

Inadequate Pollution Control in Canadian Refineries: Media Backgrounder

Notes about the method

This memo summarizes the results of our analysis of six¹ cycles of [benchmarking data](#) provided by Environment and Climate Change Canada (“ECCC”).

The [benchmarking data](#) uses a statistical methodology reviewed by Statistics Canada to compare air pollution emissions from oil refineries in Canada to US oil refineries.²

Specifically, the data compares emissions from the 15 Canadian refineries presently in operation against benchmarks calculated from emissions from up to 99 US refineries. The most recent data cycle compares 2015 emissions from Canadian refineries and benchmarks based on 2014 emissions from US refineries.

The [benchmarking data](#) compares emissions of six contaminants: sulphur dioxide (SO₂), nitrogen oxides (NO_x), particulate matter (PM_{2.5} and PM₁₀), carbon monoxide (CO), volatile organic compounds (VOCs) and benzene. In comparing emissions of these contaminants from Canadian and US refineries, ECCC specifically accounted for differences in refinery type and throughput for all contaminants except CO and benzene.

Based on this federally validated refinery [benchmarking data](#), we calculated the percentage of emission reductions each Canadian refinery must make to meet their US benchmarks for each cycle for each pollutant. We also looked for trends over time. We calculated the ratio of the emissions to their US benchmarks. We did not analyse particulate matter 10 (PM₁₀) because it encompasses particulate matter 2.5 (PM_{2.5}) and appears to show similar results.

In the results below, we ranked each Canadian refinery by the amount of mass reduction in emissions needed to meet their US benchmark. We classify the refinery needing the greatest mass reductions as the “worst” for each pollutant. We also analyze whether the emissions from any Canadian refinery moved closer to their US benchmarks over time and whether the percentage of emissions reductions required to meet US benchmarks decreased over time (i.e., whether any Canadian refinery shows an

¹ Note that we have not analyzed data for carbon monoxide or particulate matter 2.5 from 2006, as such data was not circulated to stakeholders. Although data was provided for all years but 2006 for particulate matter 10, we only analyzed particulate matter 2.5, as explained above.

² The benchmarking analysis assumes that a relationship exists between refinery emissions and refinery throughput. All pollutants, with the exception of carbon monoxide (CO) and benzene (C₆H₆), use crude throughput in measuring emission performance. For CO emissions, the refineries are grouped based on their use of CO Boilers for their cracking and coking processes. For refineries with CO Boilers, the cumulative capacities of the fluid coking and cracking processes are used as an operating parameter instead of crude throughput. All benzene emissions are measured against the reformer and aromatics capacity, and are grouped based on the availability of aromatics extraction capacity. For sulphur dioxide (SO₂) the benchmarking separates refineries into those with coking processes and those with only cracking processes.

“improving trend”) and noted that in the discussion. We also noted the refineries with emissions below their US benchmarks.

