4.5 GREENHOUSE GASES

Gases that trap heat in the atmosphere are referred to as greenhouse gases (GHGs) because, like a greenhouse, they capture heat radiated from the earth. The accumulation of GHGs is a driving force in global climate change. Definitions of *climate change* vary among regulatory authorities and the scientific community. In general, however, climate change can be described as the changing of the earth's climate caused by natural fluctuations and human activities that alter the composition of the global atmosphere. This section quantifies major sources of GHG emissions associated with the Energize Eastside project.

While GHG concentrations are global and not localized, the study area for this analysis consists of the areas where the project would directly or indirectly result in GHG emissions or where the project could result in a reduction of carbon *sequestration* rates (defined in Section 4.5.2).

Key Changes from the Phase 2 Draft EIS

The GHG assessment was revised in this Final EIS to explain recent changes in regulatory guidance and to incorporate the latest available data into the description of existing GHGs. However, these updates were minimal and did not require changes to the impact analysis or result in new findings. Tree removal would be the same as was assessed in the Phase 2 Draft EIS for the Redmond, Bellevue North, and Redmond Segments, but updated tree removal data were available for the Bellevue Central and Bellevue South Segments and both Newcastle options (see Appendix L). In addition, modifications were made to the model used for the Phase 2 Draft EIS regarding how carbon is calculated. Therefore, impacts were reassessed to account for changes to the model. The Final EIS presents the potential GHG emissions that may result from PSE's Proposed Alignment.

4.5.1 Greenhouse Gas Compounds Considered in this Analysis

The principal GHGs of concern include the following:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Sulfur hexafluoride (SF_6)

Electrical utilities, including PSE, often use SF_6 in electrical equipment at substations because of its effectiveness as an insulating gas.

Methods for Studying the Affected Environment

Emissions of GHGs at the state and county level have been estimated and published by Ecology and King County as well as Bellevue, Redmond, and Renton in the study area.

Each of the principal GHGs has a long atmospheric lifetime, existing in the atmosphere for 1 year to several thousand years. In addition, the potential heat-trapping ability of each of these gases varies significantly. For example, CH_4 is 28 times as potent as CO_2 at trapping heat, while SF_6 is 22,800 times more potent than CO_2 (IPCC, 2013; EPA, 2017). The ability of these gases to trap heat is called global warming potential.

In emissions inventories, GHG emissions are typically reported in terms of metric tons of CO_2 equivalents (CO_2e). CO_2e are calculated as the product of the mass emitted of a given GHG and its specific global warming potential. While CH_4, N_2O, and SF_6 have much higher global warming potential than CO_2, CO_2 is emitted in such vastly higher quantities that it accounts for the majority of GHG emissions in CO_2e, both from residential developments and human activity in general.

The primary human activities that release GHGs include combustion of *fossil fuels* for transportation, heating, and electricity; agricultural practices that release CH_4, such as livestock production and decomposition of crop residue; and industrial processes that release smaller amounts of gases with high global warming potential such as SF_6. Deforestation and land cover conversion also contribute to global warming by reducing the earth's capacity to remove CO_2 from the air and altering the earth's albedo (surface reflectance), thus allowing more solar radiation to be absorbed.

4.5.2 Carbon Sequestration

Terrestrial carbon sequestration is the process in which atmospheric CO_2 is taken up into plants or soil and subsequently "trapped." Terrestrial sequestration can occur through planting trees, restoring wetlands, land management, and forest fire management. This Final EIS analysis focuses on the terrestrial sequestration associated specifically with trees and shrubs, as related to the project.

Trees and shrubs act as both *carbon sinks* and carbon sources. Vegetation can act as a carbon sink by absorbing CO_2 from the atmosphere, releasing oxygen through photosynthesis, and retaining the carbon within the vegetation. Trees also act as a carbon source when they are dying and decomposing; the carbon that was stored in the trees is released and reacts with oxygen in the air to form CO_2. Younger trees that are growing rapidly can store more carbon in their leaves than older trees. However, the total amount of carbon sequestered annually by healthy, large trees is greater than younger trees because the greater number of leaves compensates for the lower productivity of larger trees (USDA, 2011; Stephenson et al., 2014).

