ALBERTA'S ENERGY CLUSTER

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Microeconomics of Competitiveness

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May 7, 2010

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Required Disclosures

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Alim Merali is a native of Edmonton, Alberta, and has previously researched the implications of US environmental regulation on a company in Alberta's oil sands.

They have used these experiences simply as background, and have not previously done analysis on Alberta's energy cluster with this method. Hence, this report represents predominantly original research.

National Context: Canada

Canada is the world's second-largest country by area with the longest coastline and highway, and most of its 33.9 million people live nearby its border with the US. It is known for its natural resources, such as 25% of the world's freshwater, 10% of its forests, 13% of its oil reserves, and abundant supplies of many others as well, which form the basis for much of its current and potential economic activity.

Despite its relative youth—Canada officially became a country in 1867—it has a rich history with advanced economic, social, and political institutions. Prior to Confederation, France and England colonized and sent many traders and settlers to Canada, and this occasionally created conflicts with the First Nations who had previously inhabited the lands. The territory was eventually ceded to England, and Canada has since remained loyal to the British Commonwealth. In the past century, Canada has developed close ties with other developed countries, particularly the US. For example, Canada joined the Canada-US Free Trade Agreement in 1998 (which ultimately expanded to NAFTA in 1994), and is an active member of economic groups and forums such as the WTO, OECD, OAS, and APEC.

Economics: Canada is the smallest economy in the G7 with a GDP of US$1.3 trillion. However, Canada's GDP per capita of US$46,000 is 2nd only to the US. Canada's key exports include automobiles, oil and gas, metals, and forestry, 78% of which is sold to the US—one of the reasons why there is a close, 0.88 correlation between the countries' growth rates (EIU, 2010). **Exhibit 1** displays the major exports.

Overall, Canada is an attractive country in which to do business, exemplified by its 8th place in the World Bank's Ease of Doing Business Index. This positive business environment has contributed toward GDP growth of an average 4.6% over the past 20 years, with lower variability than most others in the G7.

Social: There are two official languages, French and English, but the population is culturally diverse as population growth is driven primarily by immigration. Education levels are amongst the world's highest, and income inequality is lower than in most other developed countries (EIU, 2010). Canada ranks 4th in the Human Development Index, and is seen as a favorable place to live.

Political: Canada's ceremonial head of state is Queen Elizabeth II, represented in-country by the Governor-General. The head of government is the Prime Minister, the leader of the largest political party in the House of Commons ("Lower House"), presently the center-right Conservatives' Stephen Harper. The other main party is the centrist Liberals, and smaller parties include the center-left New Democrats and the separatist Bloc Quebecois. Canada also has a Senate ("Upper House") that reviews and ratifies decisions of the House of Commons, whose members are periodically appointed by the Prime Minister. The Prime Minister can pass legislation rather quickly without significant roadblocks at the federal level, but notably the country's 10 provinces have significant autonomy, such as ownership of natural resources. Historically, nationalist sentiment in French-speaking Quebec and a sense of political alienation across resource-rich Western Canada have been divisive factors.

Competitiveness: Canada Diamond Analysis ***(Exhibit 2)***

Canada is a very competitive nation, currently ranked 12th (GCR, 2009). This is driven by effective Microeconomics of Competitiveness and Social Infrastructure and Political Institutions, but the country is challenged by weaker Macroeconomic Policy.

Factor Conditions (Positive): Canada's economy benefits from its well-educated, multi-cultural, and broadly-skilled workforce. The country enjoys the world's highest levels of secondary enrollment and utilization of computers, and it has a breadth of high-quality management education programs (ICP, 2009). It also has relatively well-developed infrastructure, such as a coast-to-coast railroad and highway network and many international airports. Finally, Canada uses its broad-based endowment of natural resources, especially its oil and gas, metals, forests, and fish, to generate competitive, regionally-concentrated clusters.

However, compared to its common benchmark, the US, Canadians hold fewer advanced degrees, work with lower intensity (i.e., number of hours), and have lower productivity (ICP, 2009). Time and cost of transportation across the country is onerous, and this often makes inter-provincial trade less attractive

than trade with the US. Finally, Canadian firms, especially SMEs, do not enjoy the same level of access to venture capital and other sources of funds as the US.

Demand Conditions (Positive): Canadian consumers have high incomes with low inequality, and tend to be sophisticated buyers with access to detailed information. Canada's relationship with the US and its membership within NAFTA also enlarges the de facto "domestic" market. However, high tax rates compared to the US partially mute Canadians' ability to purchase goods.

Context for Firm Strategy and Rivalry (Negative): Canada ranks very well in areas such as the ethical behavior of firms (8th), effectiveness of law-making bodies (9th), and rule of law (10th). In addition, the labor market is generally competitive and flexible.

Unfortunately, these advantages are offset due to a number of government influences such as: government spending levels (24th), the burden of regulation (46th), and the distortion of taxes and subsidies on competition (49th). This is also apparent under Macroeconomic Policy, such as: poor government surplus or deficit (41st) and government debt (99th). The World Bank's Ease of Doing Business Index further exemplifies this issue, ranking the country low on paying taxes (28th) and registering property (35th).

More so than lengthy distances, there exist many government-caused barriers to internal trade. 32% of CEOs actually consider trade barriers between provinces worse than trade barriers with the US, and 60% of them believe that this results both from "bad politics and bad economics" (COMPAS, 2004). Barriers to labor mobility are seen as the most serious issues, especially different rules on certification for trades and professions, followed by numerous technical barriers to agri-business trade, different standards for transportation, preference for local suppliers in procurement, discriminatory investment treatment, and inconsistent environmental regulations.

Related and Supporting Industries (Neutral): Canada has healthy technological development (9th), specialized research and training (9th), and supplier quality (8th), but is inhibited by supplier quantity (24th) and cluster policy (36th).

Issues for Canada's Competitiveness

The key issues for Canada's competitiveness are the impact of government taxes and regulation; lower levels of worker productivity relative to the US; dependence on the US export market coupled with barriers to inter-provincial trade and limited penetration of other export markets; and, the availability of funds for entrepreneurship.

Canada-Level Recommendations

1. **Simplify regulations on the private sector (Medium Difficulty)** – The federal government should ease the burden of regulations that impose costs on firms; distort competitive forces; and, raise barriers to entry in key clusters. This should be done by way of public-private consultations, ideally on a cluster-by-cluster basis to improve results on cluster policy.
2. **Reduce taxes on business investment (Medium-Low Difficulty)** – If the federal government increases incentives for firms to invest in new technology and other long-term assets, it would help improve the productivity of Canadian workers (ICP, 2009).[1]
3. **Encourage higher enrollment rates in advanced education programs (Medium Difficulty)** – In order to take advantage of Canada's high-quality advanced education, but address shortfalls in participation versus the US, federal and provincial governments should raise financial incentives both to universities and students in order to increase participation levels.
4. **Develop infrastructure to enable trade (Medium-High Difficulty) –** The federal government should continue to upgrade infrastructure for trade, such as expansion of ports in British Columbia (and rail-links to these ports) that facilitate the shipment of goods to emerging markets in Asia.

[1] Interview with official at Institute for Competitiveness and Prosperity

5. **Sign new free-trade deals (Medium-High Difficulty)** – The federal government should broaden Canadian firms' market access by signing new trade pacts, especially in Asia but also in South America and the EU, and firms should also take the initiative to pursue non-US markets more aggressively.
6. **Reduce inter-provincial trade barriers (Medium Difficulty)** – The federal government should facilitate dialogue between all provinces and develop a framework deal to reduce inter-provincial trade barriers, particularly on labor mobility and regulation (e.g., transportation, environmental). Professional associations and other interest groups should play a key role in this process.
7. **Increase availability of venture capital (Low Difficulty)** – The financial services industry, coupled with incentives from the federal government (and funds from public sources, such as the Canada Pension Plan) should increase the availability of venture capital for SMEs.