Summary of findings

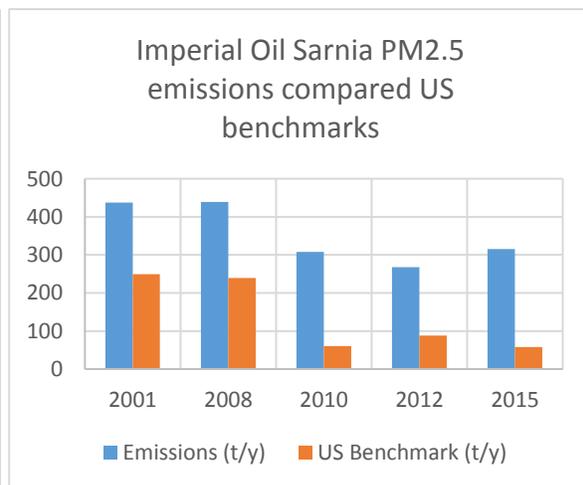
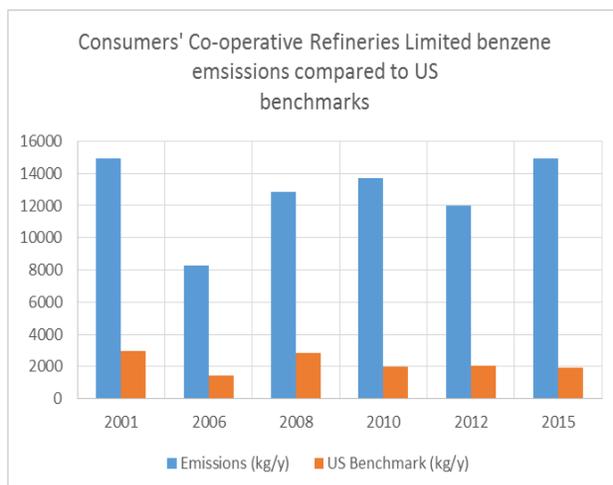
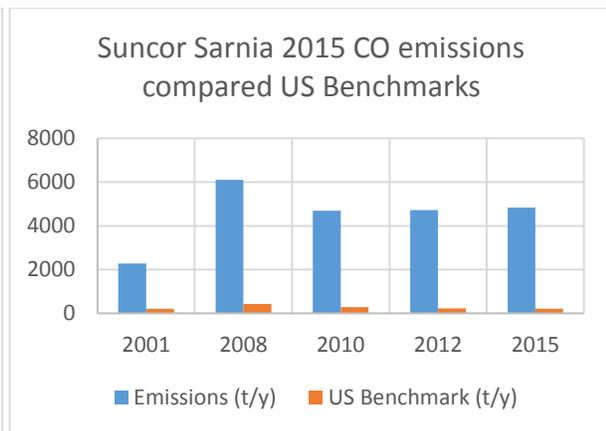
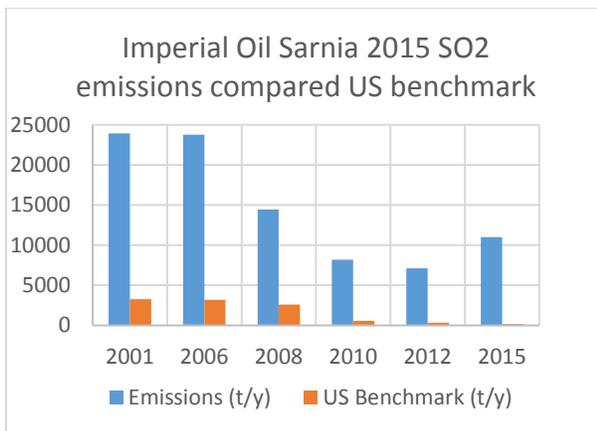
In 2015, the Imperial Oil refinery in Sarnia, Ontario was the worst Canadian refinery for SO₂, PM_{2.5}, and NO_x emissions as compared to the US benchmark.

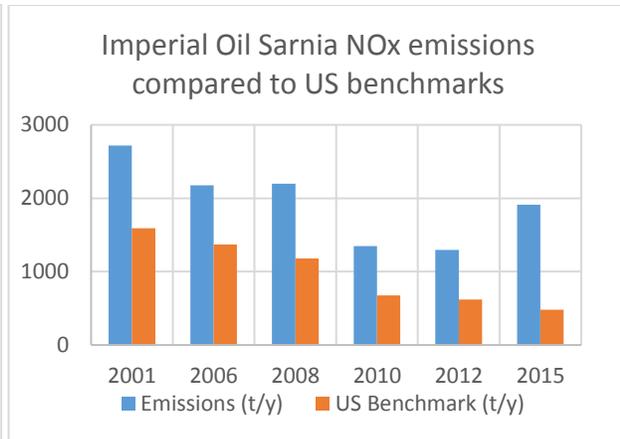
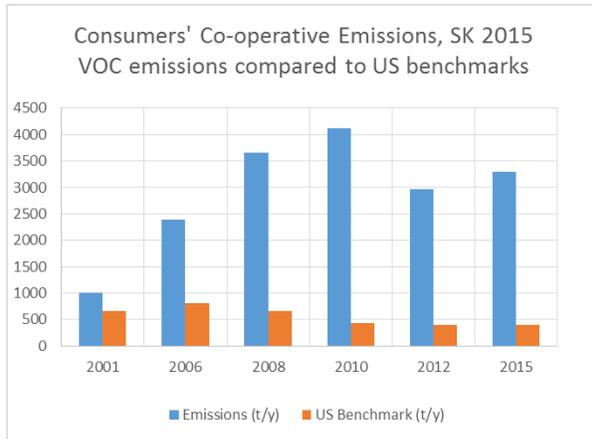
The Consumers’ Co-operative Refining Limited refinery (now Co-op Refinery Complex) in Saskatchewan was the worst Canadian refinery for benzene and VOC emissions as compared to the US benchmark.

