	\$1,600 - \$4,000
	Peak Demand Savings	MWh/year		Annually	TBD - PSE	\$1,600 - \$4,000
	Energy Efficiency Savings	MWh/year		Annually	TBD - PSE	\$1,600 - \$4,000
Hourly Avoided Generation	PV Generation Time Series	kWh/hr	Meter Data or AMI Analysis	tbd	tbd	\$8,000 - \$16,000
	Energy Storage Dispatch Time Series	kWh/hr	Battery Vendor Data	tbd	tbd	\$8,000 - \$16,000[†]
	Hourly Peak Demand Shift Time Series	kWh/hr	Meter Data or AMI Analysis	tbd	tbd	\$8,000 - \$16,000
	Hourly Energy Efficiency Savings Load shape	kWh/hr	RTF load shapes or AMI analysis	tbd	tbd	\$8,000 - \$16,000
Marginal Hourly Emissions	Hourly Renewable Energy Generation Output	MWh/hr	WattTime (if applicable)	tbd	tbd	\$4,000 - \$8,000
PSE GHG Reports	Emissions Rate of PSE Generation	tons CO2/kWh	PSE Greenhouse Gas Inventory	Annually	TBD - PSE	\$1,600 - \$4,000

[†]Depending on data quality, this cost may be higher

Expected Program Impact on Metric

Solar PV, demand-response/load flexibility, and energy efficiency resources will reduce CO_2. While all distributed resources have the potential to reduce GHGs, storage will not always reduce marginal emissions. If customers use storage to capture arbitrage opportunities or reduce demand charges, or if PSE uses storage to reduce wholesale electricity costs, this calculation may reveal that marginal GHGs stay neutral or may even increase. PSE therefore may wish to consider using marginal emissions forecasts to inform storage dispatch optimization algorithms.

Energy storage impacts emissions at the grid level by increasing or decreasing net demand on a marginal basis, i.e. conceptually impacting whether the marginal power plant operating (the last power plant in the plant “stack”) ramps up or down with respect to grid demand. The marginal power plant in the stack tends to be the least efficient, most costly to run, and highest emitting. When storage charges it conceptually increases demand from this marginal power plant thereby increasing emissions, and when storage discharges it decreases demand from this last power plant. The marginal power plant operating changes frequently throughout the day, at an hourly or shorter time interval. If energy storage tends to charge when the marginal power plant is a relatively low emitter of GHGs (e.g. during daytime when solar plants are operating, or when hydro or wind is operating) and discharge when the marginal power plant is a relatively high emitter of GHGs (e.g. during peak periods of demand, late afternoons or evenings), storage can effectively reduce net emissions from marginal power plants for a given time period, when taking into account energy storage efficiency losses.

However, battery operational software that is programmed to decide when to charge and discharge energy storage projects is often based upon economic objectives and not GHG emission objectives. Maximizing economic gain (or utility bill savings for behind the meter projects) tends to be the driving factor. Retail tariffs (rate structure) tend to be relatively static in nature and designed to have some time sensitive economic structures (e.g. peak and off-peak rates) to incentivize changes in demand. Retail tariffs are typically designed based on average system characteristics like peak demand and are often immutable for years until periodic general rate cases making them hard to align with hourly, daily, or seasonal variations. Retail tariffs are not aligned with marginal GHG emission rates. When a battery is programmed to maximize return to the owner based on a retail tariff, the legacy retail tariff price signals may not incentivize the battery to charge when marginal emission rates are lowest and discharge when marginal emission rates are highest. The result can increase net emissions for the system even if the battery is operating optimally from an economic perspective.

IMPROVED OUTDOOR AIR QUALITY

Customer Benefit Indicator Categories

Public Health. Recent studies have suggested that regional territories can save millions of dollars through renewable energy and energy efficiency resources.[5] As PSE's meets the CETA requirements, reduced fossil fuel use in electric generation decreases emissions, increasing outdoor air quality, which will directly benefit public health. This metric will quantify the reduction of PM2.5, SO_2, and NOx, the conventional generation emissions that contribute to poor outdoor air quality and impact public health. The net impacts of transportation electrification on these emissions will also be measured, when these projects are included as part of PSE's future Clean Energy Implementation Plan.

Applicable Population

This benefit will impact all customers and may more specifically benefit customers living in areas with worse air quality. This may also impact people outside PSE's service territory as energy sources used for PSE's electric supply include some outside PSE's electric service territory.

Examples

Stakeholder Example Question: Does the program improve outdoor air quality?

Example: PV Program. A program that installs PV capacity will reduce the need to supply that electricity from conventional generation. This metric will estimate the improvement in outdoor air quality due to the reduced conventional electricity generation.

Metric

This metric can be calculated at three levels of granularity as follows:

- **PSE Customers.** Metric tons of annual PM2.5, SO_2, and NOx emissions from resources that serve PSE load
- **PSE Portfolio Participants**. Clean energy program portfolio impacts on PM2.5, SO_2, and NOx emissions
- **PSE Single Program Participants**. Individual program impacts on PM2.5, SO_2, and NOx emissions

[5] https://www.hsph.harvard.edu/news/hsph-in-the-news/renewable-energy-projects-can-improve-health/

Measurement

Table 7 presents the calculation to measure PSE's program improvements on outdoor air quality.