Sub-National Context: Alberta

Alberta is a land-locked province in Western Canada, and has a population of 3.6 million concentrated in the capital city of Edmonton (1.1 million) and the business hub of Calgary (1.1 million). The rest of the population is scattered in medium-sized cities, such as the tourism hub of Jasper and Banff and the oil sands hub of Fort McMurray, as well as many small towns and rural areas.

History: The land that now forms Alberta was initially inhabited by the First Nations and thereafter by traders and settlers from Eastern Canada, and it officially became a province in 1905. Originally, Alberta had a relatively homogenous ethnic make-up, and it focused primarily on rural industries, such as cattle, wheat, canola, and forestry. In the 1950s and beyond, Alberta attracted an influx of people from across Canada and globally, which also included many ethnic minorities especially later-on in the century. The population became substantially more urban, and oil and gas become the key industy.

Economics: Alberta has a GDP of C$260 billion (3rd in the country), but its GDP per capita of C$75,000 is 60% higher than the Canadian average (Statistics Canada). It has also typically had low levels

of unemployment at approximately 4%. Exports are 35% of GDP, primarily oil and gas sold to the US, but also agriculture, forestry, and tourism (Government of Alberta).

Alberta's economy has become progressively more dependent on the energy sector as of the 1970s. In the absence of the energy sector, the baseline growth of Alberta's economy from 1970-2005 would have been an estimated 3.7% per year, but the energy sector has led to growth of an additional 2.0% per year—1.5% from conventional sources, and 0.5% from the oil sands—and currently accounts for 60% of the province's economy (Mansell and Schlenker, 2006).

In large part because of the energy industry, Alberta has outperformed the Canadian average on a number of key economic indicators. From 1997-2007, goods exports increased by roughly 140% versus 50% for Canada, and investment increased by roughly 170% versus 90% for Canada (PwC, 2009). However, this growth was accompanied by higher volatility, as annual fluctuations in growth rates tend to be 2-3% per year for Alberta versus 1-2% for Canada.

In addition, this economic growth has expectedly resulted in significant population growth at nearly double the Canadian average over the past decade, and Alberta has recently dwarfed other provinces in the level of inter-provincial migration (Government of Alberta).

Because of its lucrative energy sector, Alberta has struggled to diversify. In addition to its core resource-based sectors (and services and suppliers for these sectors), Alberta has tried to make strides in knowledge-intensive areas such as high-tech and life sciences. Nonetheless, Alberta's growth correlates closely with energy prices.

Social: Alberta's social indicators mostly resemble those of Canada. Similarly, approximately 80% of the population is urban, but unlike the major cities in Ontario, Quebec, Manitoba and British Columbia, Alberta's major cities are farther away from large population centers in the US. The province is known for above-average quality in education, health care, and other social services, driven by the government's

ability to finance them. However, because of the appeal of jobs in the energy sector, education completion is actually lower than Canada's: 2% lower high-school completion, 15% lower college participation, and 6% lower university participation (Statistics Canada).

Political: Alberta, similarly to the other provinces, is governed by an elected unicameral legislature and a ceremonial Lieutenant Governor-General. The leader of the largest party in the Legislative Assembly serves as Alberta's Premier.

The province has historically been dominated by right-of-center governments, unlike the centrist leanings across Canada. Notably, right-of-center parties—currently the Progressive Conservatives, previously other parties such as Social Credit—have governed for 89 of 105 years of Alberta's history, and they have typically won landslide governments with over 80% of seats in the Legislative Assembly.

Because of its energy wealth and right-of-center government, Alberta has often had tense relations with the comparatively more centrist, Ontario- and Quebec-dominated federal government, except for situations like the present in which Canada is led by the Conservative, Alberta-native Stephen Harper. Constitutionally, Alberta has ownership of its resources, but the federal government has influence in areas such as environmental laws and international trade. Alberta has felt that the federal government does not adequately represent its interests internationally, which is why it has setup its own offices abroad to complement the efforts of federal officials. For example, a high-profile former provincial Cabinet Minister presently serves as Alberta's Representative to the US, housed within the Canadian Embassy.

Competitiveness: Alberta Diamond Analysis ***(Exhibit 3)***

Factor Conditions (Positive and Negative): Alberta benefits immensely from the abundance and concentration of its natural endowments, especially its conventional oil and gas reserves in many "pockets" across the province; oil sands around Fort McMurray; and, forestry in a number of regions. In addition, R&D investments by firms and universities tend to be closely aligned with the resource-based clusters, such as engineering technology for oil and gas extraction.

However, Alberta is often challenged by the availability of human talent. Despite high rates of inter-provincial migration, acute labor shortages plague key industries in up-markets. The lower rates of high school, college, and post-secondary completion versus Canada mitigate this issue in the short-term, but they also lower the potential productivity of the workforce in the long-term. In addition, the fact that Alberta is land-locked and has mountains on its border with British Columbia makes it relatively difficult to build transportation infrastructure to move goods for shipment to Asia. Transportation infrastructure has also been an issue inside Alberta, as development has not kept pace with the rapid population growth. The Edmonton-Calgary corridor is well served today (albeit without an oft-proposed high-speed rail link), but connections to other areas in which the natural endowments are mostly based remains weak.

Demand Conditions (Neutral): Alberta's industries and families are heavy users of local inputs—especially oil and gas, but also forestry and agriculture. In addition, Alberta has extremely low temperatures throughout its lengthy winter seasons, which also requires the heavy use of oil and gas.

Unfortunately, because the province's economy is so volatile, consumption of such local inputs is similarly volatile. Overall, though, the supply of oil and gas, forestry, agriculture, and other such resources routinely exceeds the province's internal demand.

Context for Firm Strategy and Rivalry (Positive): Alberta's firms compete aggressively for labor due to the aforementioned human capital challenges, and for capital due to the presence of many other lucrative investment opportunities in the vicinity. Moreover, the right-of-center government tends to be business-friendly, with relatively less-intrusive regulation than other provinces or the federal government. Alberta is the only province without a sales tax, and its 37% total tax rate (i.e., fully inclusive of all types of federal and provincial taxes) and 10% corporate tax are lower than other provinces (Fraser Institute, 2009). In addition, there is a very close relationship between business leaders and government officials, as well as social ties within the province's business community, which continually fosters collaboration.

Despite these positive factors, the large energy sector has led to a non-diversified economy—emerging clusters other than energy do not benefit from the same context of rivalry. Furthermore, Alberta's high inflation driven by the energy sector has created uncertainty for other firms. Finally, unresolved issues regarding First Nations land claims have also created uncertainty over new projects.

Related and Supporting Industries (Neutral): In each of its key clusters, Alberta has an array of related and supporting industries that have been attracted by a healthy core cluster. Unfortunately, though, some key elements of the value chain are outside Alberta, such as refineries for oil sands.

Issues for Alberta's Competitiveness

The foremost issues for Alberta's competiveness are its ability to reduce and manage volatility from energy prices; upgrade the education levels of its population to support economic sustainability and diversification in the long-term; address infrastructure challenges in high-growth regions; and, build links with non-US markets for its exports, both within Canada and globally.

Alberta-Level Recommendations

1. **Establish an Alberta Sovereign Wealth Fund (Low Difficulty)** – The provincial government should channel funds from energy royalty "windfalls" in up-markets into an independently-managed fund that invests in non-energy sectors. This would help to diversify Alberta's economy as well as buffer volatility caused by the energy market.
2. **Reduce and smooth-out government spending (Low Difficulty)** – In energy up-markets, the provincial government should aim to save more of its revenues, especially by funding the aforementioned sovereign wealth fund. Hence, it would be mitigating inflation in up-market years, saving for "rainy days" of low energy prices, and reducing the sharp "peaks-and-valleys" in government spending and surpluses or deficits.
3. **Develop infrastructure outside the Edmonton-Calgary corridor (Medium-High Difficulty)** – For growth regions such as Fort McMurray, the provincial government should, in partnership with

local construction firms, further develop transportation infrastructure (e.g., expansion of the Edmonton to Fort McMurray highway and construction of new railways). This should be done mostly in energy down-markets, as economic activity in industries such as construction can help both to smooth economic volatility and prepare the economy for pressures on infrastructure in up-markets.

