

Winter 2009 edition

Knowledge Insider

Where business meets opportunity | **Energy edition**

50
years/ans
1959-2009



Farm Credit Canada
Advancing the business of agriculture

Canada





Table of contents

2 | Do you need an energy plan?

Introduction	2
Canada's abundant energy sources	3
The world depends on crude oil	4
The current state of crude oil	7
Volatile prices	8
Who sets the price?	8
Energy systems impact climate changes	11
Demand for electrical power is growing too	11
We can transition successfully	14

16 | Energy solutions

Planning for the long term	16
Energy sources for your business	17
Biomass	20
• Biodiesel	20
• Biogas	21
• Ethanol	23
Wind power	24
Solar power	26
Geothermal power	27
What's next for transportation?	29
• Plug-ins	29
• Natural gas	29
• Hydrogen power	30
Other power sources	30
Copying natural systems: cogeneration and biorefineries	30
Efficient engineering	31
Energy conservation	32
Watch for new business opportunities	34
Carbon credit markets are opening for business	34
Pay attention to the customer	35
What's on the horizon?	37
Managing through transition	38
Power your future	38

39 | Tips, tools and strategies

Footnotes and sources	48
-----------------------------	----

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.

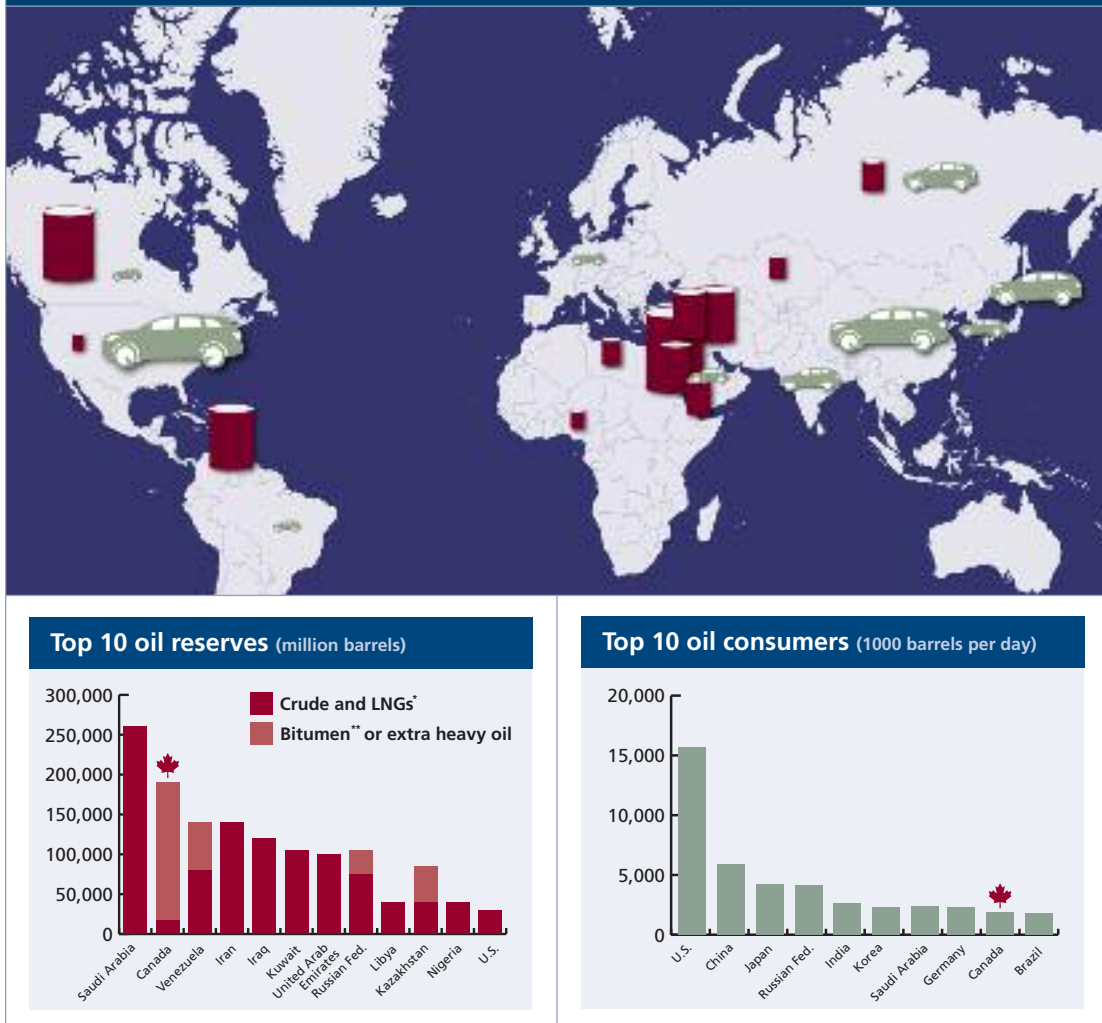
Canada's abundant energy sources What's in our energy mix?

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



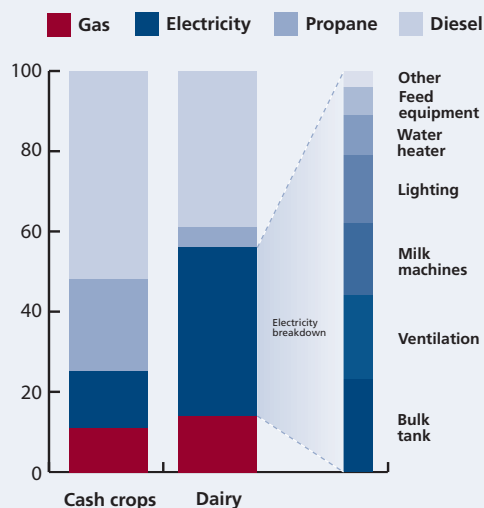
Farms and agribusinesses tied to fossil fuels are more vulnerable than those mainly using electricity.

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.

