Work in Progress - Not for Public Distribution

Interstate BRIDGE Replacement Program

DRAFT Energy Technical Report

February 2023

Work in Progress - Not for Public Distribution

Oregon

For Americans with Disabilities Act (ADA) or Civil Rights Title VI accommodations, translation/ interpretation services, or more information call 503-731-4128, TTY 800-735-2900 or Oregon Relay Service 7-1-1.

Washington

Accommodation requests for people with disabilities in Washington can be made by contacting the Washington Department of Transportation (WSDOT) Diversity/ADA Affairs team at wsdotada@wsdot.wa.gov or by calling toll-free, 855-362-4ADA (4232). Persons who are deaf or hard of hearing may make a request by calling the Washington State Relay at 711. Any person who believes his/her Title VI protection has been violated, may file a complaint with WSDOT's Office of Equal Opportunity (OEO) Title VI Coordinator by contacting (360) 705-7090.

Work in Progress - Not for Public Distribution

DRAFT

Energy Technical Report

Work in Progress - Not for Public Distribution

This page intentionally left blank.

Work in Progress - Not for Public Distribution

CONTENTS

Work in Progress - Not for Public Distribution

FIGURES

TABLES

Work in Progress - Not for Public Distribution

ACRONYMS AND ABBREVIATIONS

Btu	British thermal units
CEQ	Council on Environmental Quality
CO2e	carbon dioxide equivalent
CRC	Columbia River Crossing
DEQ	Oregon Department of Environmental Quality
Ecology	Washington Department of Ecology
EIA	U.S. Energy Information Administration
EO	Executive Order
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Association
FTA	Federal Transit Administration
GHG	greenhouse gas
I-5	Interstate 5
IBR	Interstate Bridge Replacement
ICE	Infrastructure Carbon Estimator
LPA	Locally Preferred Alternative
MAX	Metropolitan Area Express
NEPA	National Environmental Policy Act
OAR	Oregon Administrative Rules
ROD	Record of Decision
SDEIS	Supplemental Draft Environmental Impact Statement
SEPA	Washington State Environmental Policy Act
USC	United States Code
VMT	vehicle miles traveled
WSDOT	Washington State Department of Transportation

Work in Progress - Not for Public Distribution

1. PROJECT OVERVIEW

This technical report identifies, describes, and evaluates the existing energy consumption and trends within the study area and the long-term and temporary effects on energy from the Interstate Bridge Replacement (IBR) program. It also provides mitigation measures for potential effects on energy when avoidance is not feasible.

The purpose of this report is to satisfy applicable portions of the National Environmental Policy Act (NEPA) 42 United States Code (USC) 4321 "to promote efforts which will prevent or eliminate damage to the environment." Information and potential environmental consequences described in this report will be used to support the Supplemental Draft Environmental Impact Statement (SDEIS) for the IBR program pursuant to 42 USC 4332.

The objectives of this report are to:

- Define the study area and the methods of data collection and evaluation (Chapter 2).
- Describe the existing energy consumption within the study area (Chapter 3).
- Discuss potential long-term, temporary, and indirect effects on energy resulting from construction and operation of the Modified Locally Preferred Alternative (LPA) compared to the No-Build Alternative (Chapters 4, 5, and 6).
- Provide proposed avoidance and mitigation measures to help prevent, eliminate, or minimize environmental consequences from the Modified LPA (Chapter 7).
- Identify federal, state, and local permits and approvals that would be required (Chapter 8).

The IBR program's Modified LPA is a modification of the LPA for the Interstate 5 (I-5) Columbia River Crossing (CRC) project, which completed the NEPA process with a signed Record of Decision (ROD) in 2011 and two reevaluations that were completed in 2012 and 2013. The CRC project was suspended in 2014. The IBR program's SDEIS is evaluating the effects of changes in design since the CRC ROD, as well as changes in regulations, policy, and physical conditions.

Please refer to the separate IBR Program Description file on the portal for a description of the Modified LPA, Modified LPA Construction, and the No Build Alternative. The IBR Program Description will be inserted into the final version of this Technical Report.

Work in Progress - Not for Public Distribution

2. METHODS

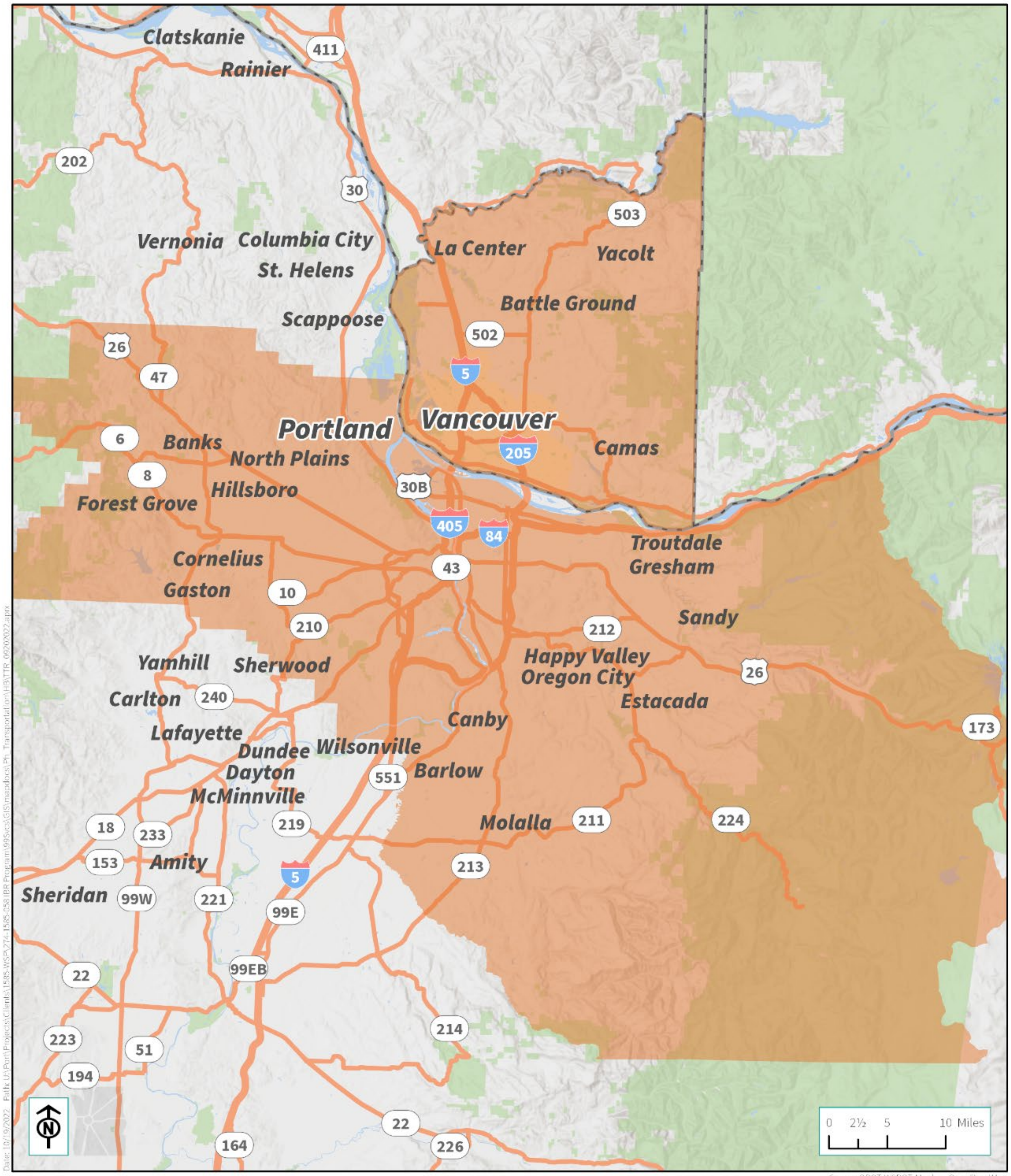
This section describes the methods used to evaluate energy and greenhouse gas (GHG) emissions impacts from the Modified LPA.