4. **Strengthen mandates and provide incentives for education completion (Medium Difficulty)** – The provincial government should require energy firms to employ only high school graduates, or minimally to ensure part-time education while they work. In addition, savings from energy up-markets should be used to provide scholarships and other incentives to students for post-secondary education. This can help diversify the economy by building the skill-base of workers after they leave energy jobs.
5. **Spearhead plans to curb inter-provincial trade barriers in Western Canada (Medium Difficulty)** – Alberta, as the largest economy in Western Canada, should work closely with neighboring provinces in order to lead initiatives that reduce barriers. It should complement the federal government's efforts and also be a model for other provinces. Specific opportunities include Alberta-British Columbia cooperation to facilitate trade with Asia, and Alberta-Saskatchewan cooperation in oil and agriculture.

Cluster Analysis: Energy

Oil and Gas Clusters

Despite its high capital requirements and significant use of technology, the value chain of oil and gas production is fairly straightforward (**Exhibit 4**). Challenges exist in each element, most notably in exploration, production, and processing. New sources of petrochemicals are harder to find, and require more technology or energy to produce and process. Consumers of the value chain include, for example, individuals purchasing gasoline for their cars, electricity utilities purchasing natural gas for power plants, and businesses purchasing petro-chemical products as factor inputs for their production.

There are three main types of petro-chemical input to the value chain: conventional oil, conventional gas, and oil sands. Conventional oil and gas are rather straightforward products to extract:

after drilling a hole, the pressure underneath the earth pushes the liquid and gas upward. New innovations enable companies to capture additional oil and gas as the reservoir starts to dry-up. Oil sands production is more complicated, though. Resources located closer to the earth (i.e., within 30 meters of the surface) utilize bulldozers to shovel oily sands into three-story tall trucks. The sands must then be washed away from the oil, which requires four barrels of water per barrel of heavy oil bitumen (CanadasOilSands.ca, 2010). Deeper oil sands require the injection of steam into the reservoir—0.5 barrels of water per barrel of heavy oil bitumen— which melts the oil away from the sand, and then the oil is pumped to the surface. The cost to produce these resources varies dramatically, with supply costs per barrel (i.e., operating costs, capital costs, taxes, royalties, rate of return) for conventional oil in places like Saudi Arabia at under $1, whereas Alberta's oil sands cost as high as $36 to $40 per barrel (NEB, 2004).

Canada is amongst the largest global oil and gas producers, slightly larger than smaller OPEC-member countries such as the UAE, Venezuela, or Kuwait, but one-third of Saudi Arabia or Russia (**Exhibit 5**). Based on the levels of reserves and current rates of production, Canada's resource base has one of the longest production windows globally, suggesting that Canada's role in global energy markets will likely grow over time (EIA, 2010). Notably, Alberta makes-up more than 95% of current production and future reserves (CAPP, 2010). These reserves are predominantly in oil sands-related formations, suggesting that the average cost to produce in Alberta will increase over time (BP, 2009).

Alberta distinguishes itself from most other energy clusters because of its distinctive reliance on brackish heavy oil, tar sands, and high sulfur bitumen (Dusseault, 2001). Venezuela's Faja del Orinoco belt is the other location that has a large supply of heavy oil sand deposits. These reservoirs are similar in scale, namely that each has oil sand reserves about equal to the world's total reserves of conventional crude oil. They are also similar in terms of their high extraction cost, reliance on high energy prices for viability, source from "unconsolidated sandstones," and high reservoir porosity. However, the regions are dissimilar due to age (i.e., Alberta's oil sands are much older), patent concentration (i.e., Canada is a heavy oil "Center of Excellence"), climatic conditions (i.e., Venezuela is best geared for conventional techniques),

access to developed-world capital, and technological sophistication. The US also has smaller but statistically meaningful oil sand deposits. However, their composition, local climactic conditions, and regional regulatory environment make their extraction far less attractive. Small oil sand deposits can also be found in Russia (e.g., Siberia), the Republic of Congo, and Madagascar. Production in these countries remains in the early planning and pilot phases. Given the size of its natural endowment, its central reliance on the oil sands, and stable government, Alberta's advantage as a cluster is expected to remain sustainable relative to its peers for the foreseeable future.

Alberta's Oil and Gas Cluster

Alberta's oil sands resources are primarily located near Fort McMurray in Northeastern Alberta, approximately 450 km away from of the capital city of Edmonton. Transportation connections to the city are considered poor, such as no passenger railway, a six-hour bus or car trip on a single-lane highway, and an airport operating at 3x over-capacity (Gilbert, 2010). Conventional oil and gas resources are even more widely dispersed throughout the province.

Exhibit 6 displays the cluster map with the players involved directly and indirectly in extraction. The heart of Alberta's energy cluster contains firms that explore, produce, process, and transport energy across the three major types of petro-chemical product. Nearly all of the energy produced by the cluster is refined and transported elsewhere, so downstream elements of the value chain, such as storage and sales, are not in the cluster map.

There are three major company groups in the heart of the cluster. International, integrated firms (e.g., BP, Shell, Exxon Mobil) perform multiple aspects of the value chain in multiple regions globally. Roughly 10 of these firms, all with revenues more than C$25 billion, operate in the cluster, but only Suncor has its headquarters in Calgary. Large, focused firms perform one value chain element globally (e.g., TransCanada Pipeline, Schlumberger) or multiple elements in one region (e.g., EnCana). These firms have annual revenues of C$2-25 billion, with less than 100 operating in the cluster. Some of these firms

may be outsourced providers on specific functions, such as Baker Hughes or Schlumberger with respect to drilling and production. Finally, there are nearly 1,000 small, focused companies. These can be as small as 3-4 individuals with only 1-2 wells, or a geologist as a consultant, or a firm such as Pengrowth Energy that has a collection of producing wells in the cluster with annual revenues of C$2 billion. Firms typically grow by acquisition, not organically.

Beyond the core value-chain, there are also numerous elements that support the cluster:

Infrastructure: Alberta's petro-chemical resources are mostly in very remote, harsh, terrain, hence they require significant support from infrastructure-related companies, most notably housing providers (e.g., on-site, temporary, permanent), construction firms, municipal service providers, transportation firms (e.g., road, rail, air), and equipment manufacturers.

Government: Both federal and provincial governments (and arms-length entities they have created) are involved in the cluster. Cluster operations must interact with and seek approvals from, in particular, the National Energy Board, Alberta Energy Utilities Board, and the Provincial Ministries of Energy and Environment. In addition, the technical nature of work requires certification of employees from a variety of professional licensing bodies. Finally, First Nations reservations are located on or near production wells, and as they have rights to the surface of the land, they are critical stakeholders in the cluster.

Education: Secondary, university, and technical and vocational institutions support the cluster by developing skilled (e.g., engineers, geologists, managers, oil rig-hands) and semi-skilled (e.g., truck drivers, heavy machinery operators) human capital.

Capital Markets: As a capital intensive industry, local public and private entities, as well as the infrastructure for financial transactions, finance capital projects and conduct energy transactions.

Industry Groups: A variety of Institutions for Collaboration (IFCs) and research entities support cross-cluster collaboration, and will be discussed further below.

Environment: Finally, environmental concerns are also a fundamental part of the cluster. Environmental inputs (e.g., energy/power companies, water-related firms) are required for production, transport, and processing. Other firms manage byproducts from production and processing, such as sulfur, and the protection and reclamation of the land adjacent to and water used by energy projects.

Players in the energy cluster naturally must locate near the resource, and since oil fields tend to be adjacent to each other, cluster firms are similarly co-located. An unintended benefit is the ability for these firms to achieve scale economies for infrastructure investments such as roads, housing, common pipelines to a refinery hub, and collaborative research and development. The negative consequence of this, however, is a scarcity of inputs, such as skilled and unskilled labor and water, a necessary element for oil sands extraction and production.