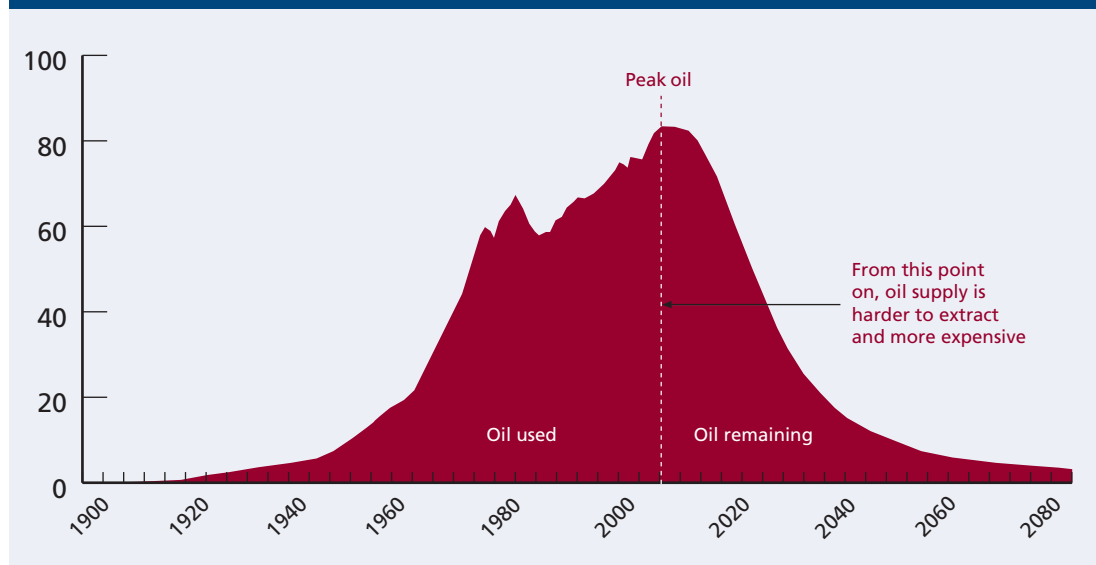
The current state of crude oil

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 4: OPEC member nations

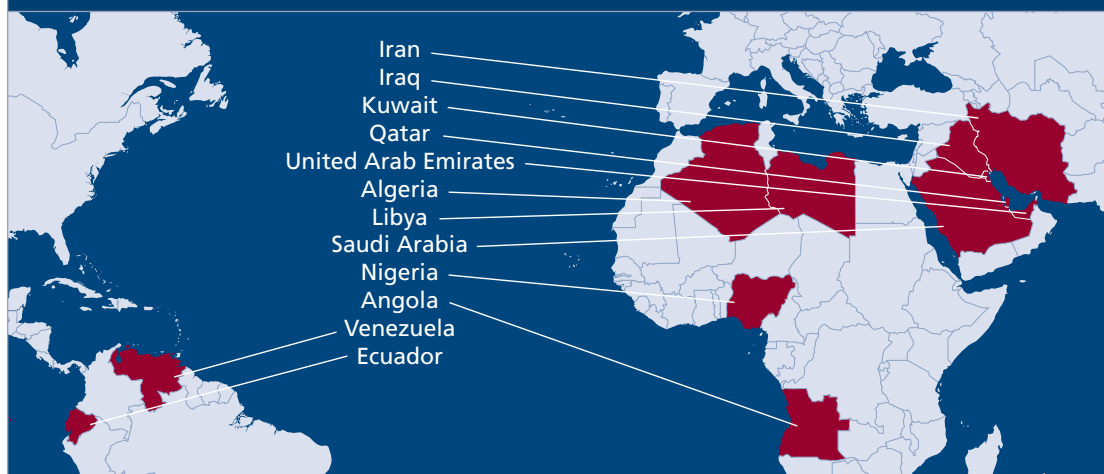
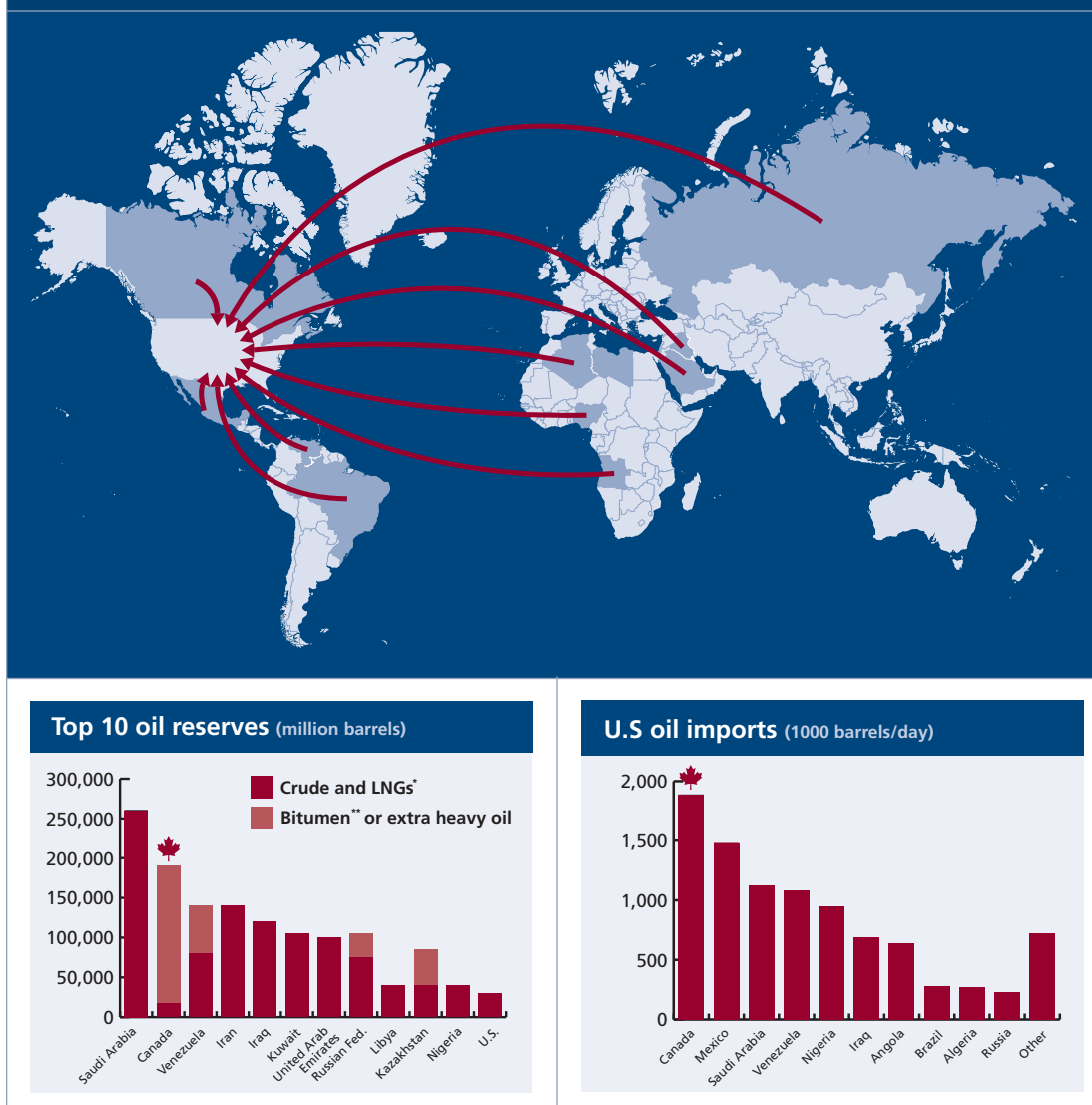


