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OIL SANDS INDUSTRY ENERGY REQUIREMENTS AND GREENHOUSE GAS (GHG) EMISSIONS OUTLOOK (2015-2050)

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Executive Summary

This study highlights the contribution of the oil sands industry to the Canadian economy, energy use, and the environment.

In 2014, Alberta's economy was estimated to be $305.5 billion, the third largest in Canada after Quebec and Ontario. Within Alberta, the mining, quarrying, and oil and gas sector (including the oil sands) was $83.8 billion or 27.4 percent of the provincial economy and 5.2 percent of the Canadian economy. In 2013, capital investment from the oil sands was $30.8 billion,[1] 27.7 percent of Alberta's total, and 7.7 percent of Canada's total capital investments.

Alberta's crude bitumen reserves are some of the world's largest deposits of crude oil behind those of Saudi Arabia and Venezuela (BP, 2015). From the onset of development in the late 1960s, advances in extraction methods have unlocked vast amounts of oil sands resources. Production of oil sands crude has increased rapidly, reaching over 2.3 million barrels per day (MMb/d)[2] by the end of 2014. This accounted for 74.9 percent of Alberta's crude oil production, 59.2 percent of total crude oil production across Canada, 12.3 percent of North America's crude oil production, and 2.6 percent of the world's total crude oil production. This places Canada fourth behind the United States, Russia and Saudi Arabia, among the largest crude oil producers in the world.[3]

The oil sands industry is one of the largest producers of primary energy both in Alberta and in Canada. The industry is also one of the largest end-users of energy including the use of natural gas for thermal energy and hydrogen production, the use of electricity, and diesel fuel use. From an environmental perspective, continued growth in production from the oil sands, coupled with increasing energy use, have resulted in an increase in greenhouse gas (GHG) emissions from fuel combustion and fugitive sources.

Oil sands crude extraction accounted for 46.7 percent of Alberta's primary energy production in 2014, and 33.6 percent of end-use energy demand.[4] In 2014, the oil sands industry accounted for 20.8 percent of the province's total electricity demand, 29.5 percent of natural gas use in the province (excluding gas used for power generation),[5] and 19.5 percent of total diesel fuel demand.

[1] Based on estimates from (ARC Financial Corp., 2015) and (Canadian Association of Petroleum Producers (CAPP), 2015)

[2] Refers to bitumen extraction as opposed to net oil sands supply

[3] Based on data from (BP, 2015) and (Canadian Association of Petroleum Producers (CAPP), 2015)

[4] Based on data from (Alberta Electric System Operator (AESO), 2014), (Alberta Energy Regulator (AER), 2014), (National Energy Board (NEB), 2015), (Statistics Canada, 2015), and CERI estimates

[5] The percentage share increases to 40.7% when including natural gas purchases for power generation for oil sands projects, which in turn accounted for 63.9% of the total natural gas used for power generation in 2014, according to data from (Alberta Energy Regulator (AER), 2014)

Increased economic activity in the province over the last decade, led by strong and growing oil sands production, coupled with a growing share of energy use by the oil sands industry, have in turn resulted in growing GHG emissions from the industry.

The oil sands sector GHG emissions of 62 million tonnes of carbon dioxide equivalent (MMt CO_2 eq.) was 23 percent of total provincial emissions of 267 and 8.5 percent of the total national emissions of 726 MMt CO_2 eq. in 2013.[6] This is a 94 percent increase from 2005 GHG emissions of 32 MMt CO_2 eq.

The federal government has recently announced its intentions to reduce national GHG emissions to 30 percent below 2005 GHG emissions (of 749 MMt CO_2 eq./year) by 2030. In Alberta, the 2008 climate change action strategy called for a province-wide GHG emissions target of 236.0 MMt CO2 eq./year by 2020, and 176.0 MMt CO2 eq./year by 2050, with an emphasis on the energy efficiency improvements, decarbonizing energy production, and deployment of carbon capture and storage (CCS) technologies.[7] More recently, the provincial government has indicated its ambition to review and change the climate change strategy.[8]

The focus of this report is on quantifying GHG emissions associated with energy use from the oil sands industry, including fuel used to generate electricity to meet the requirements of the industry. Energy intensity factors were assessed for different types of energy and different types of projects across the oil sands industry. Intensities per unit of output (crude bitumen or synthetic crude oil) are estimated to range from as low as 0.14 gigajoules per barrel (GJ/bbl) to as high as 4.07 GJ/bbl.

