

Chapter 22 Greenhouse Gases

This chapter describes greenhouse gases and how the project alternatives could affect greenhouse gas emissions.

Words in **bold** and acronyms are defined in Chapter 32, Glossary and Acronyms.

22.1 Affected Environment

Greenhouse gases (GHGs) are chemical compounds found in the earth's atmosphere that absorb and trap long-wave thermal radiation emitted by the land and ocean, and radiate it back to earth. The resulting retention and build-up of heat in the atmosphere increases temperatures, which causes warming of the planet through a greenhouse-like effect (EIA 2009b). This effect is commonly referred to as "global warming." Global warming has occurred in the past from natural processes, but evidence shows that it has accelerated in the past few centuries, especially since the Industrial Revolution, as a result of increased anthropogenic (caused or produced by humans) emissions of GHGs. For example, atmospheric concentrations of carbon dioxide (CO₂), a primary GHG, have continuously increased from about 280 parts per million (ppm) in preindustrial times to 379 ppm in 2005, a 35 percent increase (IPCC 2007). Anthropogenic activities are increasing atmospheric concentrations of GHGs to levels that could increase the earth's temperature up to 7.2°F by the end of the 21st century (EPA 2010b).

The GHGs present in the earth's atmosphere include water vapor (H₂O), ozone (O₃), CO₂, methane (CH₄), nitrous oxide (N₂O), and trace amounts of fluorinated gases, such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆) (EPA 2010b). GHGs are emitted into the atmosphere through both natural processes and anthropogenic sources. Along with clouds, water vapor (the most abundant GHG) accounts for the largest percentage of the greenhouse effect. However, water vapor concentrations fluctuate regionally, and human activity does not directly affect water vapor concentrations except at a local scale, such as near irrigated fields. Ozone is not directly emitted by anthropogenic sources, but is instead formed through chemical reactions with other pollutants. Ozone can be emitted by transmission line corona, as described in Chapter 21, Air Quality. The amounts emitted, however, are extremely small, temporary, and localized, and thus do not contribute in a measurable way to global warming (USDOE 2010).

The GHGs emitted from human activities that are typically inventoried in GHG analysis and reporting are CO₂, CH₄, N₂O, and fluorinated gases (EPA 2010b; The Climate Registry 2008). CO₂ is the major GHG emitted from anthropogenic sources, and CO₂ emissions from the combustion of fossil fuels constitute 81 percent of all U.S. GHG emissions (EPA 2010c; EIA 2009a). CO₂ enters the atmosphere primarily through the burning of fossil fuels such as coal, natural gas and oil, as well as from wood or biomass combustion, land use changes, and the manufacturing of cement. Similar to CO₂, CH₄ is emitted during the production and transport of fossil fuels, but is also released into the atmosphere as emissions from microbes, livestock, agricultural practices, and volcanoes. Atmospheric concentrations of CH₄ have increased 148 percent above pre-industrial levels (EPA 2010b). N₂O is emitted from agricultural and industrial activities and from the combustion of fossil fuels and solid waste; as well as naturally emitted from the breakdown of nitrogen in soils and the earth's oceans. Atmospheric levels of N₂O have increased 18 percent since the beginning of industrial activities (EPA 2010b).

Fluorinated gases, including HFCs, PFCs, and SF₆, are synthetic compounds emitted through industrial processes and now are being used to replace ozone-depleting compounds such as chlorofluorocarbons (CFCs) in insulating foams, refrigeration, and air conditioning. The most common use of SF₆ is as an electric insulator and interrupter in equipment that transmits and distributes electricity, such as substation equipment like circuit breakers and switches. The EPA requires electric utilities, like BPA, to report SF₆ emissions annually including those from equipment installation, use, decommissioning, and disposal (EPA 2008c). Although they are emitted in smaller quantities, fluorinated gases are powerful GHGs that have high global-warming potential (GWP) given their ability to trap considerably more heat than CO₂. Atmospheric concentrations of fluorinated gases have been increasing over the last two decades and are expected to continue to increase (EPA 2010b).

Over the last decade, a number of federal and state regulations have required the mandatory inventory and reporting of GHGs from large sources in the United States. In 2009, the EPA issued a rule on the Mandatory Reporting of Greenhouse Gases (EPA 2011b). The rule requires suppliers of fossil fuels or industrial GHGs, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more per year of **carbon dioxide equivalent (CO₂e)** to submit annual emissions reports to the EPA. Likewise, Executive Orders 13423 and 13514 require federal agencies to estimate, manage, and reduce GHG emissions by agency-defined target amounts and dates.