Cluster History

The type of resource in the cluster has also changed over time (**Exhibit 7**). Conventional oil was dominant from the 1950s to 1970s, which was then supplanted by natural gas. Oil sands have a rising share of Alberta's energy production, but represent only ~25% of total energy output. The increase in oil sands' share of overall production is also seen in an increase in oil sands' share of investment into the cluster (**Exhibit 8**). Moreover, investment levels over the past 20 years have roughly mirrored the price of oil. This implies that companies make investment decisions in the short-term, with relatively less concern for the long-term implications. This is particularly stark as one international, integrated economist noted that "on one project we started spending CapEx 10 years before the first oil."[2]

This short-term planning became apparent in the economic crisis of 2008-2009. Over C$90 billion of oil sands projects were abruptly cancelled as firms attempted to conserve cash and minimize production over the slump in oil prices. Winter drilling programs decreased, and the decreased production levels combined with decreased oil and gas prices caused the provincial government to post a fiscal year deficit

[2] Interview with economist at international, integrated firm in Alberta's energy cluster.

(the first one in 15 years) and forecast three additional years of deficit (Government of Alberta, 2009). Even today, companies are hesitant to make large investments into the cluster, due to environmental and cost concerns related to one of the world's most difficult-to-produce energy resources (Reuters, 2010).

Cluster Performance, Government Policies, and Institutions for Collaboration

Overall, provincial revenues from oil and gas production has grown at a rate of 6.8% since 1970, with a ~15% annual growth from 1998-2008, net of inflation (**Exhibit 9**) (CAPP, 2010). Growth since the late 1990s has roughly mirrored the price of oil (i.e., WTI 1998-2008 CAGR is ~19%). However, government policies, in particular, took effect when oil revenues and oil prices diverged in the 1980s, and in 2004-2006. In 1979, the federal government's National Energy Program capped the price of oil that companies could receive, and the federal government kept the difference between the market price and the federally-imposed price. In 2004, the provincial government increased the royalty that companies paid for every barrel of oil equivalent produced. In both cases, firms in the cluster slowed capital expenditure and scaled-back operations in order to maintain profitability. This demonstrates the level at which any new or unexpected government policies can directly impact cluster competitiveness.

Nonetheless, the provincial government's policy regime has mostly been favorable towards the energy cluster. As the cluster was developing in the 1930s, the province focused efforts on developing and harnessing the cluster by establishing a baseline regulatory framework, developing necessary infrastructure (e.g., pipelines across Canada and to key US markets), and negotiating with the federal government to secure jurisdiction over natural resources. In the 1970s and 1980s, the provincial government transitioned toward policies more intended to strengthen the cluster, by establishing a then-predictable royalty regime, price deregulation of natural gas, and an effort to decrease tariffs with the US. Oil sands became the provincial government's focus in the 1990s, by reducing royalties to encourage investment and development of oil sands resources, as well as developing institutes for collaboration to support a deregulated power market. At the turn of the century, the provincial government again shifted focus to sustainable development, notably mandating companies to self-monitor greenhouse gas emissions,

developing standards for land and water protection, developing an endowment to fund research into energy innovation, and investing in First Nations communities to support their partnership with cluster-related companies. More recently, to support the energy cluster in the global economic crisis, the provincial government reduced royalties on new conventional oil and gas wells to 5% or less, and also provided small companies with a drilling royalty credit. Despite criticism that the provincial government has been too "hands-off" in industry regulation, particularly with respect to environmental issues, government action has improved the cluster's competitiveness substantially more than it has harmed it, such as a pipeline infrastructure to connect output to a US market free of tariffs, environmental standards, investments in the cluster's local communities, and research and development efforts to foster innovation.

Private-sector Institutions for Collaboration (IFCs) have also emerged in the cluster. IFCs such as Canadian Association of Petroleum Producers (CAPP) and Petroleum Services Association of Canada (PSAC) are well-funded and have broad industry participation. In addition, Alberta Innovates: Energy and Environment Solutions is one of the new corporations within Alberta's provincially-funded research and innovation system. It built on the former Alberta Energy Research Institute and aims to raise further the level of collaboration on research activities. Other key IFCs in the cluster are Clean Air Strategic Alliance, Alberta Research Council, Energy Resources Conservation Board, and Aboriginal Partnership. These and other IFCs act as spokespersons for the industry to government, local communities, and interested parties outside the cluster. They work closely with government, compile statistics, and disseminate best practices. These groups are particularly beneficial to the small firms in the cluster, as they do not have the budgets of international, integrated firms to carry-out intensive government relations and public outreach programs. Large, focused firms have substantial capabilities inside the cluster, but are nonetheless benefited by IFCs

However, one criticism of IFCs is that their reach and impact outside the cluster is rather limited. There are multiple spokespeople, each of whom does reasonable job to communicate issues and facts on oil sands production to an outside audience. Collectively, though, the presence of so many spokespeople often creates a disjointed message.

One further example of collaboration across firms is the joint venture Syncrude. Started as a collaborative research group in 1964, Syncrude was one of the first producers of oil sands in Alberta in 1978, and has grown to become the largest oil sands producer in Canada (Canadian Oil Sands Trust, 2008). The JV is comprised of seven partners, the largest with a 36% share. Each firm pays a pro-rata share of its cash costs, with each firm sharing best-practices to improve the productivity of the Syncrude resource. Recently, one JV partner sold its stake to Sinopec (an integrated Chinese oil company), which was one of China's first major investments into Alberta's energy cluster (New York Times, 2010).

*Competiveness: Cluster Diamond Analysis (**Exhibit 10**)*

Factor Conditions (Positive and Negative): The cluster's natural endowment of energy reserves is second only to Saudi Arabia. To support this endowment, two large universities are located in the cluster, and both have targeted research institutes (e.g., University of Calgary's Institute for the Sustainable Energy, Environment, and Economy) and high-quality engineering programs to support the knowledge needs. Lastly, capital expenditures are readily financed through public and private capital markets, especially for the major firms and large-scale projects in the cluster.

However, the remote location of the cluster yields challenges. First, the pipeline infrastructure for the cluster focuses heavily on the US, as there is no liquids pipeline to West Coast ports that could enable shipment of oil to Asia. Second, the bog-like land conditions can only support road travel in the winter, when temperatures may reach below -40C. Further, one economist at an international, integrated firm in the cluster noted that "[the company's] capital expenditure costs are grossed up 50-200% from our standard pricing, due to skilled labor shortages and high transportation costs."[3] Lastly, there is a shortage of temporary and full-time housing for workers, as housing prices are the most expensive in Canada with an average house in Fort McMurray selling for C$640,000 (Wood Buffalo, 2010).

[3] Interview with economist at international, integrated firm in Alberta's energy cluster

Context for Firm Strategy and Rivalry (Positive): The cluster benefits from a diversity of firms. International, integrated companies bring foreign expertise that focuses on conventional oil and gas production, refining, and transport. However, oil sands innovations are created locally typically by small, focused firms, or research institutes within the cluster. Instead of hoarding their proprietary technology, these small firms act as external contractors to large, international firms, and research institutes use IFCs to distribute best practices.

It appears that Alberta is attempting to become a heavy-oil "Center of Excellence". This is shown by comparing the number of patents to millions of barrels of oil produced per day (**Exhibit 11**). The US clearly produces the most patents per energy output, but Canada is ahead of all other large energy-producing countries, including other countries with large heavy oil reserves, namely Venezuela and Russia. Because few countries have expertise in heavy oil production, Alberta's cluster has had to innovate and develop new technologies on its own. The provincial government strives to support innovation through flexibility in new technology use, but it could do more to ease the regulatory processes.[4] In the short- to medium-term, this cluster effort is intended to make Alberta's oil sands cost-efficient to produce even in energy down-markets. In the long-term, this innovation may enable the cluster's firms to license their technological know-how to other heavy oil clusters globally and invest directly in clusters outside Alberta, thereby raising the potential pay-off of innovation by Alberta's energy cluster.