Figure 5: Where the U.S. gets its oil

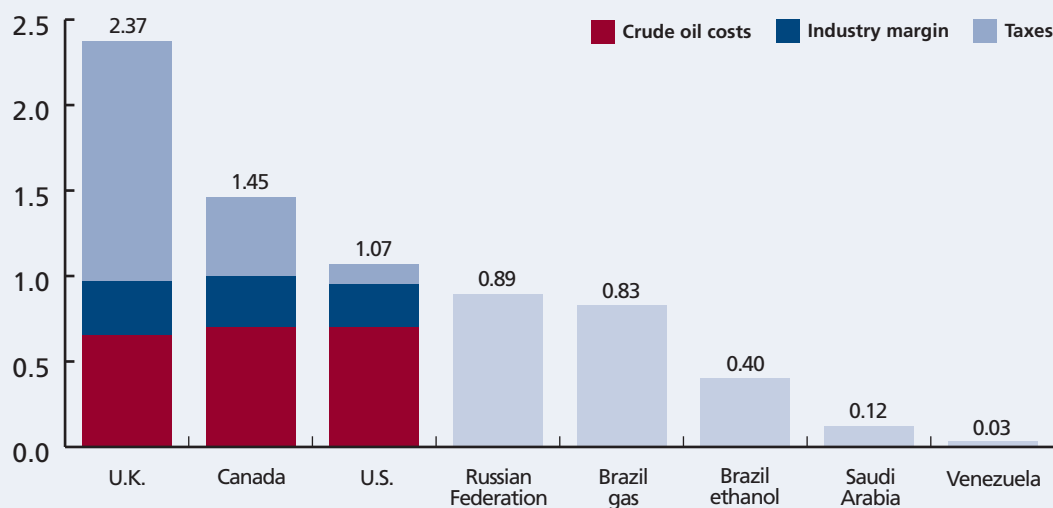


Who sets the price?

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



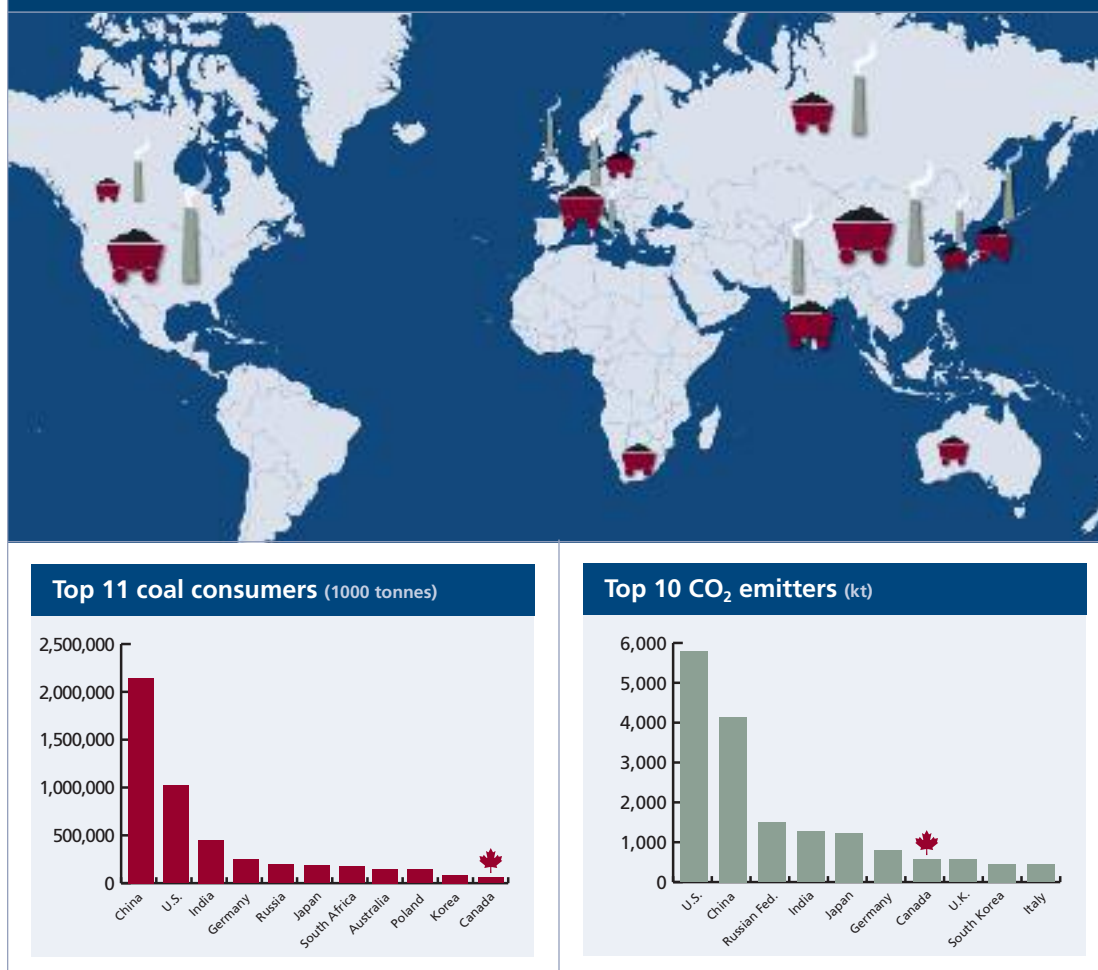
Exxon is often thought to be the world's largest oil company.
See how its assets compare to companies whose assets are nationalized.