In the state of Washington, Executive Orders 07-02 and 09-05 issued by the governor direct state agencies to work with western states and Canadian provinces to develop a regional emissions reduction program designed to reduce GHG emissions to 1990 levels by 2020 (Ecology 2010b). Similarly, in Oregon, House Bill 3543 (codified at Oregon Revised Statutes [ORS] 468A.205), directs state and local governments, businesses, nonprofit organizations, and individual residents to reduce GHG emissions in Oregon; by 2010, arrest growth of GHG emissions; by 2020 begin to reduce GHG levels to 10 percent below 1990 levels; and by 2050 achieve GHG levels at least 75 percent below 1990 levels (Oregon Global Warming Commission 2010).

Models predict that atmospheric concentrations of all GHGs will continue to increase over the next century, but the extent and rate of change is difficult to predict, especially on a global scale.

22.2 Environmental Consequences

General impacts that would occur for the action alternatives are discussed below. Impacts would be similar for all action alternatives.

22.2.1 Impact Levels

Impacts would be **high** where project activities would cause the following:

- Estimated GHG emissions exceed 4 million metric tons of CO₂ equivalent (CO₂e), the approximate GHG emissions from a major industrial combustion source (e.g., a 500-MW coal-fired generation facility)

Impacts would be **moderate** where project activities would cause the following:

- Estimated emissions exceed the annual Mandatory Reporting of Greenhouse Gases threshold outlined by the EPA, or 25,000 metric tons of CO₂e, but are below the level of a baseload (500-MW) coal-fired generating facility. Assuming an average emission factor of 2,100 CO₂e per megawatt hour (MWh) from coal consumption for electric generation, a 500-MW coal-fired generation facility would emit about 4 million metric tons of CO₂e annually (EIA 2000). The annual emission range with a moderate impact would be between 25,000 and 4 million metric tons of CO₂e.

Impacts would be **low** where project activities would cause the following:

- Estimated GHG emissions do not exceed the annual Mandatory Reporting of Greenhouse Gases threshold of 25,000 metric tons of CO₂e as outlined by the EPA

No impact would occur where project activities would not create GHG emissions.

22.2.2 Impacts Common to Action Alternatives

Direct GHG emissions from non-generating utility projects, such as transmission line construction and operation and maintenance, are primarily limited to vehicle and equipment emissions, and the impacts to GHG concentrations from these projects typically are low. GHG emission estimates were calculated for each of the action alternatives using currently accepted guidance and methodologies developed by the EPA and Climate Registry, and are described below. Each action alternative would contribute to atmospheric GHG concentrations from the following sources:

- During construction, through the use of gasoline and diesel powered vehicles, including cars, trucks, construction equipment, and helicopters, and through soil-disturbing activities and vegetation removal (e.g., conversion of a forested area to an access road or cleared transmission corridor)
- During operation and maintenance, through the use of gasoline and diesel powered vehicles and helicopters for routine patrols of the transmission line corridor, maintenance project work (e.g., vegetation management, site-specific repairs of roads and transmission line towers), emergency maintenance, and resource review

In general, GHG emissions are inventoried for CO₂, CH₄, N₂O, and high-GWP gases in terms of CO₂e, which is computed by multiplying the mass of the gas being measured (e.g., CH₄) by its estimated GWP (e.g., CO₂=1, CH₄=21, N₂O=310). For the proposed project, estimated emissions were calculated for each GHG based on project activities and converted to CO₂e based on the GWP of the GHG emitted. The contributions from each gas were then combined to get the overall estimated CO₂e emissions. These calculations were done for both project construction and project operation and maintenance.

22.2.2.1 Construction

Direct GHG emissions would result from construction workers commuting to and from the site, operating construction equipment (e.g., dozers, augers, backhoes, graders, heavy-duty trucks, and front-end loaders), and helicopter operation. To provide a conservative analysis and ensure

that the potential contributions to GHG concentrations from the project are adequately considered, the analysis was based on the following assumptions:

- Emissions were calculated based on a 30-month construction period.
- An average of 45 vehicles (i.e., standard pick-up trucks) per day would be needed to transport all construction personnel, with an average round trip distance of 100 miles per vehicle, per day.
- An average of 2 vehicles (i.e., standard pick-up trucks) per week would be needed to transport BPA staff to the project site, with an average round trip distance of 100 miles per vehicle.
- The fuel economy of a standard pick-up truck was estimated at 18 miles per gallon.
- An average of 2 helicopter round trips per day would be made for 10 months, with an estimated fuel economy of 4 miles per gallon and an average round trip distance of 100 miles.
- An average of 40 pieces of 200-horsepower construction equipment would be operating at full power for 8 hours per day, 5 days per week.

Estimation of GHG emissions from soil disturbance was not included in this analysis. Research has shown that these emissions are short-lived and return to background levels within several hours (Kessavalou et al. 1998; Aalde et al. 2006). Given that the methodology used to estimate vehicle emissions was overestimated, the low levels of GHG emissions from temporary soil disruption that would occur are considered to be accounted for in the overall construction emission rates.

