



2015 Lower Fraser Valley Air Emissions Inventory and Forecast Final Report and Summarized Results

March 2018



The 2015 emissions inventory and forecast for the Canadian portion of the Lower Fraser Valley airshed was prepared by Metro Vancouver, with the exception of marine vessels, non-road and biogenic emissions inventories provided by Environment and Climate Change Canada, railway and locomotive emissions inventories provided by the Vancouver Fraser Port Authority, and portions of the Fraser Valley estimates provided by the Fraser Valley Regional District. Emissions data for Whatcom County was obtained from US EPA's National Emissions Inventory Database, Northwest Clean Air Agency and Washington Department of Ecology.

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- Insurance Corporation of British Columbia
- Municipal Fire Departments
- Northwest Clean Air Agency
- Statistics Canada
- TransLink
- Vancouver Airport Authority
- Vancouver Fraser Port Authority
- Washington Department of Ecology

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Section A – Introduction

This report provides the results of the 2015 Lower Fraser Valley airshed emissions inventory and forecast, including information on the types of air emission sources in the Lower Fraser Valley, their location and the amount of air contaminants emitted.

The report includes historical trends in emissions for 1995, 2000, 2005 and 2010. It also presents a forecast of emissions to the year 2035, in five-year increments. The forecast includes estimates of future emissions that account for changes in activity (growth or decline) combined with changes in emission rates or controls. These changes could be influenced by technological advances, environmental regulations, process and control equipment deterioration, fuel formulations or other factors. The forecast allows for an assessment of future air emissions and potential impacts of emission reduction measures.

The emissions inventory for 2015, and estimates for previous and future years, serves many purposes. Together with Metro Vancouver's ambient air quality monitoring network, the inventory provides information that can be used to evaluate the performance of programs and actions contained within Metro Vancouver plans and strategies related to air quality management and greenhouse gas reduction.

The inventory and forecast can also identify areas where additional management actions are needed, and provide support in the development of new regulatory programs as well as inform development of new climate action and air quality management plans for the region. It can also be used to develop scenarios to assess or evaluate the impact of policy measures and regulatory requirements.

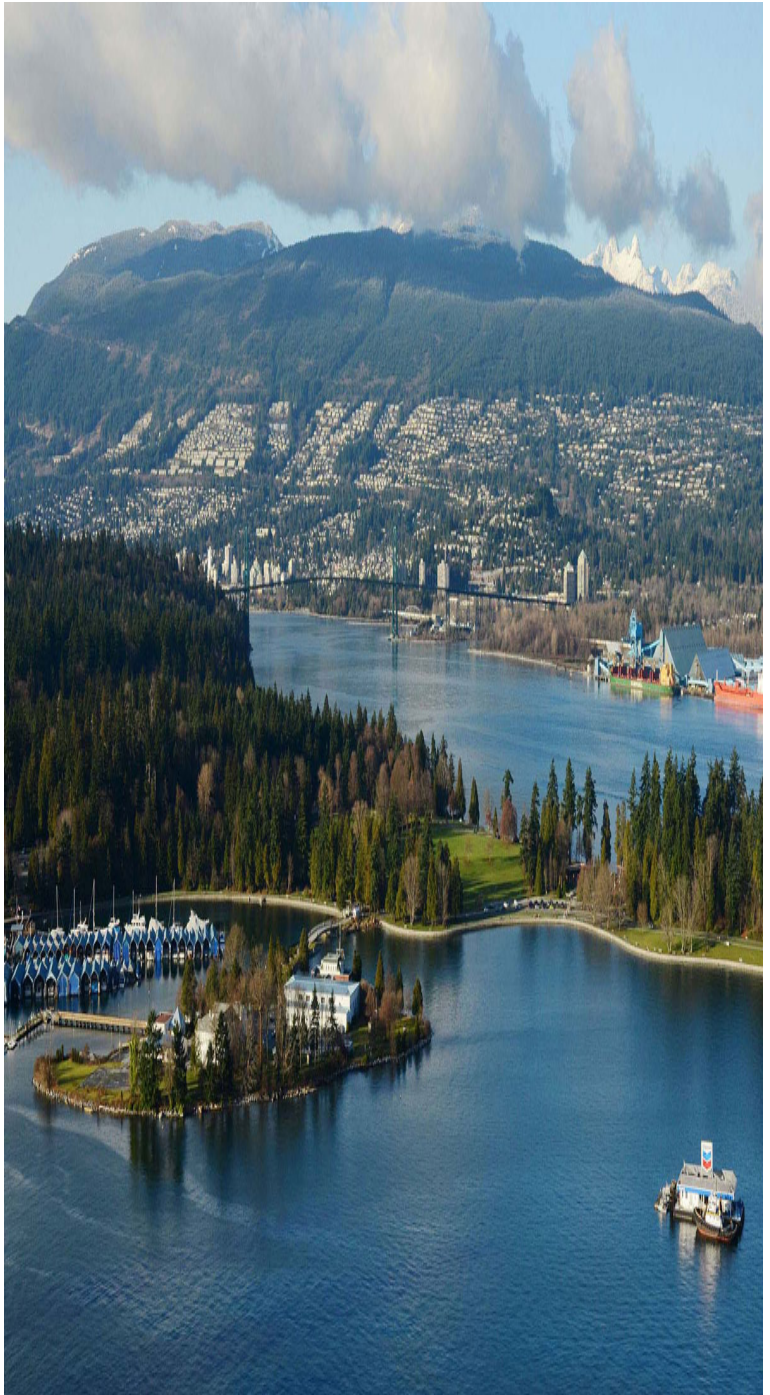




Figure 1: Study area for the Lower Fraser Valley airshed emissions inventory

What is the Study Area?

The 2015 emissions inventory has been compiled for the Lower Fraser Valley airshed in British Columbia (BC), including the Metro Vancouver Regional District, the south-western portion of the Fraser Valley Regional District (FVRD) and Whatcom County in the State of Washington, which is representative of the United States portion of the Lower Fraser Valley airshed (Figure 1).

In 2015, the study area had a combined population of approximately 3.03 million.

What Emissions Are Inventoried?

Greenhouse Gases

Greenhouse gases contribute to global climate change, a shifting of the world's climate systems to wider variability and more intense extremes. Greenhouse gases included are:

- Carbon dioxide (CO₂)
- Methane (CH₄)
- Nitrous oxide (N₂O)

Common Air Contaminants

The common air contaminants addressed in this inventory include:

- Nitrogen oxides (NO_x)
- Total particulate matter (PM)
- Inhalable particulate matter (PM₁₀)
- Fine particulate matter (PM_{2.5})
- Sulphur oxides (SO_x)
- Volatile organic compounds (VOC)
- Ammonia (NH₃)
- Carbon monoxide (CO)

Sources of Emissions

The emissions inventory includes three main categories of emissions: industrial sources, area sources, and mobile sources. Table 1 defines these sources.

Historical Trends and Forecasts

The forecasts use projections from numerous sources on variables such as changes in population, economy, kilometres travelled, fuel consumed and future growth. The forecast represents “business as usual” projections, and incorporates all known and committed federal, provincial and regional regulatory and policy measures, as well as new emission sources. Table 2 lists the policy measures quantified in the forecast.

