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Knowledge Insider

Where business meets opportunity | Energy edition

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Farm Credit Canada
Advancing the business of agriculture

Canada





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Do you need an energy plan?



Where are your energy opportunities?

Many will remember 2008 as the year oil prices skyrocketed to an all-time high of over US\$147 a barrel in July, falling below US\$60 late in the year. What do volatile energy prices mean for our economy, lifestyle and the future of Canadian agriculture?

Recent history shows that the world successfully weathered energy crises in 1973 and again in 1979. What's different about this one? The energy crisis of 2008 is set within a dramatic backdrop of shifting global wealth, increased consumer demand for value-added products (including agriculture products), intense competition for new international markets and global warming.

We have opportunities to move beyond our dependence on fossil fuels into an era of sustainable, affordable, environmentally friendly energy. Those who transition well will have the competitive advantage.

While we don't know what the future holds, we can prepare by examining long-term trends. There is no single solution. We need a mosaic of answers

that increases the quality of our lives, enables a prosperous economy and provides a better future for our children and grandchildren. Somewhere between the energy challenges of today and a secure, sustainable future are action-oriented people with a courageous vision.

We are on the threshold of an energy revolution that could change Canadian agriculture and our society as we know it. It could signal a golden age for the industry. Perhaps solutions will come from entrepreneurs like you.

In this edition

We're going to explore energy and its impact on Canada's agri-food system and your business:

- the current energy situation, the latest trends and developments, and Canada's energy sources
- the world's dependence on crude oil and other renewable and non-renewable sources of energy
- the complex economic, political and environmental factors controlling the price of oil and why diversifying your energy source might make sense
- the impact of energy systems on climate change
- historical insights into energy innovations that moved society from the use of one energy type to another
- possible solutions including insights from top industry experts and entrepreneurs, tips to help you manage the energy needs of your agriculture business
- the recipe for a secure sustainable energy future

Imagine your energy future

Night is falling. It's time to check the calves. Your heating system's sensors know which pens hold young animals and heat only those areas. The constant lull of the radio seems to keep the animals calm. When the wind blows, your wind turbine generates electricity to store in your big box hydrogen cell, where all the electricity is held. You check to make sure your tractors and combine are connected for overnight refuelling. These machines are being refuelled with high-grade biogas, created with your own biodigester and purifier. The lower-grade gas fires up your generator and also replenishes the big box. The smaller tractors and your car are powered by your electricity and smaller fuel cells.

Your neighbour doesn't have on-site generation. She has smart metering that helps her decide when to charge her equipment. Costs range from 2 cents/kW hour off-peak to 20 cents/kW hour at high-peak times. She changed her milking and pipeline cleaning schedule because that's when her electricity demands were highest and happened to overlap with peak hours. She won't pay top dollar for her highest volume anymore! Doing chores half an hour earlier, twice a day helps to avoid peak rates. She cut her bill by half. You sell power to her if the grid goes down because of ice or storms. It rarely happens since "distributed energy" came about.

You pick her up to drive to the local plasma converter. It used to be the town dump. There, you dispose of things the biodigester can't handle: old

tires, buckets from chemicals and anything toxic. Operating at extreme temperatures, the plasma converter reduces everything to molecules, creating pure water, gas and non-toxic substances that harden to glass¹. The glass can be pulverized for roads, sand and buildings. While you chat, she asks for your old biodiesel equipment. She wants to tinker. With part of the soy crop set aside, you made your own fuel for years. Now all of your equipment is electric or natural gas. You sell your soy crop to a broker who sells it to feed, food, fibre or biofuels manufacturers, depending on the price available and the quality of your crop.

Solar collectors dry your crop. The community invested in a lightning tower to capture energy and cost effectively store it for up to a year.

Your computer is your command and control centre. Using telematics, which combine computer science and telecommunications, it continually reports all data back to the local microgrid. The grid adjusts demand and dispatch based on its diverse sources of energy. Long ago, you decided not to sell to the grid, yet your neighbours who do can choose when to upload excess to get the best rates. The country is connected into the smart grid in the way everyone is connected to the Internet. It does everything from switching on your dinner to closing your blinds and setting your alarm.

Your calves are in great shape and so is your energy program.

