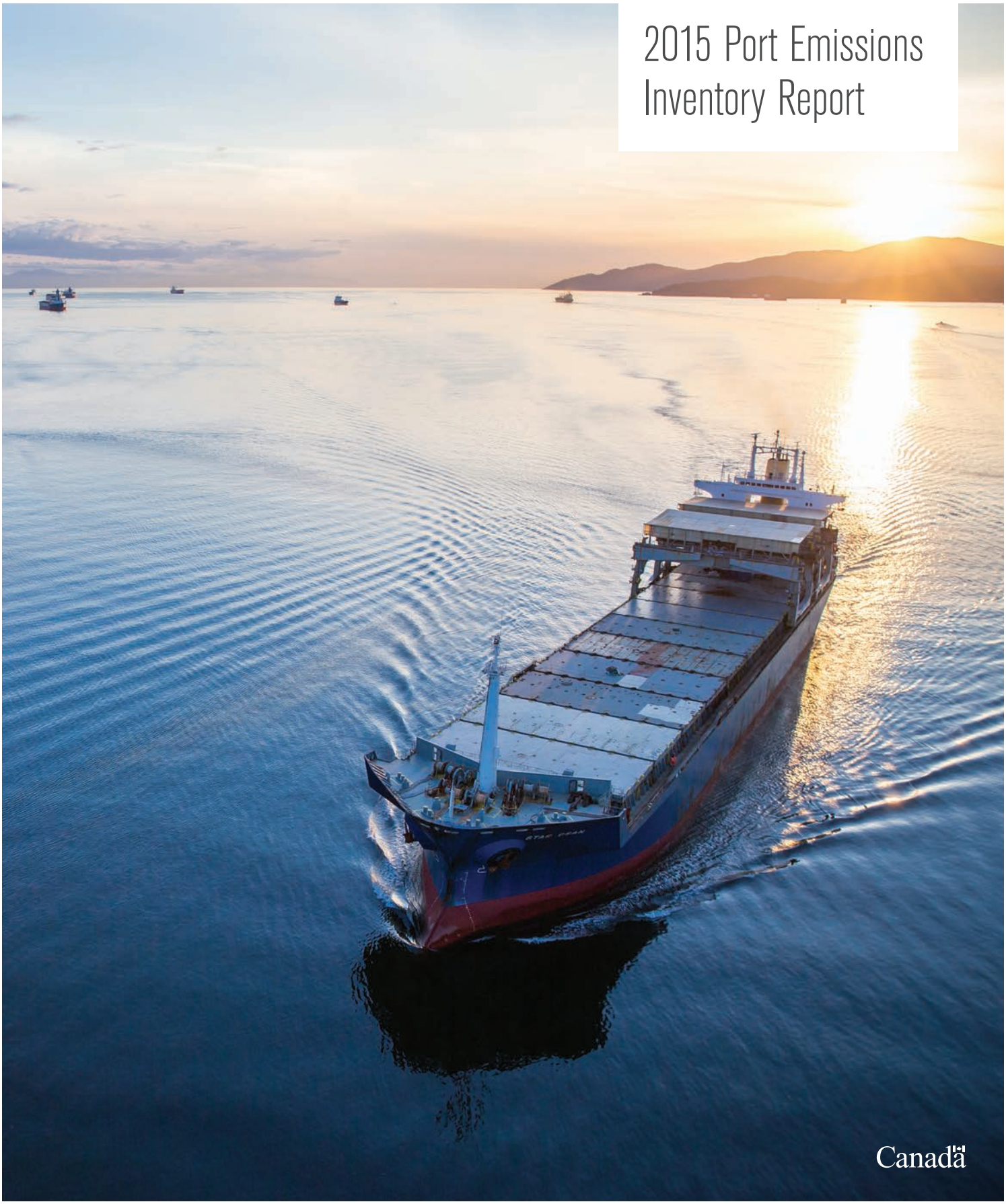
PORT of vancouver

2015 Port Emissions Inventory Report



Canada

Introduction

The 2015 Port Emissions Inventory Report presents an estimate of air emissions associated with activity at the Port of Vancouver. It provides detailed estimates of emissions by type for 2015, as well as a backcast to 2010 and forecast to 2030. The report also includes an overview of the Vancouver Fraser Port Authority's initiatives to reduce emissions and encourage energy conservation at the Port of Vancouver.

Contents

Cautionary note regarding forward-looking statements

The information provided in this report is intended for educational and informational purposes only. While the information in this report is believed to be accurate, it is provided without warranty of any kind, whether express or implied. This report is not intended to endorse or recommend any particular product, material, or service provider, nor is it intended as a substitute for engineering, legal, or other professional advice. Such advice should be sought from qualified professionals.

Message from the President and Chief Executive Officer

2015 Port Emissions Inventory
November 2017

In 2016, we set a vision for the Port of Vancouver to be the world's most sustainable port. For us, a sustainable port delivers economic prosperity through trade, maintains a healthy environment and enables thriving communities.

Among other things, our vision means we must make business decisions that help reduce emissions associated with port activities, improve air quality, and lessen the impact of port operations on the environment and human health.

As stewards of Canada's largest port, we recognize the leadership role that we must play in facilitating emission reductions. To that end, we have worked closely with terminal operators and other port users to develop an inventory of air pollutants and greenhouse gas emissions from marine, rail, on-road, non-road and administrative activities associated with the Port of Vancouver.

I am pleased to present the 2015 Port Emissions Inventory Report, representing nearly two years of engagement, data collection, analysis and modeling. The inventory results reaffirm the significant progress that has been made toward reducing air pollutant emissions, showcasing what is possible when we all work together toward a common objective. The inventory results also show that even though greenhouse gas (GHG) emissions per tonne of cargo are decreasing, total GHG emissions are forecast to continue to increase with growth in trade. This will be an important issue for the port and transportation industry as Canada works toward meeting its climate change commitments.

Marine shipping remains among the most energy efficient methods of transporting goods and can play an important role in facilitating a transition toward a low carbon economy. I am encouraged by the industry's success in reducing sulphur oxide emissions and believe we can replicate this success if we work together to address greenhouse gas emissions.

I encourage you to read through the report to learn more about port-related air emissions, and the environmental initiatives the port authority is leading to promote emission reductions, protect air quality and reduce the port's contribution to climate change.

Robin Silvester, President and Chief Executive Officer

Acknowledgments

The 2015 port emissions inventory was completed with assistance from consultant SNC-Lavalin and port stakeholders. We would like to acknowledge the input and expertise provided by the following organizations:

- BC Marine Terminal Operators Association
- British Columbia Ministry of Environment & Climate Change Strategy
- British Columbia Ministry of Transportation and Infrastructure
- Chamber of Shipping of British Columbia
- Cruise Lines International Association – North West & Canada
- Environment and Climate Change Canada
- Metro Vancouver
- Port of Vancouver tenants
- Railway Association of Canada
- Shipping Federation of Canada
- Transport Canada

SEND US YOUR FEEDBACK

We welcome and value your feedback. Please send comments or questions to environmentalprograms@portvancouver.com

Vancouver is known for natural beauty and clean air, and it will take the collaboration and support of many stakeholders to keep it that way.

Emissions inventory

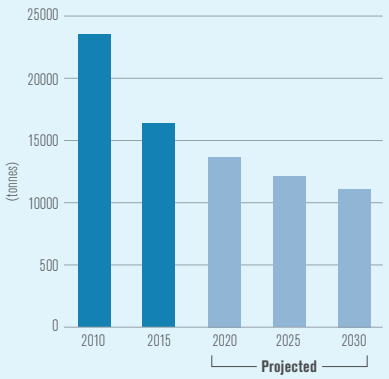
For emissions to be reduced, they must first be measured. That's why we conduct air emission inventories at the Port of Vancouver every five years, at the same time as regional and national inventories. The results identify trends so we can improve our programs and policies, and ultimately reduce emissions.

Per cent change in total emissions by source from 2010 to 2015

	Marine	Rail	On-road vehicles	Non-road equipment	Administrative operations
Air pollutants	↓36%	0%	↓31%	↓26%	↑14%
Greenhouse gas emissions	↑10%	↑17%	↑23%	↑18%	↑7%

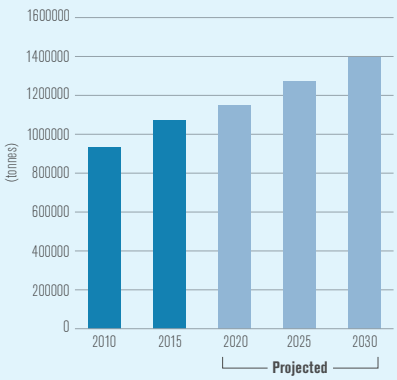
Key findings

Air pollutants



Air pollutant emissions have decreased significantly since 2010 despite growth in trade through the port – a result of stronger regulation and investment in technology.

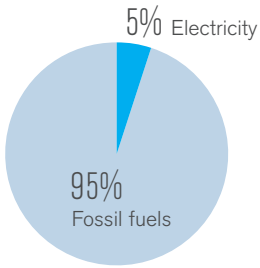
Greenhouse gas emissions



Greenhouse gas emissions per tonne of cargo have decreased, but total emissions have increased and are forecast to continue increasing with growth in trade through the port.

Challenge

Energy use



Fossil fuels make up 95% of port-related energy use. We will need to work with government and industry stakeholders to reduce port energy consumption through conservation and efficiency, and facilitate a transition to low carbon energy alternatives like hydroelectricity.

Our vision is to be the world's most sustainable port. We are working to reduce port-related air emissions that affect air quality and contribute to climate change.

Our approach

At the Vancouver Fraser Port Authority, we focus on supporting early compliance with pending environmental regulations, improving efficiency and promoting clean technology. We collaborate with government and industry stakeholders to undertake port emission inventories and enhance air quality monitoring, which enables us to track and report our progress toward achieving our vision.

