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Briefing Note

Canadian Oil Sands and Greenhouse Gas Emissions

The Facts in Perspective

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At a Glance

Cumulative greenhouse gas emissions from Alberta's oil sands are increasing fast. Emissions from oil sands more than doubled, increasing by 121 per cent, between 1990 and 2008. Planned growth indicates greenhouse gas emissions from oil sands will continue to rise resulting in a near tripling of emissions between 2008 and 2020.

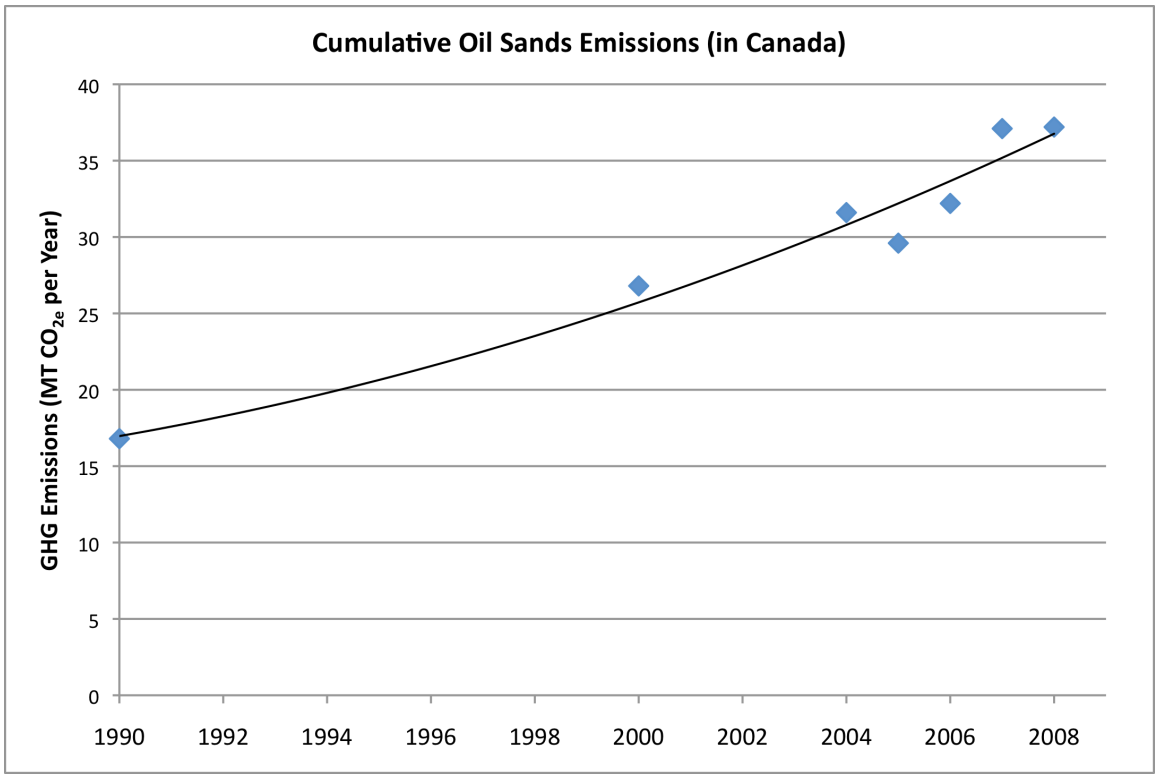
This briefing note outlines key information about greenhouse gas emissions from Canada's oil sands today and in the future. Recent attention to the issue of greenhouse gases in Canada and the U.S. prompted the Pembina Institute to outline key issues in more detail.

In particular, there is a growing concern with a substantial increase in total greenhouse gas emissions by 2020 from Canada's oil sands. Part of this increase will occur as the result of in situ production that is set to overtake oil sands mining production in 2017. Continued demand for oil sands production will only exacerbate this increase.