In addition to the forecast, emissions are also reported back to 1995, in five-year increments. This gives an indication of trends in emissions over time, and allows for comparison of emissions in previous years to the current year.

Table 1: Emissions source categories, definitions and sub-categories

Source Category	Sub-Categories
Industrial Sources Industrial sources are facilities or utilities operating under an air discharge permit, or in some cases a regulation issued by Metro Vancouver or the BC Ministry of Environment and Climate Change Strategy (BC MOE), or under a Solid Waste Management Plan authorized by BC MOE, or under the jurisdiction of the Washington State Department of Ecology or Northwest Clean Air Agency. In general, these sources are large, stationary sources that release pollutants into the atmosphere.	<ul style="list-style-type: none"> •Bulk Shipping Terminals •Chemical Manufacturing •Concrete Batch Plants •Electric Power Generation •Heating / Cogeneration Utilities •Metal Foundries and Metal Fabrication •Non-metallic Mineral Processing Industries (e.g., cement plants) •Paper and Allied Products •Petroleum Products •Primary Metal Industries •Wood Products •Miscellaneous Industrial Sources
Area Sources Area sources are smaller, broadly distributed light industrial, commercial, institutional, residential, agricultural and naturally occurring sources that normally do not require an air discharge permit. In some cases, they may be regulated by other mechanisms, such as Metro Vancouver bylaws.	<ul style="list-style-type: none"> •Agricultural Sources •Chemical Products (Industrial, Commercial, and Consumer) (e.g., paints, solvents) •Fuel Distribution •Fugitive Dust (e.g., road, coal and construction) •Heating (e.g., homes and commercial space) •Natural Sources •Vegetative Burning •Waste (e.g., landfills, sewage and waste-to-energy) •Miscellaneous sources
Mobile Sources Mobile sources have no fixed geographic location, and are typically vehicles or equipment (operating on roads or off road), marine vessels, locomotives and aircraft involved in transportation of people and goods.	<ul style="list-style-type: none"> •Aircraft •Heavy-Duty Vehicles •Light-Duty Vehicles •Marine Vessels •Non-Road Engines and Equipment (e.g., construction, lawn and garden) •Rail Locomotives

Table 2: Policy measures included in the forecast

Source Category	Policy Measure
Industrial Sources	<ul style="list-style-type: none"> •Metro Vancouver (MV) permit changes •Boilers and Heaters Regulation (MV)
Area Sources	<ul style="list-style-type: none"> •Agricultural Boilers Regulation (MV) •Architectural Coatings Regulations (Federal) •Automotive Refinishing Regulations (Federal, MV) •BC Carbon Tax (BC) •Boilers and Process Heaters Regulation (MV) •Concrete and Concrete Products Industries Emission Regulation (MV) •Dry Cleaning Regulations (Federal) •Landfill Gas Regulation (BC) •Gasoline Distribution Emission Regulation (MV) •Solid Fuel Burning Domestic Appliance Regulation (Provincial) •Wastewater Systems Effluent Regulations (Federal) •Woodstove Exchange Program (MV, FVRD)
Mobile Sources	<ul style="list-style-type: none"> •Aircraft NO_x Standards (Federal) •BC Carbon Tax (BC) •Emission Control Area (ECA) (Federal) •Gasoline Vapour Control Regulation (BC) •Heavy Duty Vehicle and Engine Greenhouse Gas Regulation (Federal) •Tier 3 Engine and Fuel Standards for Light Duty Vehicles (Federal) •Light Duty Vehicles Greenhouse Gas Regulation (Federal) •Low Carbon / Renewable Fuel Standards (Federal / BC) •Non-Road Diesel Engine Bylaw (MV) •Non-Road Engine Emission Regulations (Federal) •Renewable and Low Carbon Fuel Requirements Regulation (Provincial) •Sulphur in Fuel Regulations (Federal)

For more information on policy measures and sources included in the forecast, contact AQInfo@metrovancover.org.

Section B – Results by Pollutant

This section provides summaries of emissions information by pollutant for 2015, with trends from 1995, and a forecast to 2035.

Greenhouse Gases (GHG)

Some greenhouse gases (GHG) arise from natural sources, while others result from human activities. GHG emissions from human activity have already warmed the earth’s average temperature by more than 1°C, and are shifting the world’s climate systems to wider variability and more intense extremes. Climate change will have multiple impacts in our region in the coming decades.

The principal greenhouse gases for which emissions have been estimated are carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). Other greenhouse gases, such as hydrofluorocarbons, perfluorocarbons and sulphur hexafluorides, have not been included in this report, as they are believed to be insignificant in the region, compared to CO₂, CH₄ and N₂O. GHG are expressed as CO₂-equivalent (CO₂e), which aggregates all GHG emissions based on the relative heat-trapping power (or global warming potential, GWP) of each pollutant compared against CO₂. For example, methane is 25 times as potent as CO₂ and therefore the GWP of CH₄ is expressed as 25 CO₂e, while the GWP for N₂O is 298 CO₂e.

The main contributors to total GHG emissions in the Lower Fraser Valley (LFV) airshed in 2015 were cars and light trucks, the petroleum products sector (mainly refineries), the non-metallic mineral sector (mainly cement plants), heating (e.g., buildings), non-road engines and heavy trucks and buses (Figure 2).

Over the inventory period, GHG emissions were highest in 2000, due in part to emissions from an electric power generation plant in Metro Vancouver. GHG emissions in the LFV decreased significantly in 2005, then increased slightly in 2010, before decreasing again to 2015. From 2015 to 2035, in a “business as usual” forecast, GHG emissions are projected to hold steady in the LFV airshed, with about a 1% decrease in Metro Vancouver and mostly unchanged in the FVRD.