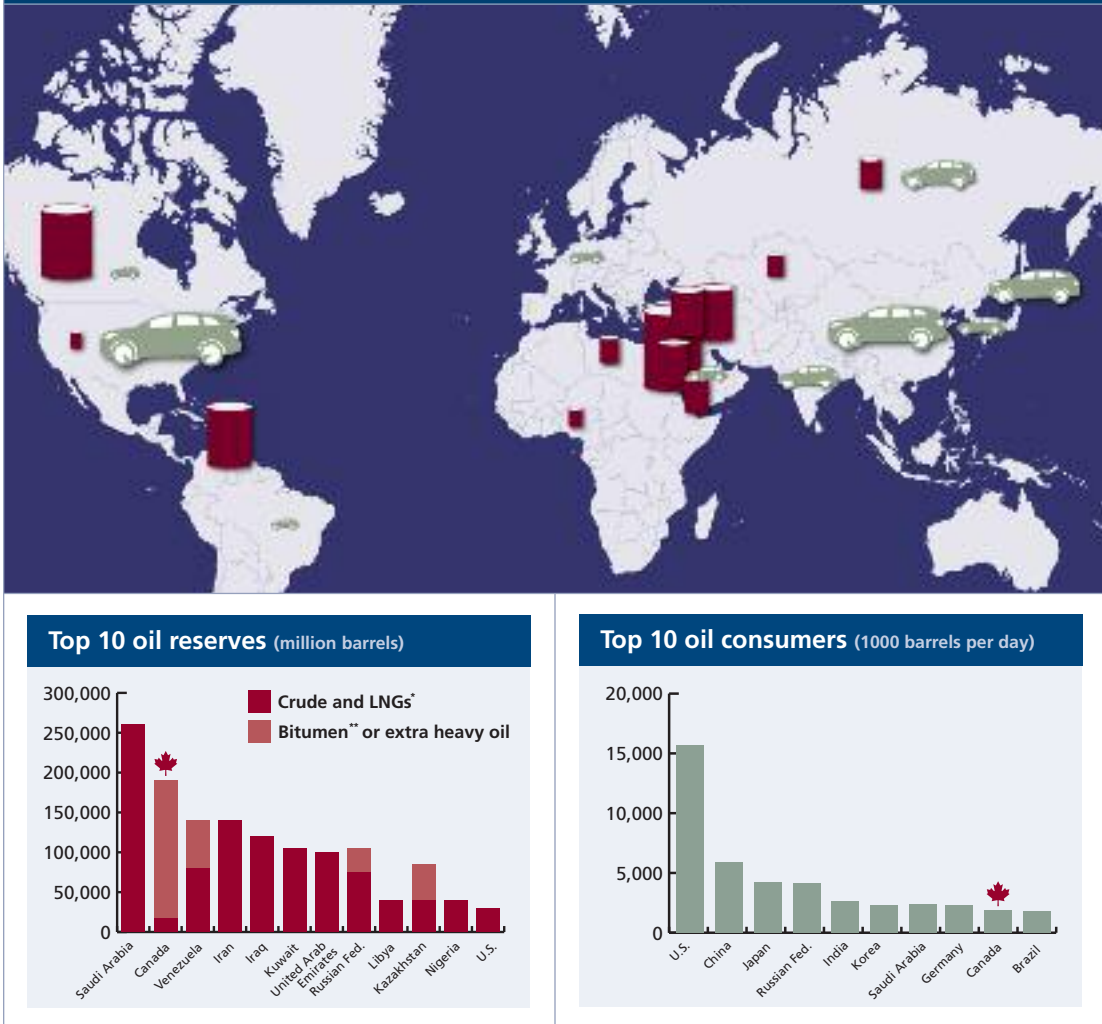
Canada's abundant energy sources What's in our energy mix?

Canada has an abundance of renewable and non-renewable energy resources, and is in an enviable position to develop a sustainable future. With the Athabasca oil sands, our oil reserves are second only to Saudi Arabia (Fig. 1 page 4). Despite vast reserves, we are not immune to global politics or market factors because we participate in a free market economy and compete to purchase oil at the going market price.

We are the world leaders in uranium production and hydroelectricity, two sources of relatively clean power. With our expansive crop lands and open spaces, biofuel and wind potential is also formidable.

Our advanced research and innovation environment encourages the production of clean energy technologies that can be exported, like advancements with hydrogen and carbon recapture in coal burning. Canada has the potential to be a leader in the next energy frontier.