Finally, while it is clear that greenhouse gas emissions from oil sands are small compared to total U.S. emissions, greenhouse gas emssions will increase if reliance on Canadian oil sands continues to grow. Canada is now the largest supplier of crude oil to the U.S. supplying 19 per cent of the country's total crude imports in 2008.[1] This rate is up from 15 per cent in 1998. If Canada plays a growing role in meeting the U.S. need for crude oil, and the oil sands continues to grow and make up a larger portion of Canada's oil production, the oil sands and the emissions associated with them will have a growing effect on climate impacts in both Canada and the U.S. Furthermore, a growing reliance and demand for oil sands in both countries has implications for broader climate policy.

Cumulative greenhouse gas emissions from Canada's oil sands are growing fast.

Greenhouse gas emissions from oil sands more than doubled, increasing by 121 per cent, between 1990 and 2008.



Source: Emissions data from Canada National Inventory Report[2]

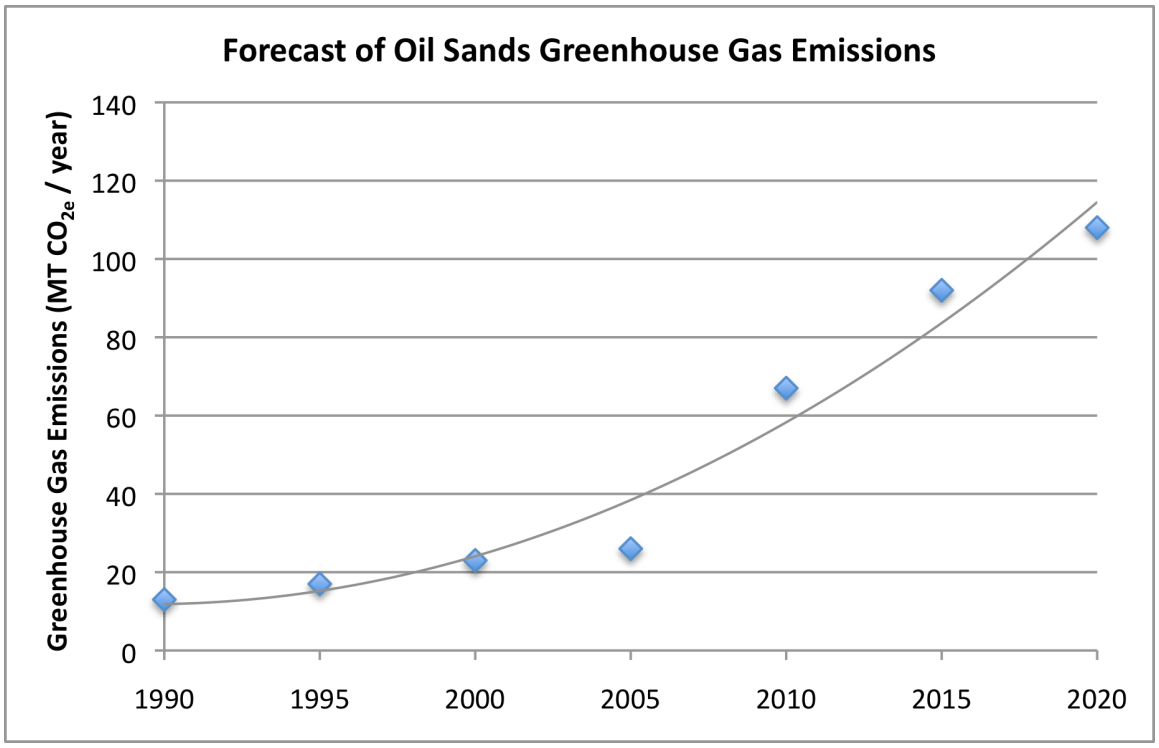
Note: The National Inventory Report only reports oil sands emissions that occur in Canada. This includes production and of the emissions associated with upgrading that occurs in Canada. Emissions from upgrading that occurs in the U.S. for bitumen that is exported from Canada before it is upgraded is not accounted for in the National Inventory Report. Also, the NIR does not reflect emissions associated with upstream land use or natural gas production and does not include downstream refining or combustion.