2.1 Study Area

The study area for the Energy Technical Report is shown in Figure 2-1. Energy and GHG impacts were evaluated for the regional roadway network and the proposed transit alignment and facilities based on the boundaries of Metro's regional travel demand model, which encompasses Multnomah, Clackamas, Washington, and Clark Counties.

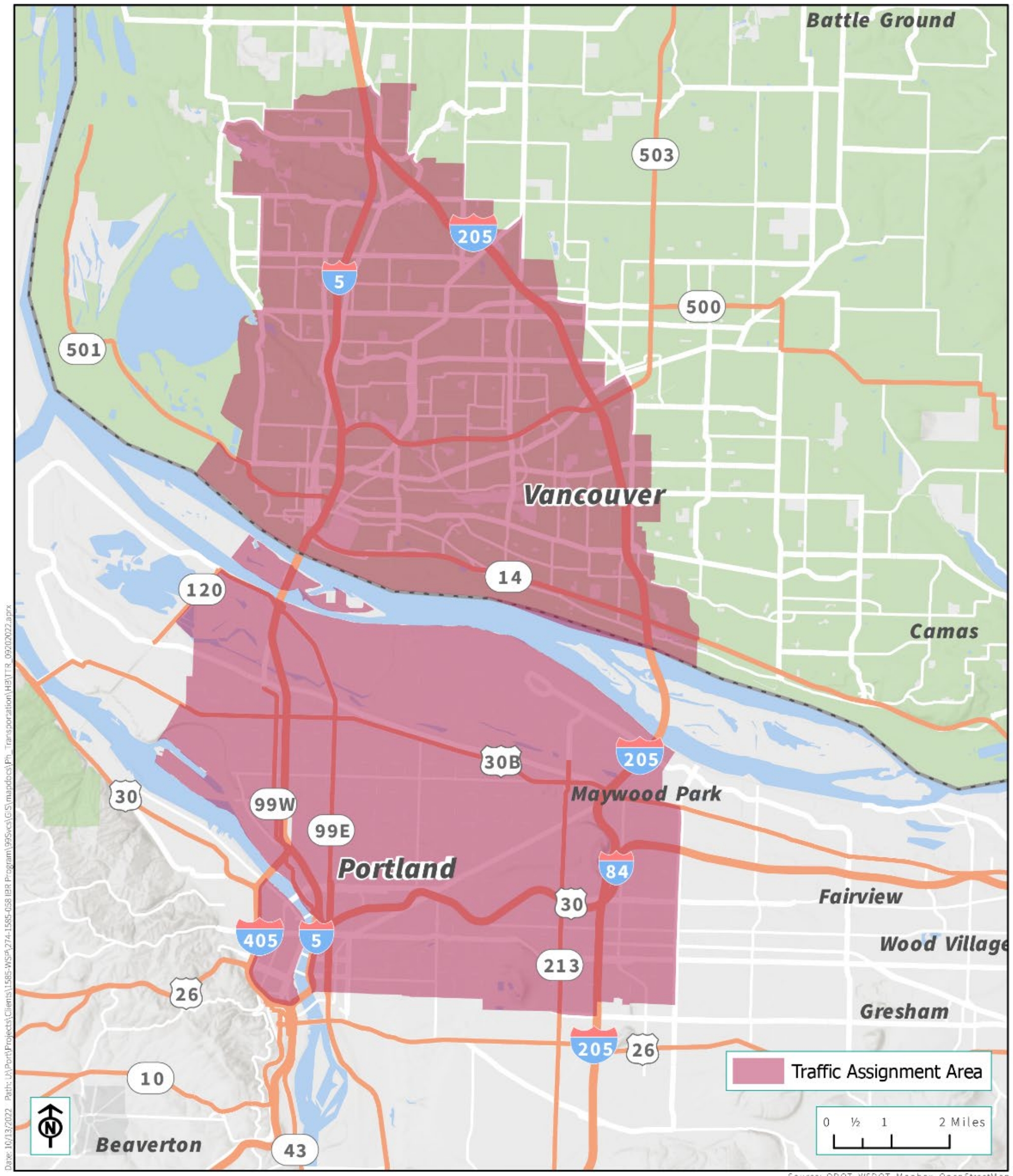
To estimate the program's effects on a smaller scale, the energy consumption and GHG emissions were also calculated only using the traffic segments that are in the traffic assignment area shown in Figure 2-2 . This area is defined in the Transportation Technical Report as the area where vehicle travel is affected by the program.

Figure 2-1. IBR Energy and Greenhouse Gas Study Area



Work in Progress - Not for Public Distribution

Figure 2-2. IBR Program Traffic Assignment Area



Work in Progress - Not for Public Distribution

2.2 Relevant Laws and Regulations

The assessment of potential energy effects considered the IBR program's consistency with applicable federal, state, and local policies. Federal and state laws require entities emitting more than threshold values to measure, report, and, in some instances, obtain permits to emit GHGs. However, most federal, state, and local laws quantitatively regulate energy use or GHG emissions mainly in terms of conserving energy, providing the means to improve the efficiency of energy use, and striving toward long-term GHG emission reduction goals.

An estimate of the Modified LPA's energy consumption was used to determine the IBR program's consistency with the following relevant laws, regulations, and policies. While there are no regulations, that set limits on energy use or GHG emissions specifically, the Modified LPA should show that energy would be used wisely and that ways to reduce or minimize energy use have been considered in the program's decisions.

2.2.1 Federal Laws, Regulations and Policies

2.2.1.1 National Environmental Policy Act

NEPA (42 USC 4332) requires that federal agencies consider environmental effects before taking actions that could substantially affect the human environment. As interpreted by the Council on Environmental Quality (CEQ), NEPA requires that the "environmental consequences" of a proposed project be considered in the decision-making process, including "energy requirements and conservation potential of various alternatives and mitigation measures" (Sec. 1502.15(e)).

On August 1, 2016, the CEQ released the Final Guidance for Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews. This guidance was most recently updated in 2023 with interim guidance. The interim guidance provides federal agencies a common approach for assessing their proposed actions, while recognizing each agency's unique circumstances and authorities. The guidance explains how agencies should apply NEPA principles and existing best practices to their analysis with recommendations that include leveraging early planning processes to:

- Consider GHG emissions and climate change in the identification of proposed actions and alternatives.
- Quantify a proposed action's projected GHG emissions or reductions for the expected lifetime of the action.
- Use projected GHG emissions associated with proposed actions to help assess potential climate change effects.
- Provide additional context for GHG emissions to allow decision makers and the public to understand any tradeoffs associated with an action.
- Incorporate environmental justice considerations into their analysis of climate-related effects.

Work in Progress - Not for Public Distribution

2.2.1.2 Federal Highway Administration Technical Advisory T 6640.8A (1987)

Federal Highway Administration (FHWA) Technical Advisory T 6640.8A provides guidance on the preparation of environmental documents, including the analysis of energy effects. It states that an environmental impact statement "should discuss in general terms the construction and operational energy requirements and conservation potential of the various alternatives under consideration" (FHWA 1987).

2.2.1.3 Federal Fuel Economy Standards

The National Highway Traffic Safety Administration (NHTSA) Corporate Average Fuel Economy (CAFE) standards regulate how far our vehicles must travel on a gallon of fuel. NHTSA sets CAFE standards for passenger cars and for light trucks (collectively, light-duty vehicles), and separately sets fuel consumption standards for medium- and heavy-duty trucks and engines. CAFÉ standards were finalized in 2022, requiring an industry-wide fleet average of approximately 49 mpg for passenger cars and light trucks in model year 2026, by increasing fuel efficiency by 8% annually for model years 2024 and 2025, and 10% annually for model year 2026.