Figure 1: World crude oil resources and consumption



*LNG is liquid natural gas. **Bitumen is an oil and sand mixture.

The world depends on crude oil

Developed and developing nations rely on crude oil. In fact, global transportation networks cannot function without it. Supplies of crude are neither infinite nor renewable, and substitutes are not easily found. The International Energy Agency predicts that global demand for oil will rise by 35 per cent by 2030.

Some countries rely less on oil than others. A recent survey comparing future economic growth to oil supply ranks India and China as being highly dependent, and Canada and the U.S. as being moderately dependent. Economic growth in most European countries does not rely on oil. They planned ahead, diversified their energy sources and partially decoupled their economic growth from the use of fossil fuels.²

Figure 2: Your business depends on crude oil



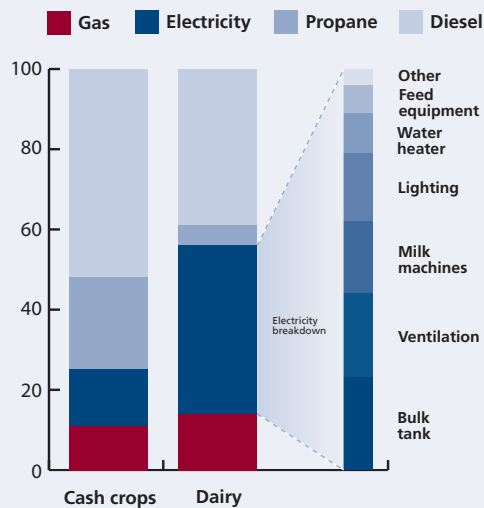
Farms and agribusinesses tied to fossil fuels are more vulnerable than those mainly using electricity.

How dependant is your business on the products derived from a barrel of crude oil?

What expenses top your energy bill? Is it providing warmth for chicks or hatching eggs, diesel for field work or transportation or electrical bills for manufacturing?

Your potential energy solutions depend on your answers.

The energy bill of two farm types



What happens to a barrel of oil?*



*Adds up to more than 100% because of gains due to processing

Table 1: Canada, U.S. and global electricity mixes

Energy type	Uses	Cost	Canada	U.S.	Global
Natural gas	<ul style="list-style-type: none"> • non-renewable • heating, transportation, electricity 	3-5¢/kW-h	8.1%	17%	18.3%
Coal	<ul style="list-style-type: none"> • non-renewable • electricity, industry 	3-5¢/kW-h	14.7%	51%	38.7%
Nuclear	<ul style="list-style-type: none"> • non-renewable • electricity, science 	2-4¢/kW-h	11.8%	21%	17.1%
Petroleum	<ul style="list-style-type: none"> • non-renewable • transportation, industry 	no cost data	2.5%	2%	7.5%
Hydro	<ul style="list-style-type: none"> • renewable • electricity 	<2¢/kW-h	59.8%	3%	16.6%
Solar (PV)	<ul style="list-style-type: none"> • renewable • lighting, heating, electricity 	18-25¢/kW-h	Less than 1%	Less than 1%	0.3%
Biomass	<ul style="list-style-type: none"> • renewable • heating, electricity, transportation 	8¢/kW-h	1.3%	3%	1%
Geothermal	<ul style="list-style-type: none"> • renewable • heating, electricity 	5-7¢/kW-h	Less than 1%	Less than 1%	0.3%
Wind	<ul style="list-style-type: none"> • renewable • heating, electricity 	3-5¢/kW-h	1.7%	Less than 1%	0.3%

Table 2: Factors affecting crude oil price, supply and demand**Long-term trends**

- effects of hitting “peak oil”
- changes in estimates of supplies and of how much is economical to recover
- demand growth, particularly in Asia where more cars are driving longer distances
- U.S. dollar strength
- world GDP growth
- technology advances
- government tax policy
- world events and political stability in oil-producing countries
- amount of exploration and refinery building
- inventory levels including hoarding and strategic stockpiling
- sovereign wealth funds³
- corruption

Short-term factors

- consumer behaviour, like choice of car model, discretionary travel (summer peak), use of public transit, long weekends and holidays
- weather, including Gulf Coast hurricanes, heat and cold waves
- panic, fear, hoarding and scarcity pricing
- speculation,⁴ hedging and forward-contracting
- large speculators with the means to purchase energy and who can store it or hold production back in the ground as prices increase
- lack of information about global energy inventories
- market volatility, which provides an opportunity for speculators and hedge funds to profit, further exaggerating underlying volatility
- OPEC quotas

Canada's rich variety of hydro, wind, solar, coal and nuclear power gives it many options for making electricity (Table 1). This mix contrasts markedly to our transportation energy mix, which is 96 per cent fuelled by crude oil derivatives.