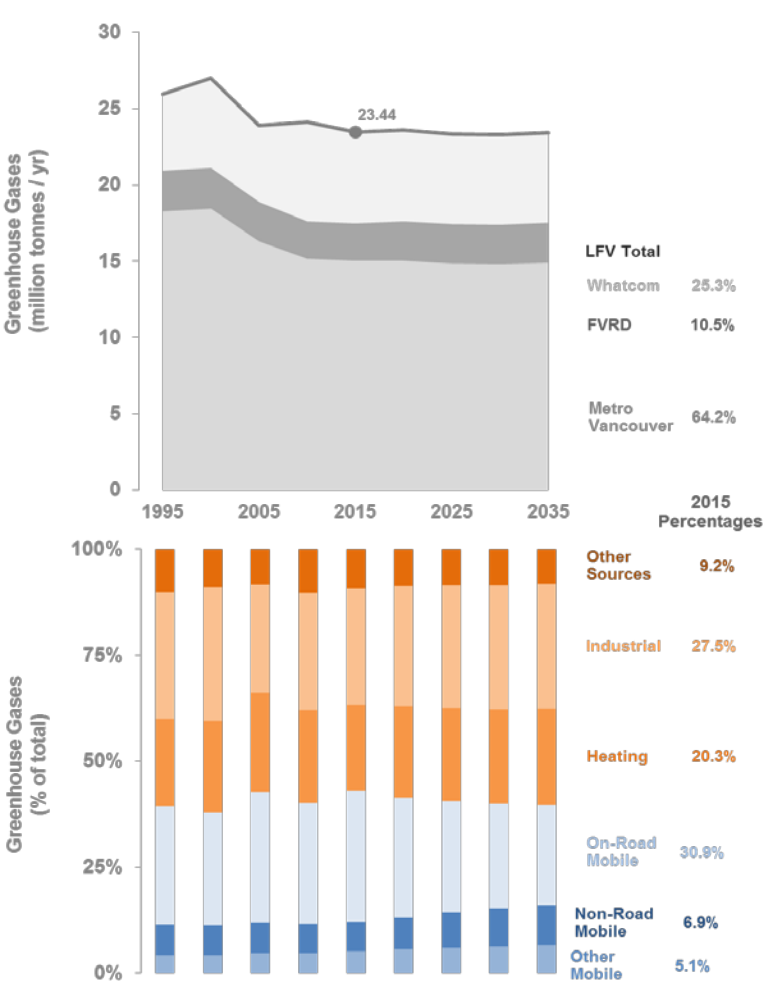


Figure 2: Lower Fraser Valley Greenhouse Gas Emissions Trends and Percentage Distribution across Sectors

In contrast, a decrease of about 34% in GHG emissions from light-duty vehicles is expected between 2015 and 2035. This decrease is primarily due to the effect of vehicle GHG emission regulations on the regional vehicle fleet. Growth in the economy and the region’s population is projected to result in an increase in overall vehicle travel, which reduces the benefits due to fleet turnover and more stringent engine emission standards.

The decrease in vehicle GHG emissions from 2015 to 2035 is countered by projected increases of 12% from the heating of buildings (i.e., residential and commercial natural gas usage), 7% from the industrial sector (primarily cement in Metro Vancouver and petroleum in Whatcom County),

and 37% from non-road engines. In the LFV, the industrial sector is projected to overtake on-road transportation as the largest source of GHG emissions from 2020 onwards. In Metro Vancouver, the heating sector is projected to overtake on-road transportation as the largest source of GHG emissions by 2030.

Carbon Dioxide (CO₂)

Carbon dioxide (CO₂) is released to the atmosphere when fuels (e.g., gasoline, diesel, natural gas, oil, coal) are burned. In Metro Vancouver and FVRD, the main contributors of CO₂ are cars and light trucks and heating (e.g., buildings). CO₂ is also released from certain industrial processes through chemical reactions that do not involve combustion, for example, the production of mineral products such as cement, the production of metals such as iron and steel, and the production of chemicals. Metro Vancouver also has significant emissions from cement plants and petroleum refining. In Whatcom County, the main contributors are petroleum refining, electric power generation and aluminum smelting.

Historically, emissions of CO₂ were highest in 1995 and 2000, due in part to significant emissions from an electric power generation plant in Metro Vancouver. CO₂ emissions from this facility were significantly lower in 2010 and have remained low due to decreased operations.

In 2015, light-duty vehicles, heating and industry were the major sources of CO₂ emissions in the LFV. CO₂ emissions in the airshed decreased from 2010 to 2015, despite a growing population and increased economic activity. Population increases translated into more vehicle travel, resulting in increased emissions from cars and light trucks, while non-road engines also saw a slight increase in emissions from increased activity. However, even with an increase in population, CO₂ emissions from heating were significantly reduced, dropping approximately 10% from 2010.

Between 2015 and 2035, CO₂ emissions from light-duty vehicles are expected to decrease, primarily due to the effect of vehicle GHG emission regulations on the regional vehicle fleet. By 2035, industry (primarily cement industry in Metro Vancouver and petroleum industry in Whatcom County) is expected to be the dominant source in the LFV, followed by on-road transportation sources and heating of buildings (residential and commercial natural gas usage).

Methane (CH₄)

Methane (CH₄) is emitted during the production and transport of natural gas, as well as from the decomposition of organic wastes in municipal solid waste landfills, and from the raising of livestock. Mobile and industrial sources make minor contributions to CH₄ emissions.

From 2015 to 2035, the two dominant sources of CH₄ are landfills and cattle. Historically, emissions from landfills had been the leading contributor of CH₄ emissions. As landfill emissions continue to decrease (largely due to improved landfill gas collection at the City of Vancouver's landfill in Delta, and decreased anaerobic activity at decommissioned landfills), agricultural sources in the FVRD, Whatcom County and Metro Vancouver are projected to play a more significant role in future years.

Nitrous Oxide (N₂O)

Nitrous oxide (N₂O) is mostly emitted from combustion of fossil fuels in motor vehicles and non-road equipment, and agricultural activities.

N₂O emissions decreased from 2000 to 2025 due to more stringent emissions standards for light-duty cars and truck. From 2025 to 2035, emissions from non-road engines and other non-road transportation sectors such as rail locomotives and marine vessels are expected to grow due to increased activity in these sectors.

Common Air Contaminants

The following sections provide emission summaries for common air contaminants for 2015, with trends from 1985, and a forecast to 2035.

Nitrogen Oxides (NO_x)

Nitrogen oxides (NO_x) are formed when fuel is burned at high temperatures, for example, in an engine or boiler. Under certain weather conditions, NO_x can react with other chemicals to form ground-level ozone, secondary particulate matter and acid rain. NO_x can irritate the lungs and lower resistance to respiratory infections. Nitrogen oxides, which include nitric oxide (NO) and nitrogen dioxide (NO₂), are reported by convention as NO_x on the basis of the molecular weight of NO₂.

In 2015, NO_x emissions in the LFV were dominated by mobile sources, including cars and trucks (on-road), marine vessels and non-road engines and equipment (Figure 3). Industrial sources and natural gas use in homes and offices also contribute to NO_x emissions.

NO_x emissions decreased from 1995 to 2015, and in a business as usual forecast, are projected to continue to decrease further to 2035, although the downward trend slows from 2030 to 2035.

Emissions from light and heavy-duty vehicles have decreased over time, largely due to improved vehicle engine emission standards and the AirCare vehicle inspection and maintenance program that operated until 2014.

While marine vessels are projected to be the largest source of NO_x in the region in 2035, their emissions are projected to decrease by 24% from 2015 to 2035. Growth in shipping activities is countered by the emission reductions achieved through implementation of the North American Emission Control Area (ECA), which requires cleaner engines and will reduce NO_x emissions from marine vessels.