Trees suffering from disease will slow and eventually arrest the process of photosynthesis, thus limiting the ability of the affected tree to act as a carbon sink. Therefore, maintaining healthy trees keeps carbon stored in trees; however, certain landscape maintenance activities can generate modest GHG emissions (USDA, 2011). For example, water use, fertilizer use, exhaust from gas- and diesel-powered landscape equipment, and vehicle trips for maintenance crews result in CO_2 emissions. Carbon sequestration varies with both the species of trees as well as the age of trees; as a general example, 1,000 pine trees sequester approximately 32 metric tons of CO_2e per year (CAPCOA, 2013).

4.5.3 Greenhouse Gases in the Study Area

Ecology estimated that in 2013, Washington produced about 94 million gross metric tons (about 104 million U.S. tons) of CO_2e (Sandlin, 2016). Sources of GHG emissions in the state are shown in Figure 4.5-1.

King County last inventoried countywide GHG emissions for the year 2012. Community consumption-based emissions (which include some *lifecycle emissions* associated with food consumed within the county but grown elsewhere) totaled 55 million metric tons of CO_2e (King County, 2015), although only about 15 million metric tons were emitted within the county.

As described on page 4-9 of the Phase 1 Draft EIS, the cities of Bellevue and Renton have developed GHG inventories.

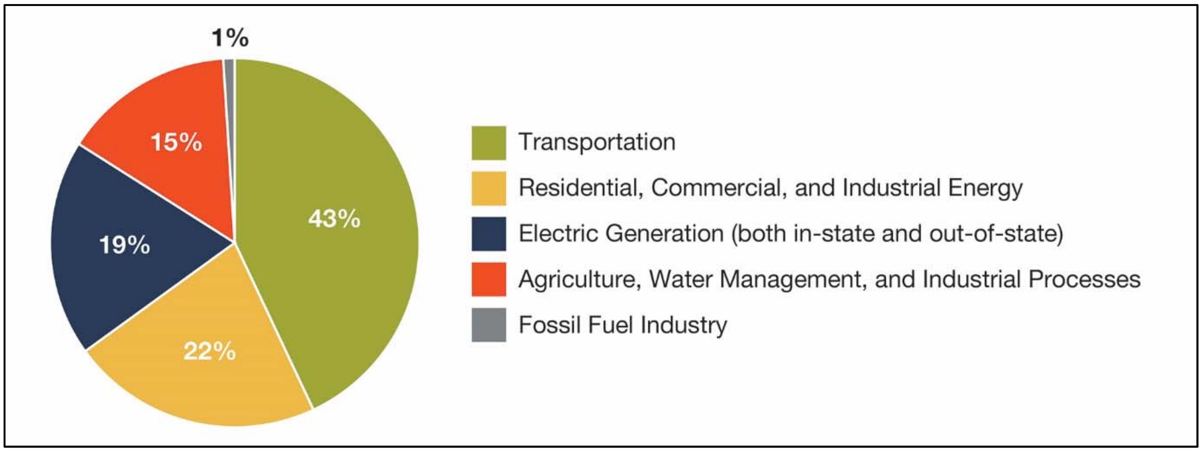

Figure 4.5-1. Sources of GHG Emissions in Washington State

4.5.4 Relevant Plans, Policies, and Regulations

The Phase 1 Draft EIS provided an overview of the planning policies and regulations pertinent to GHG emissions. For the Phase 2 Draft EIS, the policies and regulations considered were updated to be applicable to the project-level analysis (see Section 3.4.2 of the Phase 2 Draft EIS). On April 5, 2017, the Council on Environmental Quality (CEQ) withdrew its *Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews* (CEQ, 2016) for further review. Consideration of GHG sources identified in the guidance was used in the impact assessment; however, the GHG sources used are typical to those used in other land use planning analyses, such as the General Reporting Protocol of the Climate Registry (The Climate Registry, 2016) and the Bay Area Air Quality Management District's CEQA Air Quality Guidelines (BAAQMD, 2017). Therefore, no changes have been made to the GHG impact assessment methodology for this Final EIS.