The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule, issued by NHTSA and EPA in 2020, sets tough but feasible fuel economy and carbon dioxide standards that increase 1.5% in stringency each year from model years 2021 through 2026. These standards apply to both passenger cars and light trucks, and will continue our nation's progress toward energy independence and carbon dioxide reduction, while recognizing the realities of the marketplace and consumers' interest in buying vehicles that meet all of their diverse needs.

2.2.2 State Laws, Regulations and Policies

2.2.2.1 Oregon Policies

Oregon Statewide Planning Goals – (Oregon Administrative Rules [OAR] Chapter 660 Division 15 [660-015])

In 1991, the Land Conservation and Development Commission adopted the Oregon Transportation Planning Rule (OAR 660-012-0000). This rule is responsible for the application of Oregon's statewide planning goals to newly incorporated cities, annexation, and urban development on rural lands (OAR 660-015). The core of this program comprises 19 statewide planning goals, two of which are applicable to energy: Goal 12, Transportation and Goal 13, Energy Conservation.

Goal 12 – Transportation (OAR 660-12-035)

Goal 12 states that the following standards shall be used to evaluate and select transportation system alternatives: "the transportation system shall minimize adverse economic, social, environmental and energy consequences."

Goal 13 – Energy Conservation (OAR 660-015-0000(13))

Goal 13 states that land and uses developed on the land must be managed and controlled so as to maximize the conservation of all forms of energy, based on sound economic principles (OAR 660-015).

660-044-0020 – Greenhouse Gas Emissions Reduction Target for the Portland Metropolitan Area

Section 44 of OAR 660-44 outlines specific GHG reduction targets, for the years 2040 through 2050, applicable to the Portland metropolitan area.

Executive Order (EO) 20-04 – Directing State Agencies to Take Actions to Reduce and Regulate Greenhouse Gas Emissions

EO 20-04 directs certain state agencies to take specific actions to reduce emissions and mitigate the impacts of climate change and provides overarching direction to state agencies to exercise their statutory authority to help achieve Oregon's climate goals.

2.2.2.2 Washington Policies

Applicable regulations and guidance in Washington include:

State Environmental Policy Act (SEPA) and state implementing regulations, Washington Administration Code 197-11 and 468-12

The Washington State Environmental Policy Act (SEPA) requires environmental review of development proposals that may have a significant adverse impact on the environment. If a proposed development is subject to SEPA, the project proponent is required to complete the SEPA Checklist. The Checklist includes questions relating to the development's air emissions. The emissions that have traditionally been considered cover smoke, dust, and industrial and automobile emissions. An evaluation of GHG emissions are not currently required as part of the SEPA process.

WSDOT Guidance – Project-Level Greenhouse Gas Evaluations under NEPA and SEPA (WSDOT 2018).

WSDOT addresses air quality, energy, and greenhouse gas emissions from projects together because they often use the same tools, however each analysis has slightly different triggers. WSDOT has prepared guidance and templates to address the GHG and energy impacts from transportation projects.

2.3 Data Collection

Energy supply and demand in Washington and Oregon are generally characterized by energy supply sources and use sectors. The following sources provide information on general energy supply and demand:

- U.S. Department of Energy/Energy Information Administration
- Washington Office of the U.S. Department of Commerce
- Oregon Department of Energy

For example, resource adequacy is discussed in Oregon's 2020 Biennial Energy Report (Oregon Department of Energy 2020), and a review of the status of Washington's State Energy Strategy is included in the state's 2019 Biennial Energy Report (Washington State Department of Commerce 2018). Washington's State Energy Strategy was updated in 2021 using historical, existing, and future energy demand data from the Energy Information Administration.

In addition to the general resources describing energy supply and demand for Washington and Oregon, statewide GHG emission trends were retrieved from reports from the Oregon Department of Environmental Quality (DEQ) and Washington Department of Ecology (Ecology).

The analysis also used regional travel demand model data provided by the IBR program's traffic analysts. Additional data specific to the Modified LPA, including construction cost and activity estimates, travel demand forecasts, and traffic and transit operations data, were collected from the IBR program team.

2.4 Analysis Methods

The analysis methodology compared the Modified LPA's potential adverse and beneficial effects to those of the No-Build Alternative pertaining to energy use and GHG emissions in compliance with NEPA, applicable state environmental legislation, and local and state planning and land use policies. The analysis includes the type and amount of energy that would be consumed, and GHG emissions, in the building and operation of the Modified LPA. At a regional level, the analysis provides estimates of energy consumption and GHG emissions under the Modified LPA, compared to the No-Build Alternative, to help identify potential program impacts and inform the decision-making process. The energy consumption and GHG emissions were estimated for analysis year 2015 to represent existing conditions, which corresponds to the base year of the regional travel demand model that is the basis for the regional emissions analysis. Energy and GHG emissions for the Modified LPA and the No-Build Alternative were estimated for 2045, the project's design year.

2.4.1 Significance Thresholds

There are no regulatory significance thresholds related to energy use or GHG emissions from transportation projects. Instead, substantial effects in energy use would occur if the Modified LPA increased demand to the point that the supply of energy (e.g., petroleum reserves) was insufficient to meet existing and future projected demand, or if there were an increase in energy use that created concern in meeting the demand for energy.

While many jurisdictions desire to minimize GHG emissions and have identified long-term goals and reduction targets, there are no regulatory standards that quantifiably limit a project's GHG emissions.

Work in Progress - Not for Public Distribution

2.4.2 Operational Effects Approach

The analysis looked at the effects of the IBR program on energy use and GHG emissions associated with the operation and maintenance of components of the Modified LPA. Effects from operations are based on the amount of fuel energy used by on-road vehicles (including private, freight, and transit vehicles) and energy from electrical needs associated with the extension of light rail transit in the study area. Effects from maintenance are based on periodic maintenance activities such as sweeping, restriping, vegetation management, and pavement preservation.

2.4.2.1 On-road Vehicle Operations

The U.S. Environmental Protection Agency's (EPA's) MOVES model version MOVES3.1.0 was used to estimate energy consumption and GHG emissions from the roadway links in the study area. MOVES is the EPA's state-of-the-art tool for estimating emissions from highway vehicles. The model is based on analyses of millions of emission test results and considerable advances in the EPA's understanding of vehicle emissions. Compared to previous versions, MOVES3.1.0 incorporates the latest emissions data; applies more sophisticated calculation algorithms; accounts for new regulations, including the Heavy-Duty Greenhouse Gas Phase 2 rule and the Safer Affordable Fuel Efficient Vehicles Rule; and provides an improved user interface. Table 2-1 summarizes the MOVES run specifications used for the energy and GHG analysis.

Table 2-1. MOVES Run Specification Options

MOVES Tab	Model Selections
Scale	• County Scale • Emission Rates Calculation Type
Time Span	• Hourly time aggregation • January and July • Weekday • Analysis years 2015 and 2045
Geographic Bounds	• Multnomah County was used to represent emissions from segments in Oregon, consistent with Metro's regional emissions model[a] • Clark County was used to represent emissions from segments in Washington
Vehicles/Equipment	• All on-road vehicle and fuel type combinations
Road Type	• Rural restricted, rural unrestricted, urban restricted, and urban unrestricted
Pollutants and Processes	• CO_2e, total energy consumption, and precursor pollutants needed to make the calculations. • Processes included running exhaust.
Advanced Features	• MOVES Advanced Features option was used to create a database for each state that accounts for the adoption of California's Low Emission Vehicle program.

Work in Progress - Not for Public Distribution

MOVES Tab	Model Selections
Output	• Output was a table of emission rates in units of gram per mile or Joules per mile for each hour of a January weekday and July weekday, by roadway type, vehicle type, and speed bin.

[a] Although the study area spans multiple counties in Oregon, Multnomah County was used to represent all Oregon emissions in the metropolitan Portland area, consistent with Metro's approach to regional emissions modeling

CO_2e = carbon dioxide equivalent, MMBtu = million British thermal units

MOVES input files were developed following EPA methodology using model defaults and data provided by DEQ and Ecology to represent regional climate conditions, fuel specifications, and fleet makeup. The EPA methodology does not include input files for electric vehicle use. For each alternative, two MOVES runs were created to determine the emission rates—one applicable to Oregon roadway segments using Oregon regional conditions and one applicable to Washington roadway segments using Washington regional conditions. Table 2-2 summarizes specific inputs and their sources.