Our air and energy initiatives target key port-related emission sources:	Marine	Rail	On-road vehicles	Non-road equipment	Administrative operations
Emissions inventory Our activity-based inventory enables us to estimate port-related air emissions from a variety of sources. The inventory informs our policy and programs by helping us identify trends and priority areas for action.	✓	✓	✓	✓	✓
Northwest Ports Clean Air Strategy The strategy was developed in partnership with the ports of Seattle and Tacoma and the Northwest Seaport Alliance to reduce port-related air emissions in the Georgia Basin-Puget Sound air shed.	✓	✓	✓	✓	✓
EcoAction Program Ships can receive harbour dues discounts by meeting voluntary environmental best practices. Participation in the program grew to 612 vessel calls in 2016, representing more than 20 per cent of all vessel calls.	✓				
Shore power Since 2009, shore power at the Canada Place cruise terminal has eliminated 474 tonnes of air pollutants and 16,138 tonnes of greenhouse gases. We're installing shore power at two container terminals, to be completed in 2018.	✓				
LNG bunkering Along with other global ports, we're preparing the port for liquefied natural gas as a marine fuel, which will reduce ship air emissions.	✓				
Truck Licensing System Container trucks that access the port meet minimum environmental requirements for engine age, emission controls and idle reduction.			✓		
Non-Road Diesel Emissions Program We work with port tenants to accelerate change-over of older diesel equipment through a combination of fees and rebates.		✓		✓	
Energy Action initiative In partnership with BC Hydro, this program helps port tenants advance energy conservation measures and access financial incentives.				✓	✓
Climate Smart We offer training for port tenants to measure and reduce greenhouse gas emissions. 11 tenants participated in 2015, collectively eliminating 2,788 tonnes of CO_2e.		✓	✓	✓	✓

Learn more about our air and energy initiatives at portvancouver.com/cleanair

About us

Vancouver Fraser Port Authority

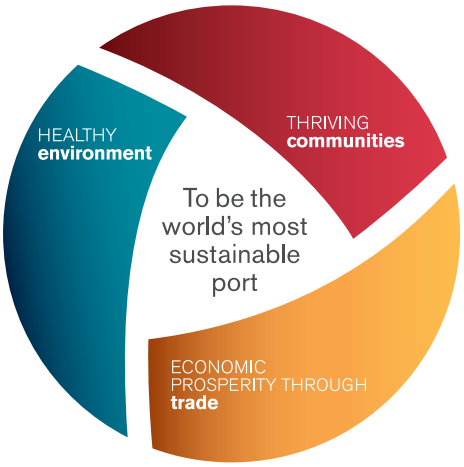
Our mission is to enable Canada's trade objectives, ensuring safety, environmental protection and consideration for local communities.

Our vision is to be the world's most sustainable port.

The Vancouver Fraser Port Authority is responsible for managing federal lands and waters at the Port of Vancouver on behalf of Canadians and in support of national trade objectives. We are a non-shareholder corporation established by the Government of Canada in January 2008, pursuant to the *Canada Marine Act,* and accountable to the federal minister of transport.

Our approach to sustainability

We believe that a sustainable port delivers economic prosperity through trade, maintains a healthy environment, and enables thriving communities, through meaningful dialogue, shared aspirations and collective accountability. To maintain a healthy environment, we are working to improve air quality and minimize greenhouse gas emissions.



Read more about our approach to sustainability at portvancouver.com/sustainability

Initiatives influencing port emissions

The below timeline shows significant milestones in our air emission programs, as well as the key regulations driving emission reductions.

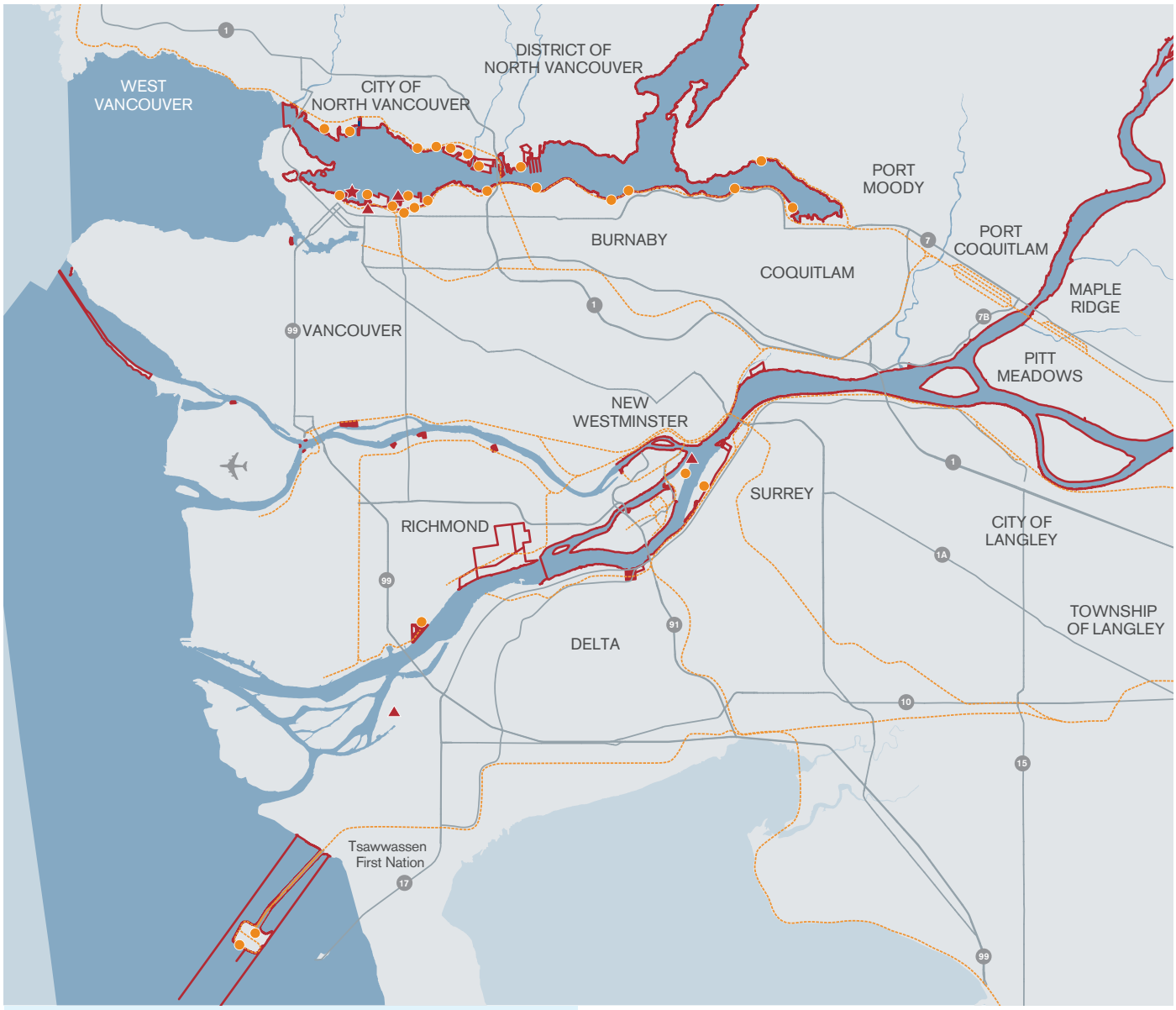
- **2005** • First port-wide emissions inventory conducted
- **2007** • EcoAction Program for ships launched
- **2007** • Northwest Ports Clean Air Strategy initiated
- **2008** • Truck Licensing System environmental requirements implemented
- **2009** • Shore power for cruise ships installed at Canada Place
  • Blue Circle Award for vessels debuted
- **2010** • Port authority operations become carbon neutral
  • Second port-wide emission inventory conducted
- **2012** • Government of Canada set diesel fuel sulphur content limit at 0.0015%
  • International Maritime Organization (IMO) set North American Emission Control Area fuel sulphur limit at 1.0%
- **2013** • Energy Action initiative launched
- **2015** • Non-road diesel emission program launched
  • IMO Emission Control Area fuel sulphur limit set at 0.1%
  • Third port-wide emissions inventory conducted
  • Climate Smart partnership established
- **2016** • IMO set nitrogen oxide emissions limit for new ships operating in Emission Control Areas

■ Port authority initiatives ■ Key regulations

Port of Vancouver

The Port of Vancouver is Canada's largest port, and the third largest in North America in terms of annual tonnes of cargo. Positioned on the southwest coast of British Columbia in Canada, the port is home to 27 major marine cargo terminals and three Class 1 railroads, offering a full range of facilities and services to the international shipping community.

The port operates across five cargo sectors: automobile, breakbulk, bulk, container and cruise. In 2016, 136 million tonnes of cargo valued at $202 billion was traded with more than 170 world economies. About 93 per cent of the cargo that moves through the port is for Canadian import and export markets, with the remainder for the United States.



Port authority
- ★ Head office
- ▲ Other facilities

Port infrastructure
- ● Port terminals
- Rail network
- Roads
- Port authority-managed federal lands
- Port authority navigational jurisdiction

Jurisdiction

The port authority's jurisdiction consists of 16,000 hectares of water, more than 1,000 hectares of land and approximately 350 kilometres of shoreline. It borders 16 municipalities and intersects the asserted and established territories and treaty lands of several Coast Salish First Nations.

2015 port emissions inventory

Port-wide emission inventories are conducted every five years. The 2015 port emissions inventory estimates air emissions from marine, rail, on-road, non-road, and administrative activities associated with the Port of Vancouver.

What's included

Air pollutants

Air pollutants affect local and regional air quality. They can directly affect human and environmental health, which can, in turn, produce secondary economic impacts, such as increased health care costs or lost work days. The following air pollutants are considered in our inventory:

• sulphur oxides (SO_X) • nitrogen oxides (NO_X)
• fine particulate matter ($PM_{2.5}$) • volatile organic compounds (VOCs) • carbon monoxide (CO) • ammonia (NH_3

Greenhouse gases

Transportation activities at ports, such as marine shipping, use of rail and non-road equipment, and trucking, are heavily dependent on fossil fuels. The use of these fuels contributes to climate change through the release of greenhouse gas emissions and black carbon. The inventory includes black carbon emissions, and the following greenhouse gases measured in terms of their carbon dioxide equivalent (CO_2e):

• carbon dioxide (CO_2) • methane (CH_4) • nitrous oxide (N_2O)

Energy usage

The sources of energy used in port activities, as well as the efficiency of energy used, influence the quantity and type of emissions. To help us gauge energy efficiency and identify clean technology options, we consider both energy sources and energy usage in our inventory.

What's not included

Emission sources not covered in this report include fugitive emissions associated with dust, vapours, and refrigerants, up/downstream emissions associated with the production or consumption of cargoes, as well as emissions associated with heavy industrial processes on or adjacent to port lands, such as chemical or cement manufacturing. These emissions are considered by the port authority in special studies and project environmental reviews, and/or by other governmental agencies, including Transport Canada, Environment and Climate Change Canada, and Metro Vancouver.

Methodology

The emissions inventory uses detailed 2015 activity data to estimate current emissions, backcast emission estimates to 2010 and forecast to 2030.

Creating the port emissions inventory

1 Determine scope

Identify the sources of emissions at the port and the geographical scope of the inventory.

2 Collect activity information

Collect, model and validate real-time activity data and operating information for each source group.

3 Apply emission factors

Apply emission factors obtained from government and industry sources to the activity data.

4 Generate emission estimates

Produce the 2015 emission estimates and conduct quality checks and analysis to inform backcast and forecast.