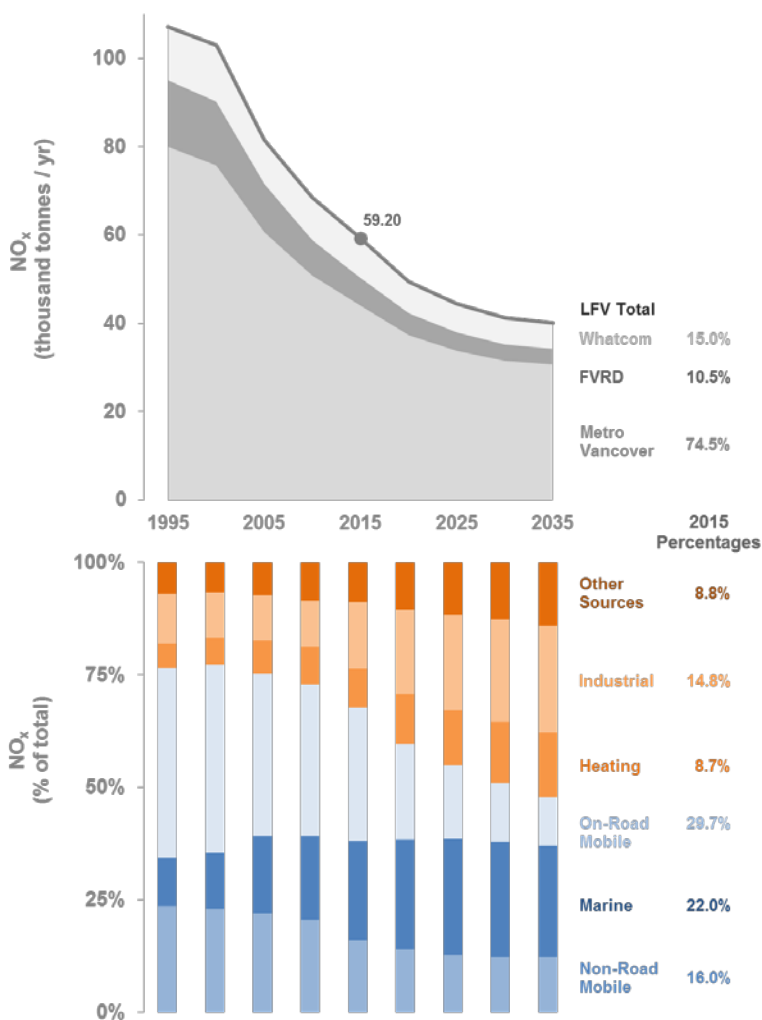


Figure 3: Lower Fraser Valley NO_x Emissions Trends and Percentage Distribution across Sectors

Particulate Matter (PM)

Particulate matter (PM) like dust, soot, smoke, pollen and sea salt is a mixture of solid particles and liquid droplets. PM is emitted from sources like windblown dust, fuel combustion, industries such as coal and grain handling, and vehicle movement on roads. PM is characterized by its size, as different size fractions have different impacts and sources. The most common size fractions are total PM, inhalable PM and fine PM.

Total Particulate Matter

Total particulate matter is made up of particles of all sizes. Important sources of total PM include construction and demolition dust, residential wood heating, wind erosion of agricultural land, tilling and industrial activities.

Inhalable Particulate Matter, PM_{10}

PM_{10} refers to particles smaller than 10 microns. In comparison, a human hair is about 50 to 100 microns in diameter. PM_{10} can be breathed into the lungs and is associated with health impacts, although to a lesser degree than those associated with $PM_{2.5}$. Significant sources of PM_{10} include construction and demolition dust, residential wood heating, industrial activities, wind erosion of agricultural land, and non-road engines.

Fine Particulate Matter, $PM_{2.5}$

$PM_{2.5}$ refers to particles smaller than 2.5 microns. They can be breathed deep into the lungs and may contain substances that are particularly harmful to human health. Scientific studies have linked these small particles to premature death, aggravated asthma, acute respiratory symptoms, and chronic bronchitis. $PM_{2.5}$ also scatters light in the atmosphere and reduces visual air quality.

At this size fraction, residential wood burning for heating is the most significant source in the LFV in 2015, with industry and mobile sources (e.g., non-road engines, onroad vehicles, marine vessels) as other large sources (Figure 4).

Following a steady decrease from 1995 to 2030, emissions of $PM_{2.5}$ in the LFV are expected to increase slightly from 2030 to 2035, in a business as

usual forecast. Residential wood burning and industrial sources are projected to be significant sources of $PM_{2.5}$ in 2035. Residential wood burning emissions show a slight decrease through the forecast period, but given the longevity and slow replacement of wood burning appliances, wood burning remains as the most significant source of $PM_{2.5}$ in 2035. On-road transportation emissions are projected to continue to decrease, driven by stringent emission standards for new light and heavy-duty vehicles, and continued use of clean on-road fuels.

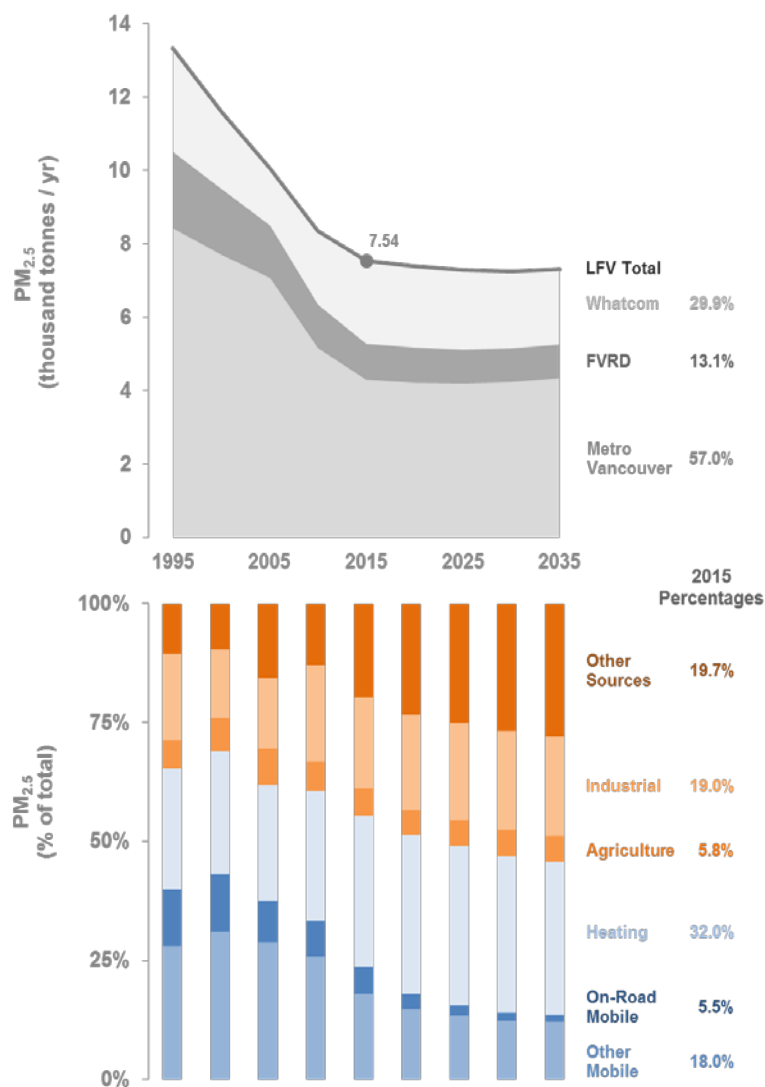


Figure 4: Lower Fraser Valley $PM_{2.5}$ Emissions Trends and Percentage Distribution across Sectors

Diesel Particulate Matter (DPM)

Diesel engines emit a mixture of air pollutants, mainly composed of gaseous exhaust and particulate matter. Diesel particulate matter is a toxic air contaminant, and is classified as carcinogenic to humans by the International Agency for Research on Cancer. Emissions from diesel engines also include many other cancer-causing substances.