The Suncor refinery in Sarnia was the worst Canadian refinery for CO emissions as compared to the US benchmark.

No pollutants emitted by Canadian refineries showed a clear trend of reductions that would bring them closer to the US benchmarks. Some got worse, in that the gap between emissions from the Canadian refinery and the relevant US benchmark increased. It is important to note the US benchmarks may have decreased over time as US refineries improved, making the benchmarks a moving target.

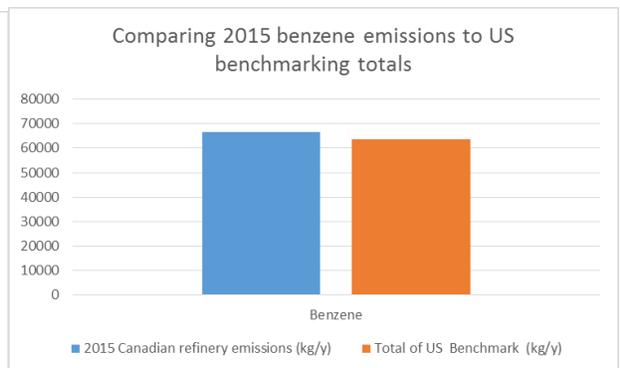
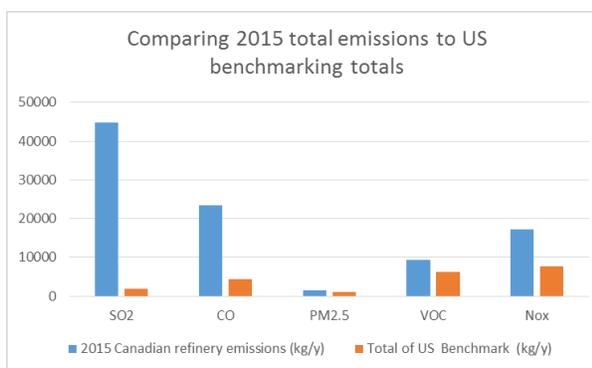
The graphs below depict the emissions versus benchmark for the worst Canadian refinery in 2015 for each pollutant through the [benchmarking](#) cycles.



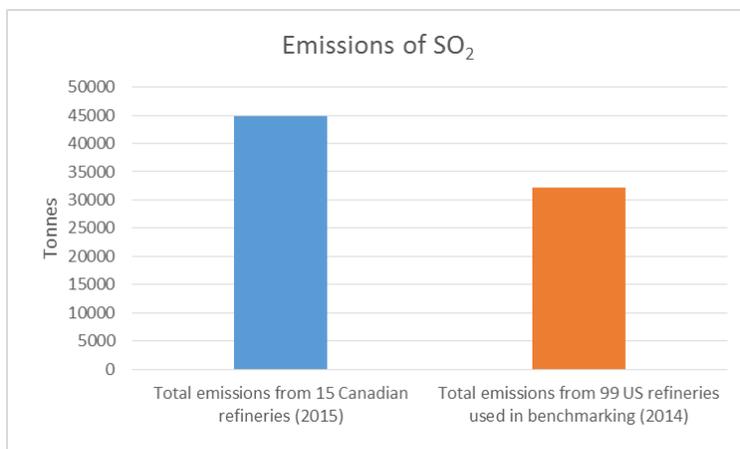


Graph comparison of 2015 totals to US benchmark totals

These graphs compare the total 2015 emissions from all 15 Canadian refineries to the total of the 15 benchmarks calculated from the 2014 emissions of up to 99 US refineries. The biggest gap between the Canadian refineries and US benchmarks is in SO₂ emissions, followed by CO and NOx.



Canadian refineries are so far behind in controlling SO₂ emissions compared to their US counterparts that the total SO₂ emissions from all 99 US refineries used to establish the benchmarks is less than the total emissions from the 15 Canadian refineries.