5 Develop backcast and forecast

Based on expected trade growth, regulatory changes, and fleet turnover, develop a backcast of emission estimates for 2010 and forecast out to 2030.

What is an emission factor?

An emission factor is the rate of emissions associated with an activity such as fuel combustion, which is dependent on factors such as engine age, technology, fuel type and operating conditions. These factors come from organizations that undertake research and/or testing to estimate the rates, including the U.S. Environmental Protection Agency, Environment and Climate Change Canada, Railway Association of Canada, and BC Hydro.

How are emission backcasts and forecasts estimated?

The backcast and forecast are created by scaling the 2015 emission estimates in consideration of factors such as:

- known regulatory changes affecting fuels and technologies.
- cargo volumes in 2010 and anticipated or assumed cargo volumes in 2020, 2025 and 2030.
- an assumption that the age distribution of equipment remains the same over time.

How accurate are the estimates?

In preparing the 2015 port emissions inventory, we formed technical advisory groups, consisting of key stakeholders in government and the shipping industry, to help us refine our approach and understand its limitations. The inventory follows best practices and is consistent with methodology used by other ports and regulatory agencies; however emissions are estimated and not directly measured. Consequently, we recognize some areas of uncertainty remain. In particular, forecasts beyond 2015 are subject to an increasingly higher degree of uncertainty related to future cargo volumes and environmental regulations.

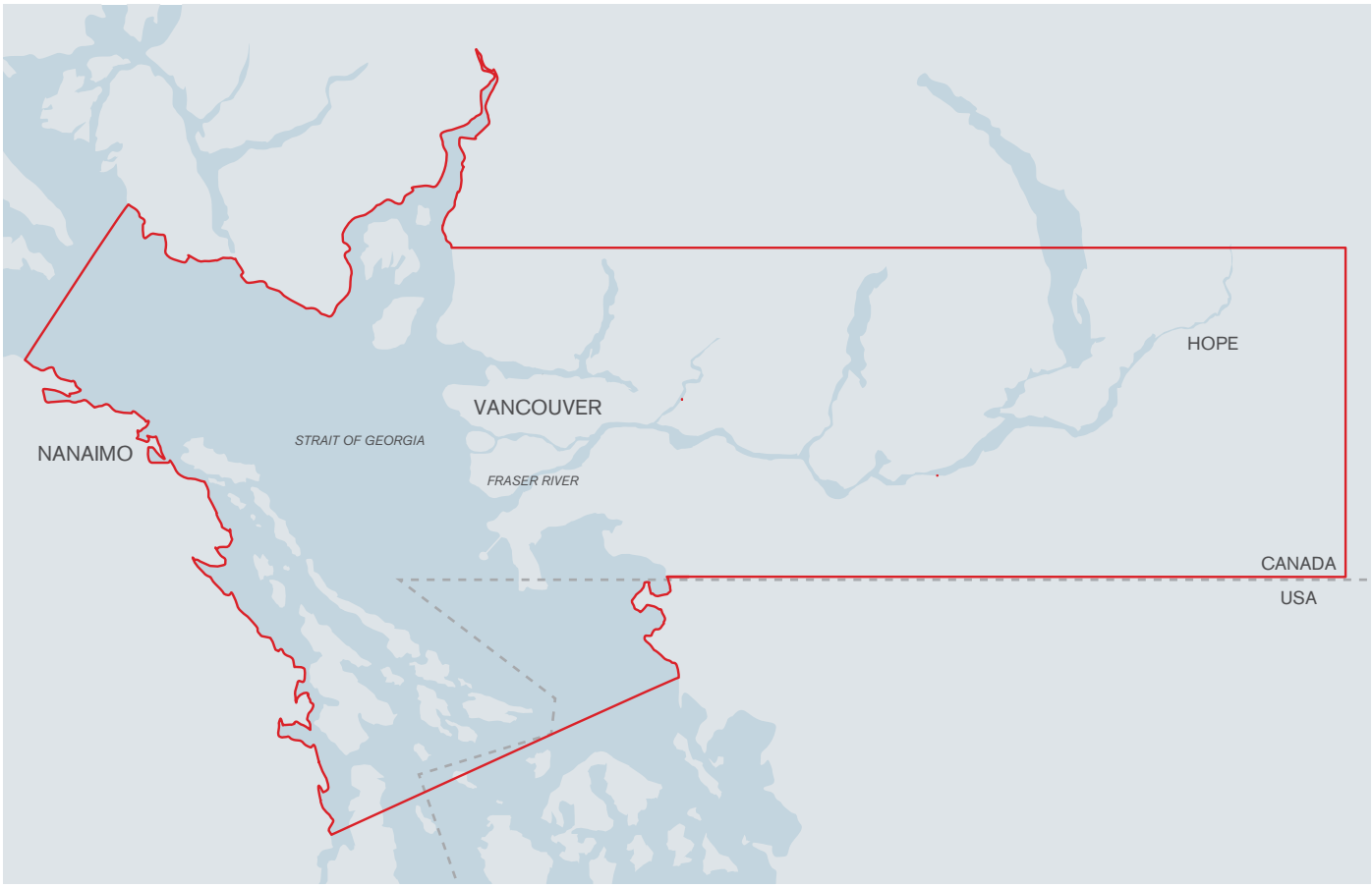
Scope

The inventory includes emissions associated with fuel and electricity used by marine and rail sectors, on-road vehicles, non-road equipment, and administrative operations.

Deep-sea terminals facilitate the movement of cargo between ship, rail, and truck transportation modes. Goods arrive and depart by sea on ocean-going vessels, facilitated by harbour tugs. Railways and trucking companies move goods to and from terminals by land. These transportation activities are operated by port tenants or other companies independent of the port authority.

Boundary

The geographic boundary of the inventory captures port-related activities in the region, both within and beyond the jurisdiction of the port authority, as shown below.



■ **Port emissions inventory boundary**

Emission sources

Marine

Ocean-going vessels

Over 3,100 ocean-going vessels call at our port every year. Using the positioning technology on board each vessel, emissions are estimated from their main engines, auxiliary engines, and boilers.

Harbour tugs

Harbour tugs escort tankers, position vessels at terminals, and tow barges and logs throughout the port. Emission estimates are based on operator records of fuel usage.

River dredging

The Fraser River is dredged to maintain the navigational channel. Emission estimates are based on fuel usage, as reported by operators.

Rail

Mainline locomotives

Three Class 1 railways and one charter railway service the port, using large locomotives to transport goods across North America. Emission estimates are based on route taken and cargo transported through the region.

Switcher locomotives

Rail cars are positioned at terminals and regional rail yards by smaller switcher locomotives, including fuel-efficient gen-set locomotives. Emission estimates are based on tenant data and quantities of cargo transported.

On-road vehicles

Container trucks

A fleet of about 1,700 port-licenced container trucks service terminals, warehouses, rail yards, and customer facilities within the region. Emission estimates are based on activity data obtained from global positioning system technology on each truck.

Other vehicles

Emissions from other vehicles moving commodities and passengers to and from port lands are estimated based on data provided by port tenants and modeling to predict vehicle routes.

Non-road equipment

Information about equipment operating on port lands is obtained through tenant questionnaires. Emission estimates are based on engine information and fuel consumption data for each piece of equipment.

Cranes and stackers

Over 320 cranes and stackers handle containers at terminals and transload facilities.

Loaders

More than 750 loaders handle dry bulk and breakbulk products, mostly at port terminals.

Terminal tractors

There are approximately 350 tractors, designed to shuttle containers, operating within terminal yards.

Miscellaneous equipment

More than 350 other pieces of equipment serve general use purposes at port facilities.

Administrative operations

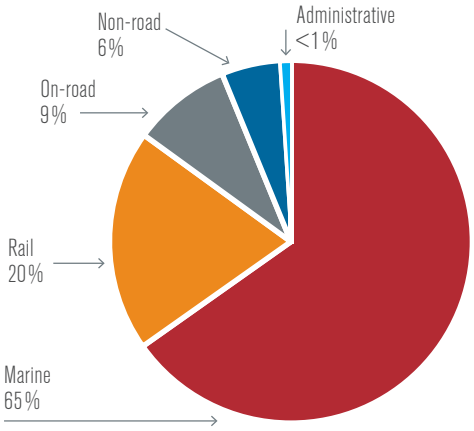
Emissions associated with heating and electricity for buildings on port lands and lighting terminals are captured through usage data and tenant questionnaires.

Results

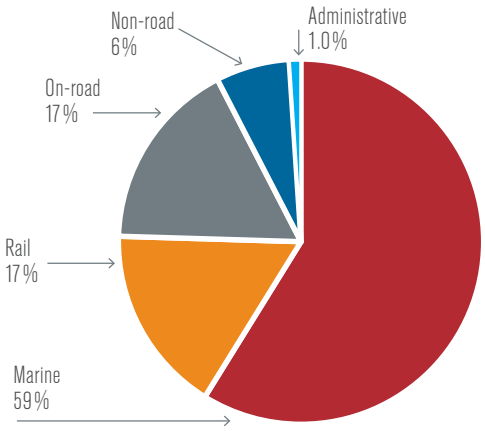
The 2015 Port Emissions Inventory Report presents an estimate of fuel combustion- and electricity-related emissions from port sources and associated activities. The results include detailed estimates of emissions by pollutant for 2015, as well as a backcast of emissions to 2010, and forecast to 2030, in five-year increments. We report both total (absolute) emissions and emissions intensity (emissions per tonne of cargo).

Port-related emissions

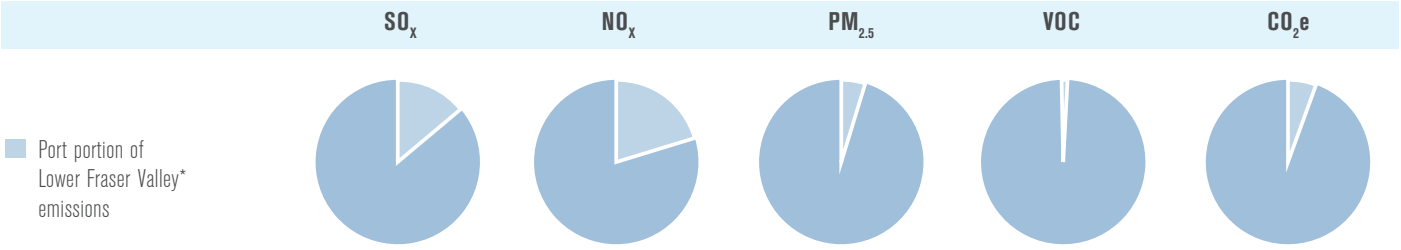
Air pollutant emissions by source, 2015



Greenhouse gas emissions by source, 2015



Emission contributions to regional, provincial and national totals by type (tonnes), 2015



	SO_x	NO_x	$PM_{2.5}$	VOC	CO_2e
Port of Vancouver	268	12,971	288	567	1,079,686
Lower Fraser Valley	1,626	50,357	5,243	65,828	17,529,390
British Columbia	60,485	276,444	80,882	164,868	60,900,000
Canada	1,054,399	1,893,775	1,620,872	1,858,662	722,000,000

* The Lower Fraser Valley includes the entire Metro Vancouver region and the southwestern portion of the Fraser Valley Regional District.