Cumulative oil sands emissions have more than doubled since 1990 — a growth of 121 per cent from 1990 to 2008. Oil sands emissions of 37.2 megatonnes in 2008 forecasted to grow to 108 megatonnes by 2020 means a near tripling of emissions.

Planned growth indicates greenhouse gas emissions from oil sands will continue to rise nearly tripling from 2008 to 2020.

Given 2008 oil sands emissions of 37.2 megatonnes, forecasted growth to 108 megatonnes by 2020, means a near tripling of emissions. To put that into perspective, this is nearly double the greenhouse gases currently emitted from New York City with 61.5 megatonnes reported in their 2007 inventory.[3]

Several sources, including the Government of Canada (as shown in both figures below) have forecasted the growth of greenhouse gas emissions from oil sands. These forecasts are generally based on expected oil sands growth rates and oil sands emissions intensities.



Source: Government of Canada, Turning the Corner: Canada's Energy and GHG Emissions Projections [4]

- By 2020, emissions will be more than eight times greater (or 730 per cent) than in 1990.
- More recent trends (between 2008 to 2020) still suggest there will be a near tripling in oil sands emissions, growing 190 per cent.

A 2006 Pembina Institute report, *The Climate Implications of Canada's Oil Sands Development*, calculated that oil sands emissions could grow to between 113 and 141 megatonnes per year by 2020, based on projected oil sands growth rates.[5]

Some studies comparing oil sands greenhouse gas emissions intensity to "conventional" or "average" oil consumed in the U.S. should be approached with caution.

While greenhouse gas emissions have long been a key point of discussion relating to oil sands, the debate has recently changed. In the past, emissions were generally compared based on a production intensity that included upgrading emissions and may have been a well-to-tank approach that also included refining. Recently, however, discussions about emissions have changed to include other factors such as transportation. The problem is a lack of clarity for what is defined as conventional or average U.S. crude. Consequently, findings made as a result of these studies can be skewed.

For example, some studies have compared oil sands to crude oils from a variety of sources. Resulting claims indicate oil sands are "within the same range" or only five to 15 per cent more greenhouse gas emissions-intensive than some conventional crudes. This is particularly the case with two reports recently released by the Alberta Energy Research Institute comparing the lifecycle greenhouse gas emissions from oil sands and other sources of crude (Jacobs[6] and TIAX[7]).

While these reports include some useful analysis, their findings have been misrepresented. There are three main reasons these numbers are critiqued:

1. The comparison of emissions from oil sands to emissions from conventional or average U.S. crude sources were too similar due to the data set used.[8] Both reports compare oil sands to conventional crudes that were found to be heavier and more emissions intensive than the actual average crude entering the U.S. This artificially reduced the gap between oil sands intensities and what is labelled as "conventional" crude in the reports.[8]
2. Methodologies behind both reports have also been criticized for data discrepancies, not having an adequate peer-review process, not having a detailed independent technical review, for making use of unverified modelled data rather than actual oil sands emissions data, and for having insufficient presentation of assumptions and methodologies.[8] Other problems have also been noted with the reports, such as the calculations did not include upstream emissions associated with natural gas production, calculations based on low steam-to-oil ratios for in situ oil sands resulting in lower emissions values, and not clearly illustrating how cogeneration credits were allocated.[8]
3. Some of the oil sands used in the comparisons against conventional crudes, were oil sands that were mixed with another non-oil sands product, resulting in a misleading comparison. When oil sands bitumen is transported via pipeline to the U.S. without being upgraded (and synthetic crude sometimes as well), a low carbon intensive diluent, such as naptha diluent, is added so that the mixture can flow to its destination. The addition of this product lowers the combined emissions intensity of the oil sands though because it is no longer purely oil sands.