One potential threat to competitiveness lies in the nature of the oil and gas market. First, oil sands requires significant production scale to produce economically, due to the capital expenditure required to achieve first oil production, either through the steam injection or stripping of the earth's surface needed to start shoveling and trucking oil sands. Second, oil-sands output requires more upgrading and processing than conventional oil, which is currently a weakness for the cluster.

[4] Interview with Kyle Fawcett, Member of the Legislative Assembly of Alberta

Demand Conditions (Neutral): Despite the rural location of the cluster, much of the gas produced is used by industry in the region, primarily for electricity generation (Government of Alberta, 2009). Alberta's oil sands producers use significant quantities of gas to extract and refine the raw materials, and other parts of the energy supply chain, such as refiners, are also heavy users. In addition, the US is a significant customer (**Exhibit 12**), receiving over two-thirds of the output (CAPP, 2010). Furthermore, Canada has historically been one of the highest users of energy. The average Canadian uses some 8.2 tons of oil-equivalent annually, versus the US at 7.8 and the UK at 3.4 (World Bank, 2008).

However, there is rising public sentiment against so-called "dirty oil." Environmental groups have launched public-relations campaigns against the environmental impact of what they pejoratively refer to as Alberta's "tar sands." Their efforts are buoyed by media reports of the impact of tailing ponds—specifically, water that is left-over after washing oil out of oily sands. These ponds have been accused of causing higher cancer rates in local populations, and 1,600 ducks died when they landed on a pond in 2008 (Jones, 2010). In addition, "Well-to-Wheels" or lifecycle greenhouse gas intensity is 5-15% higher for Alberta's oil sands than conventional oil, and the difference is even large if one considers only the extraction and upgrading processes (IER, 2010).

Because of these environmental concerns, dependence on the US market is a threat to the demand. In 2007, the state of California passed a landmark Low Carbon Fuel Standard (LCFS) requiring that transportation fuels sold in California have a net 10% reduction in greenhouse gases, which may soon inhibit oil sands output from this market. Eleven more states may soon adopt the California standard, further limiting the size of the US market for the cluster's exports (Environmental Leader, 2010). Institutional investors have become more cautious of oil sands investments due to environmental risks, such as the California State Teachers' Retirement System suggesting that "the environmental risks associated with oil sands development comes with long-term financial risk for the CalSTRS portfolio" (Legorano, 2010).

Related and Supporting Industries (Neutral): Since one out of every seven jobs in Alberta is related directly to the province's energy cluster, the provincial government and the private sector are aligned towards supporting a successful cluster. More specifically, post-secondary institutions across the province are focusing research and teaching efforts on energy-related disciplines, such as the University of Alberta's Centre for Oil Sands Innovation and the Construction Research Institute for Canada.

The location of local suppliers of specialized equipment presents a challenge for the cluster. Industrial equipment (e.g., oil drilling rigs, refinery/upgrader components) is typically constructed in Edmonton, and then transported to the production sites nearby Fort McMurray in a costly process that can sometimes take up to 5-10 days due to transportation challenges.

One other challenge is that cluster does not contain a robust end-to-end energy value chain within its geographical boundaries. Most notably missing from Alberta's cluster is the refining and large-scale sale of oil and gas products, as Western Canada only has 3% of total refining capacity of North America, and can only refine ~25% of its own output (CAPP, 2010). Bitumen—processed, but unrefined oil sands—requires significant refining to become a market-ready product, and thus the cluster is giving other regions the opportunity to collect the value created by refining this product. That said, oil sands refining also comparatively emits more greenhouse gases than other types of oil, so refining elsewhere helps the cluster manage its emissions levels, particularly in a context where carbon tariffs or cap-and-trade are more likely.

Issues for Cluster's Competitiveness

Environment: The energy cluster's impact on the environment remains Alberta's largest concern. It is probable that pollution concerns may limit future development in the region, and that excessive use of fresh-water in the extraction and upgrading processes may impair the local population, related clusters, and regional eco-systems. The higher-than-conventional greenhouse gas emissions are expected to impose significant costs on Alberta's industry in the form of carbon tariffs or cap-and-trade system. For example, a modest carbon tariff of US$20/tC02e would impose a cost of $2.21 per barrel of oil on the oil sands

versus $0.52 on conventional oil—a gap that widens starkly to $5.53 and $1.29, respectively, in a possible $50/tCO2e carbon tariff scenario (Levi, 2009). In a blunt passage, National Geographic summarized the cluster's environmental performance as follows:

> *"To extract each barrel of oil from a surface mine, the industry must first cut down the Boreal forest, remove an average of two tons of peat and dirt that lies above the oil sands layer, then two tons of the sand itself. It must heat several barrels of water to strip the bitumen from the sand and upgrade it, and afterward discharge contaminated water into tailings ponds. Last April, some 1,600 migrating ducks mistook one of those ponds at a newer Syncrude mine north of Fort McKay for a hospitable stopover, landed on its oily surface, and instantly died. The incident stirred international attention and Greenpeace broke into the Syncrude facility and hoisted a banner of a skull over the pipe discharging tailings, along with a sign that read "World's Dirtiest Oil: Stop the Tar Sands" (Kunzig, 2009).*

Infrastructure: The inadequate civil infrastructure is another challenge for Alberta's energy cluster. This ranges from housing prices in the Fort McMurray area that are 2x the Canadian average, to road and railway traffic that is over-capacity for the current transportation needs. Indeed, until the 1970s, Albertans reached the Fort McMurray area mostly by boat or, in the winter, by dogsled. Gas, electricity, telephones, and water were not installed until the 1980s.

The mining infrastructure itself is also a challenge. The electric shovels that dig up the oil sands stand at over three-stories tall. The large-sized trucks used to haul oil sands carry 400-ton loads each time, burn 50 gallons of diesel fuel an hour, and require a forklift to change their tires, which wear out about every six months (Kunzig, 2009). It is costly to maintain and service this over-stretched infrastructure.

Factor Costs: Alberta must also optimize innovation and factor costs in order to increase the cluster's competitiveness. Currently, high factor costs limit production growth, and new resources require additional technology in order to produce at a competitive cost.

Dependence on US Export Market: Lastly, the high dependence on the US market for refining, storage, and sales makes the cluster extremely dependent to both its federal- and state-level regulation. Government regulation can change quickly and significantly impact exploration plans and firm profits, such as the LCFS movement spearheaded by California and potentially soon to be followed by others.

Cluster-Level Recommendations

Government

1. **Strengthen the implementation of current environmental policies (Medium Difficulty)** – Federal and provincial governments have created policies on environmental sustainability of the cluster (e.g, Alberta's Land-Use Framework, Canada's "Turning the Corner" plan on greenhouse gas cuts). These policies would help protect air, land, water, biodiversity and human health, and to address the cluster's long-term competitiveness. However, they have mostly not yet been implemented, and thus, are ineffective. For example, Alberta's Water Management Framework has not been fully enforced, leading to increased usage of freshwater from the Lower Athabasca River. Other water sources exist for firm to use in oil sands processing (e.g., recycled water or non-potable water from deep aquifers) with relatively limited impact on operations, so less freshwater use would likely not impair the cluster's long-term competitiveness. Hence, Alberta should strengthen the implementation of current policies by setting milestone implementation targets, using the royalty regime to manage and monitor firms' environmental performance, and improving engagement with multiple stakeholders.
2. **Create an endowment to fund sustainable research development (Low Difficulty)** – Similar to a provincial fund dedicated to medical research, Alberta should earmark a share of oil and gas royalties for a fund to enhance sustainable resource development research at the provinces primary universities (e.g., University of Calgary's Institute for Sustainable Energy, Environment, and Economy).
3. **Reduce regulatory burdens associated with new technology (Low Difficulty)** – Small, local firms are developing innovative ways to improve oil sands extraction, while decreasing energy or water use (e.g., underground controlled combustion, vapor extraction, or solvent-assisted production). However,

these processes are often held-up in multiple regulatory approvals, hence the provincial government must fast-track technology that is proven, safe, environmentally friendly, and favorable to the cluster.