Table 2-2. MOVES County Data Manager Inputs – No Electric Vehicles

County Data Manager Tab	Data Source – Oregon	Data Source - Washington
Source Type Population	DEQ	Ecology
Age Distribution	DEQ	Ecology
Fuel Supply, Fuel Usage Fraction, Fuel Formulation	DEQ	Ecology
Alternative Vehicle Fuel Type	MOVES default	MOVES default
Inspection/Maintenance Programs	DEQ	Ecology
Meteorological Data	MOVES county defaults	MOVES county defaults
Road Type Distribution[a]	DEQ and MOVES defaults	Ecology and MOVES defaults
Average Speed Distribution[a]	DEQ and MOVES defaults	Ecology and MOVES defaults
Vehicle Type Vehicle-Miles Traveled[1]	DEQ and MOVES defaults	Ecology and MOVES defaults

DEQ = Oregon Department of Environmental Quality; Ecology = Washington Department of Ecology

[a] These data are required to develop MOVES emission rates. Project-specific values were applied during post-processing

Agency-supplied input files were used for the analysis of the Modified LPA, with the analysis year modified as necessary.

Electric Vehicle Considerations

The EPA methodology does not provide MOVES defaults for electric vehicle use, and conservatively assumes that no electric vehicles are in the fleet. WSDOT and ODOT expect that the vehicle fleets in Oregon and Washington in 2045 will have a significant increase in electric vehicles, which would result in a large reduction in GHG emissions.

Work in Progress - Not for Public Distribution

DEQ recommended a methodology for the vehicle fleet to account for expected electric vehicle penetration of passenger vehicles, medium trucks, and heavy trucks. WSDOT and ODOT reviewed the DEQ methodology and determined that these assumptions are applicable to the Washington and Oregon vehicle fleet for this GHG analysis. The recommendations are based on state mandates that will limit future sales of fossil-fuel-powered vehicles. This methodology reflects the decrease in tailpipe GHG emissions but does not include changes to the amount of energy consumed by electric vehicles. GHG emissions from electricity needed to power electric vehicles are included in the fuel cycle calculations.

The gradual transition of medium and heavy trucks to electricity as a fuel type was accounted for by modifying the MOVES default Alternative Vehicle Fuel Type input file. Following the DEQ guidance, this file assigns the percentage of each fuel type by model year, as shown in Table 2-3.

Table 2-3. Fuel Assumptions for 2045 Analysis – With Electric Vehicle Assumptions

MOVES Model Year	Medium Trucks					Heavy Trucks		
	Gasoline	Diesel	CNG	Ethanol	Electric	Diesel	CNG	Electric
2020–2024	19.0	72.0	0.0	9.0	0.0	100.0	0.0	0.0
2025–2029	22.0	68.0	0.0	9.0	1.0	99.0	0.0	1.0
2030–2034	22.4	61.2	0.0	9.2	7.1	94.1	1.0	5.0
2035–2045	21.2	50.5	0.0	9.1	19.2	88.0	1.0	11.0

CNG = compressed natural gas

Following the DEQ recommendations, the MOVES output was then adjusted to assume that 52% of emissions from gasoline-powered passenger vehicles will have zero tailpipe emissions of carbon dioxide equivalent (CO_2e) because they are electric.

On Road Vehicle Emissions Calculations

Link-by-link traffic data were obtained from the transportation analysis for:

- Existing Conditions (2015)
- No-Build Alternative (2045)
- Modified LPA (2045)

The link-by-link traffic data indicated the link length and roadway type and included volume and average modeled speed data for every hour of an average weekday. Volumes were provided by vehicle type (passenger vehicles, medium trucks, and heavy trucks) and accounted for expected changes to the vehicle mix in the future with or without the Modified LPA. The volume data were processed using the following assumptions:

- Road Type Distribution – The roadway types and locations were mapped to the four MOVES roadway types: rural restricted, rural unrestricted, urban restricted, and urban unrestricted. The off-network road type was not used for this analysis.

Work in Progress - Not for Public Distribution

- Average Speed Distribution – The link-level traffic data were provided for each hour of an average weekday. Speeds were mapped to 5-mile-per-hour speed bins that are used by MOVES.
- Vehicle Type Vehicle Miles Traveled (VMT) – VMT for each vehicle type was determined for each roadway link by multiplying the link volume by the link length. For each alternative, the VMT for each vehicle type was summarized by hour, road type, speed bin, and state.

The volume data were used to determine the total VMT for each vehicle type by hour, road type, speed bin, and state. The VMT data were multiplied by the corresponding MOVES emission rates to calculate total daily emissions of CO_2e and total daily energy consumption for the following scenarios:

- Existing Conditions (2015)
- No-Build Alternative (2045) No Electric Vehicle Assumptions
- Modified LPA (2045) No Electric Vehicle Assumptions
- No-Build Alternative (2045) With Electric Vehicle Assumptions
- Modified LPA (2045) With Electric Vehicle Assumptions

Fuel Cycle Assumptions

In addition to the on-road vehicle emissions calculated using MOVES, the contribution from the fuel cycle was calculated. The fuel cycle for fossil-fueled-powered vehicles includes emissions released through extraction, refining, and transportation of fuels used by vehicles traveling in the study area. Fuel cycle emissions from fossil-fuel-powered vehicles were calculated by applying the FHWA fuel cycle factor (0.27) to the MOVES modeled results, as directed in the ODOT and WSDOT guidance.

Under the scenarios that account for future electric vehicles, it is assumed that 52% of emissions from gasoline-powered passenger vehicles will have zero tailpipe emissions of CO_2e. Fuel cycle emissions from the electric vehicles were calculated by using the value 0.000124 metric tons of CO_2e per mile. This value was derived from the projected 2045 carbon intensity of electricity in Multnomah County provided by ODOT (ODOT 2022), and the average kilowatt hours of electricity needed to run a model year 2022 electric vehicle for 100 miles (expressed as kilowatt hours per 100 miles), as provided by the U.S. Department of Energy (U.S. Department of Energy 2023).

2.4.2.2 Transit Operations

GHG emissions associated with the operation of transit vehicles, stations, and park-and-rides were estimated using the Federal Transit Administration's (FTA's) Transit GHG Estimator version 2. The Transit GHG Estimator spreadsheet tool allows users to estimate the partial-lifecycle GHG emissions generated from (and the energy used in the construction, operation, and maintenance phases of) a project across select transit modes. The data used to estimate emissions from transit operations associated with the Modified LPA are summarized in Table 2-4.

Table 2-4. FTA Greenhouse Gas Estimator Inputs for Modified LPA

Transit Component	Parameter	Input Value
Facility Operations	Combined square footage of stations	20,000 square feet
Light Rail Vehicle Operations	Annual vehicle miles traveled	1,151,351 miles

2.4.2.3 Maintenance

GHG emissions and energy use from routine maintenance on the roadways and light rail infrastructure proposed with the Modified LPA were evaluated using FHWA's Infrastructure Carbon Estimator (ICE) spreadsheet tool (see Section 2.5.3).

2.4.2.4 Additional Impact Considerations

Additional impacts were evaluated qualitatively. Traffic congestion due to vehicle collisions and bridge lifts lead to energy consumption and GHG emissions that would not occur with implementation of the Modified LPA. These changes are qualitatively discussed based on the availability of supporting data.

2.4.3 Construction Effects Approach

The Modified LPA's construction effects on energy supply and GHG emissions were calculated using the FHWA's ICE spreadsheet tool (FHWA 2021), which provides construction energy consumption estimates based on the project type and size; construction traffic delays; and construction equipment, materials, and routine maintenance. The ICE tool includes assumptions based on a nationwide database of construction bid documents, data collected from state departments of transportation, and consultation with transportation engineers and lifecycle analysis experts.