Air pollutants

Important air pollutants in the region include: sulphur oxides, nitrogen oxides, fine particulate matter and volatile organic compounds. In combination with carbon monoxide and ammonia, these pollutants collectively are smog-forming pollutants.

Between 2010 and 2015, smog-forming pollutant emissions decreased by 30 per cent, primarily as a result of regulatory changes affecting sulphur oxide and fine particulate matter emissions from marine, non-road, on-road and rail sources. Emissions are forecast to decrease by another 32 per cent by 2030 due to regulatory changes affecting nitrogen oxide emissions. Although port cargo throughput is expected to rise, these regulations will offset a corresponding rise in emissions, resulting in a significant reduction in both the total smog-forming pollutant emissions and the emissions intensity, per tonne of cargo throughput.

Pollutant

Smog-forming pollutants include sulphur oxides, nitrogen oxides, fine particulate matter, volatile organic compounds, carbon monoxide, ammonia

Source

Fuel combustion

Direct impacts

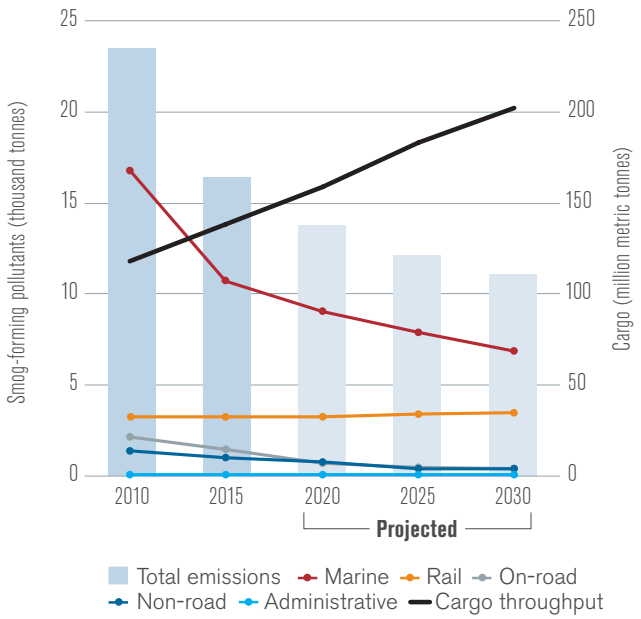
Human health: reduced respiratory system function, aggravation of asthma, increased risk of cardiovascular disease, premature death

Environmental: reduced visibility (haze), damage to vegetation, odour, acid precipitation

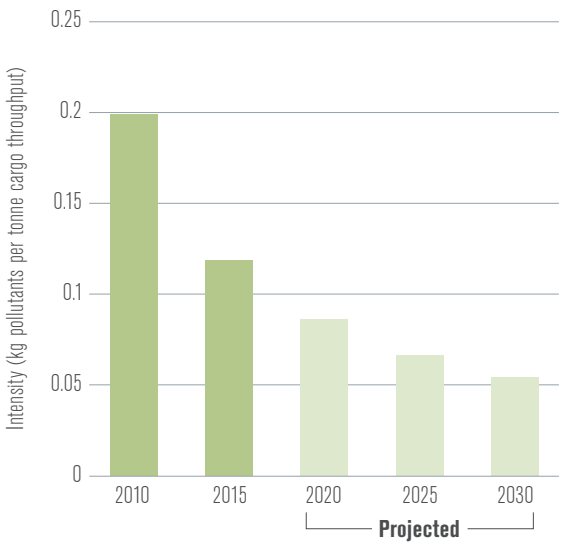
Indirect impacts

Formation of ground-level ozone and secondary particulate matter

Air pollutant emissions and cargo throughput, 2010-2030



Air pollutant emissions intensity, 2010-2030



Sulphur oxide emissions

Between 2010 and 2015, sulphur oxide (SO_X) emissions decreased dramatically, a direct result of international regulations limiting the sulphur content in ship fuel. In 2012, the International Maritime Organization, responsible for regulating the shipping sector, designated an Emission Control Area off the coast of North America, which set limits on the allowable sulphur content in marine fuel. More stringent limits were imposed in 2015. The Government of Canada enforces the Emission Control Area regulations within Canadian waters. Also contributing to the decline in sulphur oxide emissions were federal regulations, implemented between 2006 and 2014, which reduced the maximum sulphur content allowed in fuels used in on-road vehicles, off-road engines, locomotives, small stationary engines, and small domestic vessels. Our forecast suggests that in the absence of additional regulations, projected growth in trade through the Port of Vancouver is anticipated to result in small, incremental increases in SO_X emissions from 2015 to 2030.

In 2015, marine sources accounted for 99 per cent of port-related SO_X emissions at the port. This is due to the fact that marine grade fuels contain higher amounts of sulphur than fuels used for domestic land-based activities. The cargo sectors with the greatest cargo volumes – bulk and container – are associated with 49 per cent and 27 per cent respectively of total SO_X emissions at the port.

Pollutant

Sulphur oxides (SO_X) are compounds that contain sulphur and oxygen

Source

Combustion of sulphur-containing fuels

Direct impacts

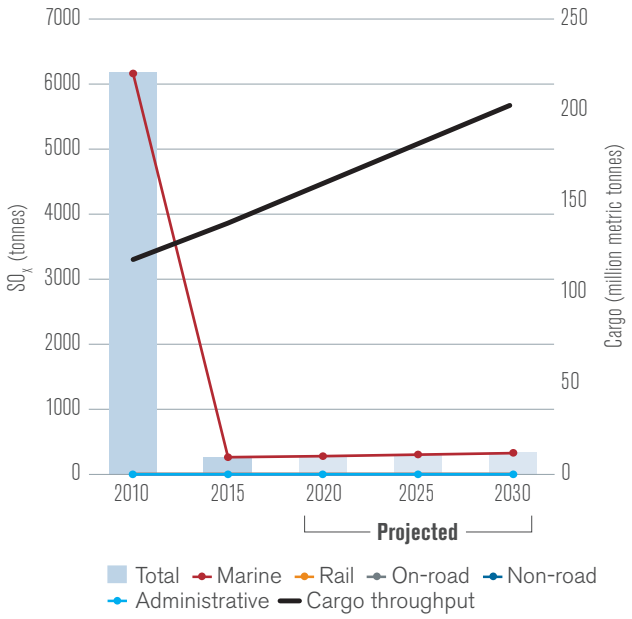
Human health: reduced respiratory system function, aggravation of asthma, increased risk of cardiovascular disease, premature death

Environmental: reduced visibility (haze), damage to vegetation, acid precipitation

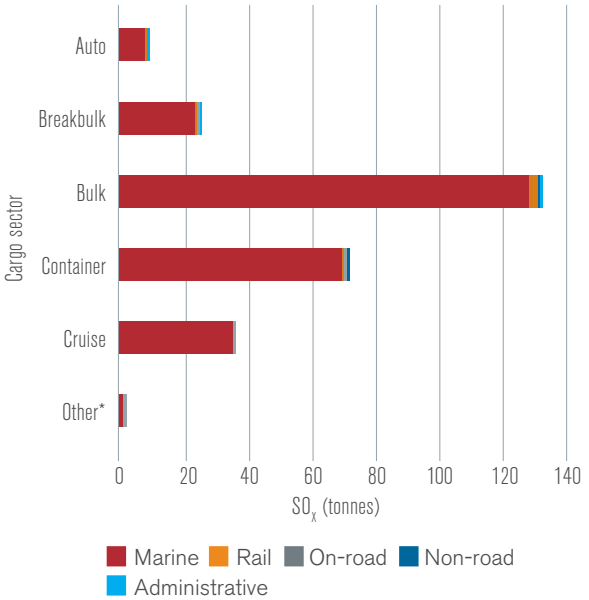
Indirect impacts

Formation of secondary particulate matter

SO_X emissions and cargo throughput, 2010-2030



SO_X emissions by cargo sector and emissions source, 2015



*Includes activities related to movement of domestic goods.

Nitrogen oxide emissions

Port-related nitrogen oxide (NO_X) emissions decreased slightly from 2010 to 2015 and are forecast to decrease by about 40 per cent by 2030 despite projected increases in cargo traded. This trend is driven by the International Maritime Organization's increasingly stringent engine emission limits for newly constructed ocean-going vessels operating in Emission Control Areas. The Government of Canada has also introduced NO_X regulations for new ship engines, vehicles and equipment, which is another factor influencing the decline.

The highest quantities of NO_X emissions are from the bulk and container sectors, which handle the most cargo. While marine activity contributes the majority of NO_X emissions at the port, the movement of bulk cargo by rail accounts for 16 per cent of total NO_X emissions. The on-road emission source for the container sector is also significant, representing about six per cent of total NO_X emissions.

Pollutant

Nitrogen oxides (NO_X) are compounds that contain nitrogen and oxygen

Source

Fuel combustion

Direct impacts

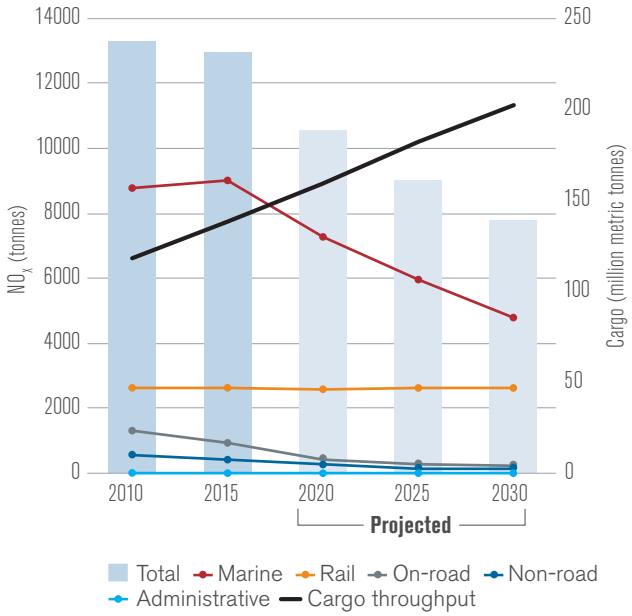
Human health: reduced respiratory system function, aggravation of asthma

Environmental: reduced visibility (haze), damage to vegetation, acid precipitation

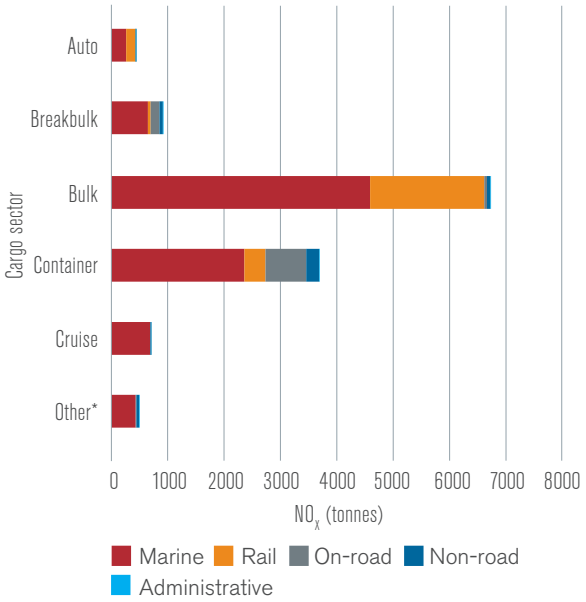
Indirect impacts

Formation of ground-level ozone

NO_X emissions and cargo throughput, 2010-2030



NO_X emissions by cargo sector and emission source, 2015



*Includes activities related to movement of domestic goods.