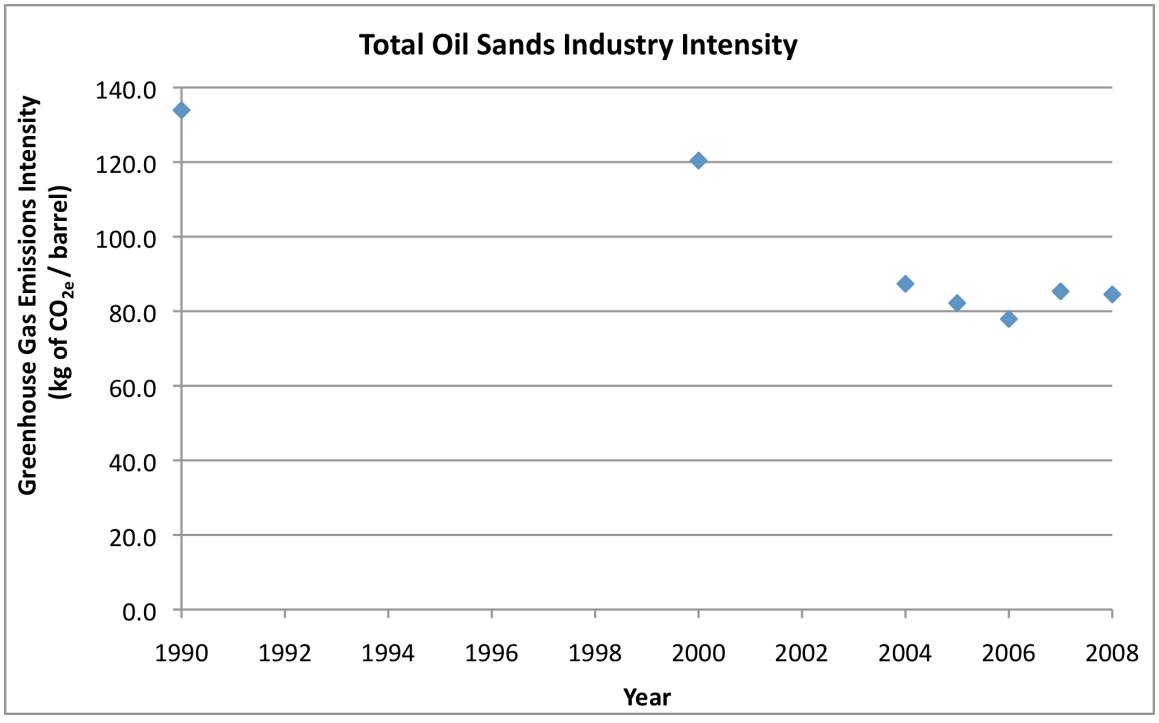
   In the Jacobs report, for example, the steam assisted gravity drainage bitumen used for analysis was blended with diluent to create a mixture called Dilbit. Because of the lower-carbon intensive diluent, this mixture has lower per barrel emissions intensities than pure

bitumen. Since a portion of the resulting product is not from oil sands, it is misleading to suggest these oil sands emissions are lower.

Full comments from multiple reviewers can be found online at: http://www.albertainnovates.ca/media/15768/post workshop stakeholder input.pdf.