There is no question that Canada has the resources to sustain its economy and lifestyle in the short term. In the longer term, finding new alternatives and an energy mix that reduces dependence on fossil fuels are imperative. It's time for hindsight, insight and foresight.

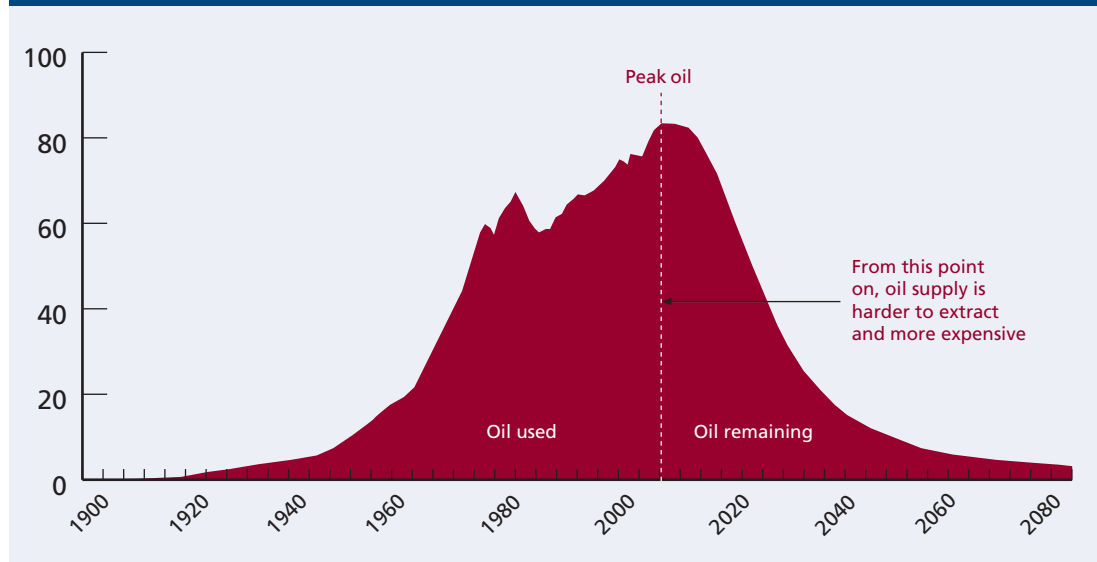
The current state of crude oil

Have you heard of peak oil? It means we have used over 50 per cent of readily available oil resources. After the halfway point is reached, (Fig. 3) it is more challenging and expensive to produce. With increasing demand and volatility in the marketplace, risks to the economy and society increase.

Some believe we already have or are about to hit a global peak oil situation. If this is true, decades of enjoying inexpensive gas have come to an end. Peter Tertzakian, bestselling author and top oil and gas analyst, says if oil ever drops back to 1990s price levels, it will be because of other global economic concerns that will overshadow the price of oil. Viable options to address peak oil exist. However, to have substantial impact, they must be implemented more than a decade in advance of peaking.⁵

We won't run out of oil any time soon. There is plenty of oil and natural gas in functioning deposits and in proven resources in Kurdistan, Antarctica, the Barents Sea and the Canadian Arctic. We simply can't access and exploit new discoveries quickly enough to bridge the widening gap between shrinking supplies and growing demand. Experts estimate it takes between seven and 10 years – and massive investment – to get a new field up and running.

Figure 3: World oil production 1900-2080 (millions of barrels per day)



Geopolitical issues have a significant impact on world oil supplies. Many countries within the Organization of the Petroleum Exporting Countries (OPEC) (Fig. 4) and others who export oil are located in historically unstable regions (Fig. 5, Fig. 7 page 12).

Volatile prices

People will remember 2008 for the historic U.S. election, the worldwide financial collapse and as the first time in history that the price of oil hit over US\$147 a barrel. The price came down as quickly as it went up. (Fig. 11 page 22).