Table 7. Improved Outdoor Air Quality Calculation

Title	Calculation	Notes
Annual Avoided AQ Emissions [PM2.5,SO_2, NO_x/year]	$AQE_{(p,y)} = AVERT\langle AG_{(p,y)}\rangle$	*AVERT = EPA tool that estimates annual CO_{2e} reductions based on Avoided Generation input* *$AG_{(u,y)}$* = Avoided Generation by Program, Portfolio, and/or PSE per Year
Annual Avoided AQ Emissions per Generation Resource [PM2.5,SO_2, NO_x/year]	$AQE_{(g,y)} = ME_{(g,y)}$	*ME = Measured Emissions at each of PSE's generation facilities [PM2.5, SO_2, NO_x/year]*
Net Annual Avoided Transportation AQ Emissions [PM2.5,SO_2, NO_x/year]	$Net\ AQE_{(p,y)} = \langle AE(ICE)_{(p,y)} - E(EV)_{(p,y)}\rangle$	*$AE(ICE)_{(p,y)}$* = Avoided Tailpipe Emissions from Internal Combustion Engines by EV Program, Portfolio, and/or PSE per Year *$E(EV)_{(p,y)}$* = Emissions from Electricity Generated to Charge EVs by EV Program, Portfolio, and/or PSE per Year
Annual Avoided Tailpipe Emissions from Internal Combustion Engines [PM2.5,SO_2, NO_x/year]	$AE(ICE)_{(p,y)} = \langle ER(ICE) \times C(EV)_{(p,y)} \div \eta(EV)\rangle$	*ER(ICE)* = Emissions Rate (kg/mile) of ICE Vehicle Replaced by EV Program *$C(EV)_{(p,y)}$* = Electricity Consumption of EVs by Program, Portfolio, and/or PSE per Year η (EV) = Efficiency of EV (kWh/mile)

Measuring this indicator first requires estimating the annual energy saved or generated from the programs being evaluated. The next step is to identify the marginal generating units and associated emissions characteristics, expressed as an emissions factor for each pollutant in kilograms per Megawatt-hour (kg/MWh). Emissions factors can be adopted from the EPA Avoided Emissions and generation Tool (AVERT). This methodology is computationally simple and requires less labor and data than other analysis types, however it is somewhat insensitive to the dispatch process. Total emissions reductions are calculated by applying the emission factors from AVERT to the avoided generation from clean energy programs. Alternatively, the emissions can be tracked by measuring them directly at PSE generation facilities.

The net emissions reductions from transportation electrification are calculated by subtracting the avoided tailpipe emissions from electric vehicle programs from the actual emissions associated with the electricity generated to charge the vehicles. The emissions from charging can be calculated by applying PSE's generation emissions factors to the electricity generated for electric vehicle charging. The granularity of the avoided emissions calculation will depend on the data used to calculate avoided CO2 emissions for PSE Transportation Electrification Plan reporting. Average tailpipe emissions rates are reported annually by the EPA in kilograms per mile (kg/mile) by vehicle size and powertrain

Issues and Data Gaps

Issue 1: Lack of Localized Measurement. EPA AVERT tool provides outputs at the county level, which may not be granular enough to determine effects in named populations. Further, this does not reflect the full range of supply portfolio issues, such as from power purchased on the wholesale market.

Risk Mitigation Recommendation. PSE could consider how emissions overall will evolve as its electric portfolio changes. PSE could consider performing an analysis to develop scaling factors.

Data Sources

Table 8 presents the data sources to calculate reductions in PM2.5, SO_2, and NOx.

Table 8. Data Sources for Calculating Improvements in Outdoor Air Quality

Category	Dataset	Units	Source	Source Reporting	Date of Release	Estimated Cost
Annual Avoided Generation	Renewable Energy Generated	MWh/year	PSE Program Tracking Data	Annually	TBD - PSE	$1,600 - $4,000
	Energy Storage Dispatched	MWh/year		Annually	TBD - PSE	$1,600 - $4,000
	Peak Demand Savings	MWh/year		Annually	TBD - PSE	$1,600 - $4,000
	Energy Efficiency Savings	MWh/year		Annually	TBD - PSE	$1,600 - $4,000
PSE GHG Reports	Emissions Rate of PSE Generation	tons CO_2/ kWh	PSE Greenhouse Gas Inventory	Annually	TBD - PSE	$1,600 - $4,000
Annual Avoided Tailpipe Emissions	Average Emissions per Vehicle Rates	g/mile	EPA, Office of Transportation and Air Quality	Annually	April 2021	$1,600 - $4,000
	EV Electricity Consumption	MWh/year	PSE Program Tracking Data	Annually	TBD - PSE	$1,600 - $4,000
	EV Efficiency	kWh/mile	PSE Program Tracking Data	Annually	TBD - PSE	$1,600 - $4,000

Expected Program Impact on Metric

Reductions in PM2.5, SO_2, and NOx emissions should follow similar trends to those reported in Section 3: Reductions in GHGs. As with GHGs, most resources will reduce these emissions, but PSE will need to monitor storage dispatch as dispatching to optimize cost may not always reduce emissions. Reductions in net transportation-related emissions per vehicle will increase as PSE increases its generation mix's share of clean energy.

IMPROVED COMMUNITY HEALTH

Customer Benefit Indicator Categories

Public Health. Similar to improved outdoor air quality, as reported in Section 4, this metric, improved public health, measures a PSE public health benefit. While the metric quantifying improvements to outdoor air quality focused on specific reductions in emissions, this metric uses those emissions reductions to quantify specific changes in health conditions, such as the instance and monetary value of asthma, heart disease, etc.

PSE is in the process of evaluating potential metrics for Community Health.

Applicable Population

This benefit will impact all customers. However, it will benefit customers who live close to emissions sources more than those further away.

Examples

Stakeholder Example Question: Does the program help abate health and safety issues related to poor air quality (e.g., asthma, heart disease)?

Example: PV Program. Similar to Section 4, improvements in outdoor air quality, this example considers a program that installs PV capacity will reduce the need to supply that electricity from conventional generation. This metric will quantify the reduction in incidence and cost of health conditions due to the PV program.

Metric

One metric that could be used is the PM2.5 emissions outputs from Section 4 to calculate changes in outdoor air quality and measure the incidence and monetary impacts that PSE's program have on various health conditions. This metric can be calculated at three levels of granularity as follows:

- **All PSE Customers**
- **PSE Portfolio Participants**
- **PSE Single Program Participants**

Health research has established relationships between air pollution and community health. Quantifying the avoided health impacts from reducing air pollution emissions Air pollution related health effects that can be quantified include: premature death (i.e., mortality), chronic and acute bronchitis, Non-fatal heart attacks, respiratory or cardiovascular hospital admissions, upper and lower respiratory symptom episodes, asthma-related health effects, asthma emergency room visits, minor restricted activity days, and work or school loss days.