Fine particulate matter emissions

Port-related fine particulate matter emissions ($PM_{2.5}$) decreased by 68 per cent from 2010 to 2015 due to the International Maritime Organization's introduction of the North American Emission Control Area for marine vessels in 2012. Improvements to federal fuel sulphur and engine emission limits contributed to reductions in particulate matter from on-road and non-road sources, most notably between 2010 and 2020. As with sulphur oxide emissions, growth in trade through the port is forecast to cause total $PM_{2.5}$ emissions to increase after 2015, in the absence of new fuel or technology regulations.

Marine activity is the most significant source of $PM_{2.5}$ emissions in each cargo sector. Rail is the second largest source of $PM_{2.5}$ emissions, accounting for 25 per cent of the total in 2015. On-road vehicles and non-road equipment servicing the container sector collectively represent about 55 per cent of the container sector's contribution to $PM_{2.5}$ emissions.

Pollutant

Fine particulate matter ($PM_{2.5}$) are airborne solid or liquid particles, 2.5 microns or less in diameter

Source

Fuel combustion

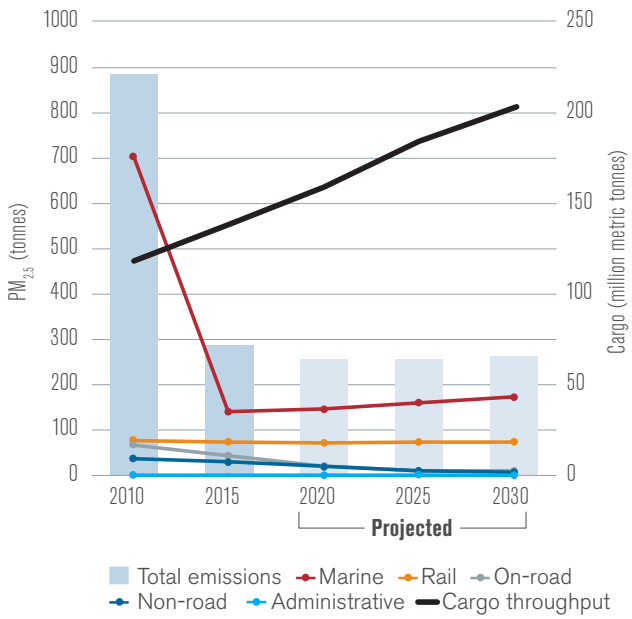
Dust generated from the movement and processing of bulk commodities[1]

Direct impacts

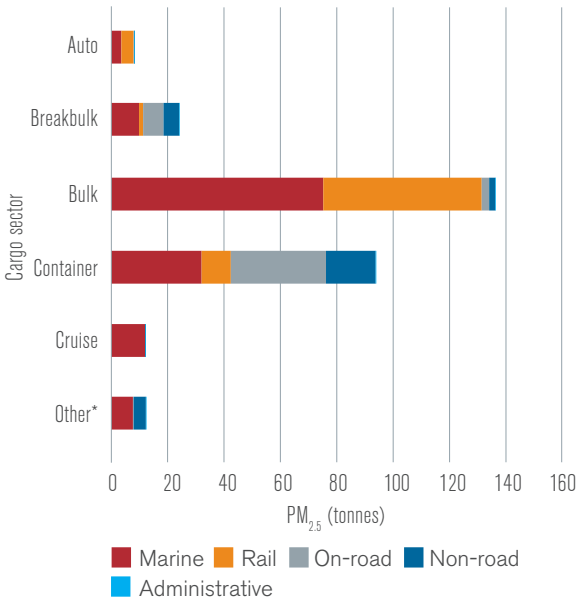
Human health: reduced respiratory and cardiovascular system function, aggravation of asthma, lung cancer, premature death

Environmental: reduced visibility (haze), damage to vegetation, acid precipitation

$PM_{2.5}$ emissions and cargo throughput, 2010-2030



$PM_{2.5}$ emissions by cargo sector and emissions source, 2015



*Includes activities related to movement of domestic goods.

[1] This report includes results of combustion- and electricity-related emissions only.

Volatile organic compound emissions

Total volatile organic compound (VOC) emissions from port activities decreased by three per cent between 2010 and 2015. Emissions are forecast to decrease another nine per cent by 2020. The short term decrease is largely driven by more stringent engine emission limits for on-road vehicles and non-road equipment. However, VOC emissions are forecast to increase after 2020, reaching nearly 2010 levels by 2030. This increase is primarily due to the expected growth in trade and vessel traffic through the port and the lack of new regulatory limits targeting VOC emissions from marine and rail engines and fuels.

The port's two largest cargo sectors, bulk and container, contribute the largest share of VOC emissions. Marine sources contribute the majority of VOC emissions for each cargo sector. Rail activity represents about 34 per cent of VOC emissions in the bulk sector, and on-road vehicles and non-road equipment being used to transport containers are collectively responsible for approximately 48 per cent of the container sector's VOC emissions.

Pollutant

Volatile organic compounds (VOCs) are gaseous chemical compounds that are primarily hydrogen- and carbon-based

Source

Fuel combustion

Evaporation of some fuels during storage and handling[2]

Direct impacts

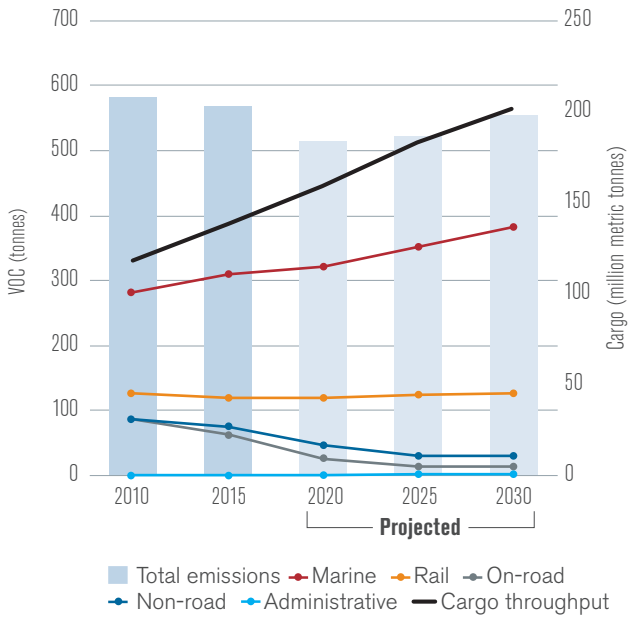
Human health: irritation of airways, headaches; nausea, damage to liver, kidney, and central nervous system, cancer

Environmental: damage to vegetation, odour

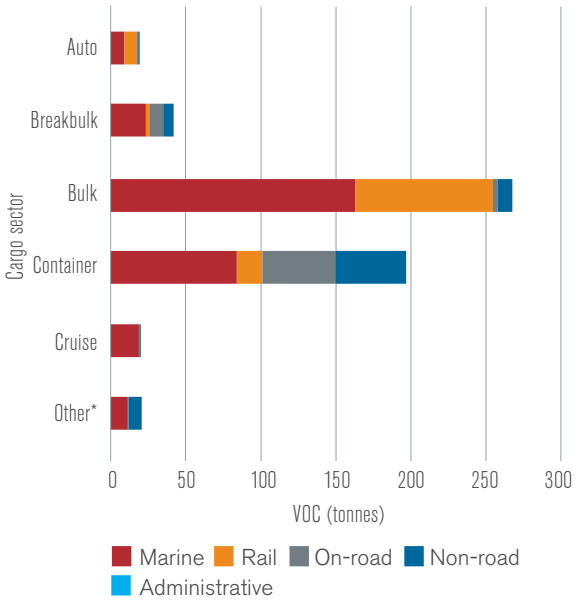
Indirect impacts

Formation of ground-level ozone

VOC emissions and cargo throughput, 2010-2030



VOC emissions by cargo sector and emission source, 2015



*Includes activities related to movement of domestic goods.

[2] This report includes results of combustion- and electricity-related emissions only.

Greenhouse gas emissions

The intensity of port-related greenhouse gas (GHG) emissions – measured as emissions per tonne of cargo – has decreased since 2010. We predict 0.85 kg less GHG emissions will be released per tonne of cargo in 2030 than in 2015. This 11 per cent decrease is due to improvements in engine and equipment efficiency.

From 2010 to 2015, total port-related GHG emissions increased by approximately 14 per cent. At the time of our analysis, no known regulations were forthcoming that would reduce total port-related GHG emissions. Consequently, our forecast shows GHG emissions steadily increasing for the foreseeable future, corresponding to an increase in cargo through the port. However, the International Maritime Organization is currently developing a strategy for GHG emissions reduction in the shipping sector. In addition, the Government of Canada is developing a pan-Canadian framework to reduce GHG emissions that will affect the transportation sector, including ports. These regulatory initiatives will be critical to reducing total GHG emissions associated with port activities.