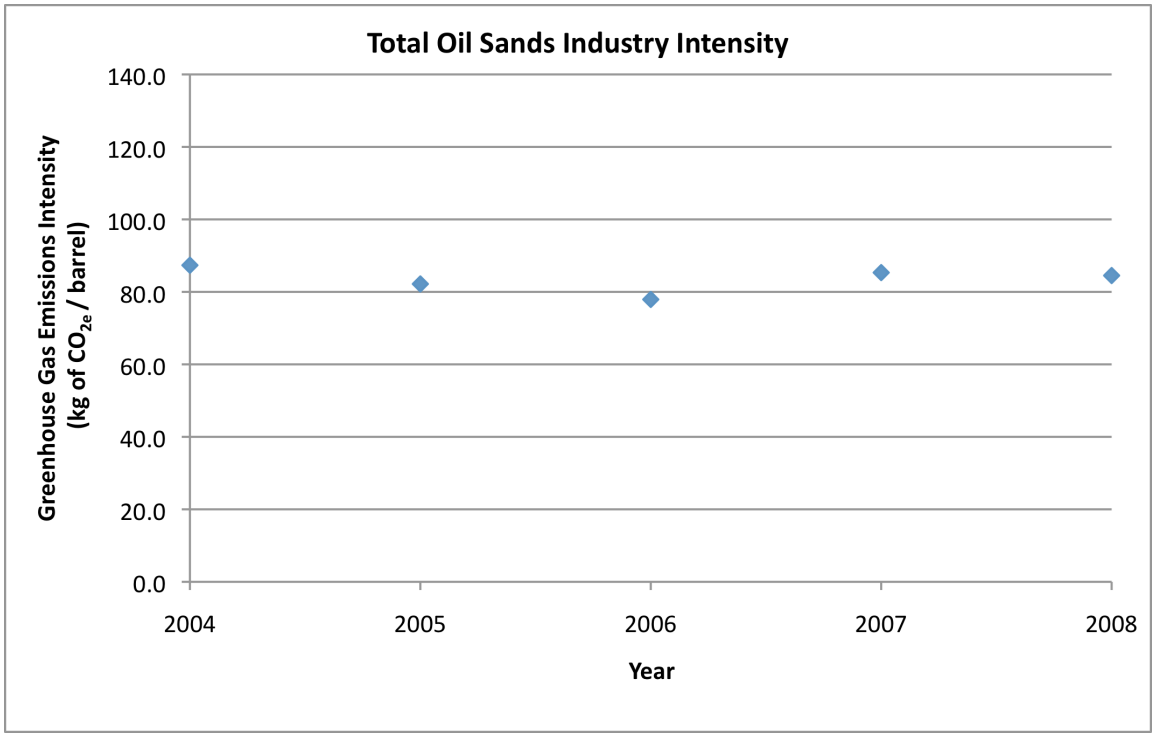
According to Government of Canada data, there has been very little improvement in average oil sands emissions intensity over the past five years.

While there was a significant improvement in greenhouse gas emissions intensity previously, it was likely due to fuel source changes for oil sands operations. Oil sands operations have transitioned from sources of energy such as coal and petroleum coke to natural gas. With this fuel source change came substantial improvements in oil sands emissions intensity. More recently, improvements in greenhouse gas emissions intensity have essentially stalled.



Source: National Inventory Report & Statistics Canada

Note: Figure is based on production data[9] and total emissions data[10] that occurs in Canada. Figure does not represent emissions from upstream gas production or downstream upgrading occurring in the U.S., refining or combustion.



Source: National Inventory Report & Statistics Canada

Note: Figure includes production data[11] and total emissions data[12] that occurs in Canada. Figure does not represent emissions from upstream gas production or downstream upgrading occurring in the U.S., refining, or combustion. This data is taken from the most recent National Inventory report. It provides data only for the years 1990, 2000 and 2004 to 2008.

As the above graph illustrates, per barrel emissions intensity for oil sands improved by just over three per cent between 2004 and 2008. There does not seem to be any trend towards continued intensity improvements.

Early improvements in oil sands emissions intensity were made possible by switching from petroleum coke to natural gas and by using cogeneration. While these improvements are noteworthy, it is unlikely that such significant further improvements will be implemented in the short-term.

Many oil sands operations switched from coal-powered grid electricity to natural gas cogeneration to provide the needed electricity and steam for their operations more reliably and more efficiently. Calculations suggest that the mining and upgrading operations that made the switch could be responsible for nearly 13 per cent of the total 39 per cent improvement in greenhouse gas emissions intensities (based on a drop of seven megatonnes per year by 2006 from business-as-usual for mining and upgrading).[13]

In the past, some oil sands operations burned petroleum coke to produce the heat required to extract bitumen from the oil sands. Coke is a very carbon intensive fossil fuel and it is likely that significant emissions reductions were achieve when operations switched from this dirty fuel to the much less intensive natural gas.