When markets work well, the price of fuel adjusts to balance supply and demand. Price shifts are determined by the size of the imbalance and the willingness of producers and consumers to respond to the gap. When supply is steady and plentiful, prices are not volatile. Fluctuations occur due to changes in the factors in Table 2 (page 6). The current peaks and valleys are signs that can indicate peak oil.

It's challenging to plan or make long-term decisions for your business when the costs of crop inputs, transportation, field work and energy are volatile and hard to estimate. This same uncertainty impacts those who fund and build large energy projects, yet investing in new energy models is critical to transitioning.

Even though we are in a time of economic slowdown, analysts agree that over the long term, the price of oil will continue to be volatile as we approach peak use conditions. Even a reprieve from high gas prices is likely temporary, but it gives us a window for planning. Foresight gives us choices. Perhaps now is the right time to learn about energy alternatives and plan to reduce your dependence on fossil fuels.

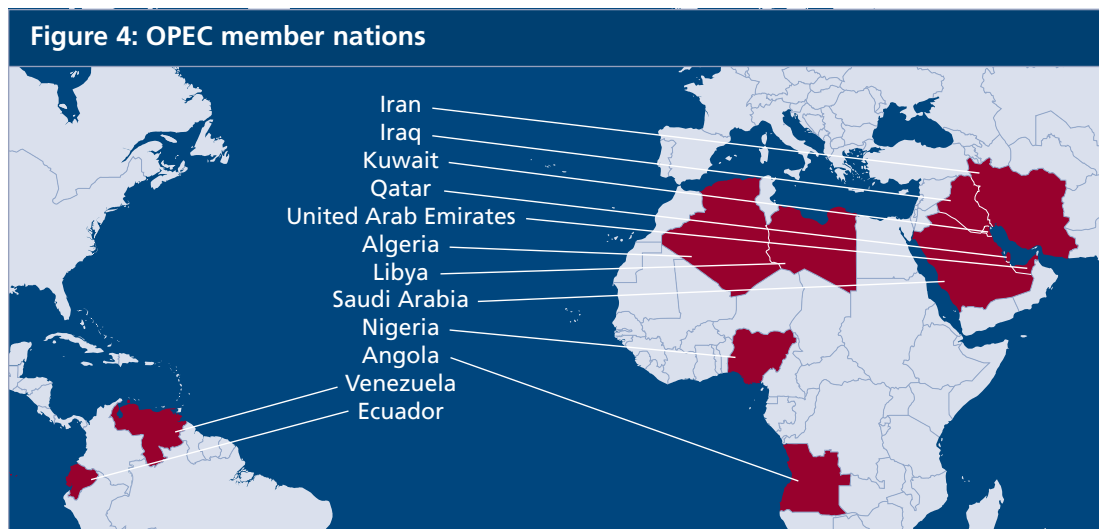
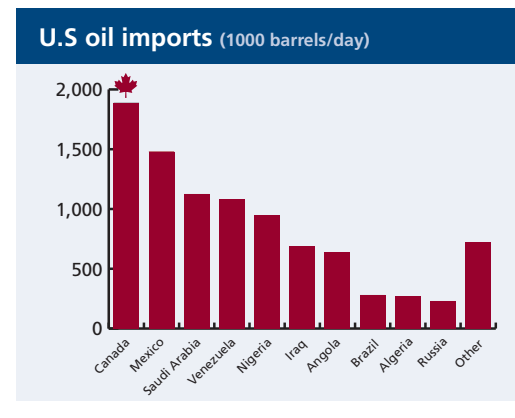
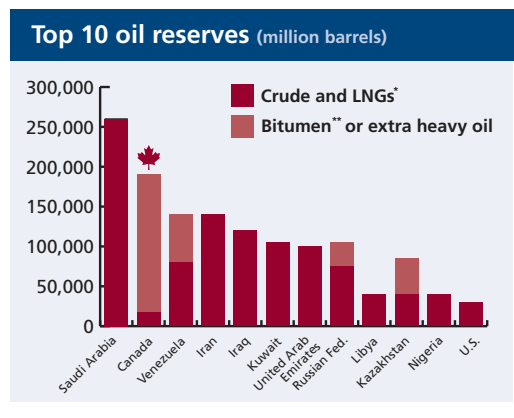