4.5.5 Long-term (Operation) Impacts Considered

4.5.5.1 Methods for Analyzing Long-term Impacts

The Energize Eastside project could result in an increase of GHG emissions from the potential loss of sequestered carbon from the removal of trees and vegetation to accommodate the new powerlines and substation. The potential loss of carbon sequestration from tree removal is based on tree inventory data prepared for PSE (The Watershed Company, 2016, 2017) for each project segment. Tree removal for the Newcastle Options (i.e., Option 1 – No Code Variance and Option 2 – Code Variance) would be roughly the same because, despite their differing pole placement and configurations, the required clearing area would be the same. Sequestration calculations were made using the i-Tree model. i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban and rural forestry analysis and benefits assessment tools (USFS, 2017). See Section 4.10, *Economics*, for information about the i-Tree model and for a discussion of the monetary value of lost *ecosystem services* due to reduced tree cover. This analysis compares the estimated change in GHG emissions for the project to the State of Washington GHG reporting thresholds (Chapter 173-441 WAC, *Reporting of Emissions of Greenhouse Gases*). The analysis of GHG emissions represents a cumulative impact analysis because impacts are only important due to cumulative effects that GHG emissions have had and are having on global climate. Impacts are assessed based on the project's potential to result in a cumulatively considerable contribution to the state and overall global GHG burden. Potential mitigation measures to minimize or eliminate GHG emissions associated with the project are considered, as warranted.

A quantitative assessment of GHG emissions of sulfur hexafluoride (SF_6) is also included in the analysis. SF_6 is a potent GHG used as an electrical insulator in some high-voltage equipment in substations and is 22,800 times more potent than carbon dioxide as a GHG (EPA, 2017). The analysis describes the state of fugitive SF_6 control that is currently used in electrical equipment manufacturing standardized by the International Electrotechnical Commission in Standard 62271-1 in 2004 (Carey, 2013), and predicts fugitive emission rates associated with large-scale electrical substations, and estimates fugitive SF6 emissions based on a standardized leakage rate.

Operational GHG impacts would result primarily from the removal of trees and vegetation that would reduce ongoing sequestration of CO_2 from the atmosphere. To a lesser degree, GHG emissions impacts would result from employee vehicle trips to maintain the new facilities. Additionally, there may be some fugitive emissions from substation equipment that use SF_6 as an insulating gas.

The following specifically defines project-level long-term (operational) impacts to GHGs:

- **Less-than-Significant** – The project would result in operational GHG emissions below the State of Washington reporting threshold of 10,000 metric tons of CO_2e in a given year.
- **Significant** –The project (after implementing mitigation measures) would result in operational GHG emissions at or above the State of Washington reporting threshold of 10,000 metric tons of CO_2e in a given year.

4.5.6 Long-term Impacts: No Action Alternative

The assessment of impacts to GHG emissions under the No Action Alternative is the same as presented in the Phase 2 Draft EIS. Under the No Action Alternative, no infrastructure improvements, changes to vegetation management activities, or new or relocated utility yards would be required. No new employee vehicle trips are envisioned under the No Action Alternative. While there would be GHG generated by ongoing maintenance and operation activities, selecting the No Action Alternative would neither increase nor decrease such activities. Consequently, there would be no operational GHG impacts associated with the No Action Alternative.

4.5.7 Long-term Impacts: PSE's Proposed Alignment

The following pages summarize the potential impacts on GHGs for PSE's Proposed Alignment, presented for the Richards Creek substation and by segment. For the Redmond, Bellevue North, Bellevue Central, and Renton Segments, the analysis was unchanged from the Phase 2 Draft EIS. For the Richards Creek substation site and the Bellevue South and Newcastle Segments, the analysis included a review of the project design as presented in the permit applications submitted to Bellevue and Newcastle (PSE, 2017b and 2017c, respectively). The results below have been revised relative to the Phase 2 Draft EIS, incorporating the more detailed information in the permit applications on tree removal. The new information and analysis have not altered the conclusions presented in the Phase 2 Draft EIS regarding significant impacts to GHG.

4.5.7.1 Impacts Common to all Components

Construction of any of the segments and the Richards Creek substation site would result in some level of sequestration losses due to tree removal. Additionally, PSE's Proposed Alignment would result in fugitive SF_6 emissions from gas-insulated circuit breakers at the Richards Creek, Sammamish, and Talbot Hill substations. PSE's Proposed Alignment would result in a project-wide sequestration loss of 134 metric tons of CO_2e per year. However, the emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant. Figure 4.5-2 presents the sequestration losses associated with each segment, and the following narrative describes the tree losses associated with each segment.