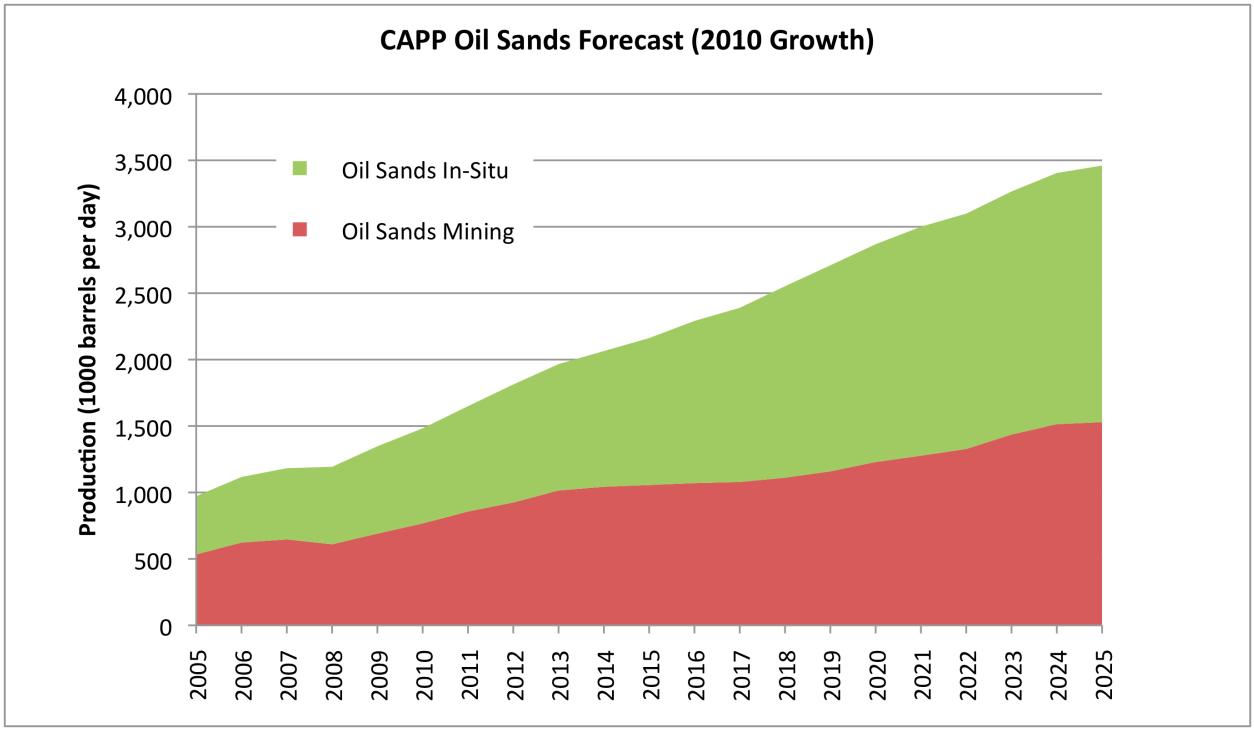
Ironically, the Government Alberta has released draft standards that would allow combustion on dirtier sources of fuel for oil sands. This would allow oil sands projects to switch from natural gas back to petroleum coke or other dirty fuel sources such as bitumen, effectively reversing the reductions in greenhouse gas emissions that occurred when they first stopped using dirty fuels. Given the cost of natural gas and the growing pace of the oil sands industry, the government is considering allowing oil sands operations to burn alternative fossil fuels such as bitumen, asphaltenes or petroleum coke for steam generation, which would create increased greenhouse gas emissions.[14] According to a Pembina Institute analysis, switching from natural gas to petroleum coke to produce the heat required for bitumen extraction could lead to a 66 per cent increase in greenhouse gas emissions per barrel produced compared to a similar facility using natural gas.[15] For more information on the potential environmental implications of this draft directive, see the Pembina Institute's letter to Alberta Environment.[16]

In situ oil sands development is more greenhouse gas intensive than oil sands mining, and with in situ production set to increase so will industry wide greenhouse gas emissions intensity.