PSE is in the process of evaluating other metric related to community health.

REDUCTION OF CLIMATE CHANGE IMPACTS

Customer Benefit Indicator Categories

Environment. Weather and climate have always been a major factor in power system planning. Climate change will alter climate and weather during the next decades and subsequently our power system. Climate change has both supply and demand-side impacts on our power system. While the nature of climate change is increased uncertainty, there is consensus in climate change research that increased annual peak electricity demand is an impact of climate change.[6]

Risk reduction. The potential power system planning and operations implications of this increase will be increased total generation and investment requirements in generation equipment and more peaked electricity prices.[7]

Applicable Population

This metric applies to all PSE customers, and cannot be applied at a locationally granular level because the impacts of climate change such as rising temperatures, wildfire and drought don't have a local cause and effect. Rising temperatures are expected throughout the Pacific Northwest increasing air conditioning loads for all PSE customers. At the same time, decreasing summer rainfall due to climate change will decrease summer hydroelectric production. These issues affect all PSE customers similarly so we will not subset the population for this indicator.

Examples

Stakeholder Example Question: Does the program mitigate the impacts of climate change i.e. Wildfires, droughts?

Example #1: T&D Deferral. Transmission and distribution deferral is a commonly used avoided cost metric to show the future T&D infrastructure expenditures that can be avoided if future load growth can be reduced. The benefits of potential peak

[6] P. 11 Table 3 (https://www.osti.gov/pages/servlets/purl/1476442)

[7] Ibid.

reduction impacts of DER and DR programs can be represented as future avoided costs that would have been passed onto all customers.

Example #2: Wildfire Risk Mitigation. Distributed energy resources (DERs) can offset potential risks from long-distance transmission. Wildfires can interrupt service on transmissions lines, leading to lower reliability.

Metric

We plan to measure our clean energy programs' abilities to reduce or offset peak demand as an indicator of reduction of climate change impacts.

- Overall peak demand reduction by season

Measurement

For each program, calculate the kilowatts of demand during peak periods shifted into off-peak periods by program resources. We present a direct estimation method that relies on primary data in Table 11 below. This calculation will generally involve creating mathematical models of the affected loads before and after implementation of the program.

Table 9 Reduction of Climate Change Impacts Calculation

Title	Calculation	Notes
Peak demand impacts	$Peak\ kW_{pre,p} - Peak\ kW_{post,p}$	*Peak kW demand program (pre) before p* *Peak kW demand after (post) program p*

Issues and Data Gaps

Peak Period

The definition of peak period should be defined based on capacity and long-term planning methodologies to best attempt to capture the drivers of new infrastructure build. In other words, is the peak considered as the single highest system demand hour per year, the highest system demand hour in summer or winter months, the highest system demand during certain hours on weekdays in summer, etc.? Is the peak local or territory wide? This approach can be developed in collaboration with PSE Resource Planning based on integrated resource planning processes.

Gathering accurate time series data from program resource dispatch during peak periods can also present a challenge in evaluating program accomplishments.

Determining the Baseline

In order to determine the impacts of the programs, a baseline must be developed for comparison. Quantifying this counterfactual (i.e., what would have happened to peak load had it not been for the program) will require a fairly sophisticated analysis. One approach PSE could take is to look at the dispatch of the resources and forecast, and actual reductions as a measurement. This sort of evaluation has standard practices for assessing demand response programs, however distributed energy resource evaluation methodologies are not as commonplace.

Data Sources

Direct estimation of peak demand savings with primary data requires the availability of hourly or sub-hourly measurements from the program resource.

Table 10 Data Sources for Reduction of Climate Change Impacts

Category	Dataset	Units	Source	Source Reporting	Date of Release	Estimated Cost
Program Peak Demand Impacts	Energy Storage Dispatched	MW/year	PSE Program Tracking Data	Annually	TBD - PSE	\$1,600 - \$4,000
	Demand Response Impacts	MW/year		Annually	TBD - PSE	\$1,600 - \$4,000
	Energy Efficiency Impacts	MW/year		Annually	TBD - PSE	\$1,600 - \$4,000

Expected Program Impact on Metric

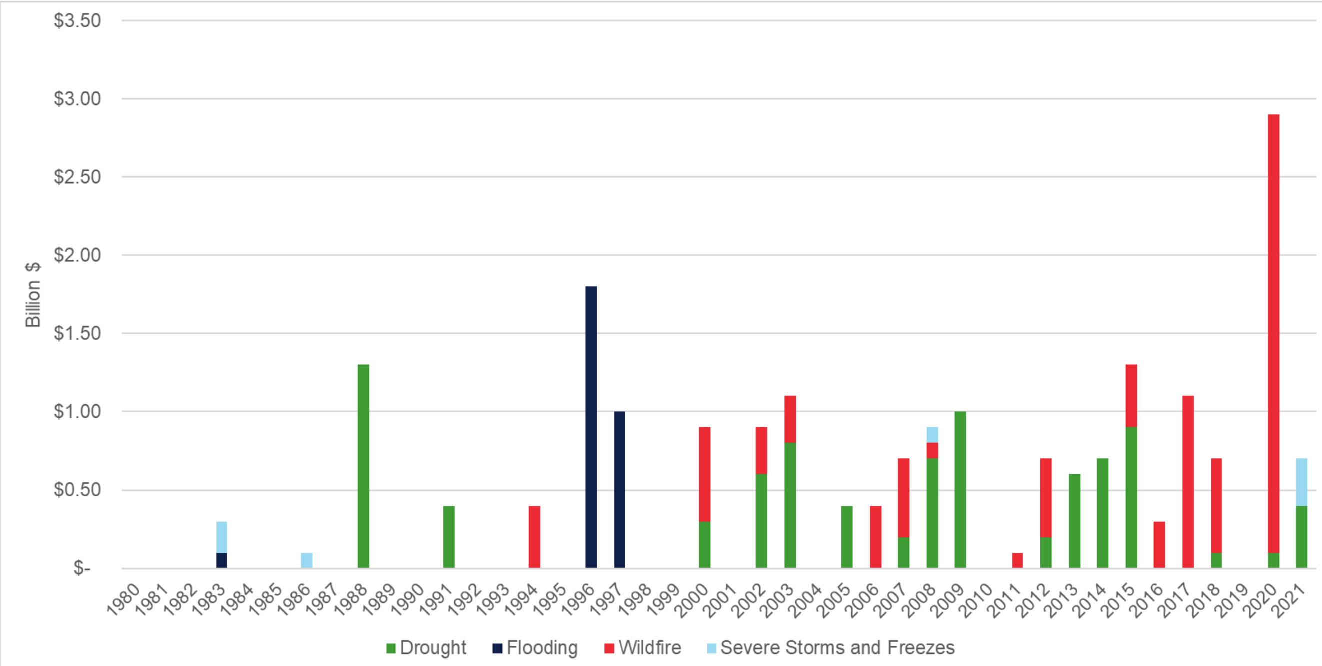
One consequence of climate change is more frequent extreme temperature events and heat waves. Heat waves tend to drive electricity demand up during peak periods which tends to drive increased infrastructure investment and further contribute to emissions which exacerbate climate change. Peak demand reduction can mitigate these issues, though this may not be possible to measure directly.