DPM emissions showed a decreasing trend from 1995 to 2015, and are projected to decrease further to 2035, in a business as usual forecast (Figure 5).

Non-road engines and marine vessels are the primary sources of DPM emissions. Following significant reductions in diesel PM emissions from stringent engine emission standards for light and heavy-duty vehicles and non-road engines, Metro Vancouver's non-road diesel engine emission regulation, and the use of lower sulphur fuels in marine vessels between 2010 and 2015, marine emissions are projected to increase in the future as marine activity in the region increases over this time period. By 2035, marine vessels are projected to be the largest source of diesel PM, followed by non-road engines and rail locomotives.

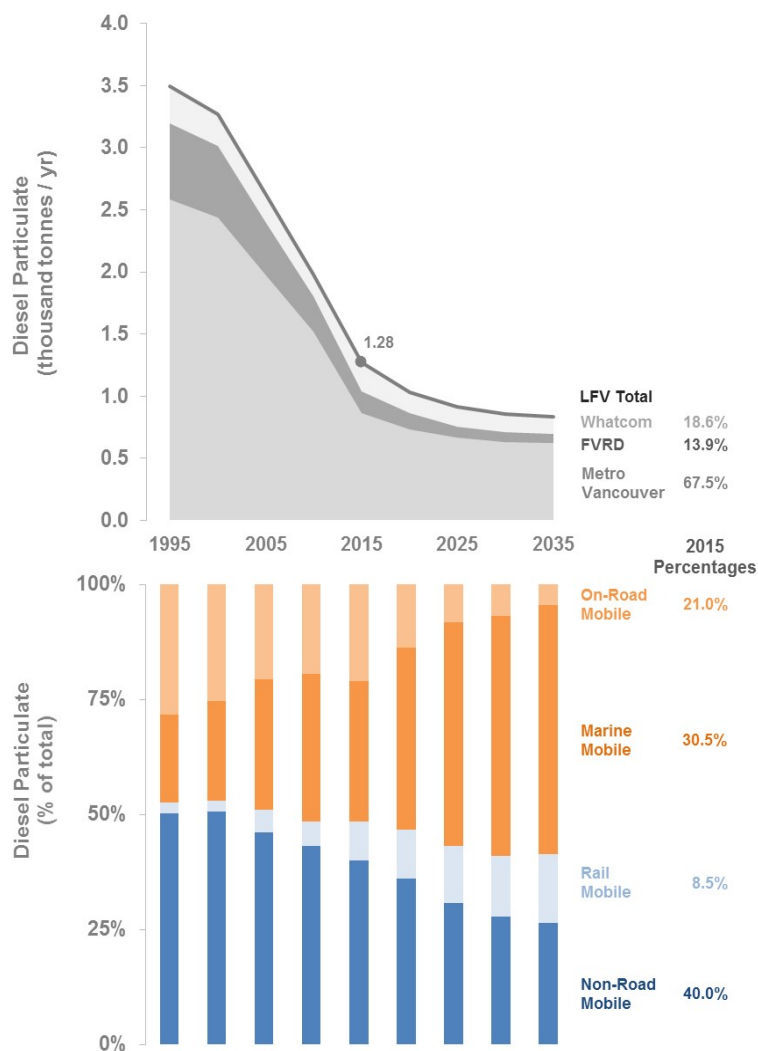


Figure 5: Lower Fraser Valley DPM Emissions Trends and Percentage Distribution across Sectors

Sulphur Oxides (SO_x)

Sulphur oxides (SO_x) are a group of sulphur compounds which, similar to NO_x, are formed when fuel is burned. Health effects associated with exposure to high levels of SO_x include effects on breathing, aggravation of existing respiratory and cardiovascular disease, and mortality. SO_x can also interact with other compounds in the air to form secondary particulate matter and can lead to acid rain formation. SO_x emissions include sulphur dioxide (SO₂) and sulphate (SO₄), and are reported on the basis of the molecular weight of SO₂.

SO_x emissions in the LFV decreased from 1995 to 2015, largely as a result of desulphurization of fuels, the shutdown of several refineries in Metro Vancouver and reduced emissions from cement plants (Figure 6). From 2015 to 2035, SO_x emissions are expected to increase moderately by less than 2% in the LFV, based on a business as usual forecast.

Historically, marine vessels, mainly ocean-going vessels in Metro Vancouver waters, were the largest contributor of SO_x emissions in the airshed, followed by the petroleum and primary metal industries operating in Whatcom County. The decrease in marine vessel SO_x emissions from the implementation of the North American Emission Control Area (ECA), which took effect in two stages in August 2012 and January 2015, resulted in the primary metal industry in Whatcom County becoming the major contributor of SO_x emissions in 2015, as well as in future years. The petroleum products industry, including refineries operating on both sides of the Canada-US border, is projected as the second-largest source of SO_x emissions during the 2020 to 2035 period.

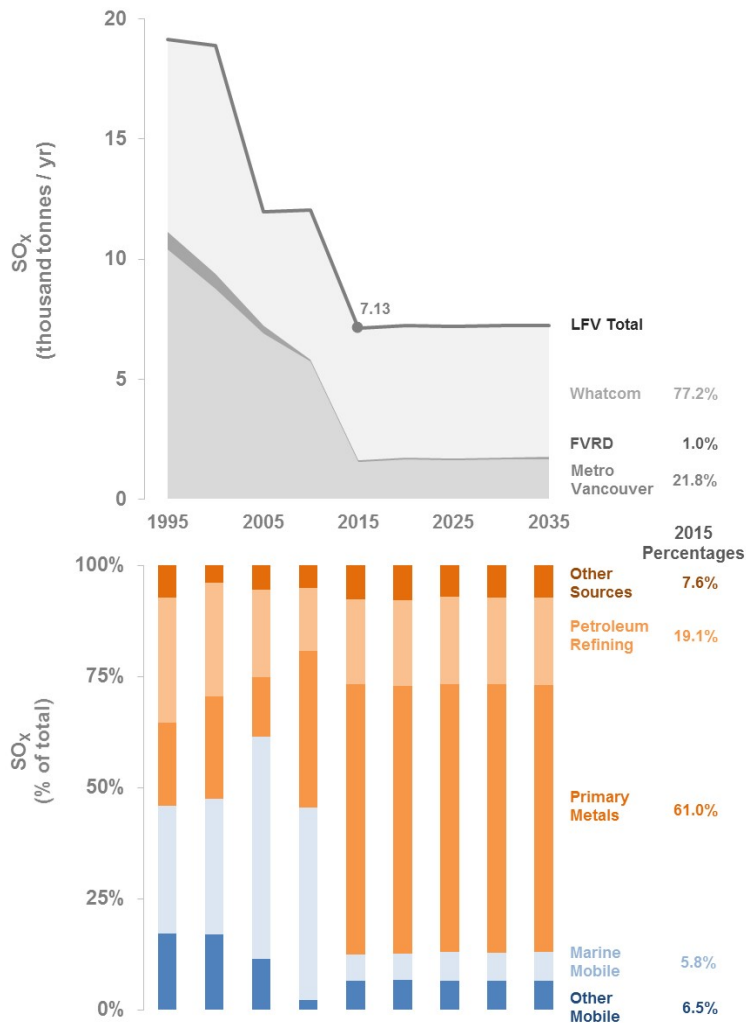


Figure 6: Lower Fraser Valley SO_x Emissions Trends and Percentage Distribution across Sectors

Volatile Organic Compounds (VOC)

Volatile organic compounds (VOC) can react with NO_x in the atmosphere to form ground-level ozone, a key constituent of smog. Some VOC also have a potential carcinogenic or toxic effect.