Estimates for cumulative (2015-2050) production volumes, energy used, and GHG emissions were developed. However, given the temporal extent of the period considered for this analysis and various assumptions, which exists in developing such estimates,[9] a scenario approach was used to understand the ramifications of changes to the different variables. The business as usual (BAU) scenario represents conditions that are most likely to unfold based on historic trends. Constrained growth (CG) assumes that global economic and crude oil market demand are not conducive to new investments and only existing and under construction oil sands projects operate in the period 2015-2050. The increased energy efficiency (IEE) scenario assumes that technology learning and innovation lead to increased energy efficiency in the oil sands sector. Conversely, the decreasing reservoir quality (DRQ) scenario assumes that over time the reservoir quality deteriorates, increasing energy intensity of bitumen extraction. The electric heating technology adaptation (EHTA) scenarios assume that a large portion of in situ projects adopt electrical extraction methods as opposed to steam based thermal recovery. Two EHTA scenarios

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[6] Based on Environment Canada's National Greenhouse Gas Inventory (Environment Canada, 2015)

[7] GHG emissions reductions via CCS in the 2008 provincial climate change strategy are estimates to account for 139 MMt CO_2 eq. in reductions by 2050, or 69.5% of the total anticipated GHG emissions reduction (of 200 MMt CO_2 eq.)

[8] Alberta Environment Climate Change Strategy, http://esrd.alberta.ca/focus/alberta-and-climate-change/climate-change-strategy/default.aspx. Accessed in August 2015.

[9] See Figure 47 on Chapter 1 for more on these

(low adaptation and high adaptation) represent a situation where electricity based recovery techniques may potentially be attractive under a stringent carbon policy. Table E.1 presents the results for the aforementioned six different scenarios.

Table E.1: Cumulative (2015-2050) Oil Sands Production Volumes, Energy Used, GHG Emissions, and Intensity Factors Under Different Scenarios

Scenario	Production		Energy Used			GHG Emissions		
	Production (billion bbl)	Difference from BAU (%)	Energy used (billion GJ)	Difference from BAU (%)	% chg. Energy/% chg. Prod.	Emissions (billion tCO2 eq.)	Difference from BAU (%)	% chg. Emissions/% chg. Energy
BAU	52.4	0%	66	0%	n/a	4.2	0%	n/a
CG	35.2	-33%	45	-32%	1	2.9	-32%	1.0
IEE	52.4	0%	47	-30%	n/a	3.0	-29%	1.0
DRQ	52.4	0%	97	46%	n/a	6.1	44%	1.0
EHTA-Low	52.4	0%	63	-6%	n/a	4.4	4%	0.6
EHTA-High	52.4	0%	59	-11%	n/a	4.6	8%	0.7

Source: CERI

Energy and emissions outlook under the BAU scenario shows that energy intensity and emissions intensity marginally decreases over the outlook period. Nonetheless, the total emissions continue to grow due to growing production levels.

Under the CG scenario, cumulative production volumes for oil sands from 2015 to 2050 are 32.8 percent lower compared to the BAU scenario, cumulative energy use decreases by 32.0 percent, and cumulative GHG emissions decrease by 31.7 percent. Those reductions are due to lower production, negating any economic benefits that are plausible under the BAU production level. Energy intensity and fuel mix are assumed the same as in the BAU case.

In the remaining four scenarios, the production volumes are the same as in the BAU case. IEE and DRQ are opposite scenarios in the spectrum of advances in technology and process optimization versus ageing reservoirs and deteriorating reservoir quality.

In the IEE scenario, increasing energy efficiency results in a 29.5 percent decrease in cumulative energy used compared to the BAU scenario, and subsequently, a 28.7 percent decrease in cumulative GHG emissions.

In the DRQ scenario, decreasing reservoir quality results in an increase of 46.0 percent in cumulative energy use, and subsequently, a 44.2 percent increase in cumulative GHG emissions compared to the BAU case.

In the *low* adoption rate case (EHTA-Low), overall energy use decreases by 5.8 percent compared to the BAU scenario. However, cumulative GHG emissions actually increase by 3.6 percent. In the *high* adoption case (EHTA-High), a similar trend is observed, with cumulative energy use decreasing by 11.0 percent and cumulative GHG emissions increasing by 8.1 percent. In the EHTA scenarios, thermal energy is replaced for electricity in a large cross-section of in situ projects. That leads to lower energy intensity, but the emissions increase under the electricity generation mix assumed in this analysis.

These scenarios are useful in understanding the effects on energy use and GHG emissions from the oil sands industry due to changes in production volumes, intensity factors, and adoption of new technologies.

A key finding is that thermal energy and electricity combined generally account for between 80 percent and 90 percent of both energy use and GHG emissions across the scenarios. The majority of the emissions will continue to be generated from the production of thermal energy.