DECREASE IN FREQUENCY AND DURATION OF OUTAGES

Customer Benefit Indicator Categories

Risk reduction. The continued rise in extreme weather events, from extreme heat and cold events to severe storms, sea level rise, and wildfires, puts PSE and its customers at increased risk of experiencing extended power outages. Figure 5 presents the cost of these events within the Northwest Region as calculated by NOAA. By reducing outages, PSE can reduce some of the risks associated with these events.

Figure 3. Cost of Extreme Weather Events in the Northwest Region



[8]

Resiliency. The DOE and other organizations have published several articles that advocate that utilities take specific steps to increase resilience to these events, including the number and duration of outages. This metric focuses on the degree to which PSE programs can specifically reduce customer outages. The next metric, in Section 8, Increased Resiliency more fully covers elements that address community resilience.

Energy security. In addition to climate change, this metric will also in part measure PSE's ability to provide customers with backup power potential in response to extreme weather events.

Applicable Population

This metric applies to all program participants. Non-Participating customers will also be important because they will help to represent a counterfactual that accounts for normal annual changes in outages.

Examples

Stakeholder Example Question: Does the program decrease the number of and duration of outages through the use of distributed resources?

Example: Solar Plus Storage Program. In an example where PSE administers a solar plus storage program, participating customers who have a backup battery may lose power from the grid and use their battery to maintain power. This metric will quantify the length of their outage and the kWh and duration that their backup battery delivered power through the outage.

Metric

This metric will measure a population's frequency of outages (number per year), total hours of outages, average duration of each outage, and total backup load served by DERs. The metric can be calculated and presented for the following populations:

- **All Residential PSE customers**

[8] https://www.ncdc.noaa.gov/billions/time-series

- **Residential PSE Portfolio Participants**
- **Residential PSE Single Program Participants**

We propose calculating these measurements pre- and post-participation to determine change in number and duration of outages as well as comparing participant outage statistics to non-participant outage statistics. This will help to account for normal changes in outages year-over-over due to non-program factors.

Measurement

Table 13 below presents a series of measurements to calculate the decrease in number and duration of outages. We have broken these measurements down into two modules. The first module indicates basic outage statistics that the utility should be able to calculate while the second module is the sum of energy that program resources delivered to mitigate customer outages.

Table 11. Decrease in Number and Duration of Outages Calculation

Title	Calculation	Notes
Metric 7 Module 1: Outage Statistics		
Number of Outages [Incidence/year]	$NO_{(p,y)}$	*NO = Number of outages per year for population p in year y*
Total Hours of Outages [hr/year]	$THO_{(p,y)}$	*THO = Total hours of outages for population p in year y*
Average Duration of Outages [hr]	$DO_{(p,y)}$	*DO = Average duration of outages for population p in year y*
Number of Customers Impacted by Outages [Customer Count]	$CO_{(p,y)}$	*CO = Number of Customers Impacted by Outages for population p in year y*
Metric 7 Module 2: Program-Resource Mitigate Outages		
Program Resource-Mitigated Outages [kW and kWh]	$RMO_{(p,y)} = \sum RD_{(p,y)}$	*RD = Energy delivered by resources during outages for population p in year y*

Issues and Data Gaps

Issue 1: Counterfactuals are not necessarily clear. Outages can be driven by many causes, including weather, car accidents and many other causes. A historical baseline or other formulaic approaches must be determined to quantify reductions.

> **Risk Mitigation Strategy.** This approach also may require interaction with PSE system operation and planning teams to determine the counterfactual as a baseline.

Issue 2: Behind the Meter (BTM) Resource Data Not Necessarily Available to PSE. If PSE wishes to calculate storage-mitigated outages, they will not have access to battery dispatch data unless they have coordinated with battery vendors to have access to those data.

> **Risk Mitigation Strategy.** PSE should seek to include site-specific battery dispatch data transfers within contracts with participating vendors. If battery vendors are willing, able, and incentivized to provide each outage metric, this will be the easiest path for PSE to calculate this measurement. However, if battery vendors do not have full visibility into the customer’s outage duration, these details may not be enough to calculate the full metric. If vendors cannot provide full

calculated metrics, they should be able to provide battery state of charge, so PSE could align battery performance during known outages to calculate the metric. This, however, would complicate the calculation.

Data Sources

Table 14 below presents the data sources to use for this calculation.