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

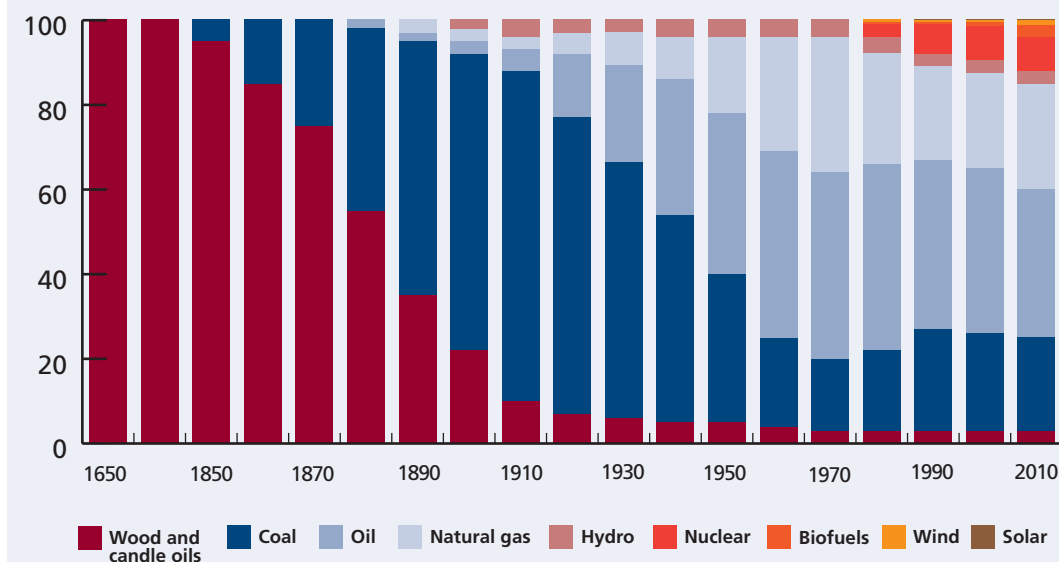
People in developed countries use far more energy and emit far more GHGs per capita than the developing world.

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.

Energy solutions



Planning for the long term

Short-term trends can be volatile, disruptive and unpredictable. They can distract you from your plans. Dr. Larry Martin of the George Morris Centre said he has never seen a time when expectations, predictions and plans are based on whatever happened in the previous two weeks.

John Gardiner, founder of Common Cause, said his life mission was to see “a series of great opportunities brilliantly disguised as insoluble problems.”

You can plan with confidence around long-term trends. Getting from where we are today to where we need to be means developing a long-term

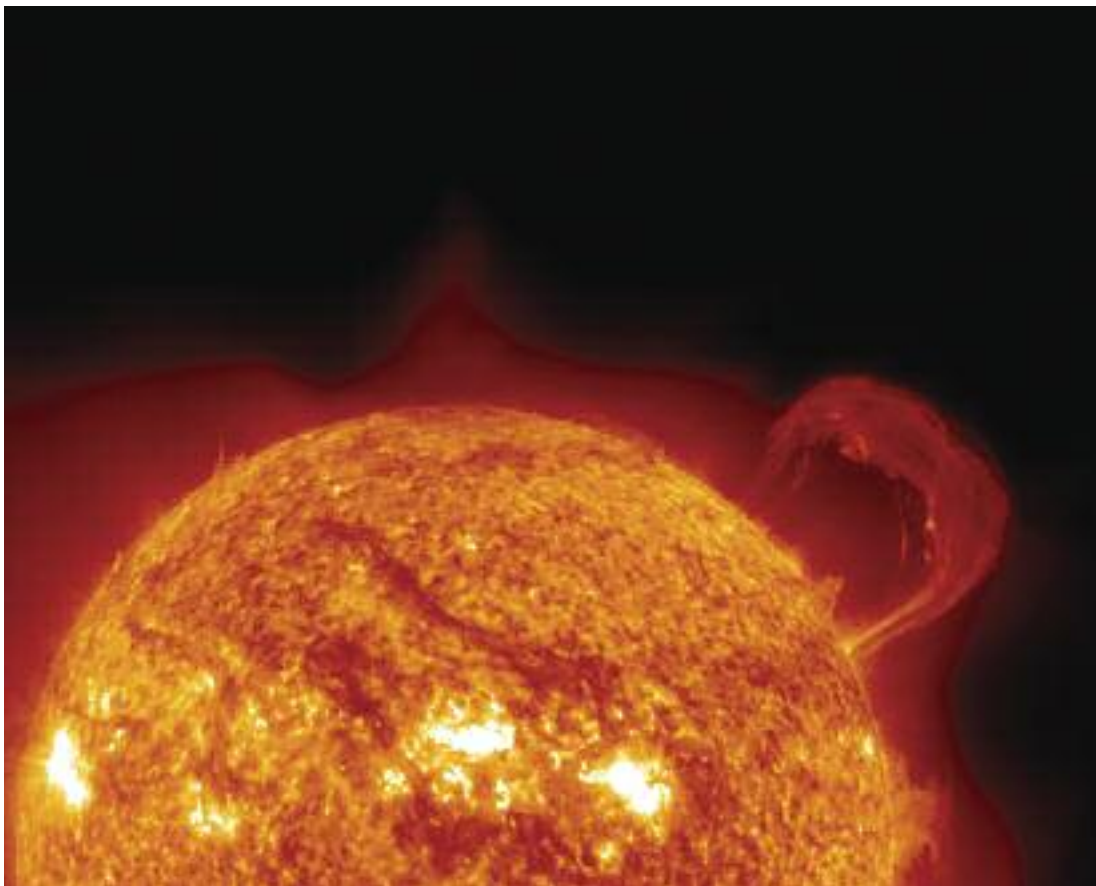
transition plan. This will help you develop mitigating strategies, capitalize on opportunities and lucrative first-mover options and avoid making reactive or crisis-driven decisions. How you decide what’s best for your business depends on your planning horizon and your beliefs about the longer term.