Pollutant

Greenhouse gases (GHGs), including carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)

Source

Fuel combustion

Evaporation of some fuels during storage and handling[3]

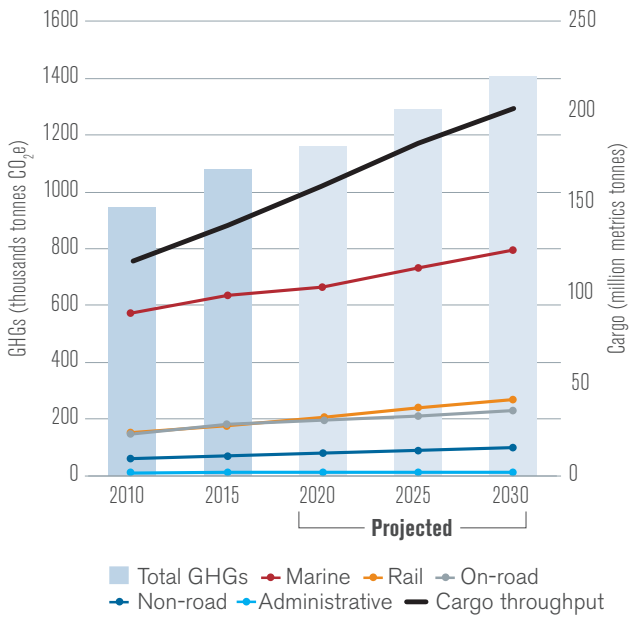
Direct impacts

Environmental: global warming, ocean acidification

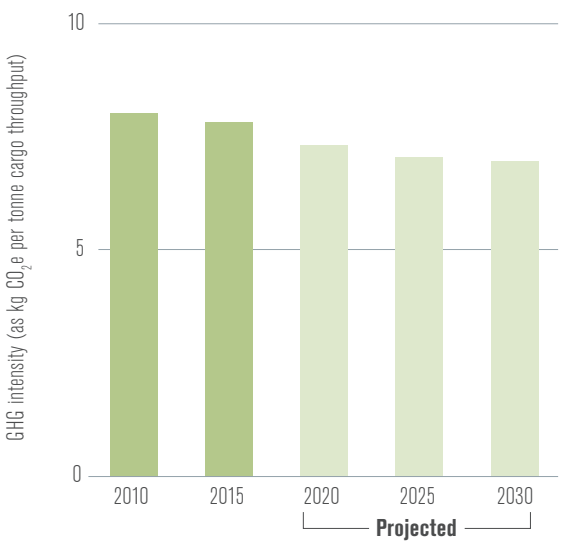
Indirect impacts

Climate change and associated impacts, including sea level rise, more frequent and severe weather events (e.g. heat waves, storms, floods, droughts, forest fires), migration of disease, food and water insecurity, extinction of species

GHG emissions and cargo throughput, 2010-2030



GHG emission intensity, 2010-2030



[3] This report includes results of combustion- and electricity-related emissions only.

Black carbon emissions

Black carbon emissions decreased by 66 per cent between 2010 and 2015 as a result of fuel sulphur regulations that came into effect during this period. Black carbon emissions from ocean-going vessels declined by 79 per cent, and reductions were also achieved from on-road, non-road, rail, harbour tugs and river dredging vessel sources.

Black carbon emissions are forecast to represent 11 per cent of port carbon dioxide equivalent emissions (CO_2e) at least until 2030 on a 100-year global warming potential timeframe.

Global warming potential is a measure of the heat trapping ability of pollutants relative to carbon dioxide and is most commonly estimated based on a 100-year timeframe. Black carbon emissions, however, have a higher global warming potential in the short term, over a 20-year timeframe. This presents an opportunity to reduce the port's contribution to climate change in the short term.

In 2015, black carbon emissions represented about 40 per cent of total CO_2e emissions at a 20-year timeframe. This figure is expected to decrease nine per cent by 2030 largely due to improvements in engine emission controls.

Pollutant

Black carbon is a component of fine particulate matter

Source

Fuel combustion

Direct impacts

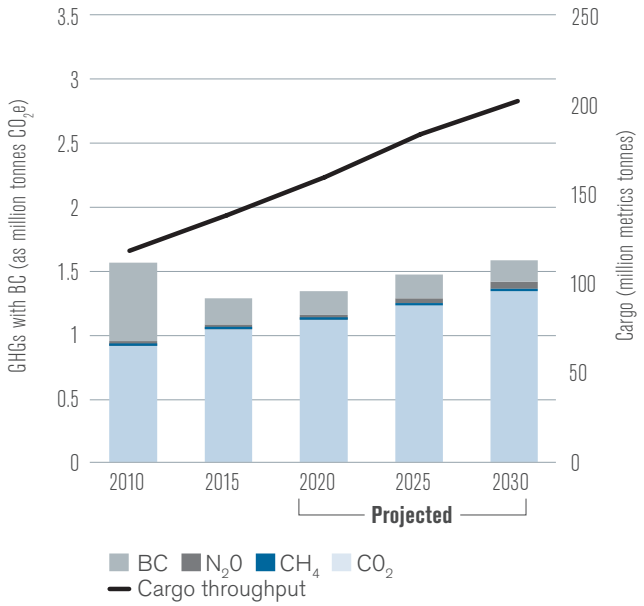
Human health: reduced respiratory and cardiovascular system function, aggravation of asthma, cardiovascular disease, lung cancer, premature death

Environmental: global warming, melting of ice and snow, reduced visibility (haze), damage to vegetation

Indirect impacts

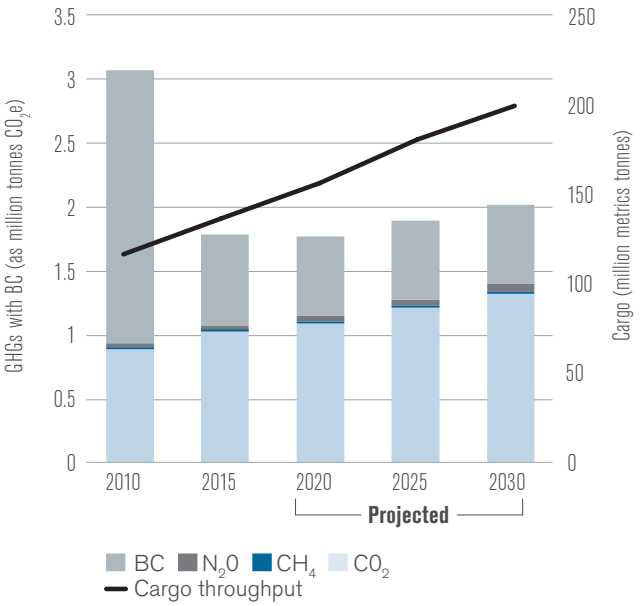
Climate change and associated impacts including sea level rise, more frequent and severe weather events (e.g. heat waves, storms, floods, droughts, forest fires), migration of disease, food and water insecurity, extinction of species

Greenhouse gases with black carbon over a 100-year timeframe, 2010-2030*



*CO_2e 100-year timeframe values: CH_4 at 28, N_2O at 265, black carbon at 900.

Greenhouse gases with black carbon over a 20-year timeframe, 2010-2030*



*CO_2e 20-year timeframe values: CH_4 at 84, N_2O at 264, black carbon at 3,200.

Energy usage

Moving cargo and people requires a lot of energy. Understanding where energy comes from and how it is used is an important part of managing air emissions. In 2015, energy used to move goods at the port was approximately 15 million gigajoules (GJ), roughly equal to the annual energy usage of over 140,000 homes in Canada. Most of this energy comes from fossil fuels that, when burned, release emissions that affect air quality and contribute to climate change.

The bulk and container sectors consume the most energy at the port because they comprise the majority of cargo handled at port terminals. Diesel, including domestic marine fuels, accounts for approximately 48 per cent of the energy used at the port, with ocean-going vessel fuel (bunker fuel) being the other major source of energy at 45 per cent. Although total energy use is forecast to increase, energy use per tonne of cargo has decreased by about three per cent since 2010. This decrease in energy usage is forecast to continue due to improvements in engine and equipment efficiency.

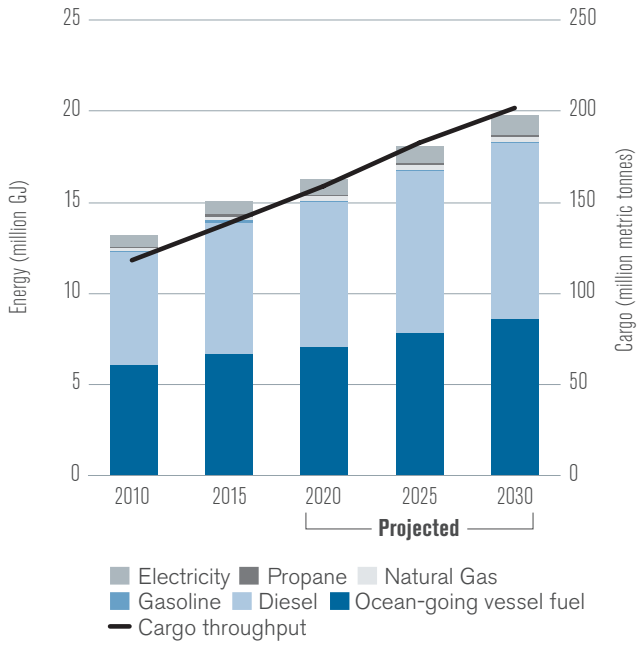
Electrification
Transitioning to low carbon fuels, or energy like hydroelectricity will reduce port greenhouse gas emissions.

Greenhouse gas emissions intensity by fuel type (CO_2e per megajoule of energy)

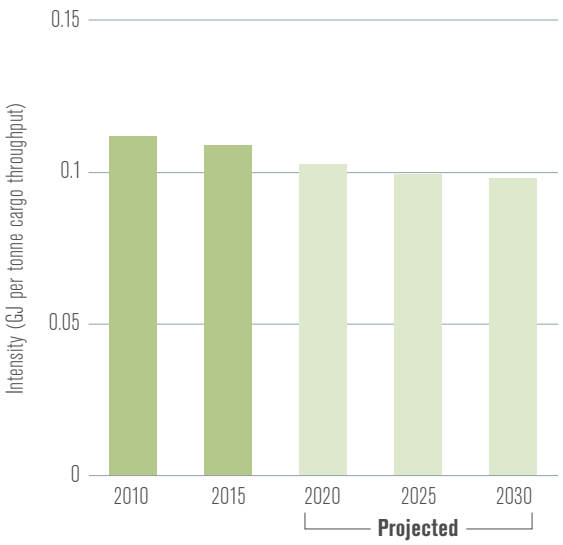
Fuel Type	g CO_2e per MJ
Ocean-going vessel fuel:	
Marine heavy fuel oil	76.01
Marine diesel oil	70.91
Marine gas oil	69.87
Diesel	70.52
Gasoline	70.44
Propane	60.33
Natural gas	57.10
BC Hydro electricity	**5.56**

· US EPA, AP-42: Compilation of Air Emission Factors, Fifth Edition, Volume 1, Appendix A; September 1985
· Environment and Climate Change Canada, National Inventory Report, 1990-2015: GHG Sources and Sinks, Part 2, Annex 5

Energy usage and cargo throughput, 2010-2030



Energy intensity, 2010-2030



Air and energy initiatives

We've implemented a number of initiatives to facilitate emission reductions and help us realize our vision of being the world's most sustainable port.