Some background on each pollutant

All six pollutants analysed have been linked with negative human health impacts. A recent [assessment](#) from Health Canada concluded that even short term exposure to elevated SO₂ levels can cause respiratory problems in adults, particularly those with asthma, and in children. NO_x includes the gases nitrogen oxide (NO) and nitrogen dioxide (NO₂), but NO emitted during combustion quickly oxidizes to NO₂ in the atmosphere. NO₂ in the air forms acid that, when inhaled, adversely effects respiratory systems. Ground level ozone is a component of smog that forms via a chemical reaction between NO_x and VOCs in the presence of sunlight. Benzene is a VOC and a known human carcinogen.

PM₁₀ is particulate matter 10 micrometres or less in diameter, and is also known as inhalable particulates. PM₁₀ also includes PM_{2.5}, which is particulate matter 2.5 micrometres or less in diameter. PM_{2.5} is known to negatively impact the heart and lungs, and can cause asthma attacks, chronic bronchitis, and heart attacks. Finally, exposure to CO can cause breathing difficulties, impaired motor functions and, in severe cases, death. Exposure to CO has also been linked to cardiovascular diseases like angina. SO₂ and NO_x in aerosol form can contribute to overall PM₁₀ and PM_{2.5}.

Policy Background

Efforts to bring air pollution emissions from Canadian refineries in line with US refineries began 17 years ago, through a joint federal-provincial process under the Canadian Council of Ministers of the Environment (CCME). The National Framework for Petroleum Refinery Emission Reductions (NFPRER) began in 2001 and ended in 2015. A [CCME report](#) from 2005 includes [benchmarking](#) results based on 2001 emissions data. Data from 2015 shows that 14 years later, many Canadian refinery emissions were still significantly higher than their American counterparts.

The performance of Canadian oil refineries relative to refineries in the US has been assessed multiple times over the past 10 years.³ Results have consistently shown a large gap between many Canadian refineries relative to the midpoint of their US counterparts.

US refineries' emissions are regulated under the US Clean Air Act. There is no federal equivalent in Canada. In October 2012, the CCME agreed to implement a Canada-wide [Air Quality Management System](#) (AQMS), with the federal government regulating refineries' emissions using tools such as the *Canadian Environmental Protection Act, 1999* (CEPA).

In June 2016, the federal government finalized the [Multi-sector Air Pollutants Regulations \(SOR/2016-151\)](#) under CEPA, but for oil refineries they are limited to the regulation of NO_x emissions from new engines. [A rule has been proposed to reduce VOC leaks](#) from refineries. No emissions requirements have been proposed for SO₂, PM_{2.5} or CO emissions. The federal government has taken no further regulatory action under CEPA to reduce industrial air pollution emissions from refineries under the AQMS program.

In June 2017, the House of Commons Standing Committee on Environment and Sustainable Development released a report recommending sweeping changes to CEPA, which has not been

³[Benchmarking](#) was conducted assessing Canadian refinery emissions from 2001, 2006, 2008, 2010, 2012 and 2015.