Estimation of biogenic emissions from vegetation removal also was not included in this analysis. There would be no biomass combustion sources related to the project. In addition, while biomass combustion, biomass decay, and other vegetation changes are understood to cause the release of carbon from biogenic origins (i.e., carbon that was recently contained in living organic matter), the long-term effects of these changes are not well understood. Although various governmental agencies and committees, including the Intergovernmental Panel on Climate Change (IPCC), are working on developing a methodology to allow for quantification and reporting of biogenic emissions, an accurate and consistent methodology has yet to be developed. At this time, biogenic emissions related to land management and forestry do not need to be reported, and any direct or indirect emissions resulting from biomass combustion (i.e., biomass electrical generation facilities) should not be included with GHG emission calculations (The Climate Registry 2008). As with project-related soil disturbances, given that the methodology used to estimate vehicle emissions was overestimated, any GHG emissions from biogenic emissions that would occur are considered to be accounted for in the overall construction emission rates.

22.2.2.2 Operation and Maintenance

GHG emissions would also occur during operation and maintenance of the line, roads, and substations. Analysis was based on the expected annual occurrence of approximately 60 routine patrols, 160 routine maintenance work visits, 40 emergency maintenance visits, 8 natural resource reviews, and 2 aerial inspections via a helicopter. The helicopter and vehicles would most likely access the transmission line from the Portland or Vancouver metro area. The

average round trip would be about 100 miles. While annual variations would likely occur, operation and maintenance activities were conservatively assumed to be generally consistent over a 50-year period, the effective operating life of a transmission line.

22.2.2.3 Summary of GHG Contributions

The assumptions described above were used to estimate the overall GHG emissions for the construction period and the post-construction operation and maintenance activities of the proposed project (see Table 22-1). While all emissions of GHGs can be considered important in that they contribute to global GHG concentrations and climate change, the total estimated CO₂e emissions from the project would be very low compared to emissions from significant industrial combustion sources and other regional sources. While BPA considered the potential emissions from all of the principal inventoried GHGs, CO₂ emissions would account for an estimated 27 percent of the total GHG contributions that would be emitted over the life of the project.

Table 22-1 Estimated Greenhouse Gas Emissions from the Action Alternatives¹

Estimated GHG Emissions of the Action Alternatives	CO ₂ Emissions (in CO ₂ e Metric Tons)	CH ₄ Emissions (in CO ₂ e Metric Tons)	N ₂ O Emissions (in CO ₂ e Metric Tons)	Total CO ₂ e ² Emissions (in Metric Tons)
During 30-Month Construction Period	25,500	2,000	12,100	39,600
During Annual Operations and Maintenance	680	190	2,700	3,600
Annualized Average Emissions ³ Over 50 Years	1,190	230	3,000	4,400
Notes:				
1. Ozone is not included as O ₃ emissions from transmission line corona would be small, temporary, and localized.				
2. CH ₄ and N ₂ O emissions have been converted into units of CO ₂ e using the IPCC GWP factors of 21 GWP for CH ₄ and 310 GWP for N ₂ O.				
3. Annual averages are based on the assumption that the effective operating life of the transmission line is 50 years.				
Sources: EIA 2009, EPA 2011a				

To provide context of the relative contribution level these GHG emissions represent, the EPA's mandatory reporting threshold for annual GHG emissions is 25,000 metric tons of CO₂e. This threshold is about equal to the amount of CO₂ generated by 4,400 passenger vehicles per year. This threshold requires federal reporting of GHG emissions, but does not require any other action (EPA 40 Code of Federal Regulations [CFR] Parts 86, 87, 89 et al.).

Construction would cause an estimated 39,600 metric tons of CO₂e emissions over a 30-month period (see Table 22-1) or 15840 CO₂e metric tons per year during the construction period, which would be roughly equivalent to 2,790 passenger vehicles per year. Operations and maintenance would cause an estimated 3,600 CO₂e per years, which would be roughly equivalent to 630 passenger vehicles a year for all subsequent years of operations and maintenance. Averaging the direct contribution to GHGs over the operating life of the project (50 years) would cause an average annual GHG emissions of about 4,400 metric tons of CO₂e (770 passenger vehicles). Given this relatively low level of annualized emissions, the impact on global GHG concentrations from the project would be **low**.

22.2.3 Recommended Mitigation Measures

Mitigation measures included as part of the project are identified in Table 3-2. Mitigation measures related to air emissions in Table 3-2, and such measures in Chapter 21, Air Quality, would help reduce contributions of the action alternatives to greenhouse gases.

22.2.4 Unavoidable Impacts

Unavoidable impacts would include slight increases in GHG emissions.

22.2.5 No Action Alternative

The No Action Alternative would have **no** GHG impacts because no new transmission lines, towers, access roads, or substations would be constructed. Impacts from operation and maintenance of existing lines and substations would continue unchanged.