Table 12. Data Sources for Calculating Decrease in Number and Duration of Outages

Category	Dataset	Units	Source	Source Reporting	Date of Release	Estimated Cost
Module 1: Outage Statistics	Number of Outages	Count of Outages	PSE Outage Data	Annually	TBD	$1,600 - $4,000
	Total Hours of Outages	Hours/Year		Annually	TBD	$1,600 - $4,000
	Average Duration of Outages	Hours		Annually	TBD	$1,600 - $4,000
	Number of Customers Impacted by Outages	Count of Customers		Annually	TBD	$1,600 - $4,000
Module 2: Program-Resource Mitigate Outages	Resource Dispatch during Outage	kWh	PSE for DR data Vendors for PV and storage data	Annually	TBD	$4,000 - $8,000†

†Depending on data quality, cost may be higher

Expected Program Impact on Metric

We anticipate that storage programs participants should have less time without power during an outage compared to customers without energy storage. All PSE customers should have less exposure to supply related outages.

INCREASED RESILIENCY

Customer Benefit Indicator Categories

This metric will cover the same benefit indicator categories as metric 7, decrease in number and duration of outages:

- **Risk reduction**
- **Resiliency**
- **Energy security**

Where metric 7 accounts for the specific reduction in frequency and duration of specific outages, metric 8 interprets resiliency through the lens of community access to power. As described below, metric 8 quantifies the extent to which PSE can increase access to backup power for more of its customers.

Applicable Population

This metric applies to all program participants.

Examples

Stakeholder Example Question #1: Does the program support an increase in community resilience?
Stakeholder Example Question #2: Does the program improve and/or create multiple access points to distributed resources for residencies and communities to mitigate the impacts from outages?

Example: Storage as a Service Backup Power Program. If PSE installs a large backup power supply at a local school or community center, that facility will be able to provide backup power to a certain number of residents located near the facility. This metric will quantify the number of customers who have access to this facility's emergency power.

Metric

First, this metric will calculate the number of customers who have access to emergency power in their home or facility or at a community center. Second, the metric will calculate the cumulative island-able (e.g., microgrid, energy storage) capacity installed.

The metric can be calculated and presented for the following populations:

- **All Residential PSE customers**
- **Residential PSE Portfolio Participants**
- **Residential PSE Single Program Participants**
- **PSE Residential customers in highly impacted communities or vulnerable populations**

Measurement

Table 15 below presents the sets of possible calculations that PSE can use to represent this metric.

Table 13. Increased Resiliency Calculation

Title	Calculation	Notes
Number of Customers with Solar + Storage [customer count]	$CSS_{(p,y)}$	*CSS = Number of customers with solar plus storage for population p in year y*
Number of customers served within a microgrid [customer count]	$CMG_{(p,y)}$	*CMG = Number of customers served within a microgrid for population p in year y*
Occupant Capacity of community centers that have backup power [person count]	$OCCC_{(p,y)}$	*OCCC = Occupant Capacity of Community Centers that have backup power for population p in year y*
Number of customers within a given distance to a community resilience center [customer count]	$NCCC_{(p,y)}$	*NCCC = Number of customers with within a given distance to a community resilience center for population p in year y*
Capacity of island-able solar plus storage [MW]	$CISS_{(p,y)}$	*CISS = Capacity of islandable solar plus storage for population p in year y*

Issues and Data Gaps

Defining a community resilience hub or number of customers with access to (and knowledge of) one versus those that actually utilize one may be difficult metrics to confirm and are highly subjective. E.g. someone may come by to charge their phone for 30 minutes while someone else may sleep overnight. Is the value to each of those people different for this metric?

Issue 1: Challenges Identifying Number of People Served by Community Centers. Defining the number of people who have access to a community center with backup power will require estimating facility capacity through sources such as fire department occupation limits or collecting these data through the course of program administration. In addition, the number of people who have access to the facility does not account for the variation in the amount of time that residents will spend at the facility. For example, someone may come by to charge their phone for 30 minutes while someone else may sleep overnight.

Risk Mitigation Strategy. One option would be to follow up with community resilience facilities following outages to estimate the number of customers who utilized the center during the outage.

Data Sources

Table 16 below presents the data sources to use for this calculation.

Table 14. Data Sources for Calculating Increased Resiliency

Category	Dataset	Units	Source	Source Reporting	Date of Release	Estimated Cost
Customers Served by Program	Number of customers with solar + storage	Count of Customers	PSE Tracking Data	Annually	TBD	$1,600 - $4,000
	Number of customers served within a microgrid	Count of Customers		Annually	TBD	$1,600 - $4,000
	Occupant capacity of community centers that have backup power	Count of People		Annually	TBD	$1,600 - $4,000
	Number of customers within a given distance to a community resilience center	Count of Customers		Annually	TBD	$1,600 - $4,000
	Capacity of island-able solar plus storage	MW		Annually	TBD	$1,600 - $4,000

Expected Program Impact on Metric

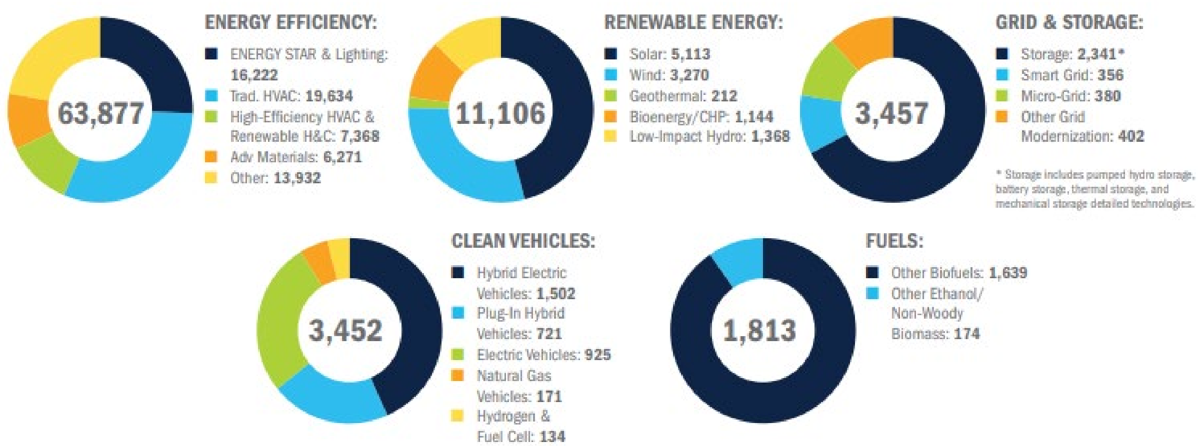
This metric will quantify the extent to which PSE programs provide customers backup power within their residence or at a community center. As customers utilize these centers to access power during an outage, it will be important for PSE to assess whether facility capacities are large enough to provide sufficient power resources to community members. For example, it is possible that customers wish to stay at facilities longer-than-expected to have sufficient and sustained power for work. It is also possible that as electric vehicle adoption enters a mass-market phase that customers will require charging infrastructure to power their vehicles. This metric as currently defined does not yet capture such nuances, although it is designed to add small additional statistics (e.g. backup EV charging station utilization) to assess whether facilities are delivering adequate services. Such additions can be made once programs are in place and PSE receives customer feedback.