4. **Increase permanent housing through re-zoning and company requirements during permitting (Low Difficulty)** – Lands nearby Fort McMurray are "Crown Lands" (i.e., government-owned), however remain largely vacant. Re-zoning this land for multi-family and low-income housing would ease the housing supply shortage. In addition, company applications for new oil and gas developments should include plans to build permanent housing in the area.
5. **Improve transportation options to the cluster (Medium Difficulty)** – The government should implement actions from Alberta's 20-year "Strategic Capital Plan to Address Infrastructure Needs," such as a twin highway from Edmonton to Fort McMurray, in partnership with the private sector and IFCs. In order to alleviate road congestion in key areas of the cluster, Alberta's government should promote bus transportation as an alternative to car travel.
6. **Increase number of skilled workers through local education and increased work permits (Medium Difficulty)** – The provincial government must encourage the federal government to increase the number of foreign worker visas for both skilled and semi-skilled workers. In addition, Alberta should develop more local talent by improving high school completion rates in the region, especially amongst First Nations youth.
7. **Improve financing conditions through foreign-flows of funds and a consistent royalty regime (Medium Difficulty)** – Alberta should continue to encourage FDI, manage M&A policies to enable foreign investment, and commit to the industry to a stable royalty regime for a period of 5-10 years, without any wild swings thereafter. This would enable foreign firms to inject capital into the industry with even lower political and economic risk because taxes on production are predictable.

Institutions for Collaboration

8. **Create a single voice for the entire cluster (High Difficulty)** – The cluster needs a coordinated public-relations campaign to dispel incorrect facts about Alberta's oil sands. IFCs, governments, and

companies are all attempting to manage public discourse, but an inconsistent, uncoordinated message has been ineffective to date. Collaboration on a united campaign would increase the energy cluster's presence in the international debate on unconventional oil.

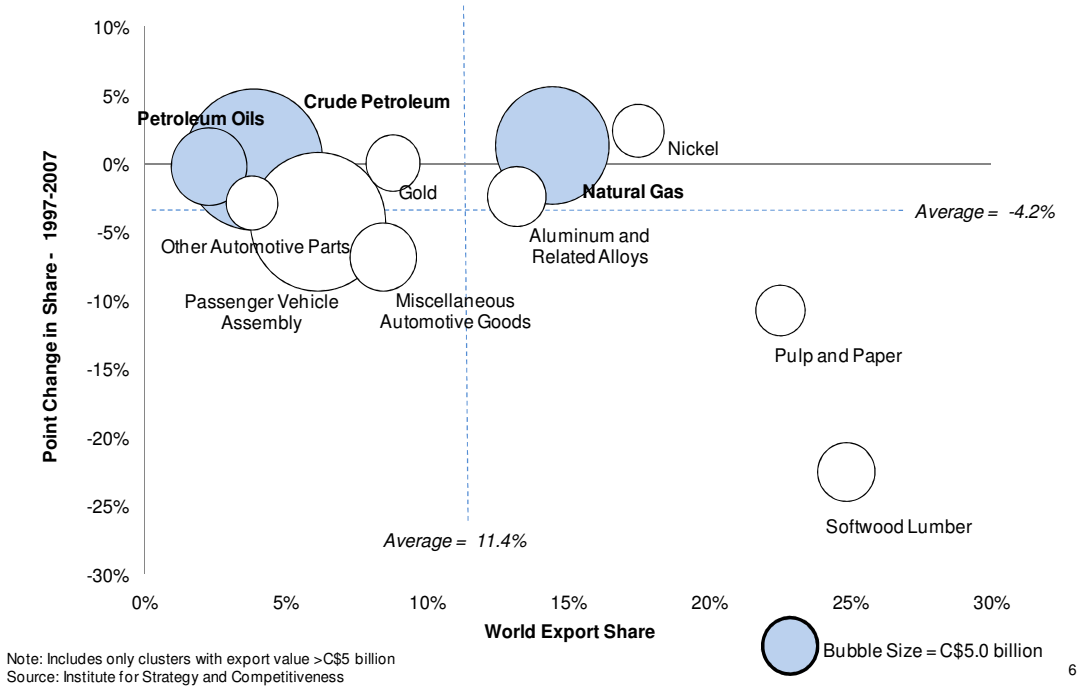
9. **Facilitate the development of new pipelines to other markets, especially to the West Coast (High Difficulty)** – IFCs and public-private partnerships should help to develop a pipeline to the West Coast to facilitate better access to Asia. In addition, the cluster could increase future sales to Eastern Canada with additional pipeline capacity and the reversal of pipelines from Quebec to Ontario. However, there are many stakeholders with whom to negotiate land right-of-ways, such as different First Nations tribes and treaty agreements. Pipeline companies are reticent to take-on this challenge, but a newly-created IFC by the provincial government could join together regulators, companies, and First Nations groups to help pipeline projects reach completion.

<u>Private Sector</u>

10. **Invest in local population education (Medium Difficulty)** – Despite a skilled worker shortage, there is a significant local population (i.e., First Nations) that is under-skilled and that has high school completion rates less than 30-40%. Firms in the cluster should invest in these communities through local schools to bring skills of these youth to a high-school level, then sponsor vocational training, and eventually offer them jobs in the cluster that have opportunities for advancement.
11. **Increase investment on environmentally-friendly energy production (Medium-High Difficulty)** – Environmental regulations by federal and provincial governments have become more stringent. However, companies in the cluster have mostly failed to comply with this new trend. Therefore, companies should increase their investment in clean energy production technology in an effort to remain competitive in the future regulatory context.

Exhibits

Exhibit 1: Canada's Exports by World Market Share (2007)



Note: Includes only clusters with export value >C$5 billion
Source: Institute for Strategy and Competitiveness

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Exhibit 2: Canada Diamond Analysis