Although both oil sands mining and in situ oil sands development are on growth trajectories, in situ oil sands development is expected to overtake mining by 2017.

Data comparing in situ and mining emissions consistently comes to the same conclusion — in situ oil sands production creates higher greenhouse gas emissions. Specifically, 2007 data used in Pembina reports[17] based on actual emissions reporting and estimates from project application environmental impact assessments indicate that in situ production (without upgrading) weighted an average 91 kg CO_{2e} per barrel compared to mining (without upgrading) at an average 36 kg CO_{2e} per barrel. In both cases, production includes upstream natural gas. It should be noted that in most cases, the bitumen from oil sands needs to undergo an intensive upgrading process to become synthetic crude before it can be used in a refinery like other crudes. Estimates suggest that greenhouse gas emissions for upgrading can be in the range of 52 to 79 kg of CO_{2e} per barrel of bitumen.[18]

In one meta-analysis[19] of well-to-vehicle tank emissions, mining showed 62 to 164 kilograms of CO_{2e} emissions per barrel (with upgrading) and in situ showed 99 to 176 kilograms of CO_{2e} emissions per barrel (with upgrading).



In Situ Versus Mining Production Rate Forecast

Source: Canadian Association of Petroleum Producers[20]

Oil sands could nearly triple in size by 2025 and in situ production will be a big part of that picture, representing 56 per cent of that growth, overtaking mining by 2017.

Alberta has much higher per capita greenhouse gas intensities than either Canada or the U.S.

On a per capita basis, Alberta greenhouse gas emissions are more than three times those of either Canada or the U.S.

Comparisons are routinely made between the relatively small greenhouse gas emissions from Canada to those of the U.S. (not surprising, given that the U.S. has a population that is nine times larger[21] than Canada's). When we factor in the difference in population size by comparing emissions per capita, we see that both countries have rather similar emissions intensities. Canada's 2008 emissions intensity per capita was 22.0 tonnes CO_{2e},[22] while 2008 emissions per capita in the U.S. were 22.6 t CO_{2e}.[23] At a rate of 69 tonnes CO_{2e} per person, if Alberta were a country, it would have per capita emissions more than three times that of either the U.S. or Canada.[24] [25]

Canada has no plan to reduce greenhouse gases and has made no progress in reducing greenhouse gas emissions.

The Government of Canada has committed to reducing greenhouse gas emissions 17 per cent below 2005 levels by 2020.[26] This pledge has been inscribed in the Copenhagen Accord,[27] but with the caveat that it may change based on developments in the U.S. This target is not fixed in any Canadian legislation and to date, the federal government has not published a plan to achieve it. If emissions rise as projected under Environment Canada's business-as-usual scenario, they will reach 28 per cent above 2005 levels by 2020, with oil sands expansion accounting for nearly half of the projected increase.[28]

Taking into account all existing policies, including the newly announced draft regulations on passenger vehicle emissions, Environment Canada anticipates that Canada's emissions will be less than half a percentage point below the 2005 level by 2012.[29] In other words, even the government acknowledges virtually no material progress will have been made towards achieving Canada's emissions target by the end of 2012.

The government states that its new passenger vehicle regulations will reduce the average tailpipe GHG emissions of new vehicles sold in 2016 by a maximum of 25 per cent per vehicle.[30] However, analysis indicates that low stringency and loopholes in the draft regulations mean the standards may not require significant fuel economy improvements beyond business-as-usual until 2016 or even later.[31] Given that light vehicles account for roughly 12 per cent of Canada's emissions,[32] it is clear that Canada's national GHG target for 2020 can only be met with significant new policies across many other sectors.