Inputs to the ICE tool used to evaluate the Modified LPA are summarized in Table 2-5 through Table 2-8. Although ICE is not recommended for bridges longer than 1,000 feet with high or deep spans, WSDOT and ODOT determined that ICE was the best overall tool for estimating all of the components of the Modified LPA with the available information. It is likely that the estimates provided for the I-5 bridge structures, which are longer than 1,000 feet, underestimate equipment exhaust emissions and embodied carbon of the materials needed. Copies of the ICE tool are included in Appendix A.

Table 2-5. Federal Highway Administration Infrastructure Carbon Estimator – Roadway Inputs

Facility Type	New Roadway (lane miles)	Construct Additional Lane (lane miles)	Realignment (lane miles)	Shoulder Improvement (centerline miles)
Urban Interstates / Expressways	32.00	5.91	9.87	0.54
Urban Principal Arterials	4.56	0.00	3.73	0.00
Urban Minor Arterials / Collectors	2.32	0.00	1.61	0.00

Work in Progress - Not for Public Distribution

Table 2-6. Federal Highway Administration Infrastructure Carbon Estimator – Bicycle and Pedestrian Facilities

Project Type	New Construction	Resurfacing
Off-Street Bicycle or Pedestrian Path – miles	2.828	0
On-Street Bicycle Lane – lane miles	8.500	0.253
On-Street Sidewalk – miles	8.977	N/A

Table 2-7. Federal Highway Administration Infrastructure Carbon Estimator – Bridges and Overpasses

Facility Type	Construct New Bridge/Overpass		Reconstruct Bridge/Overpass	
	Number of Bridges/Overpasses	Total Number of Lane Spans	Number of Bridges/Overpasses	Total Number of Lane Spans
Single-Span	2	2	4	16
Two-Span	2	12	5	40
Multi-Span (over land)	8	144	10	140
Multi-Span (over water)	4	40	4	112

Table 2-8. Federal Highway Administration Infrastructure Carbon Estimator – Light Rail Construction

Project Type	Track Miles
New construction (at grade)	1.30
New construction (elevated)	3.57
Converted or upgraded existing facility - track miles	0.13
New rail station (elevated) - stations	3.00
Structured Parking	1,270.00

2.5 Coordination

The methods described in this chapter were developed in coordination with ODOT, WDOT, DEQ, and Ecology.

Work in Progress - Not for Public Distribution

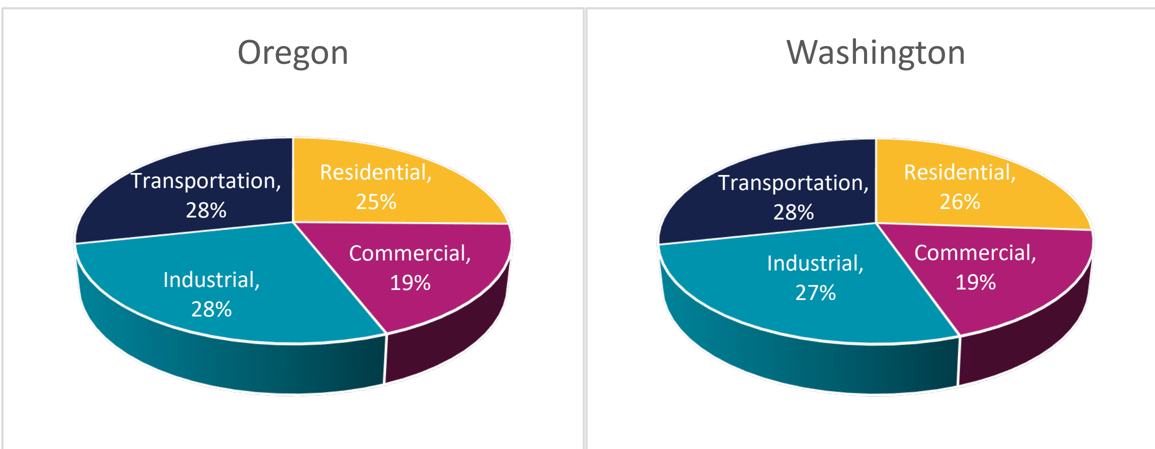
3. AFFECTED ENVIRONMENT

This chapter describes existing energy and GHG conditions and trends in the study area that may be affected by or benefit from the Modified LPA.

3.1 Energy Consumption Trends

Transportation accounts for a major portion of the energy consumed in Oregon and Washington, approximately 28% for both states (Figure 3-1). Petroleum (e.g., gasoline, diesel fuel, and jet fuel) was the predominant source of transportation-related energy consumption in Oregon and Washington in 2020, at approximately 98% for each state (EIA 2023). Natural gas and electric vehicles accounted for the remaining 2% of transportation energy consumption.

Figure 3-1. State Energy Consumption by End-Use Sector, 2020



Source: EIA 2023

Oregon ranks number 29 of the 50 states in transportation energy consumption, with 279 trillion British thermal units (Btu) of transportation energy consumed in 2020 (EIA 2023). Washington ranks number 18, with 505 trillion Btu of transportation energy consumed. In comparison, Texas ranks number one, with the consumption of approximately 2,840 trillion Btu of transportation energy in 2020.

On a per-capita basis, Oregon ranks number 35 of the 50 states in transportation energy consumption, at approximately 65.8 million Btu consumed per capita in 2020. Washington ranks number 38, with approximately 65.4 million Btu consumed per capita in 2020. In comparison, Alaska ranks first, at 224.7 million Btu of transportation energy consumed per capita in 2020.

3.2 Greenhouse Gas Emissions Trends

Vehicles that run on fossil fuels emit a variety of gases during their operation, some of which are GHGs. There are also indirect GHG emissions associated with the production and transportation of these fossil fuels. Vehicles that run on electricity do not directly emit GHGs while in operation, but there are

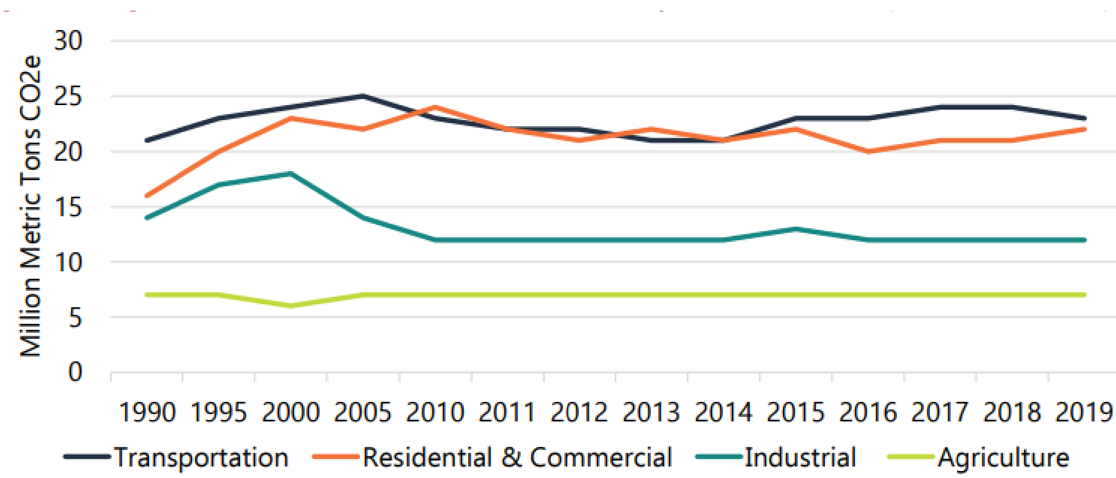
Work in Progress - Not for Public Distribution

indirect emissions of GHGs from the production of electricity needed to power vehicles such as electric cars and light rail.