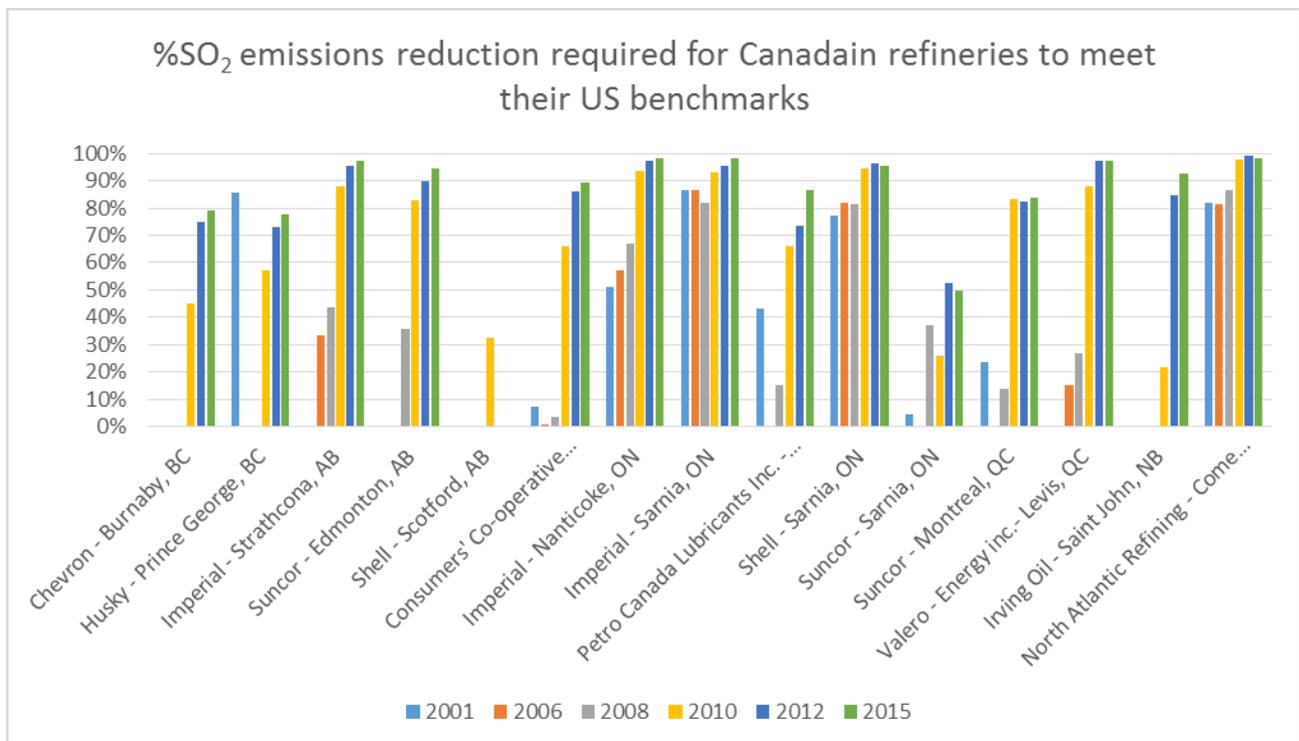
substantially amended in nearly 20 years. Minister McKenna has committed to considering these recommendations and responding by June 2018. The utter failure after 17 years to bring Canadian refineries' emissions in line with those in US is one of the many examples of the federal government's failure to regulate pollution and toxic chemicals to protect the environment and human health.

This failure affects some communities more than others. Socially marginalized and biologically vulnerable Canadians, such as women, children, low-income families, and Indigenous communities, bear more than their fair share of the risks of exposure to pollution and toxics. When it comes to the failure to reduce emissions from Canadian refineries, people who live near these facilities, such as residents of Aamjiwnaang First Nation and other communities near Sarnia's Chemical Valley, are particularly at risk.

Pollutant-by-Pollutant Analysis

Sulphur dioxide (SO₂)

The gap between Canadian and US refineries is most pronounced with respect to the pollutant SO₂. The degree of reductions Canadian refineries must make to meet their US benchmarks have increased over time, as shown in the graph below.



Of the 15 refineries, 14 are releasing far more SO₂ than a midpoint comparable US refinery, with Imperial Oil's Sarnia refinery performing the worst. Based on 2015 data, Imperial Oil in Sarnia would require a 98.4% reduction in SO₂ emissions to meet their US benchmark, but a few others are almost as bad. The Imperial Oil refinery in Sarnia emitted 62.5 times more SO₂ than a midpoint comparable

refinery in the US. All three refineries in Sarnia exceeded their US benchmarks, and SO₂ reductions required to meet the benchmarks ranged from 98% to 50%.

Comparison of totals

The total SO₂ emissions from refineries in Canada were 44791 tonnes in 2015 compared to a total of 15 US benchmarks of 1912 tonnes.