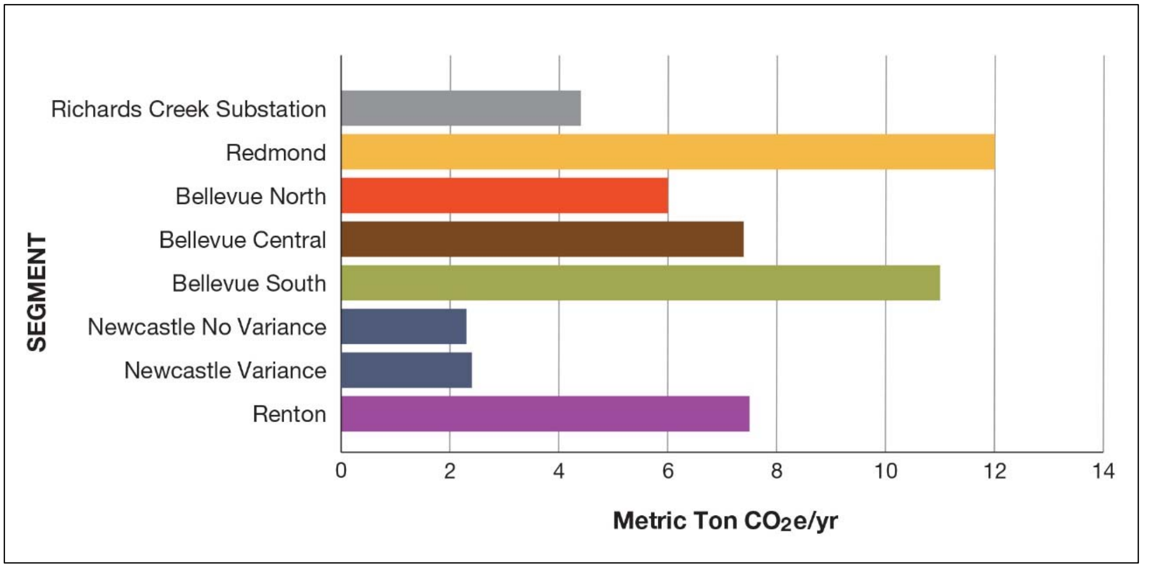

Figure 4.5-2. Estimated GHG Sequestration Losses in Project Segments

4.5.7.2 New Richards Creek Substation and other Substation Improvements

The assessment below has been updated to incorporate permit-level data for the Bellevue Central Segment, Richards Creek substation site, and the Bellevue South Segment. Analysis for the other segments has not changed. The total lot area for the substation site is 8.4 acres in size, and the substation yard would cover 1.9 acres within a fenced lot. Approximately 178 trees would be removed to allow for the installation of the substation and equipment (The Watershed Company, 2017). The loss of annual CO_2 sequestration associated with the removal of trees was estimated using the i-Tree model. Tree removal at the Richards Creek substation site would result in 4.4 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

A small number of vehicle trips are expected to be generated when the completed substation is operational. As described in the Phase 1 Draft EIS (Chapter 4, *Greenhouse Gas Emissions*), such trips would be infrequent and would not result in appreciable GHG emissions. Therefore, such trips would have a negligible effect on GHG emissions.

The substation would include a 115 kV circuit breaker with a *nameplate capacity*[1] of 128 pounds of SF_6 and five 230 kV circuit breakers, each with a nameplate capacity of 161 pounds. Additionally, one 230 kV circuit breaker would be installed at the Sammamish substation and two 230 kV circuit breakers would be installed at the Talbot Hill substation, each with a nameplate capacity of 161 pounds. At the Rose Hill substation, PSE would rebuild the existing substation from a 115 kV to 12.5 kV substation to a 230 kV to 12.5 kV substation in order to operate both lines at 230 kV such that two 230 kV circuit breakers would be installed, each with a nameplate capacity of 161 pounds. Consequently, all new breakers would total an SF_6 load of approximately 1,738 pounds. Average leakage rate for gas-insulated switchgear equipment is 0.5 percent per year as standardized by the International Electrotechnical Commission in Standard 62271-1 in 2004 (Blackman et al., 2006). This would result in fugitive SF_6 emissions of approximately 8.69 pounds per year, which is equivalent to 90 metric tons of CO_2e per year.