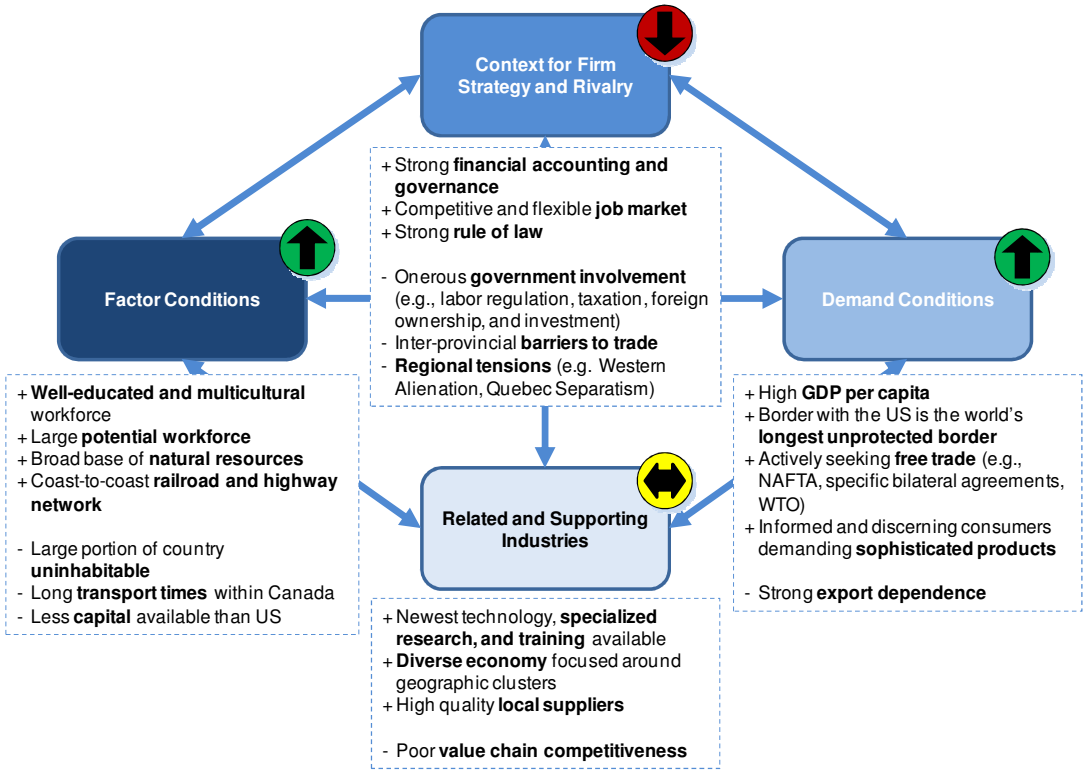


Exhibit 3: Alberta Diamond Analysis

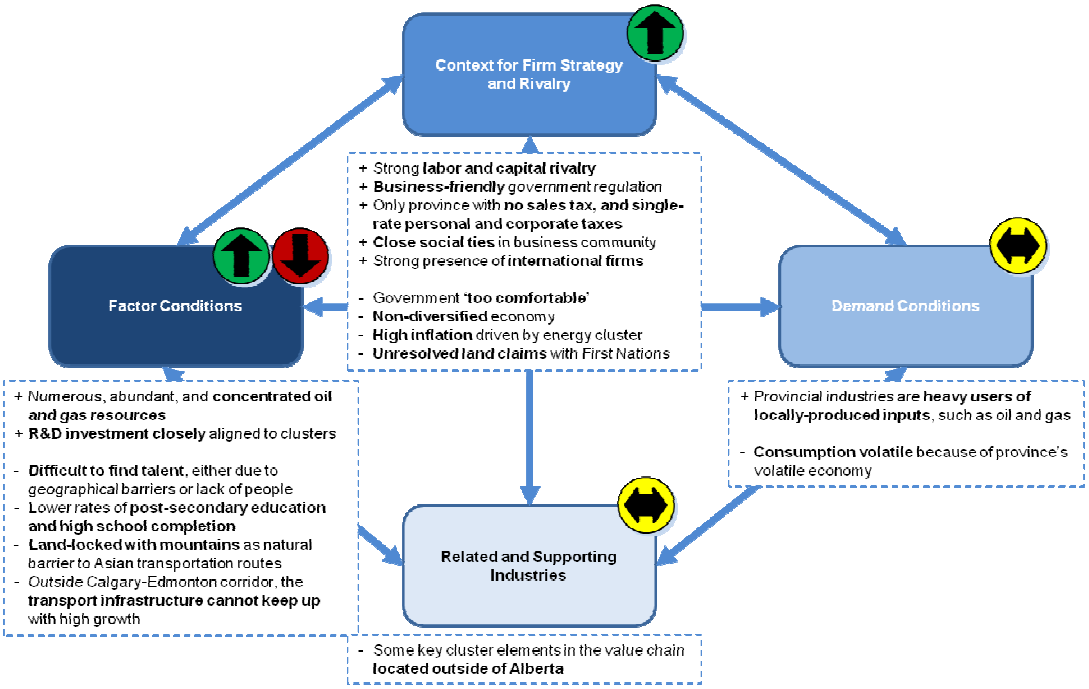


Exhibit 4: Oil and Gas Value Chain

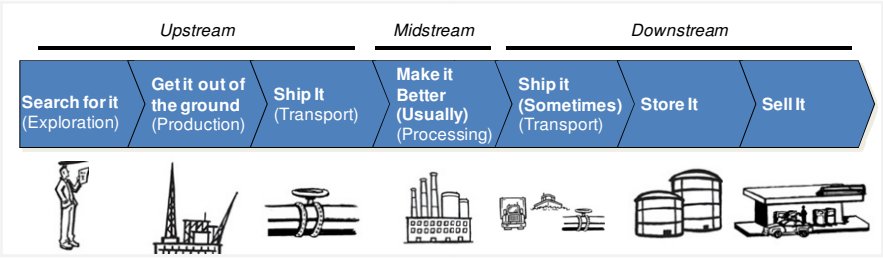
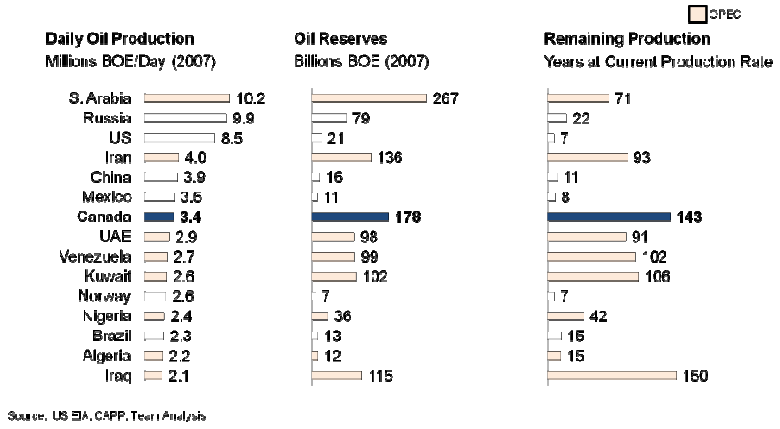