The GHGs associated with the transportation sector are carbon dioxide, methane, and nitrous oxide, and they are often reported as CO_2e. CO_2e is a unit that provides a common scale for measuring the climate-related effects of different gases based on their global warming potential. GHG concentrations are not routinely measured at air pollutant monitors. However, agencies, companies, and individuals can calculate their emissions of GHG to monitor their contribution to global GHG levels. GHG emissions are usually estimated based on indicators with readily available data, such as fuel and energy consumption, which allows analysts to add up emissions estimates of different gases (e.g., to compile a national GHG inventory) and allows policymakers to compare emissions reduction opportunities across sectors and gases.

The Oregon Global Warming Commission delivers a report to the State legislature every two years to educate and inform legislators and the public about current critical climate facts, policies, and strategies. The most recent report indicates that transportation (including highway, rail, and air transport) is the greatest contributor to GHG emissions in Oregon, followed by the residential and commercial sectors. Figure 3-2 summarizes Oregon's GHG emissions trends through 2019.

Figure 3-2. Oregon Greenhouse Gas Emissions Trends by End-Use Sector

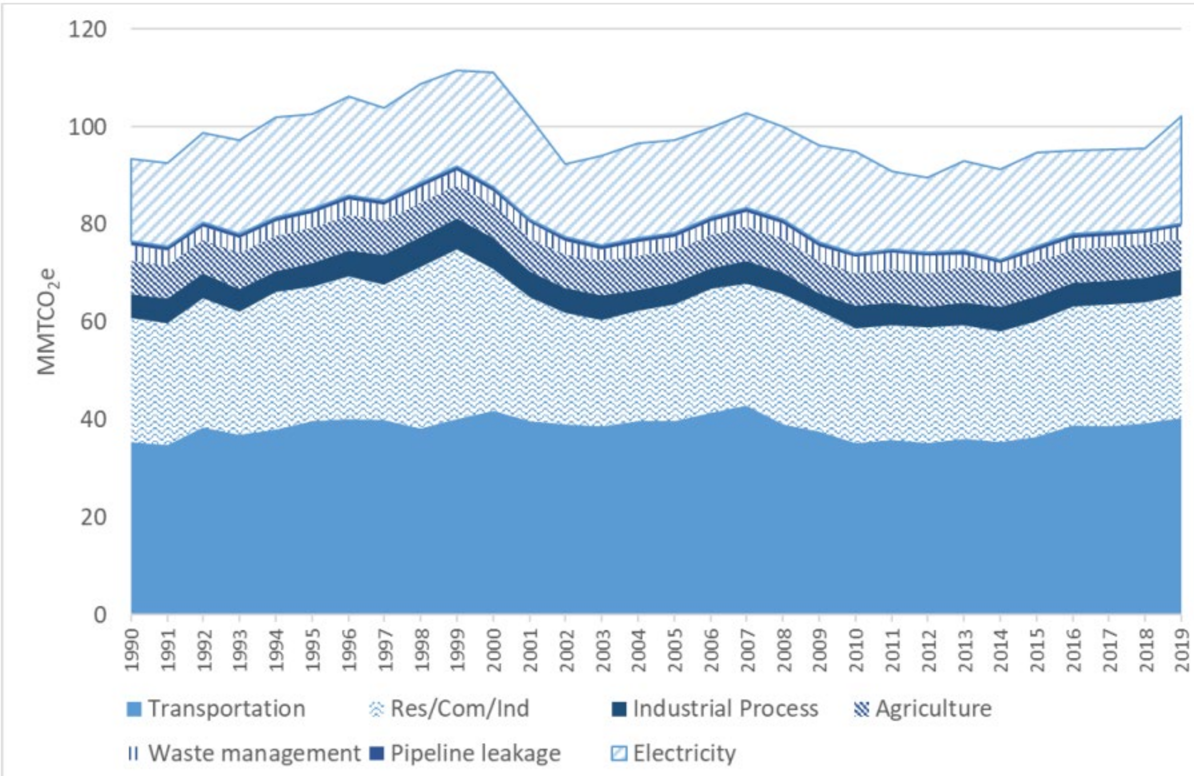


Source: Oregon Global Warming Commission 2020

Ecology publishes an inventory of Washington's GHG emissions every two years, measuring the state's progress in reducing GHGs compared to a 1990 baseline. This inventory helps Ecology design policies to reduce GHG emissions and track progress toward meeting the state's reduction goals. The inventory is based on data from a variety of sources, such as the EPA and the U.S. Energy Information Administration (EIA). Figure 3-3 shows that transportation is the greatest contributor to GHG emissions in Washington and that GHG emissions have been increasing across all sectors for the past few years.

Work in Progress - Not for Public Distribution

Figure 3-3. Washington Greenhouse Gas Emissions Trends by End-Use Sector



Source: Ecology 2022

3.3 National Energy Demand Projections

The national demand for energy depends on trends in population, economic activity, and energy prices, and the adoption and implementation of technology.

The EIA collects, analyzes, and disseminates energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment. The Annual Energy Outlook published in 2021 demonstrates a sharp decline in energy consumption in 2020 related to the COVID-19 pandemic. The EIA predicts that a return to 2019 levels of U.S. energy consumption will take years, and energy-related carbon dioxide emissions will fall further before leveling off or rising. (EIA 2023)

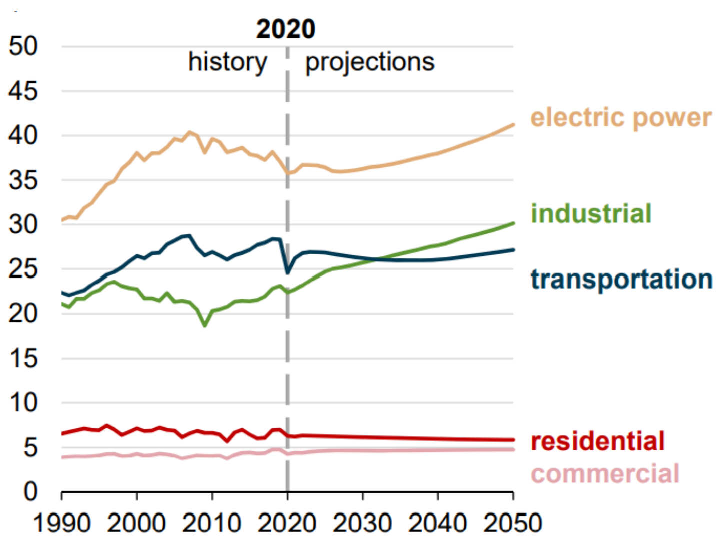
Projections in the Annual Energy Outlook focus on key factors driving longer-term demand for energy: growing economy and population; increasing use of renewables; increasing consumption of natural gas and electricity; and changing technology, behavior, and policy that affects energy efficiency in vehicles, end-use equipment, and lighting.

The EIA projects that energy consumption in the transportation sector will remain lower than its 2019 level through 2050 because travel greatly decreased in 2020 as a result of COVID-19 lockdowns, and because assumed improvements in fuel economy offset projected resumed travel growth. Energy

Work in Progress - Not for Public Distribution

consumption by light-duty and heavy-duty vehicles is anticipated to remain lower than 2019 levels for the entire projection period. Efficiency improvements offset the consumption growth from light-duty vehicle travel growth through 2043 and partially offset the consumption growth from heavy-duty vehicle travel growth through 2036. Continued growth of on-road travel increases energy use later in the projection period because the travel demand for both light- and heavy-duty vehicles outpaces fuel economy improvements. The transportation sector includes air travel, which is projected to return to 2019 levels by 2030. Figure 3-4 shows the EIA projections for energy consumption by sector.

Figure 3-4. U.S. Energy Consumption by Sector, in Quadrillion British Thermal Units



Source: EIA 2022

Work in Progress - Not for Public Distribution

4. OPERATIONAL EFFECTS

This chapter consists of two parts. The first part, Section 4.1, describes the change in operational energy consumed and GHG emissions between the No-Build Alternative and Modified LPA. For these alternatives, the operational effects are described at the regional level as annual emissions of CO_2e and annual energy use in million Btu.