Refinery	Province	Number of times (multiples) the SO ₂ emissions are above US benchmark	Reduction in SO ₂ emissions required to meet benchmark based on US refineries (t/y)	Percentage reduction in SO ₂ emissions required to meet benchmark based on US refineries	Ranking by percentage SO ₂ emissions are above benchmark based on US refineries
Imperial – Sarnia	ON	62.5	10,831	98%	1
North Atlantic Refining – Come by Chance	NF	56.9	6,436	98%	2
Imperial – Nanticoke	ON	50.5	5,790	98%	3
Valero - Energy Inc. – Levis	QC	39.5	5,004	97%	4
Imperial – Strathcona	AB	34.3	4,210	97%	5
Shell – Sarnia	ON	20.7	2,171	95%	6
Suncor – Edmonton	AB	18.4	3,224	95%	7
Irving Oil – Saint John	NB	13.6	1,688	93%	8
Consumers' Co-operative Refineries Limited – Regina (now Co-op Refinery Complex)	SK	9.6	1,561	90%	9
Petro Canada Lubricants Inc. – Mississauga	ON	7.5	605	87%	10

Suncor – Montreal	QC	6.1	612	84%	11
Chevron – Burnaby (now Parkland Burnaby Refinery)	BC	4.8	399	79%	12
Husky Energy – Prince George	BC	4.5	299	78%	13
Suncor – Sarnia	ON	2.0	111	50%	14

Note: SO₂ emissions from the Shell Refinery in Scotford, Alberta were below their US benchmark

Carbon Monoxide (CO)

Of the 15 Canadian refineries, 14 exceeded their US benchmarks for CO in 2015. The worst refinery was Suncor in Sarnia, which would require a 96% reduction in CO emissions to meet their US benchmark. Suncor in Sarnia emitted 23.4 times more CO than a midpoint comparable refinery in US, requiring a 96% reduction. Analyses of the multiple benchmark cycles show that Suncor’s CO emissions have moved further from their US benchmarks over time, while others such as Husky Energy in Prince George BC and Verlo Energy Inc. in Levis, QC have moved closer to their US benchmarks. Nine of the 15 refineries require more than a 50% reduction in CO emissions to meet their US benchmarks.

Comparison of totals

The total CO emissions from all refineries in Canada were 23511 tonnes in 2015 compared to a total of 15 US benchmarks of 4381 tonnes.

Refinery	Province	The number of times (multiples) the CO emissions are above US benchmark	Reduction in CO emissions required to meet benchmark based on US refineries (t/y)	Percentage reduction in CO emissions required to meet benchmark based on US refineries	Ranking by percentage CO emissions are above benchmark based on US refineries
Suncor – Sarnia	ON	23.4	4636	96%	1
Imperial – Nanticoke	ON	17.2	5888	94%	2
Imperial – Strathcona	AB	9.4	3584	89%	3
Irving Oil – Saint John	NB	8.4	1796	88%	4
Shell – Scotford	AB	3.2	736	69%	5

Suncor – Edmonton	AB	3.2	715	68%	6
Suncor – Montreal	QC	2.4	418	59%	7
Imperial – Sarnia	ON	2.4	571	59%	8
Consumers' Co-operative Refineries Limited – Regina (now Co-op Refinery Complex)	SK	2.4	504	58%	9
Shell – Sarnia	ON	1.8	167	43%	10
North Atlantic Refining – Come By Chance	NL	1.3	108	26%	11
Valero - Energy Inc. – Levis	QC	1.2	80	16%	12
Chevron – Burnaby (now Parkland Burnaby Refinery)	BC	1.1	24	10%	13
Husky Energy – Prince George	BC	1.1	6	8%	14

Note: CO emissions from the Petro Canada Lubricants Inc. refinery in Mississauga, Ontario were below their US benchmark.

Benzene

Of the 15 Canadian refineries, eight exceeded their US benzene benchmarks in 2015. The worst refinery for benzene emissions was Consumers' Co-operative Refineries Limited (now Co-op Refinery Complex) in Saskatchewan, and their gap with their US benchmarks increased over time. Consumers' Co-operative Refineries Limited (now Co-op Refinery Complex) emitted 7.7 times more benzene in 2015 than a midpoint comparable refinery in US, requiring an 87% emissions reduction to meet the US benchmarks. Imperial Oil in Sarnia also exceeded their US benchmarks in 2015, while Suncor and Shell in Sarnia were below.

Comparison of totals

The total benzene emissions from all refineries in Canada were 66712 kg in 2015, only slightly above the total of 15 US benchmarks of 63586 kg.