Exhibit 5: International Oil Production and Reserves



Source: US EIA, CAPP, Team Analysis

Exhibit 6: Alberta Energy Cluster Map

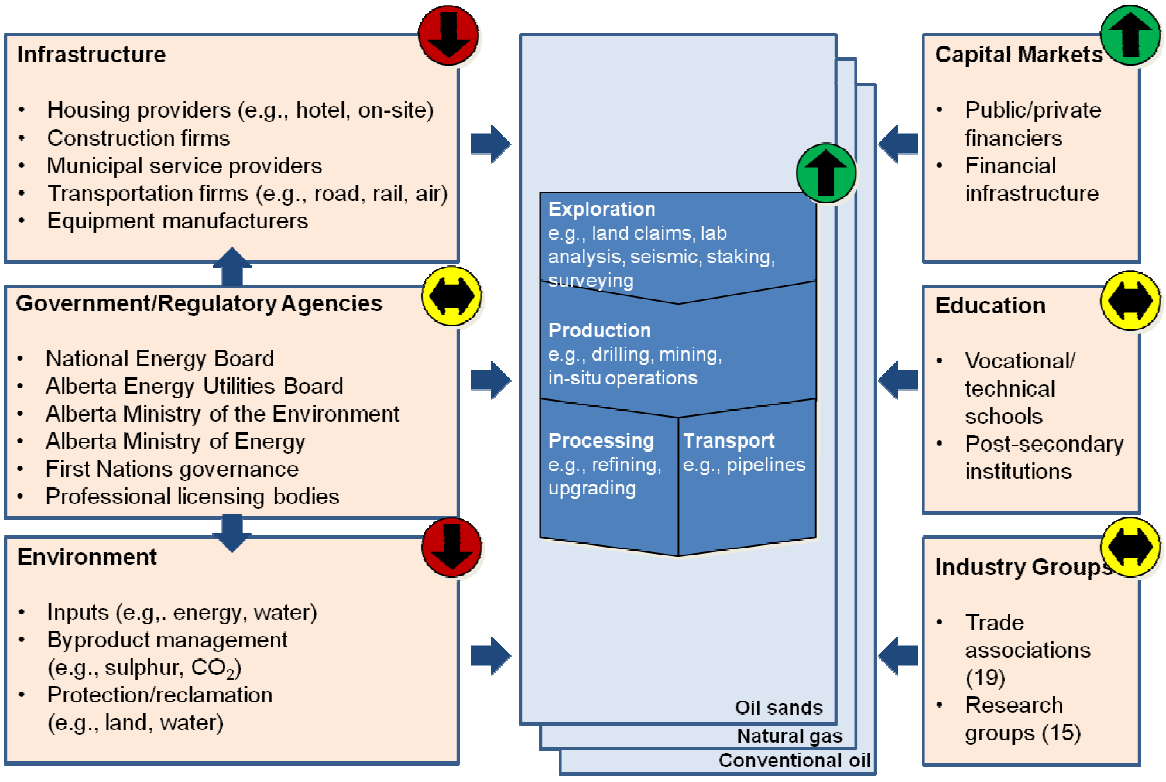


Exhibit 7: Alberta Energy Production - % of Total

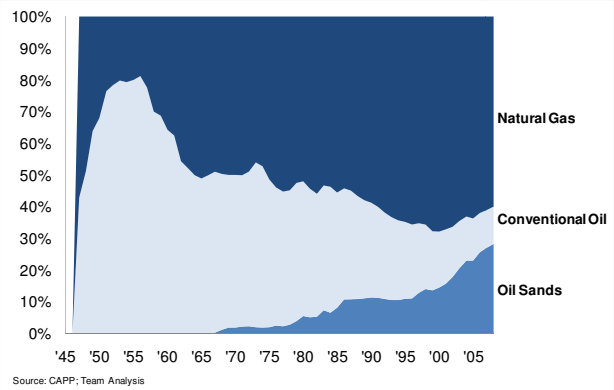


Exhibit 8: Investment in Alberta's Energy Sector

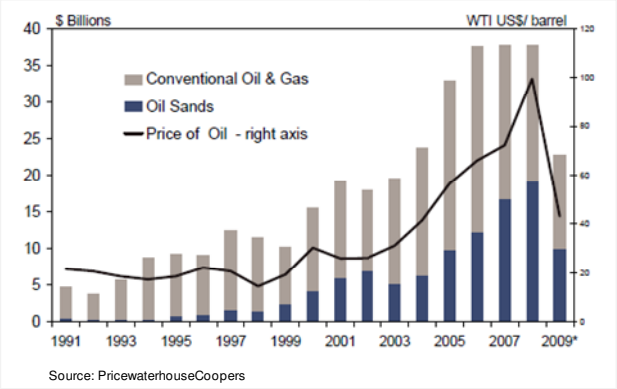


Exhibit 9: Provincial Energy Revenues vs. Oil Prices

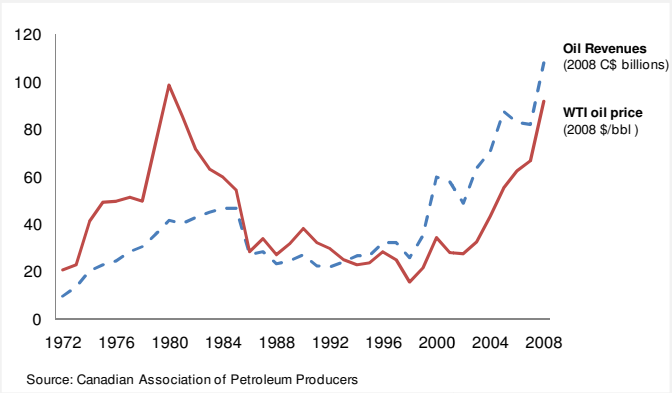


Exhibit 10: Alberta Energy Cluster Diamond Analysis

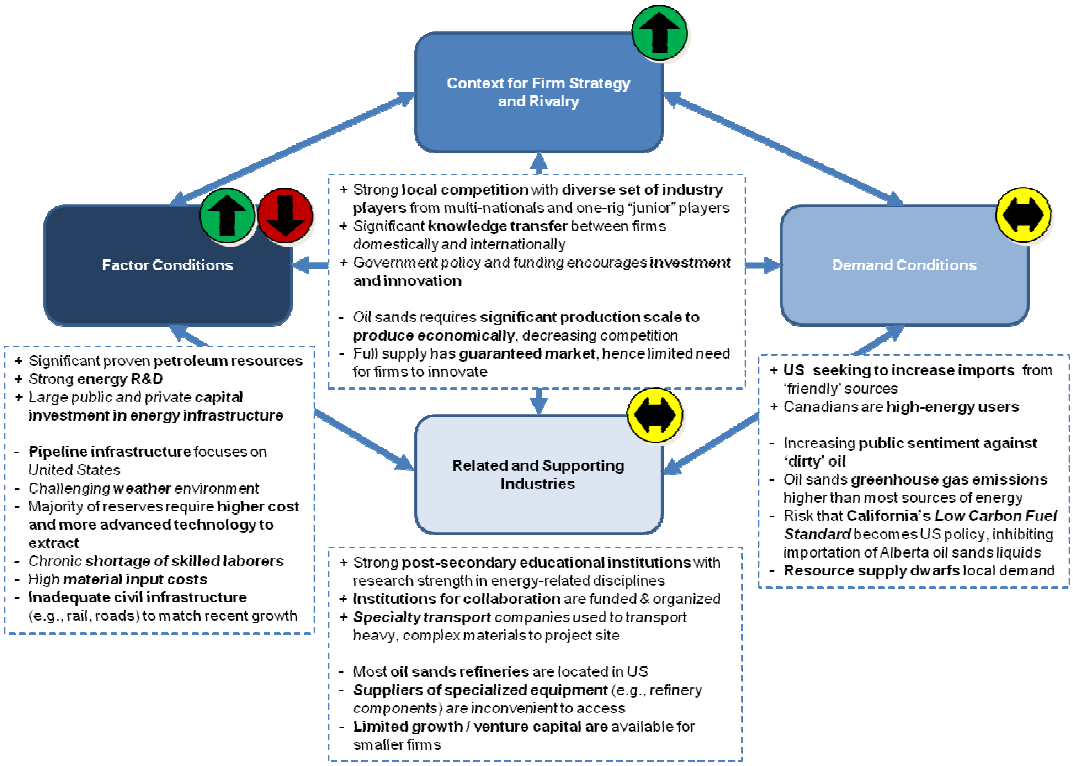


Exhibit 11: Patents vs. Energy Production

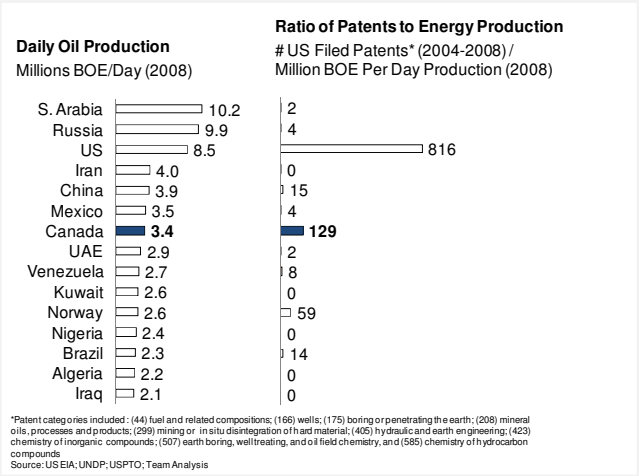
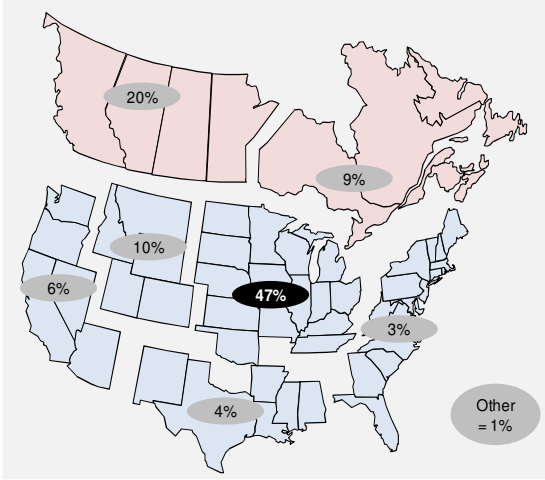


Exhibit 12: Markets for Western Canadian Oil



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