“There are risks and costs to a program of action. But they are far less than the long-range risks and costs of comfortable inaction.”
– John F. Kennedy

Can you manage volatile fuel prices? If so, perhaps no move at all is the best move for you. Do you want to minimize the risks of fluctuating prices? Perhaps you are interested in a capital project. Do you think oil prices will return to less expensive levels for the next 10 years? Then you might not want to pay for a technology that could end up being more expensive than a traditional fuel solution. It’s important to review each possible outcome against what you and your family or partners can handle financially and emotionally.

Scenario planning or jotting down a small grid can help

My planning horizon \ My assumptions about the future	Oil prices skyrocket and range between \$150-\$200/barrel	Oil prices range from \$40-\$80 due to long recession, which brings other challenges
Retire in 5 years and sell		
Retire in 7-10 years and phase out after that		
Stay in business for 20 years and have children take over		

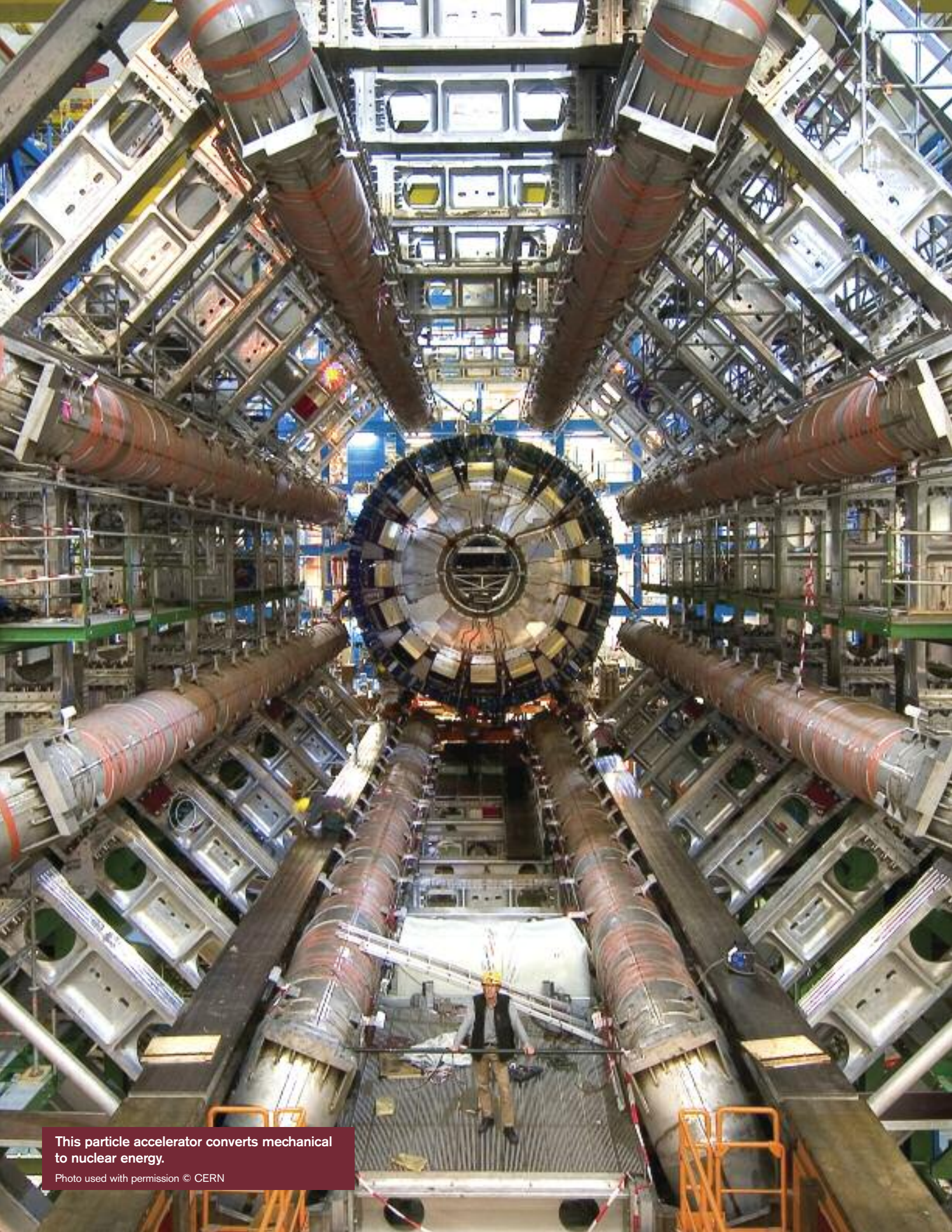


Energy sources for your business

Energy in its simplest terms is the ability to get work done. All energy originates from the sun and ends up as heat, light, nuclear, electrical, mechanical and chemical forms. It can't be created and it can't be destroyed. It simply transforms from one type to another. We have discovered many ways to convert one form into another. Others remain a mystery (Fig. 10, page 19). Some alternatives are waiting for the economics and commercialization to be right. In the face of increasing demand and rising costs of conventional sources, what may have been a pipe dream a decade ago could quickly move to the forefront. Some solutions may never take off in a big way. However, they might be perfect for your operation. Others, like hydrogen, could change the world forever.