The Modified LPA's operational effects on energy consumption and GHG emissions relate to the operations of the affected transportation facilities. Operations were analyzed for the vehicles using the roadway network, transit vehicles, and transit facilities. Data associated with transit and traffic operations were provided by the IBR program team.

The second part, Section4.2, discusses and evaluates two additional scenarios: the effects of collisions and the effects of bridge lifts. These additional scenarios have localized impacts and are discussed qualitatively since neither condition is modeled at the regional scale.

The design option at the SR 14 interchange, which includes the slight shift west of I-5, and the options for the park and ride locations in Vancouver would have the same discussion of energy use and GHG emissions as the Modified LPA; therefore, they are not specifically discussed.

4.1 Impacts from the No-Build Alternative and Modified LPA

This section describes the impacts from the No-Build Alternative and the Modified LPA in terms of roadway operations, transit operations, and ongoing maintenance of both roadway and transit facilities.

4.1.1 Roadway Operations

Estimated energy consumption and GHG emissions from vehicles using the roadway network are shown in Table 4-1. The results represent the contribution from vehicles using the roadway segments in the study area.

The results of the analysis showed that in 2045 conditions (No-Build Alternative or Modified LPA), energy consumption and GHG emissions are expected to be substantially lower than existing values for the region, which is consistent with national trends. Although the annual VMT in the study area would increase by 37% in 2045, energy consumption and GHG emissions would decrease substantially as compared to existing conditions, due to implementation of fuel and engine regulations, as described in Section 2.2.1.3. GHG emissions from the future conditions with the scenario that includes electric vehicles would be further reduced from the level of the existing conditions.

Under the scenarios that assume no electric vehicles and with electric vehicles, energy consumption and emissions would be similar under the No-Build Alternative and Modified LPA. The differences calculated by the MOVES model between the future 2045 emissions of the No-Build Alternative and the Modified LPA are less than 0.3%, which is not a meaningful difference. There are no thresholds to determine the significance of energy consumption or GHG emissions.

Work in Progress - Not for Public Distribution

Table 4-1. Daily Regional Energy Consumption and CO_2e Emissions

Parameter	Existing (2015)	No-Build (2045)	Modified LPA (2045)	Modified LPA Difference from No-Build	No Build (2045)	Modified LPA (2045)	Modified LPA Difference from No-Build
		No Electric Vehicle Assumptions			With Electric Vehicle Assumptions		
Daily VMT	43,017,603	58,696,366	58,599,755	-0.16%	58,696,366	58,599,755	-0.16%
Total Energy Consumption (mmBtu/day)	290,732	270,928	270,179	-0.28%	270,908	270,162	-0.28%
CO_2e Tailpipe Exhaust Emissions (MT CO_2e/day)	22,273	20,709	20,652	-0.28%	12,021	11,990	-0.26%
CO_2e Fuel Cycle Emissions (MT CO_2e/day)	6,014	5,592	5,576	-0.29%	6,812	6,797	-0.22%
Total CO_2e Emissions (MT CO_2e/day)	28,286	26,301	26,228	-0.28%	18,833	18,787	-0.24%

CO_2e = carbon dioxide equivalent; mmBtu/day = million British thermal units per day; MT = metric tons

To estimate the effects of the Modified LPA on a smaller scale, energy consumption and GHG emissions were also calculated only using traffic segments that are in the traffic assignment area shown in Table 4-2. The traffic assignment area is defined in the Transportation Technical Report as the area where the Modified LPA affects vehicle travel. At this scale, the future 2045 energy consumption and GHG emissions of the Modified LPA estimated to decrease by less than 0.3%, compared to the No Build Alternative under the scenario that assumes no electric vehicles and the scenario with electric vehicles, which is also not a meaningful difference.

Work in Progress - Not for Public Distribution

Table 4-2. Daily Energy Consumption and CO_2e Emissions in Traffic Assignment Area

Parameter	Existing (2015)	No-Build (2045)	Modified LPA (2045)	Modified LPA Difference from No-Build	No Build (2045)	Modified LPA (2045)	Modified LPA Difference from No-Build
		No Electric Vehicle Assumptions			With Electric Vehicle Assumptions		
Daily VMT	11,267,296	14,278,275	14,196,722	-0.57%	14,278,275	14,196,722	-0.57%
Total Energy Consumption (mmBtu/day)	76,557	67,170	66,417	-1.12%	67,170	66,417	-1.12%
CO_2e Exhaust Emissions (MT CO_2e/day)	5,864	5,139	5,080	-1.08%	3,042	3,009	-1.15%
CO_2e Fuel Cycle Emissions (MT CO_2e/day)	1,583	1,387	1,372	-0.83%	1,682	1,668	-1.08%
Total CO_2e Emissions (MT CO_2e/day)	7,447	6,526	6,452	-0.99%	4,724	4,677	-1.13%

CO2e = carbon dioxide equivalent; mmBtu/year = million British thermal units per year; MT = metric tons

4.1.2 Transit Operations

Table 4-3 summarizes the energy and GHG emissions due to increased transit vehicles and new transit facilities with the Modified LPA. While no CO_2e would be emitted at the source of use, there would be CO_2e emissions associated with the production of electricity needed to provide power to electric light rail vehicles and stations. There would also be electricity needs for lighting at park-and-ride facilities, but these emissions are not calculated by the FTA Estimator.

Table 4-3. Modified LPA Transit Operations Energy Consumption and CO_2e Emissions

Transit Element	Energy Consumption (mmBtu/year)	CO_2e Emissions (MT/year)
Light Rail Vehicles	2,638	2,524
Transit Stations	1,146	129

CO_2e = carbon dioxide equivalent; mmBtu = million British thermal units; MT = metric tons

4.1.3 Roadway and Transit Maintenance

The impacts of routine maintenance for roadways, transit vehicles, and light rail tracks were estimated for the Modified LPA. Roadway maintenance includes the emissions from vehicles performing routine maintenance activities such as sweeping, restriping, and landscaping. Table 4-4 summarizes the energy and GHG emissions from maintenance activities under the Modified LPA.

Table 4-4. Modified LPA Annualized Energy Consumption and CO_2e Emissions from Maintenance Activities

Project Element	Energy Consumption (mmBtu/year)	CO_2e Emissions (MT/year)
Annualized Value	11,078	1,088

CO_2e = carbon dioxide equivalent; mmBtu = million British thermal units; MT = metric tons

4.2 Additional Impact Considerations

This section describes the effects of these two additional considerations based on other aspects of the Modified LPA that could affect operational energy consumption and CO_2e emissions include changes in highway safety (reduction in vehicle crashes) and the elimination of bridge lifts. These additional considerations cannot be readily incorporated into the above estimates of energy consumption and CO_2e emissions. They are not modeled at the regional scale, but they can be qualitatively addressed at the local scale.

4.2.1 Long-term Effects of Collisions

The IBR Transportation Technical Report provides a list of existing deficiencies in highway geometries. Under the No-Build Alternative, increased congestion would exacerbate existing safety concerns and the frequency of collisions would likely increase. An increase in the frequency of collisions translates to slower operating speeds and increased energy consumption and CO_2e emissions.

Under the Modified LPA, the existing highway geometry deficiencies would be mitigated by adhering to current design standards, and the level of congestion would decrease, which would likely reduce the frequency of collisions. Reducing the frequency of collisions would also reduce energy consumption and CO_2e emissions compared to the No-Build Alternative.

It is difficult to quantify the effects of reducing collision frequencies associated with the Modified LPA for two primary reasons. First, there is no collision forecasting methodology accepted industry-wide, and therefore, the magnitude of change in collision frequency would be difficult to determine. Second, each collision possesses a distinct set of characteristics that make it unique, difficult to model, and not representative of typical conditions. For example, the location, lane, duration/ clearance time, and time of day are some of the many characteristics that would greatly affect how the I-5 mainline operates and the effects on energy consumption and CO_2e emissions.