Sustainable Energy Solutions

The Pembina Institute is a national non-profit think tank that advances sustainable energy solutions through research, education, consulting and advocacy. It has offices in Ottawa, Toronto, Calgary, Edmonton, Drayton Valley, Vancouver and Washington, D.C. The Pembina Institute provides policy research leadership and education on climate change, energy issues, green economics, energy efficiency and conservation, renewable energy, and environmental governance. For more information about this briefing note, please contact Danielle Droitsch, U.S. Policy Director at danielled@pembina.org or the Pembina Institute's oil sands team at its Calgary office 403-269-3344. Visit www.oilsandswatch.org/.

[1] ISH Cambridge Energy Research Associates (CERA). *Growth in the Canadian Oil Sands: Finding the New Balance*, 2009.

[2] Environment Canada. *National Inventory Report - Part 1 1990-2008 Greenhouse Gas Sources and Sinks in Canada*, 2010. Page 25, Table S-3. http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=492D914C-2EAB-47AB-A045-C62B2CDACC29.

[3] The City of New York. Inventory of New York City Greenhouse Gas Emissions, April 2007. www.nyc.gov/html/om/pdf/ccp_report041007.pdf.

[4] Government of Canada. *Turning the Corner: Canada's Energy and GHG Emissions Projections, Reference Case: 2006-2020*. March, 2008. http://www.ec.gc.ca/doc/virage-corner/2008-03/pdf/nat_eng.pdf.

[5] Government of Canada. *Turning the Corner*.

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[7] Jacobs Consultancy Life Cycle Associates. *Life Cycle Assessment Comparison of North American and Imported Crudes*. Prepared For: Alberta Energy Research Institute, no. July (2009). http://www.albertainnovates.ca/media/15753/life cycle analysis jacobs final report.pdf.

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[11] Environment Canada. National Inventory Report - Part 1 1990-2008 Greenhouse Gas Sources and Sinks in Canada, 2010. Page 25, Table S-3. http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=492D914C-2EAB-47AB-A045-C62B2CDACC29.

[12] Statistics Canada. Supply and disposition of crude oil and equivalent, monthly (cubic metres), CANSIM (database). Table 126-0001. Accessed: July 22, 2010. http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm.

[13] Environment Canada. *National Inventory Report - Part 1 1990-2008 Greenhouse Gas Sources and Sinks in Canada*, 2010. Page 25, Table S-3. http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=492D914C-2EAB-47AB-A045-C62B2CDACC29.

[14] Calculated based on cumulative emissions values for 1990 and 2008 provided above and data from the following source: Moorhouse, Jeremy, and Bruce Peachy. "Cogeneration and the Alberta oil sands - cogeneration benefits are maximized with extraction and upgrading integration." Power-Gen World Wide, Power Engineering. Accessed July 27, 2010. http://www.powergenworldwide.com/index/display/articledisplay/303182/articles/cogeneration-and-on-site-power-production/volume-8/issue-4/features/cogeneration-and-the-alberta-oil-sands-cogeneration-benefits-are-maximized-with-extraction-and-upgrading-integration.html.

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[21] Canadian Association of Petroleum Producers. "Crude Oil - Forecast, Markets & Pipelines." June (2010). Figure 2.2 / Appendix B.1.

[22] U.S. population 307 million, source: U.S. Census Bureau, Population Division - Last updated July 26, 2010. Canada population 33.3 million, source: World Bank, World Development Indicators - Last updated July 26, 2010.

[23] Environment Canada. "National Inventory Report - Part 1 1990-2008 Greenhouse Gas Sources and Sinks in Canada," 2010. Page 34, Figure 1-2. http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=492D914C-2EAB-47AB-A045-C62B2CDACC29.

[24] U.S. Environmental Protection Agency (EPA). *Inventory of U.S. Greenhouse Gas Emissions and Sinks* 1990 - 2008 (2010): 1990 - 2008. Page 8-14, Table 8-13. http://epa.gov/climatechange/emissions/downloads10/US-GHG-Inventory-2010_Report.pdf.

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[26] Government of Canada. Canada's Action on Climate Change. http://www.climatechange.gc.ca/default.asp?lang=En&n=72F16A84-1 (accessed July 30, 2010).

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[32] Environment Canada (2010), National Inventory Report, Part I, 4.