INCREASE IN CLEAN ENERGY JOBS

Customer Benefit Indicator Categories

Non-energy benefits. One of the key benefits for PSE's clean energy programs is job creation. As Figure 6 shows below, E2 has reported in their annual report that clean energy industries created over 83,000 jobs in Washington statewide in 2019.[9] According to the report, over 36,000 of those jobs are in King County alone. PSE's ability to continue to induce the creation of these jobs and measure and report them will not only support accelerating and promoting these benefits, but also facilitate a deeper understanding of how these industries create and sustain new jobs over time. This metric will ensure PSE's program continuously work to achieve the promise of new and sustained clean job creation.

Figure 4. Number of Washington jobs created by clean energy industries in 2019



Applicable Population

This metric applies to all of PSE service territory and the state as a whole, with a particular focus on customers in vulnerable populations and highly impacted communities.

Examples

Stakeholder Example Question #1: Does the program or action provide additional career opportunities to highly impacted communities or vulnerable populations?

Stakeholder Example Question #2: Does the program or action lower unemployment for highly impacted communities and vulnerable populations by providing jobs in the surrounding community?

Example #1: Multi-Family Roof-top Solar Incentive Program. If PSE provides incentives for rooftop solar, their program vendor could run trainings for local solar installers and the number of solar installation contractors in the area could increase.

Example #2: Residential Roof-top Solar Leasing. In a direct install program where PSE installs solar on a customer's roof top (leasing the space from them) the third party running the program could hire local staff to perform the installations. This metric would measure the number of workforce trainings, the number of proposals that local contractors submitted to participate with PSE, and number of contracts that PSE awarded to local vendors.

Metric

- Number of new jobs created by PSE programs that employ residents of named populations

[9] https://www.e2.org/wp-content/uploads/2019/12/E2-Clean-Jobs-Washington-2019.pdf

- Number of new employees per kW installed (solar PV, storage)
- Access to contracting and workforce development opportunities by local vendors within named populations

Measurement

Table 17 presents a set of calculations to measure the increase in clean jobs that PSE programs cause. In this table, we have broken the measurements into two categories. The first category presents a set of training and contracting summary statistics. The second category presents a way for PSE to calculate the number of clean jobs that its programs created and any non-renewable energy industry jobs it may have lost. A few of these metrics refer to "local contractors." PSE should workshop and vet the definition of this term among stakeholders to determine whether a vendor with a local office would qualify or some additional criteria, such as minimum percentage or count of local employees is necessary. PSE can use one or more of these calculations to measure the impacts of this metric,

Table 15. Increase in Clean Energy Jobs Calculation

Title	Calculation	Notes
Metric 9 Module 1: Workforce Training and Contract Statistics		
Number of workforce training events within named populations annually [events/year]	$T_{(y)}$	*T = Number of workforce trainings within named populations in year y*
Number of contracts bid on by local vendors annually [events/year]	$CB_{(y)}$	*CB= Number of contracts bid on by local vendors in year y*
Number of contracts awarded to local vendors annually [events/year]	$CA_{(y)}$	*CA = Number of contracts awarded to local vendors in year y*
Metric 9 Module 2: Clean Jobs Created Estimates		
Number of clean jobs created by PSE programs [Count of New Jobs]	$CJ_{(p,y)} = \frac{SCJ}{kW_{(s,y)}} x\ kW_{(p,y)}$	*CJ = Number of new jobs created by PSE programs p in year y* *SCJ = State jobs created* *$kW_{(s,y)}$ = kW of renewable capacity installed in the state in year y* *$kW_{(p,y)}$ = kW of renewable capacity installed in program p in year y*
Number of jobs lost due to PSE clean energy programs [Count of Jobs Lost]	$LJ_{(p,y)} = JEDI(kW_{(l,p,y)})$	*$kW_{(l,p,y)}$ = kW of non-renewable capacity retired due to program p in year y* *LJ = Number of non-renewable energy jobs lost because of PSE programs p in year y*
Net clean energy jobs created by PSE	$Net\ Jobs_{(p,y)} = CJ_{(p,y)} - LJ_{(p,y)}$	*Net Jobs = Number of new jobs created by PSE programs p in year y, minus any jobs lost in the non-renewable energy sector*

Issues and Data Gaps

- **Issue #1: New jobs per kW of renewable generation is not equal by resource.** When calculating the number of new jobs created by statewide renewables, taking a simple jobs/kW ratio may not be granular enough as the mix of statewide renewable resources may not match PSE's renewable and/or DER resources.

  - **Mitigation Strategy.** PSE could create a weighting scheme where PSE calculates jobs created per kW of each type of resource and possibly sector (utility-scale, residential, and non-residential) and weight those averages by the distribution of resources within PSE's portfolio or given program.