Work in Progress - Not for Public Distribution

Although we cannot quantify with accuracy, we can qualitatively conclude with certainty that the Modified LPA would result in fewer collisions as a result of better operations and removal of existing design deficiencies compared to the No-Build Alternative, and, in turn, the operational energy consumption and CO_2e emissions would also be reduced.

4.2.2 Long-Term Effects of Bridge Lifts

The existing Interstate bridge between Vancouver and Portland has a relatively low vertical clearance, and bridge lifts are required for some maritime traffic passage. Under the No-Build Alternative, the I-5 bridges would not be replaced and bridge lifts would continue to be required. Under the Modified LPA, the existing I-5 bridges would be replaced with a higher vertical clearance that does not require bridge lifts.

Historical bridge lift data are available from January 2015 through December 2019. During this five-year period, there was an average of 260 bridge lifts per year. The duration of a bridge lift ranged from 5 to 30 minutes, with an average of 12 minutes per lift. The number of vehicles affected depends on the time of day, ranging from about 200 vehicles during nighttime hours to more than 8,000 vehicles for lifts that occur at midday or in the evening. Consequently, the estimated vehicle queues caused by bridge lifts ranged between 0.25 and 5 miles in both the northbound and southbound directions of I-5.

Vehicles delayed by a bridge lift can produce emissions while they are idling. There is no standard methodology to estimate how many vehicles idle and how many drivers turn off their engines. To assume that all vehicles are idling would be a great overestimate because many modern vehicles have a start-stop system that automatically stops the engine when the vehicle is stationary. ODOT and WSDOT have installed signage requesting that drivers turn off their engines while idling during a bridge lift to promote cleaner air quality.

Much like the collision discussion above, although we cannot quantify the reduction in energy consumption with accuracy, we can qualitatively conclude with certainty that the Modified LPA would result in lower energy consumption and GHG emissions from eliminating the need for bridge lifts.

Work in Progress - Not for Public Distribution

5. CONSTRUCTION EFFECTS

This estimate of energy use and GHG emissions for construction associated with the Modified LPA was developed based on data provided by the IBR program team, as described in Section 2.4.3.

5.1 Impacts from the No-Build Alternative and Modified LPA

The No-Build Alternative does not include construction that addresses the purpose and need of the IBR program. Accordingly, there are no definable construction effects on energy consumption or GHG emissions associated with the No-Build Alternative.

While there is no construction proposed, it would be inaccurate to state that the No-Build Alternative would have no construction-related energy requirements or GHG emissions. For example, potholes may need filling, the I-5 bridge deck would likely need to be resurfaced and striped, and additional local capacity improvements may be needed to alleviate congestion along the I-5 mainline. While improvements such as these would be likely under the No-Build Alternative, cost estimates are outside the purview of this analysis, and therefore quantifiable energy consumption and GHG emissions cannot be calculated.

Construction impacts to energy consumption and GHG emissions from the Modified LPA are provided in Table 5-1. These values represent the sum of the total impacts over the construction period.

Table 5-1. Modified LPA Energy Consumption and CO_2e Emissions from Construction Activities

Project Element	Total Energy Consumption (mmBtu)	Total CO_2e Emissions (MT)
Materials	2,240,745	320,958
Transportation	107,670	10,546
Construction	247,435	24,236
Total	2,595,850	355,741

CO_2e = carbon dioxide equivalent; mmBtu = million British thermal units; MT = metric tons

Work in Progress - Not for Public Distribution

6. INDIRECT EFFECTS

The results presented in Table 4-1 and Table 4-2 include the indirect fuel cycle impacts that the Modified LPA would have on GHG. In addition, the energy and GHG analysis of the Modified LPA is based on travel demand modeling that includes expected growth and planned projects in the region. The Modified LPA is not expected to create other effects that would cause indirect impacts to energy use and GHG emissions.

Work in Progress - Not for Public Distribution

7. MITIGATION

There are currently no quantitative restrictions on energy use, and existing regulations lack quantifiable standards for assessing effects related to energy consumption and GHG emissions. Therefore, there are no specific mitigation measures required to reduce the Modified LPA's operational or construction effects. Energy use and GHG consumption would be minimized as described below.

7.1 Operational Effects

Estimated energy consumption and GHG emissions from operations would be similar under the No-Build Alternative and Modified LPA; therefore, no mitigation is proposed.

The Modified LPA contains numerous features to promote mode shift and reduce the need for additional capacity for VMT. These features include the 1.9-mile extension of the Metropolitan Area Express (MAX) Yellow Line, new stations, new park-and-rides, improvements to bus mobility with shoulder access, tolling, and transportation demand management and transportation system management measures. The following measures could also be implemented to promote energy efficiency and minimize GHG emissions during the maintenance and operations phases:

- Use of recycled and energy-efficient construction materials.
- Application of best management practices for maintenance of the toll gantries and supporting infrastructure.
- Use of energy-efficient electrical systems for toll gantries and technical shelters.

7.2 Construction Effects

The following measures would be implemented to minimize energy use and GHG emissions from construction activities:

- Contractors would be required to comply with ODOT Standard Specifications Section 290, which has requirements for environmental protection, and to include air pollution control measures in their work activities. These control measures include vehicle and equipment idling limitations, which would also reduce energy usage and GHG emissions.

Many of WSDOT's standards specifications to minimize air quality impacts would also reduce energy use and GHG emissions, including:

- Minimizing delays to traffic during peak travel times.
- Minimizing unnecessary idling of on-site diesel construction equipment.
- Educating vehicle operators to shut off equipment when not in active use to reduce emissions from idling.
- Using cleaner fuels as appropriate.

Work in Progress - Not for Public Distribution

- Preparing a traffic control plan with detours and strategic construction timing (such as night work) to continue moving traffic through the area and reduce backups and delays to the traveling public, to the extent possible.

Work in Progress - Not for Public Distribution

8. REFERENCES

Ecology (Washington State Department of Ecology). 2022. Washington State Greenhouse Gas Inventory: 1990-2019. Available at <https://apps.ecology.wa.gov/publications/documents/2202054.pdf> Accessed February 16, 2023.

EIA (U.S. Energy Information Administration). 2023. State Energy Data System (SEDS): 1960-2020 (complete). Available at <https://www.eia.gov/state/seds/seds-data-complete.php?sid=US>. Accessed February 9, 2023.

FHWA (Federal Highway Administration). 2021. Infrastructure Carbon Estimator. Available at < https://www.fhwa.dot.gov/environment/sustainability/energy/tools/carbon_estimator/index.cfm> Accessed January 24, 2023.

ODOT (Oregon Department of Transportation). 2022. Email from Natalie Lilijenwall, ODOT, to Rebecca Frohning, Interstate Bridge Replacement Program Team. November 16, 2022.

Oregon Global Warming Commission. 2020. 2020 Biennial Report to the Legislature. Available at <https://static1.squarespace.com/static/59c554e0f09ca40655ea6eb0/t/5fe137fac70e3835b6e8f58e/1608595458463/2020-OGWC-Biennial-Report-Legislature.pdf> Accessed February 16, 2023.

Oregon Department of Energy. 2020. Biennial Energy Report. Available at <https://www.oregon.gov/energy/data-and-reports/pages/biennial-energy-report.aspx> Accessed February 16, 2023.

U.S. Department of Energy. 2023. The Official U.S. Government Source for Fuel Economy Information. Available at <https://www.fueleconomy.gov>. Accessed January 24, 2023.

Washington State Department of Commerce. 2019. 2019 Biennial Energy Report. Washington Department of Commerce. December 2019. Available at <http://www.commerce.wa.gov/wp-content/uploads/2013/01/COMMERCE-Biennial-Energy.pdf> Accessed February 16, 2023.

WSDOT (Washington Department of Transportation). 2018. WSDOT Guidance – Project-Level Greenhouse Gas Evaluations under NEPA and SEPA. WSDOT February 2018. Available at <https://wsdot.wa.gov/sites/default/files/2021-10/ENV-ANE-GHGGuidance.pdf>