Figure 5: Where the U.S. gets its oil

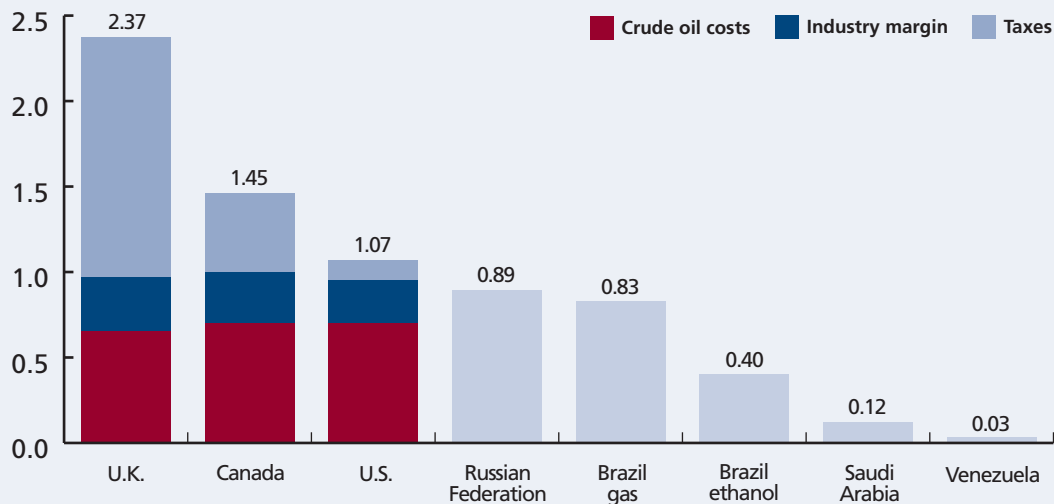


Who sets the price?

For countries buying in the free market, crude oil price is based on all the factors at play in Table 2 (page 6). Some countries like Venezuela and Saudi Arabia are oil exporters. However, they do not purchase on the world market. They set prices for crude within their countries according to domestic policy.

For those operating in free markets (Canada, U.S., U.K), the price of crude oil is more or less the same, but different tax policies and marketing costs mean differences in prices paid at the pump (Fig. 6, page 11). Gas has been heavily taxed in European countries since the 1970s oil crisis. Higher prices forced consumers to be conservation minded and to ration resources. Money raised



Figure 6: What different countries pay at the pump (CND per litre) Summer 2008

Note: cost breakdown only available for U.K., Canada and the U.S.

from higher gas taxes was invested into alternate energy sources and public transit.

Not all the costs of producing and consuming oil show up in the price at the gas pump. Other costs include oil-centric wars, escort ships in the Gulf, and the environmental burden. These hidden costs are paid through taxes, accumulate in a country's debt or, in the case of environmental accounting, are borne by future generations.

Energy systems impact climate changes

Few now question whether climate change is real. In addition to natural climate cycles, scientists agree it's very likely that man-made greenhouse gas (GHG) emissions impact the environment.⁶ Winters will be shorter, summers will be longer and the year-round temperatures will rise. It is also likely that the increase in heavy rain, heat waves, droughts and hurricanes is connected to man-made GHGs. These trends are expected to increase.

Carbon is constantly released into the environment. When a cow belches or produces manure, it releases methane (CH₄) from the

carbon in the plants it has eaten. These plants had recently captured the carbon from the air during photosynthesis. It's a short-term cycle. When we burn through an entire oil field, however, we free carbon that may have been sequestered for millions of years and will not cycle back.

"Man-made emissions of carbon dioxide jumped three per cent last year. That means the world is spewing more carbon dioxide than the worst-case scenario forecast by a Nobel Prize-winning group of international scientists in 2007."⁷ The increase reflects explosive growth in the burning of coal and manufacturing of cement.

Demand for electrical power is growing too

Our love affair with the electron is as powerful as our addiction to oil.⁸ There's a close relationship between economic growth and electric growth. As seen in Table 1, there is a wide variety in how countries choose to power their electricity needs.

Expanding cities around the world have insatiable appetites, and much of their growth is powered by generating electricity with fossil fuels. Coal is the

Figure 7: Top oil companies



Exxon is often thought to be the world's largest oil company. See how its assets compare to companies whose assets are nationalized.