The port authority's environmental initiatives support important regulatory changes as well as complement and promote voluntary action by industry. The initiatives are specific to the unique conditions in each transportation and cargo sector at the Port of Vancouver. Since launching our first air initiatives in 2007, we have helped raise awareness among port users and reduce emissions that contribute to air pollution and climate change.

We also bring together port users, supply chain partners and other stakeholders to share information, identify opportunities, and implement solutions that improve the efficiency of cargo movements. These efficiency measures often have the added benefit of reducing air emissions through minimizing wait times and unnecessary idling or queuing.

Our environmental initiatives have received external recognition, including a 2017 award from the North American Marine Environment Protection Association.

Read more about our initiatives and performance in our 2016 Sustainability Report at portvancouver.com/sustainability-report

Northwest Ports Clean Air Strategy

We partner with the ports of Seattle and Tacoma and the Northwest Seaport Alliance to reduce port-related air emissions in the shared Georgia Basin-Puget Sound air shed. The overarching goals of the Northwest Ports Clean Air Strategy (NWPCAS), relative to a 2005 baseline, are:

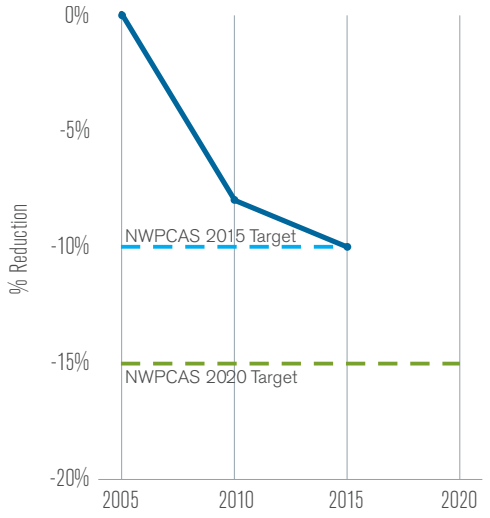
- 75 per cent reduction in diesel particulate matter[4] (DPM) emissions per tonne of cargo by 2015 and 80 per cent by 2020
- 10 per cent reduction in greenhouse gas (GHG) emissions per tonne of cargo by 2015 and 15 per cent by 2020

Based on 2015 emissions inventory data, the Port of Vancouver met the 2015 targets, achieving a 10 per cent reduction in GHG emissions and a 78 per cent reduction in DPM emissions from baseline levels.

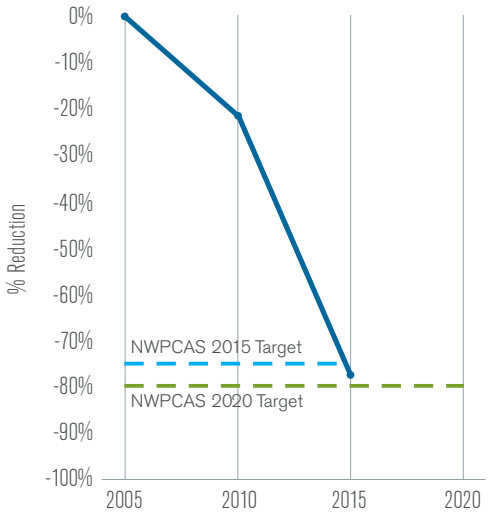
The Northwest Ports Clean Air Strategy benefits from active input from Environment and Climate Change Canada, Metro Vancouver, the Puget Sound Clean Air Agency, the Washington State Department of Ecology, and the U.S. Environmental Protection Agency.

See progress toward these goals in the Northwest Ports Clean Air Strategy annual implementation reports at portvancouver.com/clean-air

GHG emissions intensity (per tonne cargo throughput) relative to NWPCAS targets



DPM emissions intensity (per tonne cargo throughput) relative to NWPCAS targets



[4] Diesel particulate matter is a component of particulate matter, associated with the combustion of diesel fuel specifically.

Ocean-going vessels

Our approach to reducing emissions in ships includes supporting regulations, such as the International Maritime Organization North American Emission Control Area, providing incentives for positive environmental practices through our EcoAction Program, and supporting the use of shore power and cleaner fuels.

EcoAction Program

Our EcoAction Program, launched in 2007, offers discounts on harbour dues to vessels meeting voluntary environmental best practices that reduce emissions and environmental impacts. These practices include the use of cleaner fuels and technologies, and obtaining third-party environmental designations. In 2016, participation in the EcoAction Program grew to 612 vessel calls, representing 24 per cent of all eligible calls for the year. Our Blue Circle Award is given to shipping lines with the greatest proportion of participation in the EcoAction Program. In 2016, 15 shipping lines were awarded.

Shore power

Shore power enables ships at berth to shut off their diesel-powered engines and connect to the electricity grid, significantly reducing emissions that contribute to both air pollution and climate change. Since their installation in 2009, the shore power facilities at the Canada Place cruise terminal have eliminated 474 tonnes of air pollutants and 16,138 tonnes of greenhouse gases. In 2015, in partnership with the Government of Canada and with support from BC Hydro, we embarked on an initiative to develop shore power facilities at the Deltaport and Centerm container terminals. Installations are expected to be complete in 2018.

Liquefied natural gas as a marine fuel

We are working with industry and government to facilitate the use of liquefied natural gas (LNG) as a marine fuel in the Port of Vancouver. In 2016, we conducted a study that suggested the port would start seeing demand for LNG as a marine fuel as early as 2020, which would increase steadily toward 2030. The number of LNG-capable ships is expected to increase globally in response to forthcoming regulations from the International Maritime Organization on sulphur oxide and greenhouse gas emissions. LNG represents an opportunity for the shipping industry to significantly reduce air pollutants, including emissions of sulphur oxides and nitrogen oxides, as well as to achieve more modest reductions in greenhouse gas emissions. We are currently working with academic partners and the Society for Gas as a Marine Fuel to better understand the potential environmental benefits and risks associated with LNG as a marine fuel.

We're adding more ways for ships to plug in and shut off their engines, with new shore power facilities coming online at two container terminals in 2018.

Tenant operations

The port authority leases federal lands and water to over 100 industrial tenants including 27 deep-sea marine terminal operators. We work in partnership with our tenants to reduce diesel particulate matter emissions associated with cargo handling equipment through our Non-Road Diesel Emissions Program, and to promote energy conservation and greenhouse gas (GHG) reductions through our Energy Action and Climate Smart initiatives. We are also exploring low-emission technologies for cargo-handling equipment, such as electric equipment and auto-stop-start engine technology for idle reduction.

Port tenants include 27 deep-sea marine terminals, as well as a range of facilities and services that support international and domestic shipping.

Non-Road Diesel Emissions Program

Since 2015, Port of Vancouver tenants have been required to annually register diesel-powered non-road equipment, report operating hours, and pay a fee for operation of older, higher-emission equipment. To accelerate the transition to newer, cleaner equipment, up to 80 per cent of the fee is eligible for rebate once the tenant replaces, retrofits or retires the older equipment.

Energy Action initiative

Industrial tenants at the Port of Vancouver use more than 1,600[5] gigawatt hours of electricity per year. As Canada's demand for trade grows, more energy will be needed to support port operations. Since power from BC Hydro is largely from low-emission hydroelectric sources, meeting this demand with electricity from the grid can lower GHG emissions. We partner with BC Hydro to provide port tenants with expertise in industrial energy management and access to BC Hydro's financial incentives.

Climate Smart initiative

We work with Vancouver-based social enterprise Climate Smart to provide a training program that supports our tenants in measuring and reducing GHG emissions, complementing their existing efforts. The initiative facilitates a port-focused peer group to share knowledge and practices for minimizing emissions, waste and costs. We provide funding that covers 50 per cent of the cost to participate. In 2015, 11 tenants participated, collectively eliminating 2,788 tonnes of GHG emissions from their operations within the first year, while achieving $670,000 in annual cost savings. In 2016, four new tenants joined the program and several tenants elected to repeat the training to further cut carbon and costs in their operations.

Project and environmental reviews

We require permits for all activities or developments on port lands or waters. Through our Project and Environmental Review process, we review permit applications from proponents and make a determination on the potential environmental impact. We will not authorize or allow a proposed project to proceed if it is likely to result in significant adverse environmental effects. Through this rigorous review process, we work with tenants to encourage or identify opportunities for implementing sustainable practices in their projects, including energy and emissions management.

[5] Figure does not relate to energy figures presented on page 19 due to difference in scope.

Container trucks

We manage emissions from container trucks through our Truck Licensing System environmental requirements. In addition, we work with key stakeholders to improve the efficiency of operations in this sector through actions including extended gate hours, a truck reservation system and the installation of global positioning system units on trucks. Going forward, we are also collaborating with stakeholders to assess the feasibility of low-emission solutions for the trucking sector.

Truck Licensing System

All of the approximately 1,700 container trucks that access the port must enter into a Truck Licensing System agreement that includes environmental requirements for engine age, emission controls and idle reduction. Since 2008, we have phased in the requirement for trucks with engines 2006 and older to have an approved emission control device that reduces particulate matter per truck by 20 to 25 per cent. This enables interim emission reductions as we work toward the Northwest Ports Clean Air Strategy target to have all trucks meet or surpass 2007 particulate matter emission standards by 2017.

Particulate matter emissions from the more than 1,700 container trucks that access the port were reduced by 18% in 2016 as a result of our environmental requirements.

Port authority corporate emissions

We have a number of initiatives designed to reduce greenhouse gas emissions associated with the energy consumption of our own corporate operations. These include our Sort Smart waste management system, employee sustainable commuting initiatives, and lighting and temperature controls. In 2015, corporate greenhouse gas emissions totalled 1,395 tonnes. Port authority operations have been carbon neutral since 2010 through the purchase of carbon offsets.

Read more about our corporate emission reduction programs in our 2016 Sustainability report at portvancouver.com/sustainability-report

Air quality monitoring

An emissions inventory helps us understand the quantity and source of pollutants emitted, but it does not tell us the impact of these pollutants in locations where people live, work and play. For example, pollutants are dispersed by wind and can react with other components to create different pollutants. Ambient air quality monitoring helps us understand the concentration of pollutants in the air at a given location, be it from port or non-port sources. We collaborate with Metro Vancouver and other partners to monitor air quality around the port through the following initiatives:

- Metro Vancouver's T39 air quality station, located at Pebble Hill, Tsawwassen, monitors particulate matter, nitrogen oxides, ozone, sulphur dioxide, carbon monoxide and meteorology. Funded by the port authority, this station has formed part of Metro Vancouver's ambient air monitoring network since 2010 and is used in both Metro Vancouver's regional air assessments as well as our own environmental assessments.
- Tsawwassen First Nation Air Quality Monitoring Program, conducted in 2014 and 2015, included an assessment of air quality on Tsawwassen First Nation lands, compared to Metro Vancouver's T39 air quality station, as well as the contribution of coal to dustfall. The port authority led this study, with input and support from Tsawwassen First Nation, Metro Vancouver and Westshore Terminals.
- Burrard Inlet Local Air Quality Area Study Phase II monitoring began along the south shore of Burrard Inlet in 2014, focusing primarily on particulate matter and sulphur oxides. This was in follow up to the larger Phase I of the program led by Metro Vancouver. We funded the purchase, installation and a portion of the maintenance for this monitoring, which will be used to better understand the effect of port activities on air quality in Burrard Inlet.