What if you could turn manure into tractor fuel or canola into biodiesel on your own farm? How long will it take until the transportation system runs mainly on electricity or hydrogen? Imagine using a nuclear rod to power your combine. It might be easy to switch certain energy types like oil to wood or gas in combustion furnaces. Other substitutions mean reengineering the industry, supply chain and distribution networks.

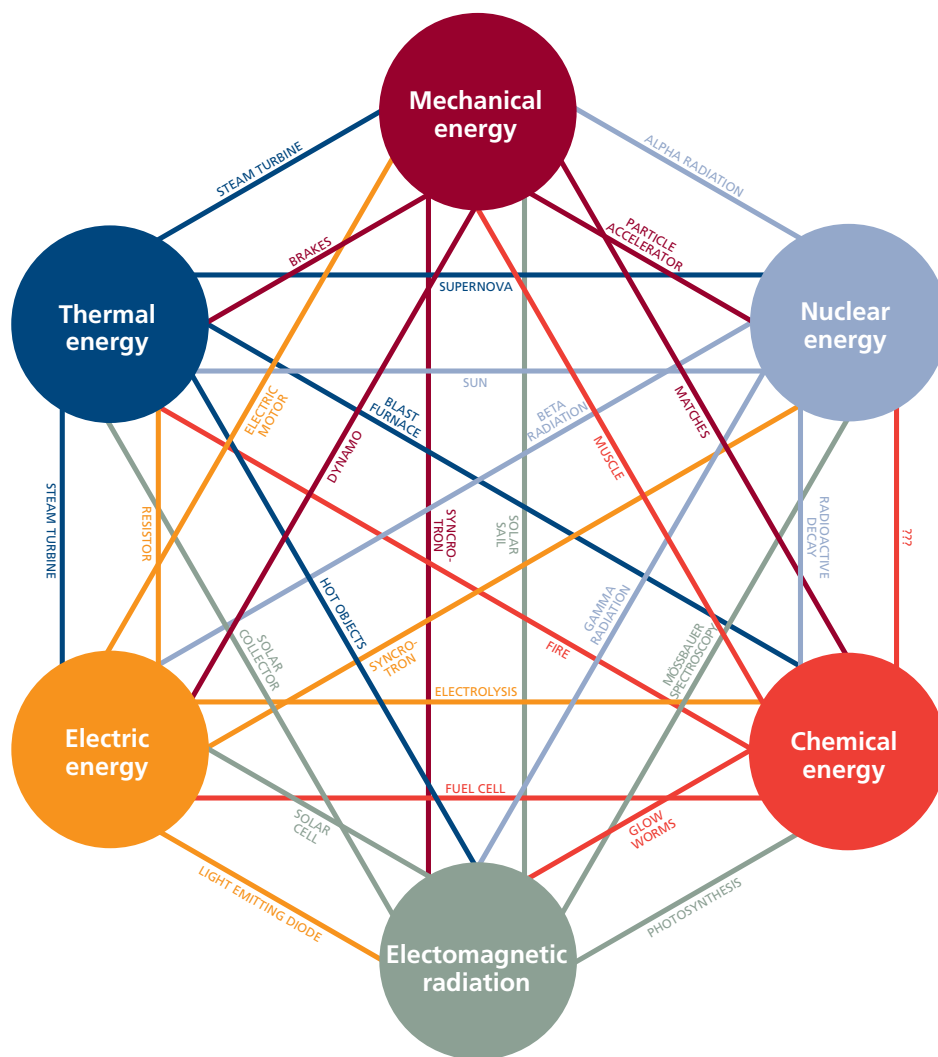
As you read through the energy options in the following pages, think about opportunities to do things differently. As part of the food value chain, you are already in the business of energy production but you may want to get involved in electricity or fuel production for your own needs or for profit.



This particle accelerator converts mechanical to nuclear energy.

Photo used with permission © CERN

Figure 10: Energy forms and how they are converted



This diagram shows energy forms and how they are converted. A solar cell, for example, converts electromagnetic radiation into electric energy. Look at the examples in the diagram and think about your energy sources. How can they be converted from one form to another to create solutions for your business?

"You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete."

– Buckminster Fuller

Making it work

Some producers and processors get involved in alternative energy. Others leave it to the professionals. Bert Mucci, a greenhouse vegetable producer, found a middle ground. He considered different options but didn't want to spend all his time overseeing energy production. He wanted to focus on managing relationships with his key customers.

Mucci provides the space and REMASCO, an alternative energy company, runs the technology. The greenhouses are heated with municipal waste pellets purchased on long-term contract. Mucci feels good about reducing environmental impacts and saving on energy costs. With this energy solution in hand, he focuses on his priorities: growing vegetables and promoting his brand.

Biomass

Biomass is anything that was once alive. Where energy production is concerned, it includes crops grown specifically for biofuels, byproducts and the waste of other processes. It can be converted to energy in several ways. Eating it moves muscles. Burning it creates thermal energy that heats, cooks

and powers steam engines or turbines. Heating it at extreme temperatures is called gasification and produces gas and liquid fuels like methane and alcohol used to power generators or fuel cells.

Finally, transforming it with biochemical processes produces biofuels (Table 3).

Biodiesel

Agriculture and Agri-Food Canada funds a biodiesel project at the University of Guelph Ridgetown Campus. It will be used for technology demonstrations, education and applied research. Other projects and case studies in the Canada and the U.S.¹⁰ show how producers can make top quality fuels with resources at their disposal.

Pure or blended biodiesel can be used in diesel engines with little or no engine modifications. New technologies are unfolding for glycerine, a byproduct of biodiesel, to convert it to a source of hydrogen that could be useful for hydrogen batteries in the future. Some airlines are experimenting with the biodiesel process to make a type of kerosene fuel. If they are successful, plane engines would need very few modifications to switch over.