The major sources of VOC in the airshed include natural sources (vegetation), chemical products use, light-duty cars and trucks, and non-road engines (Figure 7). Historically, light-duty vehicles were the primary source of VOC, but their emissions have steadily decreased due to improved new vehicle emission regulations, as well as the AirCare program in Metro Vancouver and the FVRD from 1992 to 2014.

In 2015, the chemical products sector (e.g., industrial, commercial, and consumer products such as paints, stains, varnishes, solvents, and thinners) was the main source of VOC emissions (other than natural sources). Emissions from cars and light trucks were the second most prominent source. Federal regulations for VOC use in consumer and commercial products, as well as federal and regional regulations for industrial activities, are expected to help reduce VOC emissions.

From 2015 to 2035, VOC emissions from the chemical products sector are expected to increase and remain as the dominant VOC source. By 2035, consumer products use (e.g. personal care products, household cleaners) is expected to be the largest within this sector, followed by industrial and commercial solvent use, based on a business as usual forecast.

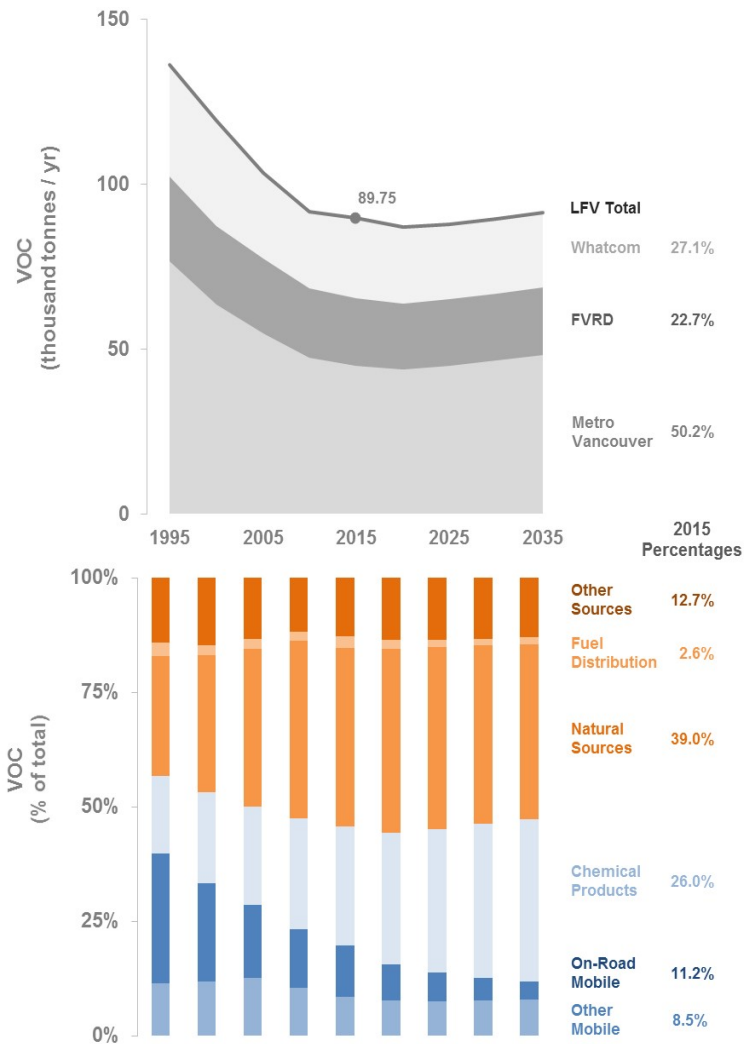


Figure 7: Lower Fraser Valley VOC Emissions Trends and Percentage Distribution across Sectors

Ammonia (NH₃)

Ammonia is a colourless gas with a very sharp odour. It is produced by animals, wastes, and fertilizer application. NH₃, along with SO_x, NO_x and some VOC, can react in the atmosphere to form secondary PM_{2.5}, thus contributing to visual air quality impairment and health effects associated with PM_{2.5}.

Emissions of ammonia in the LFV peaked in 2000, and were lower in 2010 and 2015. From 2020 to 2035, ammonia emissions are projected to increase, based on a business as usual forecast (Figure 8). Almost all ammonia emissions in the LFV comes from the agricultural sector (e.g., poultry, cattle, fertilizer application). Other sources such as cars and light trucks are also responsible for NH₃ emissions, but to a much lesser extent.

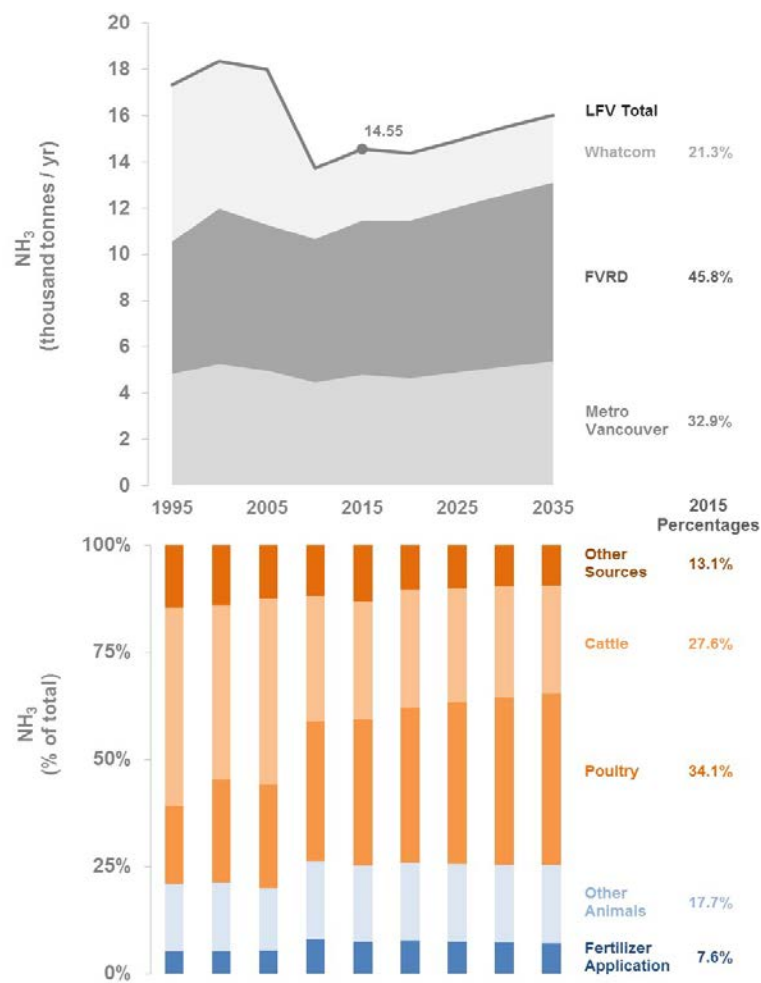


Figure 8: Lower Fraser Valley NH₃ Emissions Trends and Percentage Distribution across Sectors

Smog-Forming Pollutants

The key components of smog are small particles (including secondary particulate matter formed in the atmosphere in the presence of NO_x, SO_x and NH₃) and ground-level ozone. Ozone is a colourless and highly irritating gas that forms in the air when precursor pollutants (i.e., NO_x and VOC) react in the atmosphere, especially on hot summer days.