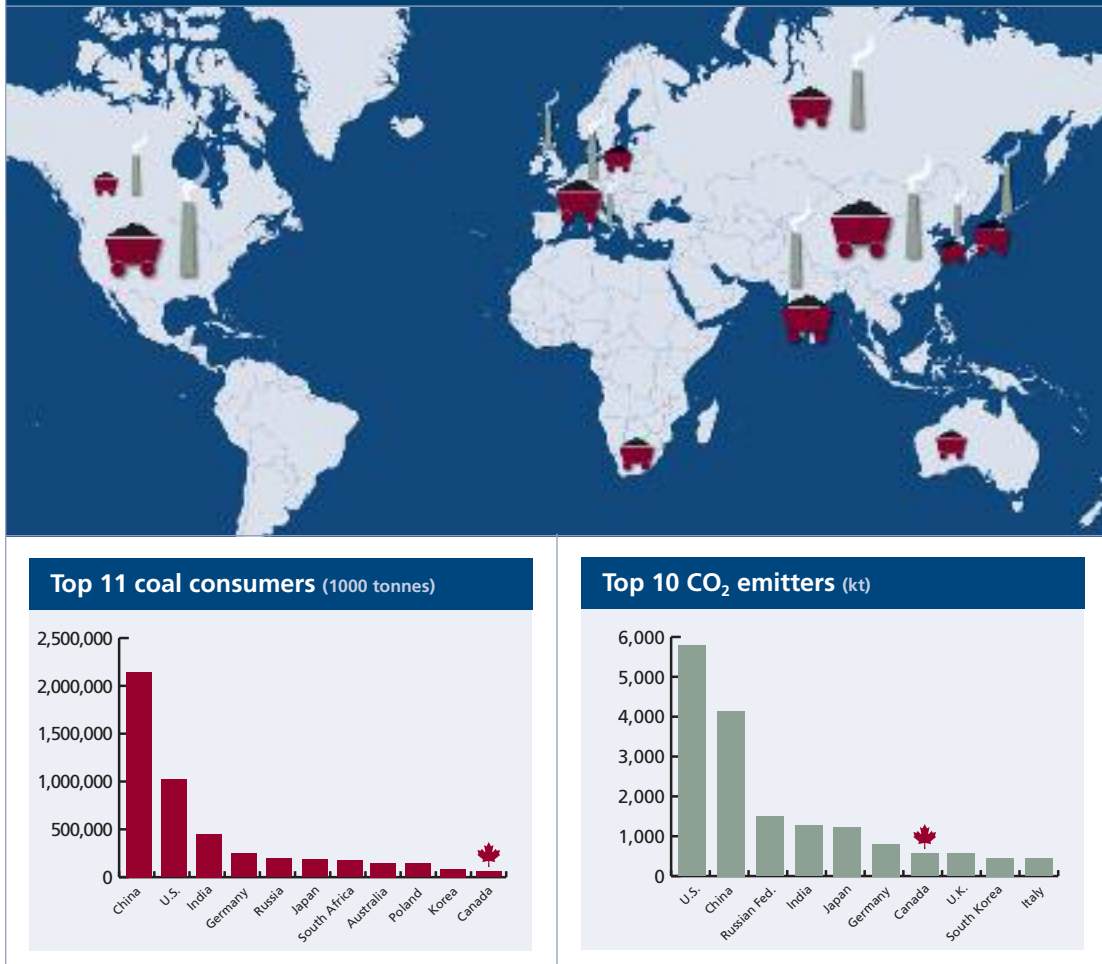
fastest growing source of electricity and the largest source of carbon dioxide emissions worldwide. (Fig. 8, page 14). Some 70 per cent of China's energy mix is fuelled by coal, with a new coal-burning plant coming into production every one to two weeks. Coal can be cleanly burned and the carbon dioxide recaptured if it's done right. Many technologies, including some from Saskatchewan are already making a difference here and abroad.

While sources of electricity don't face the same supply challenges as oil, the environmental costs of electricity expansion could be steep and will be ultimately factored into the cost.

We have seen some compelling evidence on price volatility and climate change that points to a few possibilities. We could be entering an energy transition and need to adapt. Or, we have a window of opportunity to plan our energy transition and make our own choices.



Figure 8: World coal consumption and carbon emissions



People in developed countries use far more energy and emit far more GHGs per capita than the developing world.