Table 3: Making biofuels				
End product	Feedstock	Catalyst	Process	Byproducts
Biodiesel	plant or animal organic oil-based materials such as animal tallow, soy, canola, jatropha, algae and "tall oil" from trees	ethanol or methanol	trans-esterification	glycerine, mash that may have protein/carb content suitable for feed (soy cake)
Biogases*	many biomass materials like municipal, forestry, restaurant and packing plant waste, potato slurry, grape must and manure	bacteria	digestion/decomposition	fertilizer or bedding depending on feedstock used, heat, water and CO ₂
Ethanol	starchy materials or cellulosic material such as corn, cereal grains, straw, wood and switchgrass	bacteria, yeast or enzymes	fermentation	wet or dry distillers' grains with protein and minor fat content, pulp fibre

*Methane or biogas mix that can be cleaned and substituted for natural gas



Biomass can come in many forms.

Making it work

Prince Edward Island-based Cavendish Farms will transform waste from potato processing plants into heat. The multimillion-dollar investment in new alternative energy technology will see a biogas facility built beside two french fry plants. By reducing heating oil by 30 per cent, they expect to save up to 10 million litres per year. The use of renewable potato waste will reduce greenhouse gas emissions from the plant by over 30,000 tonnes per year.

The Cavendish Farms co-generation project is part of J.D. Irving's company-wide strategy to reduce its environmental footprint.

Biogas

Food manufacturers are required to treat waste and using a process like biodigestion can offset some or all energy needs. Your waste can save or make you money.

On farms, biomass is not considered waste and is often used as a fertilizer. A biodigester can be used to treat it and add value in the process. The energy byproduct can be used for the business or sold back to the grid. With fewer odours and destroyed pathogens, the leftover solid matter can be used as fertilizer and water can be cleaned and recycled.

Some companies offer services to operate digesters. Producers benefit from waste management, bedding and heat. The management company reaps the energy and carbon credits. This option may be ideal for those want to focus on their

core business or don't want to invest capital in a biodigester.

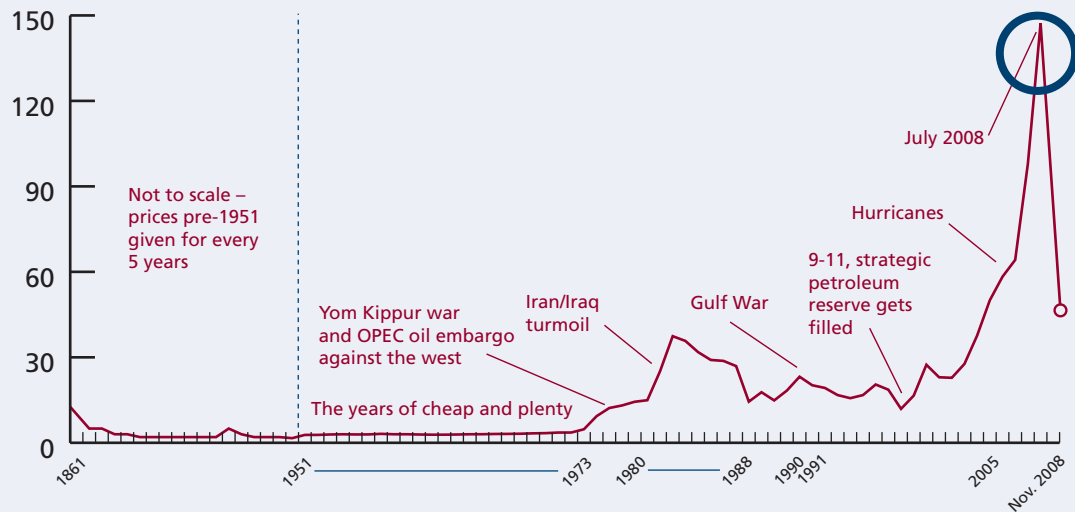
Increasingly, factories and municipalities are paying others to haul their waste away and businesses are pursuing alternative energy. More people are capitalizing on the energy in waste and exploring new sources of feedstocks. The negative price of garbage could actually become positive if biogas potential and value of byproducts is realized. As we enter new energy territory, it's important to understand the potential value of waste created by your business, value of feedstocks and the carbon credits you may be eligible for. If you already have an energy project and get your feedstocks offsite, do you have long-term contracts for feedstock supplies?

Making it work

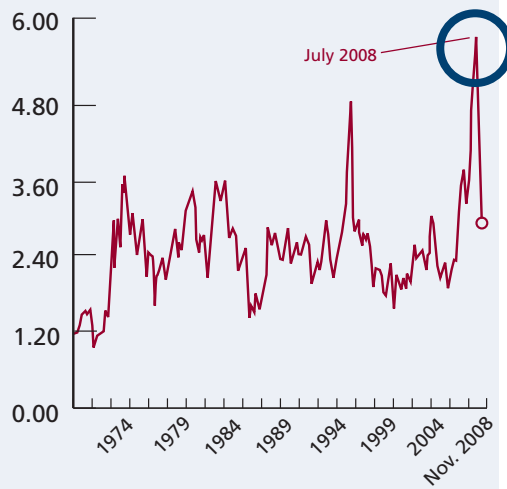
Quebec-based Ferme Famille Saint-Hilaire is a large dairy, hog and maple syrup operation. The Saint-Hilaire family invested in a low-temperature anaerobic digester to convert hog manure into biogas. The system generates heat and electricity for the operation. Not only is there less odour and runoff to contend with, but greenhouse gas emissions have gone down, phosphorous content in manure has been reduced by over 50 per cent and it's much easier to meet provincial nutrient management regulations.

Could an energy project like this help you deal with manure disposal, odour and conservation challenges?

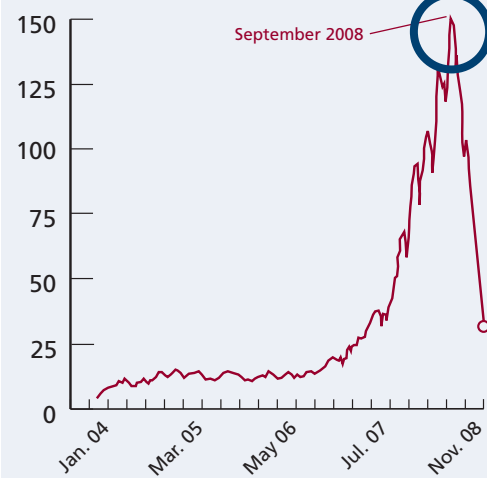
Figure 11: Historical crude oil prices (USD per barrel)



Monthly average corn price (\$/bu.)