In order to provide a simplified, aggregate indicator of trends in smog-forming emissions, the principal “smog-forming pollutant” emissions, namely NO_x, VOC, PM_{2.5}, SO_x and NH₃, have been summed. These are the major contributors to the formation of ground-level ozone and fine particulate matter, and to the degradation of visual air quality.

These emissions decreased from 1995 to 2015 in the LFV, and are projected to decrease further to 2030, but are expected to increase after that, based on a business as usual forecast (Figure 9). Smog-forming emissions from transportation sources (e.g., vehicles, non-road engines, marine vessels) show a strong decreasing trend from 2015 to 2035. This is due to improved engine emissions standards for onroad light and heavy-duty vehicles, non-road engines and marine vessels.

The slight upward trend in smog-forming emissions after 2030 is expected to be driven by a continued increase in emissions associated with chemical products such as paints, industrial solvents and coatings, adhesives and personal care products that are used by the growing population in the LFV.

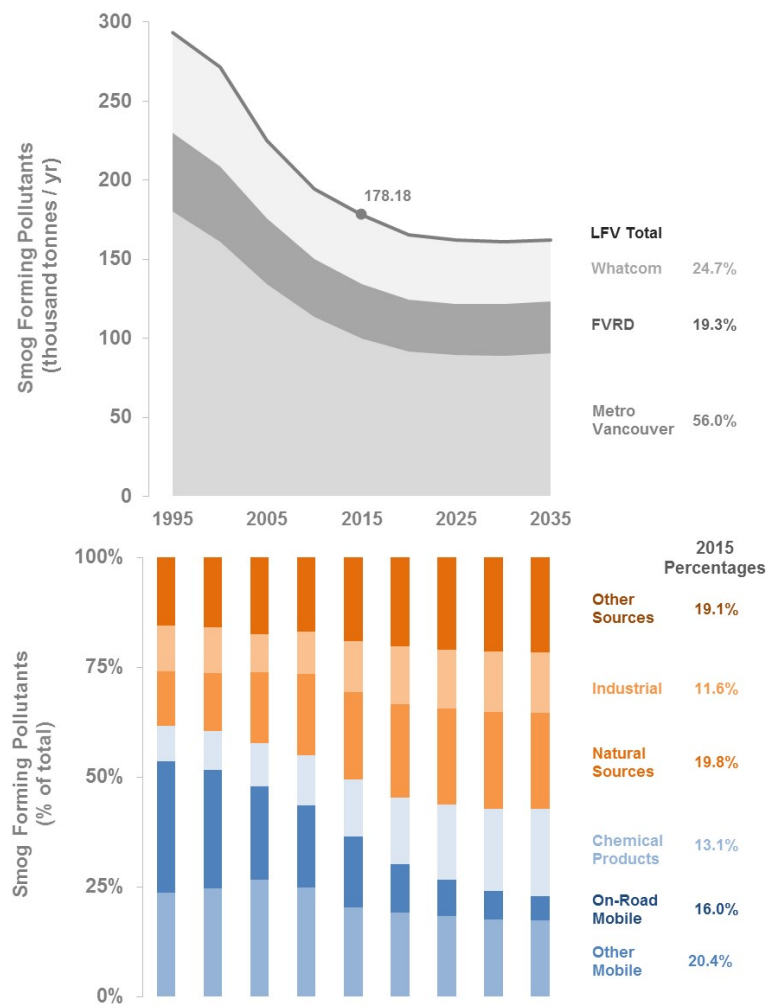


Figure 9: Lower Fraser Valley Smog-Forming Pollutant Emissions Trends and Percentage Distribution across Sectors

Carbon Monoxide (CO)

Carbon monoxide (CO), a colourless and odourless gas, is formed when carbon-containing materials such as fossil fuels do not burn completely. The main source is transportation, particularly motor vehicles and non-road engines and equipment. CO is a health concern because exposure to elevated levels can reduce the ability of the blood to carry oxygen to the heart, brain, and other tissues, resulting in impaired performance, respiratory failure, and ultimately death.

Total CO emissions in the LFV decreased steadily from 1995 to 2015, and are projected to continue decreasing in a business as usual forecast (Figure 10). By 2035, non-road engines are expected to become the primary source of CO emissions, with commercial equipment and residential lawn and garden equipment being the largest sources within this category, followed by cars and light trucks. This shift from on-road motor vehicles to the non-road engine sector becoming the largest contributor is a result of emission reductions from the AirCare program, which ended in 2014, and ongoing improvements in on-road vehicle emission standards.

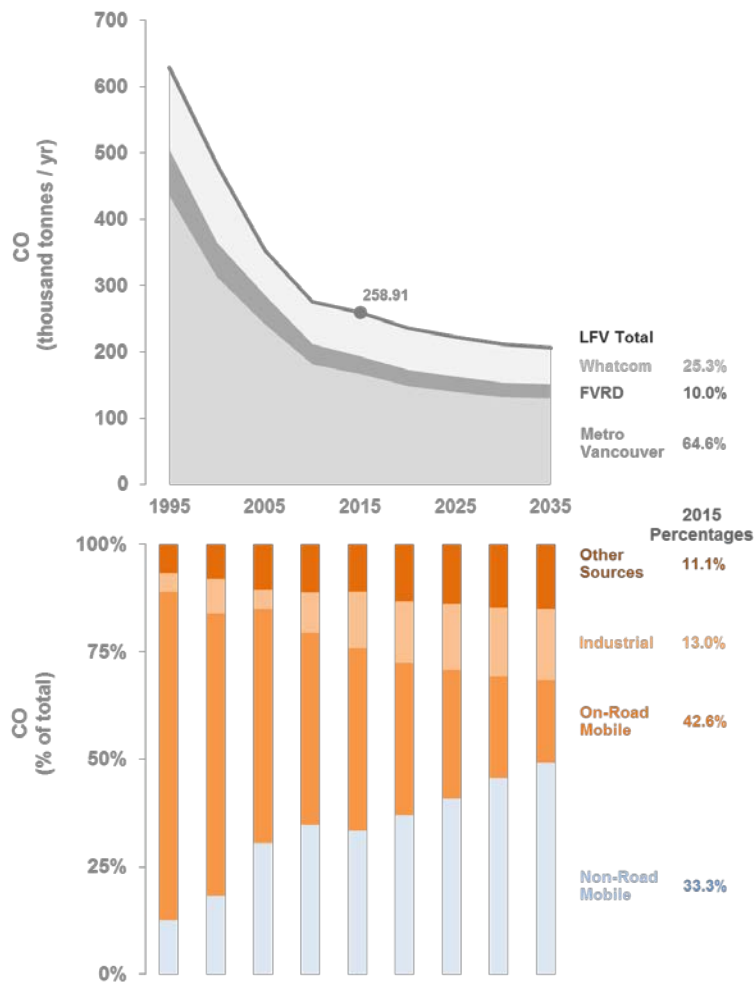


Figure 10: Lower Fraser Valley CO Emissions Trends and Percentage Distribution across Sectors

Section C – Emission Trends and Forecasts for Key Sectors

Findings from a review of the emissions inventory provides insight into a few key emission sectors.