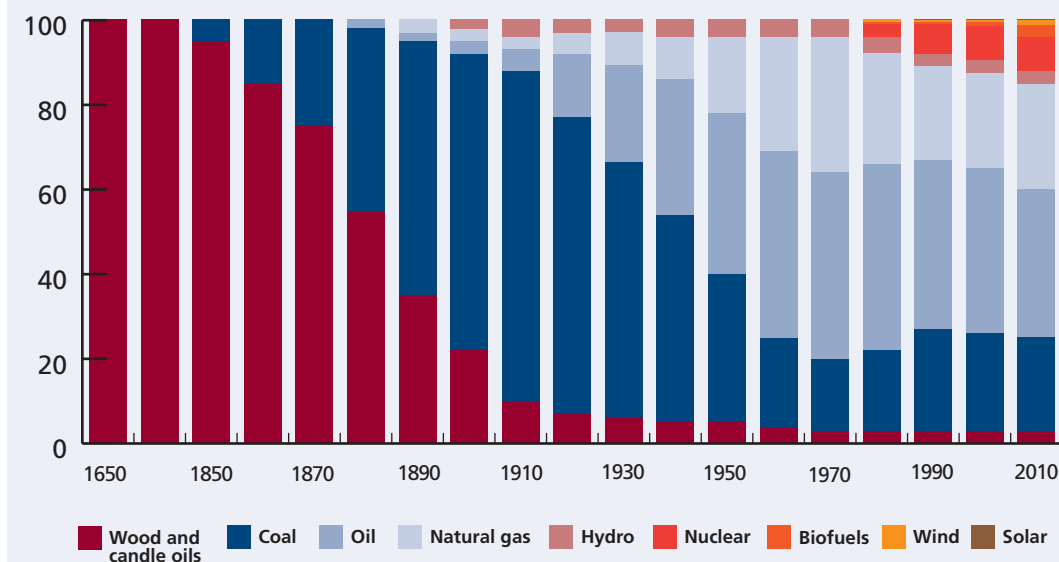
We can transition successfully

Over time, we have used different energy sources for heat, light, work and comfort. When we ran out of a source, substitutions were made. A short 150 years ago, much of the world relied on sperm whale oil for light! When whales became endangered, kerosene lamps took over, marking the first widespread use of a fossil fuel product. Wood was used throughout Europe and the Americas for heat and cooking for thousands of years. When

European forests disappeared, coal became front and centre, ushering in the industrial revolution.

The energy mix switched due to scarce resources but also shifted if there were technological advantages, national security issues or because an easier path opened up (Fig. 9). Along the way, tools were invented to help with energy extraction. One of these inadvertently became the underpinning of our modern transportation system. James Watt, the inventor of the steam engine, designed it to

Figure 9: Energy mix over time (%)



What's next? From sun to horsepower, whale oil, wood, coal, oil and nuclear energy, what new innovations are waiting in the wings? Where will we be in 2025?

replace the labour of men and animals pumping water out of flooded coal mines.

Steam engines ran on coal until Winston Churchill made a risky wartime decision. Despite abundant coal resources, Persia (present day Iran) had oil that promised speed, efficiency and logistical gains. Churchill wanted his ships to be the best. He converted the entire fleet from coal to oil-powered ships, a move that set the future politics of fossil fuels in motion. Britain's superior wartime abilities in WWI were largely credited to this major transition.⁹

The decades following the two world wars saw immense growth, trade and prosperity in the western world. It was a time of inexpensive oil. In 1973, things began to change. The U.S. was facing the decline of its domestic oil reserves and OPEC had placed an oil embargo on the West to protest its support of Israel (Fig. 11, page 22).

Prices increased to record highs, oil was rationed and many large vehicles were retired. During the 13-year embargo, some countries explored the use of renewable energy and invested heavily in public transit. Some developed their own oil reserves further. In Brazil, the government formed the pro-alcohol (ethanol) movement to reduce the expense of fuel and decrease foreign dependency. Japan began its journey to be a conservation-oriented country and Sweden started transitioning to become independent of fossil fuels.

Transition times were filled with challenges but they were also laden with opportunities for new business, services and innovation. Society emerged with a higher standard of living, a better quality of life and better health.

What could the next transition be and how will it affect your business? Countries that acted 20 or 30 years ago are better positioned to deal with today's crude oil challenges.