We collaborate with Metro Vancouver to monitor air quality in our region, for example, by funding the purchase and installation of new equipment.

Glossary of terms

Term	Description
Administrative operations	Emission source group associated with heating and electricity for buildings on port lands and lighting terminals.
Backcast	Method for estimating past emission levels in 2010 by adjusting 2015 emission estimates based on the expected age of equipment operating at the port, regulatory changes, and trade volumes.
Black carbon	A component of fine particulate matter, black carbon contributes to climate change by absorbing heat from the sun which warms the air, and if deposited on snow and ice, leads to melting. Black carbon is released through incomplete combustion of fossil and bio-based fuels. Black carbon stays in the atmosphere for a much shorter time period than greenhouse gases and has a greater impact on climate change during that period.
Carbon dioxide equivalent (CO_2e)	Carbon dioxide equivalent is a standard unit of measure used to compare different types of greenhouse gas emissions and black carbon based on their global warming potential..
Cargo sector	Category of goods transported through the port, including bulk, breakbulk, container, and cruise.
Diesel particulate matter (DPM)	A component of particulate matter that comes from the combustion of diesel fuel.
Emission factor	Emission factors are representative values relating the quantity of an emission with an activity, such as fuel combustion. The most common approach for estimating emissions, the value of an emission factor depends on engine age and technology, fuel type, and operating conditions. The 2015 port emissions inventory uses Canadian and industry-specific emission factors where available, including the U.S. Environmental Protection Agency, Environment and Climate Change Canada, Railway Association of Canada, and BC Hydro.
Forecast	Method for estimating future emission levels in 5-year increments to 2030 by adjusting 2015 emission estimates based on the expected age of equipment operating at the port, regulatory changes and expected or assumed increases in cargo handled at port terminals.
Greenhouse gas (GHG)	Group of gases, including carbon dioxide, methane and nitrous oxide, that causes global warming and contributes to climate change.
Ground-level ozone	A secondary pollutant formed by the reaction of volatile organic compounds and nitrogen oxides. It is a major component of smog, can damage synthetic materials, and can impact vegetation and decrease the productivity of some crops. Exposure has been linked to pre-mature mortality.
International Maritime Organization (IMO)	A specialized agency of the United Nations, IMO is the global standard-setting and regulatory authority for the safety, security and environmental performance of international shipping.
Liquefied natural gas (LNG)	Natural gas that has been converted to liquid form in order to increase its energy density and for ease of storage or transport.

Term	Description
Marine	Emissions source group that includes ocean-going vessels, harbour tugs, and dredging vessels.
Nitrogen oxides (NO_x)	A mixture of compounds that contain nitrogen and oxygen.
Non-road equipment	Emission source group of equipment not intended for transportation on public roads, includes cranes, container stackers, loaders, terminal tractors, and forklifts.
North American Emission Control Area (ECA)	Designated by the International Maritime Organization in 2010, the Emission Control Area requires stringent emission standards for ships in waters off North American coasts. The first and second phase fuel sulfur standards began in 2012 and 2015 respectively, and stringent nitrogen oxides engine standards for new build-vessels began in 2016.
On-road vehicles	Emission source group that includes container trucks, heavy duty trucks, terminal support vehicles, and passenger transportation.
Particulate matter (PM)	A mixture of solid particles and liquid droplets in the air. Fine inhalable particles with diameters that are generally 2.5 micrometers and smaller are referred to as fine particulate matter ($PM_{2.5}$).
Rail	Emission source group that includes locomotives that move trains as part of port operations.
Shore power	The provision of shoreside electrical power to a ship at berth while its main and auxiliary engines are shut down, effectively reducing emissions.
Smog	A noxious mixture of gases and particles that often appears as a haze in the air and has been linked to a number of adverse effects on health and the environment. The two primary pollutants in smog are ground-level ozone and particulate matter.
Sulphur oxides (SO_x)	A mixture of compounds that contain sulphur and oxygen.
Throughput	The amount of cargo traded through the Port of Vancouver.
Volatile organic compound (VOC)	A group of compounds that contain primarily hydrogen and carbon.

Data tables

2015 Air pollutants (tonnes)

Cargo sector	Source	SO_X	NO_X	$PM_{2.5}$	VOC	NH_3	CO
Auto	Marine	6.973	261.349	3.469	9.068	0.479	23.955
	Rail	0.084	170.049	4.532	8.500	0.237	24.094
	On-road	0.022	2.839	0.124	0.650	0.118	10.523
	Non-road	0.002	1.281	0.014	1.208	0.002	30.076
	Administrative	0.012	0.219	0.032	0.048	0.029	0.368
Breakbulk	Marine	21.852	648.325	9.869	23.612	1.152	63.261
	Rail	0.027	46.941	1.309	2.126	0.082	7.648
	On-road	0.214	152.840	7.437	9.263	0.580	50.091
	Non-road	0.064	70.877	5.593	7.122	0.124	55.022
	Administrative	0.035	0.650	0.096	0.143	0.087	1.092
Bulk	Marine	129.644	4,591.144	75.414	163.243	9.939	537.883
	Rail	1.181	2,027.550	56.174	91.368	3.780	334.683
	On-road	0.106	50.953	2.680	3.188	0.261	16.152
	Non-road	0.102	57.121	2.312	9.842	0.131	119.482
	Administrative	0.067	1.258	0.186	0.276	0.168	2.109
Container	Marine	70.273	2,365.135	32.113	84.020	4.013	211.589
	Rail	0.211	375.096	10.391	17.253	0.634	59.924
	On-road	0.547	716.657	33.820	48.323	1.959	302.037
	Non-road	0.374	236.487	17.588	47.164	0.728	163.191
	Administrative	0.049	0.911	0.134	0.201	0.122	1.531
Cruise	Marine	35.622	696.172	11.969	18.642	3.346	50.406
	Rail	–	–	–	–	–	–
	On-road	0.039	2.263	0.084	0.884	0.219	17.906
	Non-road	0.004	0.442	0.040	0.045	0.002	0.675
	Administrative	0.013	0.247	0.036	0.054	0.033	0.414
Other	Marine	0.672	434.713	7.630	11.515	0.936	75.413
	Rail	–	–	–	–	–	–
	On-road	0.019	6.633	0.324	0.506	0.066	4.819
	Non-road	0.045	52.177	4.348	8.853	0.080	111.714
	Administrative	0.017	0.321	0.047	0.071	0.043	0.540
Total per source	Marine	265.037	8,996.837	140.464	310.101	19.865	962.507
	Rail	1.503	2,619.635	72.405	119.246	4.732	426.349
	On-road	0.947	932.186	44.468	62.815	3.202	401.528
	Non-road	0.591	418.384	29.894	74.234	1.067	480.160
	Administrative	0.193	3.606	0.532	0.793	0.483	6.054
Total emissions		268	12,971	288	567	29	2,277

Note: Summing table numbers may not equal totals due to rounding.

2015 Greenhouse gas emissions (tonnes)

Cargo sector	Source	CO_2	CH_4	N_2O	Black Carbon	CO_2e* (100 yr)	Energy consumption (annual GJ)
Auto	Marine	14,520	1.122	0.832	2.518	14,772	194,678
	Rail	9,056	0.507	3.715	3.598	10,055	131,717
	On-road	1,507	0.174	0.331	0.060	1,600	22,481
	Non-road	124	0.143	0.004	0.004	129	2,111
	Administrative	563	2.477	0.019	0.013	637	20,597
Breakbulk	Marine	44,059	3.435	2.007	7.577	44,687	589,136
	Rail	2,906	0.163	1.192	1.039	3,226	42,266
	On-road	35,928	1.890	1.497	5.696	36,378	510,609
	Non-road	7,363	0.555	2.868	4.342	8,139	111,807
	Administrative	1,805	7.387	0.065	0.038	2,029	93,447
Bulk	Marine	324,279	23.858	38.067	58.923	335,035	4,408,349
	Rail	127,164	7.114	52.168	47.293	141,188	1,849,290
	On-road	15,239	0.895	0.978	1.944	15,523	221,919
	Non-road	8,389	1.237	2.506	1.718	9,088	399,092
	Administrative	3,413	12.546	0.115	0.073	3,795	143,338
Container	Marine	137,521	10.815	4.721	23.604	139,075	1,834,088
	Rail	22,737	1.272	9.328	8.248	25,245	330,704
	On-road	124,518	5.800	0.709	26.809	124,868	1,703,788
	Non-road	43,341	4.698	16.642	13.552	47,883	698,924
	Administrative	2,656	10.052	0.096	0.053	2,963	157,867
Cruise	Marine	69,052	5.446	2.119	10.017	69,766	920,150
	Rail	–	–	–	–	–	–
	On-road	2,162	0.304	0.627	0.006	2,337	32,590
	Non-road	100	0.030	0.015	0.027	105	1,602
	Administrative	649	2.794	0.022	0.014	733	26,641
Other	Marine	28,775	1.623	11.466	6.386	31,859	416,247
	Rail	–	–	–	–	–	–
	On-road	2,240	0.159	0.219	0.229	2,302	32,781
	Non-road	4,704	0.769	1.694	3.400	5,174	68,596
	Administrative	986	3.649	0.038	0.019	1,099	68,926
Total per source	Marine	618,204	46.299	59.213	109.025	635,192	8,362,649
	Rail	161,863	9.055	66.402	60.178	179,713	2,353,977
	On-road	181,594	9.222	4.361	34.744	183,008	2,524,169
	Non-road	64,021	7.431	23.728	23.044	70,517	1,282,131
	Administrative	10,073	38.906	0.354	0.209	11,256	510,817
Total emissions		1,035,755	111	154	227	1,079,686	15,033,743

*CO_2e reported in table includes CO_2, CH_4, and N_2O, and excludes black carbon.
Note: Summing table numbers may not equal totals due to rounding.

Our mission

To enable Canada's trade objectives, ensuring safety, environmental protection and consideration for local communities.

Our vision

To be the world's most sustainable port.

Our definition of a sustainable port

A sustainable port delivers economic prosperity through trade, maintains a healthy environment, and enables thriving communities, through collective accountability, meaningful dialogue and shared aspirations.

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