Refinery	Province	Number of times (multiples) the benzene emissions are above US benchmark	Reduction in benzene emissions required to meet benchmark based on US refineries (kg/yr)	Percentage reduction in benzene emissions required to meet benchmark based on US refineries	Ranking by percentage benzene emissions are above benchmark based on US refineries
Consumers' Co-operative Refineries Limited – Regina (now Co-op Refinery Complex)	SK	7.7	13022	87%	1
Husky – Prince George	BC	4.5	2986	78%	2
Imperial – Sarnia	ON	2.5	4832	60%	3
North Atlantic Refining – Come By Chance	NL	1.6	1600	36%	4
Imperial – Strathcona	AB	1.6	1308	36%	5
Valero - Energy Inc. – Levis	QC	1.4	0	30%	6
Imperial – Nanticoke	ON	1.2	705	19%	7

Suncor – Edmonton	AB	1.1	191	10%	8
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Note: Benzene Emissions from the Petro Canada Lubricants Inc. in Mississauga, ON; Chevron refinery in Burnaby (now Parkland Burnaby Refinery), BC; Suncor refinery in Montreal, QC; Shell and Suncor refineries in Sarnia, ON; Irving Oil refinery in Saint John, NB; and Shell refinery in Scotford, AB were below their US benchmarks.

Particulate Matter (PM_{2.5})

Of the 15 Canadian refineries, seven exceeded their US PM_{2.5} benchmarks. The Imperial Oil refinery in Sarnia emitted 5.4 times more PM_{2.5} than a midpoint comparable refinery in the US, and would have to reduce its PM_{2.5} emissions by 82% to meet the emissions of a midpoint comparable refinery in the US. Furthermore, Imperial Oil’s PM_{2.5} emissions have trended further from the US benchmark over the years. The Shell refinery in Sarnia was the fourth-worst nationally, emitting 2.4 times the amount of a midpoint comparable refinery in the US and requiring a 57% emissions reduction to meet the emissions of a midpoint comparable US refinery. Suncor in Sarnia released less PM_{2.5} than a midpoint comparable refinery in the US.

Some other refineries have either gotten worse or not shown improvements through the [benchmarking](#) cycles. These include Consumers’ Cooperative Refineries (now Co-op Refinery Complex) in Regina, SK; North Atlantic Refining in Come by Chance, NL; Irving Oil in Saint John, NB; and Suncor Energy in Edmonton, AB.

Comparison of totals

The total PM_{2.5} emissions from all refineries in Canada were 1421 tonnes in 2015, compared to the total of 15 US benchmarks of 951 tonnes.

Refinery	Province	Number of times (multiples) the PM _{2.5} emissions are above US benchmark	Reduction in PM _{2.5} emissions required to meet benchmark based on US refineries (t/y)	Percentage reduction in PM _{2.5} emissions required to meet benchmark based on US refineries	Ranking by percentage PM _{2.5} emissions are above benchmark based on US refineries
Imperial – Sarnia	ON	5.5	258	82%	1

Consumers' Co-operative Refineries Limited – Regina (now Co-op Refinery Complex)	SK	2.7	106	63%	2
North Atlantic Refining – Come by Chance	NL	2.5	76	60%	3
Shell – Sarnia	ON	2.4	57	58%	4
Irving Oil – Saint John	NB	1.6	88	36%	5
Suncor – Edmonton	AB	1.5	32	34%	6
Chevron – Burnaby (now Parkland Burnaby Refinery)	BC	1.1	2	5%	7

Note: PM_{2.5} emissions from Imperial Oil refinery in Strathcona, AB; Husky Energy refinery in Prince George, BC; Shell refinery in Scotford, AB; Imperial Oil refinery in Nanticoke, ON; Petro Canada Lubricants Inc. in Mississauga, ON; Suncor refinery in Sarnia, ON; Suncor refinery in Montreal, QC; and Valero Energy Inc. refinery in Levis, QC were below their US benchmarks .