Vehicles: GHG and Smog-Forming Emissions Are Down

Vehicles are significant contributors of both greenhouse gas and smog-forming pollutant emissions in the Metro Vancouver region, and in the broader LFV airshed. In 2015, light-duty vehicles were the largest source of GHG emissions and the second-largest source of smog-forming pollutants in the airshed.

Improved vehicle engine and fuel standards have reduced emissions of both GHG and smog-forming pollutants from motor vehicles. Growth in the economy and the region's population is expected to result in increases in overall vehicle travel; however, emissions are expected to decrease from 2015 to 2035, in a business as usual scenario. Vehicle fuel efficiency regulations and use of lower-carbon fuels are expected to reduce future GHG emissions. Similarly, NO_x, VOC, PM_{2.5} and SO_x emissions are expected to continue decreasing in future years, as a result of more stringent vehicle emission and fuel standards.

Buildings: GHG Emissions Increase, while Residential Wood Burning Emissions Decrease

GHG emissions from the heating of buildings decreased approximately 10% in the LFV between 2010 and 2015, due to reduced natural gas usage, but still contributed more than a quarter of all GHG emissions in 2015. In a business as usual forecast, GHG emissions from buildings are projected to increase approximately 12% in the LFV between 2015 and 2035, due to expected increases in natural gas consumption in both the residential and light industrial, commercial and institutional (ICI) sectors.

Residential wood burning continues to be the leading source of PM_{2.5} emissions, contributing about 28% of PM_{2.5} in the LFV, and 32% of the

PM_{2.5} in Metro Vancouver in 2015. Residential wood burning emissions show a slight decrease from 2015 to 2035, but given the longevity and slow replacement of wood burning appliances, wood burning remains as the most significant source of PM_{2.5} in 2035.

Industry: Smog-Forming Pollutant Emissions Remain Constant while GHG Emissions Increase

Emissions of smog-forming pollutants from industry were trending down for the 1995 to 2010 period, but with increases in economic activity, smog-forming emissions (primarily NO_x from the non-metallic mineral processing industry) increased from 2010 to 2015. SO_x emissions were an exception to this increase, as emissions decreased from 2010 to 2015 due to improved emissions control at refineries in Metro Vancouver and Whatcom County, and reduced production at the smelter in Whatcom County. Smog-forming emissions from industry are projected to increase slightly to 2035, under a business as usual forecast.

Industrial GHG emissions in the LFV are projected to increase by about 7% from 2015 to 2035. The largest sources of industrial GHG emissions are the non-metallic mineral processing plants in Metro Vancouver and refineries, aluminum smelter and power plants in Whatcom County. In 2035, industrial sources are projected to contribute about 29% of GHG emissions in the LFV.

Non-Road Mobile Sources: Diesel PM Reduced

Diesel PM emissions show a decreasing trend from 1995 to 2015, and are projected to continue decreasing to 2035, in a business as usual forecast. The projected decrease in emissions is due to cleaner diesel fuels, more stringent engine emission standards for both light and heavy-duty vehicles and non-road engines, and reductions due to Metro Vancouver's bylaw for non-road diesel engines. Reductions in diesel PM emissions from marine vessels are also expected due to cleaner marine fuels.

Section D – Policy and Regulation Emission Scenarios

The emissions inventory and forecast is a tool that can be used to assess policy and regulatory scenarios for the region. It can help identify areas where management actions may be needed, and provide support in development of new regulatory programs, by evaluating and assessing the emissions impacts of different approaches for managing emissions from specific sources.

The following example emission scenarios help to illustrate the uses of the inventory in assessing policy options: an “enhanced electric vehicle” scenario, and a “reduced residential wood burning” scenario. The scenarios provide emission reduction estimates under a scenario which is more stringent than business as usual, which can help inform plan development or assess the benefits and costs of improved air quality and reduced health effects.

Enhanced Electric Vehicle Scenario

The emissions inventory shows that on-road motor vehicles were the largest source of GHG emissions in the region in 2015, and that they continue to be a significant source in 2035 under a business as usual case forecast.

An enhanced electric vehicle scenario that aggressively implements demand-focussed policies (such as financial purchase subsidies, accessible charging infrastructure and non-financial incentives such as HOV lanes access and free parking) as well as supply focussed policies (e.g., policies that put direct pressure or incentives on vehicle or fuel suppliers to develop, market and sell plug-in electric vehicles), could result in 47% of new vehicle market share in 2035 being electric vehicles¹. The impact of such policies could potentially result in a 27% reduction in GHG emission from a business as usual case in 2035.

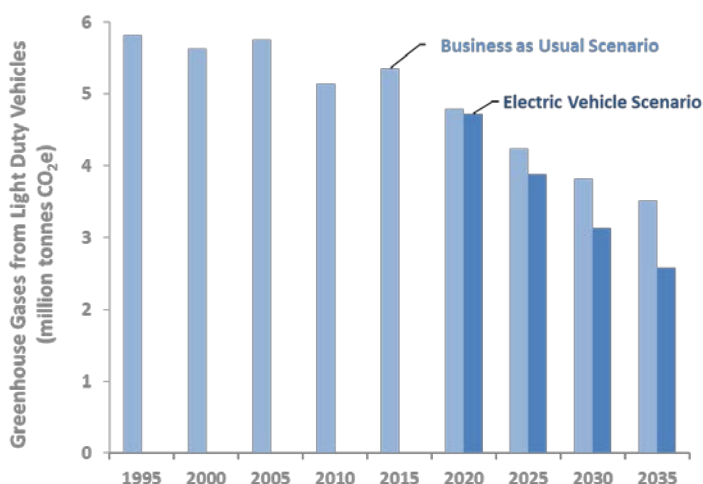


Figure 11: GHG Reductions from an Enhanced Electric Vehicle Scenario

¹ Based on: “How policy can build the plug-in electric vehicle market: Insights from the REspondent-based Preference And Constraints (REPAC) model”

<http://www.sciencedirect.com/science/article/pii/S0040162516307570>

Reduced Residential Wood Burning Scenario

Residential wood burning appliances contributed 32% of PM_{2.5} emissions in the LFV in 2015. Under a business as usual forecast, these emissions are projected to decrease only slightly by 2035, due to the longevity and slow replacement of these appliances.

This scenario evaluates the emission reduction potential of aggressively phasing out conventional fireplaces and uncertified inserts and woodstoves, through regulatory and non-regulatory measures, and replacing them with a combination of gas fireplaces and certified woodstoves and inserts by 2035. This scenario could result in a reduction of over 90% in PM_{2.5} emissions from the business as usual scenario by 2035.



Figure 12: PM_{2.5} Reductions from a Reduced Residential Wood Burning Scenario