- **Issue #2: Construction jobs created will differ from O&M jobs.** PSE will need to consider an additional layer of how O&M activities for renewable resources will impact jobs once the respective resource is online. For example, solar and gas turbines will both have some number of jobs for construction, but during operation, solar will require much fewer jobs because they don't require as much maintenance.
  - **Mitigation Strategy.** We recommend ongoing research to establish the forward-looking sustainable jobs impacts relating to renewable resources compared to conventional power plants.
- **Issue #3: Duration and tenure of new jobs is uncertain.** Beyond simply construction and O&M job positions, job turnover complicates the tracking of jobs sustainably held by people from named populations. For example, it is possible that jobs are initially filled by people from named populations, but are replaced by people from outside of named populations after a while. It is not likely that PSE will be able to track such nuanced turnover.
  - **Mitigation Strategy.** One way to account for this uncertainty is to run annual surveys among of DER maintenance crews and renewable plant employees to determine duration of tenure and whether they live in named populations or not. If retaining members of named populations proves to difficult, PSE can revisit this issue and determine whether program designs can and would be advisable to increase retention of these positions.
- **Issue #4: JEDI, powerful Department of Energy renewables economic simulation tool, does not report on DER resources.** While JEDI is close to a perfect source for this metric, it currently only has utility-scale resources and furthermore includes concentrated solar but not utility-scale PV. This makes it difficult to use the tool directly to calculate this metric.
  - **Mitigation Strategy.** Because the tool is supported by the federal government and is so easy to use, we recommend using it as a sort of benchmarking source that allows PSE to provide a relative comparison between the calculated results for DERs and JEDI's results for utility-scale resources. This is likely to be a qualitative assessment to expand context rather than a source of a quantitative adjustment.

Data Sources

Table 18 below presents the data sources we recommend for calculating the increases in clean jobs that PSE programs induce.

Table 16. Data Sources for Calculating Increases in Clean Jobs

Category	Dataset	Units	Source	Source Reporting	Date of Release	Estimated Cost
Module 1: Workforce Training and Contract Statistics	Number of workforce training events	Number of Events	PSE Tracking Data	Annually	TBD	$1,600 - $4,000
	Contracts bid on and awarded by firm and firm location	Number of contracts	PSE Contracting Database	Annually	TBD	$1,600 - $4,000
Module 2: Clean Jobs Created Estimates	New Clean Jobs per Installed Capacity (kW) of Renewables Statewide	Jobs/kW	Clean Jobs Washington annual report by E2	TBD	TBD	$1,600 - $4,000

Category	Dataset	Units	Source	Source Reporting	Date of Release	Estimated Cost
	Jobs Lost from Reduced Non-Renewable Energy Capacity	Jobs	JEDI	Annually	TBD	$1,600 - $4,000
	Capacity (kW) of Renewables by PSE program	kW	PSE Tracking Data	Annually	TBD	$1,600 - $4,000
	Jobs Created from Utility-Scale Resources	Jobs	JEDI	Annually	TBD	$1,600 - $4,000

Expected Program Impact on Metric

It is all but assured that PSE's programs will create new construction jobs. However, we have already highlighted a few potential challenges in Section 9.4.2 above. To recap, it is possible that ongoing O&M positions may be less than conventional power plants with comparable capacity. Additionally, the retention of newly-created jobs among members of named populations is not guaranteed. Employment-related impacts can be represented as net jobs if job losses that may have occurred in non-energy efficiency or renewable energy-related sectors due to the program (e.g., decrease in demand for coal) are quantified, as well. Net jobs would present the program impacts on jobs after any losses have been subtracted from the increase.[10] With additional research, PSE can track and measure these risks and challenges and adjust program designs and metric calculation methodologies accordingly.

Lastly, it is important to note that new clean jobs are not necessarily or likely to be filled by members of named populations or even local PSE residents unless programs or measurements are designed to specifically encourage and capture the locality of these jobs. Our workforce training and contract statistics measurements seek to provide a quantifiable way to assess the localization of clean job creation. If these measurements show lower-than-desired local contractor engagement, PSE can consider ways to address the concern.

[10] https://www.epa.gov/sites/default/files/2018-07/documents/mbg_2-5_economicbenefits.pdf

IMPROVED PARTICIPATION FROM NAMED COMMUNITIES

Customer benefit indicator categories

As stated earlier, PSE has committed in its IRP to support customers within named populations and ensure that they receive direct benefits from clean energy programs. These benefits include those described above and include categories including:

- **Burden reduction**
- **Non-energy benefits**
- **Energy benefits (to named populations)**

Many of the earlier metrics are designed to be calculated specifically for participants within named populations. This metric is designed to directly measure participation among highly impacted communities and vulnerable populations.

Applicable population

This metric applies to PSE customers within highly impacted communities and vulnerable populations.

Examples

Stakeholder Example Question: Does the program reduce barriers (e.g., financing, rebates or other incentives) for or target participation for Vulnerable Populations, Highly Impacted Communities or renters?

Example: CACAP Program. As mentioned in Metrics 1 and 2, CACAP is designed to provide bill assistance relief to residential customers facing financial hardship. This metric would be used to track the percentage of participants in this program who are within named populations and the percent of customers within named populations who have engaged in the program.

Metric

This metric can calculate the count and percent of participation by customers within named populations by

- ***Program***
- ***Census tract***
- ***Census tract by program***

PSE is evaluating data availability and options for measuring this metric similar to methods used for energy burden.

Expected Program Impact on Metric

This metric should be tracked over time. Ideally, customers within highly impacted communities and named populations should be able to easily access bill assistance and energy efficiency weatherization programs. However, these customers are likely to face significant barriers to DER program participation. For example, customers in the named populations are more likely to have low- or moderate-income levels that make it difficult for them to afford the equipment purchases that traditional downstream energy efficiency programs target. Over time, as PSE defines DER concept models that are appropriate for customers within named populations and their respective residences, this metric should show an increase in participation among these communities.

IMPROVED HOME COMFORT

Customer Benefit Indicator Categories

Non-energy benefits are the annual dollar savings per year associated with quantifiable non-energy impacts of PSE programs or measures. Improved home comfort encompasses several non-energy impact (NEI) types, and we expect the breadth of this metric to grow as more research is published related to it. For now, we will focus on the NEI values that are quantifiable and defensible for existing PSE energy efficiency measures.