Volatile Organic Compounds (VOCs)

Of the Canadian 15 refineries, eight exceed their US VOC benchmarks, but only four did so by a significant margin. Based on 2015 data, the Consumers' Co-operative Refineries Limited refinery (now Co-op Refinery Complex) in Regina, Saskatchewan performed the worst, and would require an 88% reduction in VOC emissions to meet their US benchmark. Consumers' Co-operative Refineries Limited (now Co-op Refinery Complex) emitted 8.2 times more VOCs in 2015 than a midpoint comparable refinery in US. Based on 2015 data, the worst Sarnia refinery was Imperial Oil. The gap between emissions from these two refineries and US benchmarks has generally increased over time. In other words, these two refineries have fallen increasingly further behind US benchmarks since 2001.

Comparison of totals

The total VOC emissions from all refineries in Canada were 9246 tonnes in 2015, compared to the total of 15 US benchmarks of 6209 tonnes.

Refinery	Province	Number of times (multiples) the VOC emissions are above US benchmark	Reduction in VOC emissions required to meet benchmark	Percentage reduction in VOC emissions required to meet benchmark	Ranking by percentage VOC emissions are above benchmark based on US refineries
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			based on US refineries (t/y)	based on US refineries	
Consumers' Co-operative Refineries Limited – Regina (now Co-op Refinery Complex)	SK	8.2	2899	88%	1
Suncor – Edmonton	AB	1.8	310	43%	2
North Atlantic Refining – Come by Chance	NL	1.3	117	24%	3
Husky Energy – Prince George	BC	1.3	67	24%	4
Imperial – Nanticoke	ON	1.3	102	21%	5
Imperial – Sarnia	ON	1.0	26	4%	6
Valero - Energy Inc. – Levis	QC	1.0	21	4%	7
Imperial – Strathcona	AB	1.0	4	1%	8

Note: VOC emissions from the Chevron refinery in Burnaby, BC (now Parkland Burnaby Refinery); Shell in Scotford, AB; Petro Canada Lubricants Inc., in Mississauga, ON; Shell in Sarnia, ON; Suncor in Sarnia, ON; Suncor in Montreal, QC; and Irving Oil in Saint John, NB were below their US benchmarks.

Oxides of Nitrogen (NOx)

Of the Canadian 15 refineries, 13 exceed their US NOx benchmarks based on 2015 data. The worst with respect to NOx emissions was Imperial Oil in Sarnia, Ontario which would require a 75% reduction in NOx emissions to meet the US benchmark. The Imperial Oil refinery in Sarnia emitted 4 times more NOx than a midpoint comparable refinery in US. The Suncor and Shell refineries in Sarnia emitted twice the amount of a midpoint comparable refinery in the US.

The most recent benchmark analysis from 2015 shows the highest gap between NOx emissions compared to US benchmarks for all but one of the 13 Canadian refineries that exceed their US benchmarks.

Comparison of totals

The total NOx emissions from all refineries in Canada were 17134 tonnes in 2015, compared to the total of 15 US benchmarks of 7708 tonnes.

Refinery	Province	Number of times (multiples) the NOx emissions are above US benchmark	Reduction in NOx emissions required to meet benchmark based on US refineries (t/y)	Percentage reduction in NOx emissions required to meet benchmark based on US refineries	Ranking by percentage NOx emissions are above benchmark based on US refineries
Imperial – Sarnia	ON	4.0	1429	75%	1
North Atlantic Refining – Come by Chance	NL	3.7	1169	73%	2
Consumers' Co-operative Refineries Limited – Regina (Co-op Refinery Complex)	SK	3.0	1028	67%	3
Imperial – Nanticoke	ON	2.6	731	61%	4
Irving Oil – Saint John	NB	2.5	1642	60%	5
Imperial – Strathcona	AB	2.2	862	55%	6
Shell – Scotford	AB	2.1	529	53%	7
Petro Canada Lubricants Inc. – Mississauga	ON	2.0	289	50%	8
Suncor – Sarnia	ON	2.0	414	50%	9
Suncor – Edmonton	AB	2.0	521	50%	10
Shell – Sarnia	ON	2.0	377	50%	11
Suncor – Montreal	QC	1.7	348	40%	12

Valero - Energy Inc. – Levis	QC	1.5	436	34%	13
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Note: NOx emissions from the Chevron refinery in Burnaby, BC (now Parkland Burnaby Refinery) and the Husky Energy refinery in Prince George, BC were below their US benchmarks.