4.5.7.3 Redmond Segment

The assessment below is the same as presented in the Phase 2 Draft EIS, as the analysis has not changed. Approximately 632 trees would be removed to allow for the installation of power lines and poles along the Redmond Segment (The Watershed Company, 2016). Tree removal along the Redmond Segment would result in 12 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

4.5.7.4 Bellevue North Segment

The assessment below is the same as presented in the Phase 2 Draft EIS, as the analysis has not changed. Approximately 509 trees would be removed to allow for the installation of power lines and poles along the Bellevue North Segment (The Watershed Company, 2016). Tree removal along the Bellevue North Segment would result in 6.0 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

4.5.7.5 Bellevue Central Segment (Revised Existing Corridor Option)

PSE's Proposed Alignment for the Bellevue Central Segment follows the route of the Existing Corridor Option as described in the Phase 2 Draft EIS. The number of trees that would be removed is the same as what was presented in the Phase 2 Draft EIS for the Existing Corridor Option, except it also includes permit-level tree data for the Lakeside substation (see Appendix L). Approximately 642 trees would be removed to allow for the installation of power lines and poles along the Bellevue Central Segment (The Watershed Company, 2016, 2017). Tree removal along the Existing Corridor Option would result in 7.39 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

4.5.7.6 Bellevue South Segment (Revised Willow 1 Option)

PSE's Proposed Alignment for the Bellevue South Segment follows the route of the Willow 1 Option as described in the Phase 2 Draft EIS. The number of trees that would be removed is the same as what was presented in the Phase 2 Draft EIS for the Willow 1 Option. Approximately 1,030 trees would be removed to allow for the installation of power lines and poles along the Bellevue South

[1] The total SF_6 containing capacity (lbs.) in installed equipment during a year. Note, that "total nameplate" capacity refers to the manufacturer recommended full and proper charge of the equipment, rather than to the actual charge, which may reflect leakage.

Segment (The Watershed Company, 2016, 2017). Tree removal along the Bellevue South Segment would result in 11 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

4.5.7.7 Newcastle Segment (Option 1, No Code Variance)

Under Option 1, approximately 244 trees would be removed to allow for the installation of power lines and poles along the Newcastle Segment (The Watershed Company, 2017). Tree removal along the Newcastle Segment would result in 2.3 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

4.5.7.8 Newcastle Segment (Option 2, Code Variance)

Under Option 2, approximately 251 trees would be removed to allow for the installation of power lines and poles along the Newcastle Segment (The Watershed Company, 2017). Tree removal along the Newcastle Segment would result in 2.4 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

4.5.7.9 Renton Segment

Approximately 351 trees would be removed to allow for the installation of power lines and poles along the Renton Segment (The Watershed Company, 2016). Tree removal along the Renton Segment would result in 7.5 metric tons of CO_2e per year in sequestration losses. These emissions would be substantially below the State of Washington reporting threshold of 10,000 metric tons and, therefore, less-than-significant.

4.5.8 Mitigation Measures

For GHG, regulations and state and local GHG reduction programs were reviewed to identify mitigation measures. Mitigation measures specified by code would be required, whereas mitigation measures based on state and local programs would be at the discretion of PSE to adopt or the local jurisdictions to impose as a condition of project approval.

4.5.8.1 Regulatory Requirements

Although there are no regulations specifically limiting GHG emissions, PSE would need to comply with applicable federal, state, and local regulations that apply to other resources, some of which would mitigate the potential for long-term adverse GHG impacts (e.g., regulations that protect tree coverage in critical areas). Mitigation measures required for compliance with these other regulations are not discretionary.

As described in Section 4.4.6, *Plants and Animals*, PSE would provide mitigation for impacts to plant resources, using on- and off-site habitat enhancements, developed in coordination with local, state, and federal agencies. The following measure is identified in Section 4.4.6, *Plants and Animals*, and would potentially offset the long-term sequestration loss impacts.

- Replace trees removed for the project based on tree protection ordinances and critical areas regulations in each jurisdiction; some of these trees would likely be planted off-site or, in the case of the City of Newcastle, mitigated by paying into an in-lieu fee program. Replacement may be based on the cross-sectional diameter of trees removed, or on habitat functions lost due to trees removal, depending on applicable regulations.

4.5.8.2 Potential Mitigation Measures

Potential mitigation measures are summarized below based on review of ongoing efforts to reduce GHG emissions related to gas-insulated switchgear throughout the U.S. Long-term operational GHG impacts would be less-than-significant, and no mitigation measures are required. However, the following BMP could be implemented to reduce GHG contributions:

Prior to Construction

- Install SF6-filled equipment with manufactured guaranteed leakage rate of 0.1 percent at the Richards Creek, Sammamish, and Talbot Hill substations. Installation of such equipment could reduce fugitive SF6 emissions by up to 80 percent over older equipment types.