Applicable Population

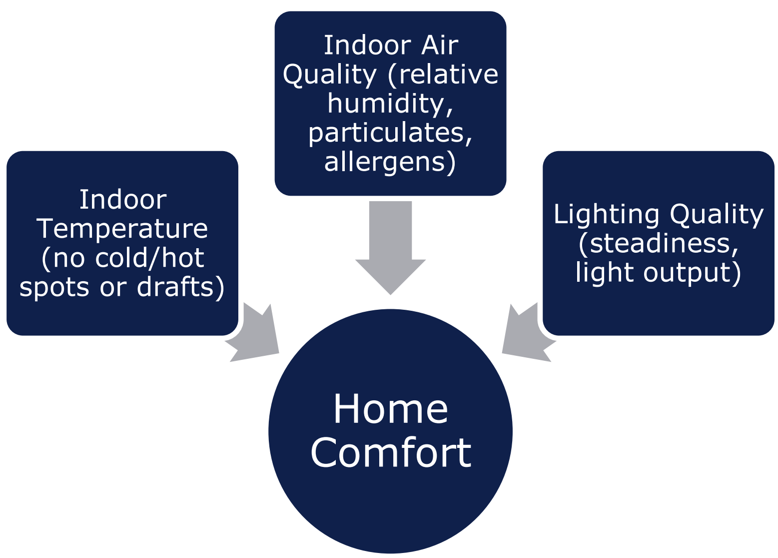
This CBI will be measured only for **program participants**. Participant NEI values are attributable benefits to participating customers, beyond energy savings, gained from installing energy efficient measures. This metric can also be calculated specifically for program participants within named communities.

Examples

Stakeholder Example Question: Does the project improve home comfort for customers including heating and cooling and indoor air quality?

Example: Direct Install Single Family Weatherization Program. The aim of weatherization programs is to improve thermal comfort by adding insulation and sealing building cracks where drafts might occur, or airborne outdoor pollutants could enter. These programs are often accompanied by the direct installation of energy efficient lighting and water saving measures. Program participants have reported feeling more comfortable in their homes after participating in these types of program, and programs are quantifying and reporting the associated non-energy impacts.

Figure 5: Components of Home Comfort



Metric

PSE has identified several non-energy benefits in our residential energy efficiency programs related to home comfort. These benefits are measured as reduced costs to the program participants, and they include thermal comfort, improved health, and lighting quality and lifetime. Thermal comfort is an individual's subjective satisfaction with their home's indoor temperature. Loss of sleep and productivity are both commonly used to value thermal comfort as a non-energy benefit of energy efficiency measures in the cooling and space heating end uses. Improved health is a non-energy impact that can be measured in reduced medical costs, reduced lost income from missed days at work, and fewer deaths. Lighting quality and lifetime benefits represent the value of improved lighting lumen levels, color, and steadiness that LED lighting provides.

Measurement

Home comfort will be measured as the sum of the present value of applicable lifetime non-energy benefits to the participants of PSE programs, consistent with the Council's methodology[11].

Table 17 Measuring Improved Home Comfort

Title	Calculation	Notes
Lifetime thermal comfort benefits	$\sum PV(B_{(t)}, L)$	*Present value of thermal comfort benefits t of measures with lifetime L*
Lifetime health benefits	$\sum PV(B_{(h)}, L)$	*Present value of health benefits h of measures with lifetime L*
Lifetime lighting quality benefits	$\sum PV(B_{(q)}, L)$	*Present value of lighting quality benefits q of measures with lifetime L*

Issues and Data Gaps

Issue with applying previous NEI research: Because the non-energy impact values PSE currently has as a deliverable from a previous project are limited to energy efficiency measures, new research may be necessary anyways. Additionally, the non-energy impact values were developed using a metanalysis to fit the values to the PSE territory. This process follows a conservative approach, so some benefits may be underestimated. These benefits may not be applicable to PSE's DER programs. Additional research and analysis would be necessary to determine whether energy efficiency home comfort non-energy benefits can be translated to DERs.

Data Sources

Table 16 shows the existing sources of data for calculating this metric.

The health benefits from the PSE Wood Smoke analysis capture the public health benefits from reducing wood burning in houses with zonal electric heat in PSE's territory. The other health-related non-energy benefits capture avoided medical costs from reduced asthma symptoms and reduced carbon monoxide poisoning.

[11]The Northwest Power and Conservation Council's Methodology for Determining Achievable Conservation Potential (https://www.nwcouncil.org/sites/default/files/Methodology.pdf)

Table 18 Data Sources for Measuring Improved Home Comfort

Category	Units	Source	Source Reporting	Date of Release	Estimated Cost
Thermal Comfort	$ per kWh	Massachusetts Program Administrators—Non-Energy Impact Framework Study Report, 2018	N/A	N/A	$1,600 - $4,000
Improved Health	$ per kWh		N/A	N/A	$1,600 - $4,000
Lighting Quality	$ per kWh		N/A	N/A	$1,600 - $4,000
Improved Health	$ per kWh	Human Health Benefits of Reducing Wood Smoke Emissions in Puget Sound Energy's Service Territory, 2018	N/A	N/A	$1,600 - $4,000
Energy Efficiency Savings	MWh/year	PSE Program Tracking Data	Annually	TBD - PSE	$1,600 - $4,000

Expected Program Impact on Metric

Poor quality housing can cause new incidences of disease or exacerbate pre-existing health conditions of residents. Infant children, pregnant women, and seniors are especially affected by their housing conditions. Thermal stress from extreme heat or cold can cause death for those in vulnerable populations. We expect programs that improve home comfort to reduce participant's thermal stress and medical costs from poor housing conditions. Improved home comfort should also increase participant's quality of life, including their ability to perform daily activities at home, school, or work. Living in poor environments leads to stress and anxiety, which takes a physical and mental toll on residents of the home.

APPENDIX

This section documents the assumptions used to estimate the effort required to track the metrics described in this document. The activities include obtaining the necessary data, performing data checks and data cleaning, and formatting the data to perform the calculations.

Level of Effort	Hours	Cost
Low	10 - 25	$1,600 - $4,000
Medium	25 - 50	$4,000 - $8,000
High	50 - 100	$8,000 - $16,000