Mosaic Company [MOS-N] (USD)



Ethanol

Some say ethanol is an American solution for an American energy problem. The U.S. offers many incentives over and above those found in Canada. In 2006, many Canadian groups undertook feasibility studies and developed marketing plans for ethanol projects. Only a handful of those ethanol projects have gone forward. Ethanol is good business when oil prices are high, feedstock prices are low and policies and incentives are in place. Here are some questions to consider:

- Can you take advantage of food, feed and all bioproduct markets? Will all of your crop go to one buyer with one supply chain, to a broker or under contract?
- Do you want to sell to a biofuel supply chain or actually buy into a biofuel company? Why are you investing?
- Can we plan in advance for energy projects and avoid reacting to crisis or missing opportunities? Can we capitalize on the next wave of biofuel developments?
- Are current feedstocks the most optimum or are there more innovative crops for biofuels?

Keep an eye on ethanol, biodiesel and natural gas developments for farm-scale projects. If you have access to your own feedstocks of cash crops, manure or cellulosic waste, you have an advantage and options. You can sell to multiple markets, including emerging energy markets, or use them to produce your own supplies.

The biggest opportunity in biofuels may be in do-it-yourself operations. Producers could take advantage of prevailing market conditions by selling grain when the price is high or by making their own fuel when the price is lower.

Biofuel discussion must include the food versus fuel debate. Prior to changes in U.S. ethanol policy, agriculture commodity markets seemed to move independently from oil markets. There is some evidence that commodities, fertilizers and crude oil prices have become more connected (Fig.11). One-third of the U.S. corn crop harvest of 2007 went to biofuels. The impacts of U.S. biofuels

Good old fashioned horse power

Animals and people are a source of energy. Many farms in the world rely on animals to do the work. Sometimes this makes sense for specialty farms, for pulling logs, collecting maple syrup or working in small places. Did you know that bike couriers burn so many calories a day, they won a tax ruling allowing them to claim extra food and snacks as fuel for their business?

policies were felt in land values, commodity prices and the share prices of companies in the commodity supply chain like Deere, Monsanto and Mosaic. The system did not have enough time to adjust supply for the new demand. One large corn crop and reductions in the amount of future ethanol that will be produced have worked their way into the marketplace. Along with the impacts of economic slowdown, commodity prices have come down across the board.

While biofuels may be part of Canada's solution, current production depends heavily on fossil fuels. Efficiency will need to improve throughout the whole value chain. As well, global demand for food and feed products will likely put more pressure on the industry. By leveraging less productive land and finding local solutions, alternatives to corn, wheat and oil seeds may be part of the answer. Crops like jatropha and developments in enzymes and feedstocks on the cellulosic front show great promise.

Using algae is another interesting possibility. Algae are fast-growing organisms that become an oily plant mass, consuming CO₂ and emitting oxygen. They grow in almost anything wet and can purify city sewage while feeding on the nitrogen and phosphates in human waste. While algae are full of oil, current production methods make the economics for use as a widespread feedstock questionable.

For more on biofuels, check out our publication at www.fcc-fac.ca/en/learningcentre/knowledge/doc/Understanding_Biofuels_e.pdf

Wind power

Wind is the fastest growing alternative energy in North America. There are plenty of open spaces and wind resources available in our rural areas, making agriculture's connection to this alternate energy a natural.

Across Canada, 83 large wind farms and a number of single turbines are in operation, for a total of 1,410 turbines. These provide one per cent of our electricity supply. We've tapped less than five per cent of the estimated potential.

In B.C., the Nai Kun wind farm offshore from the northern coastal islands of Haida Gwaii, will be a Canadian first. This five-phase project will generate enough power for 600,000 homes. Canada's largest land-based wind project in Sault Ste. Marie, Ont., houses 126 turbines and can generate power for 40,000 homes. Ontario farm operators are partnering with an energy firm creating wind farms on the north shore of

Making it work

John Glazema owns several for-profit and not-for-profit business ventures in agriculture and land development. He's been thinking about alternative energy for years. During a trip to Holland in 2005, he bought six decommissioned windmills and shipped them to Abbotsford, B.C. and Alternative Energy Inc. became his latest business venture.

Considering wind as an option? Glazema learned a lot about wind in the past three years. Choosing energy options that fit with your location is key. Wind resources are viable in some areas and not others. Don't jump in too quickly. Glazema set up turbines in several B.C. locations, including his back yard, to monitor wind patterns and try out the equipment. Look for ways to capitalize on green energy practices. Finally, watch for government funding and policy changes that may open the door to an alternative energy future.

John has yet to sell his first windmill in Canada. When the winds are right, he'll be ready.

Connecting to the grid

Distributed energy (DE) projects present challenges. Utilities and grids have archaic infrastructures, and there's a long way to go to match supply with cyclical demand. Canada and the U.S. are closely tied together through shared electrical grids. There are increasing concerns about their health. And electricity cannot be stored. Hydrogen fuel cells that can store electricity may revolutionize some of these issues. Different provinces have different processes for attaching to the grid. Some operators need a permit queue. You might benefit from being first in line or you might get caught in regulatory challenges while the world figures out smart grids and small-scale distributed energy projects. There could also be surprising gaps related to the price you are paid for producing energy versus the price you pay to buy it back from the grid. Some producers choose to be self-sufficient for these reasons. Others find it profitable to produce and sell surplus.

Lake Erie. Southern Alberta is also a regional powerhouse with around 150 turbines in the vicinities of Fort Macleod, Castle River and Taber.

Turbines can have 100-metre diameter spans. Seen from a distance in fields or on water, their size can seem deceptively small.

Traditional energy companies are moving into wind production. Last year, Hydro Québec issued a request for proposal for 2,000 megawatts of wind power.¹² It is a key supplier of electricity to east coast states, and anticipates an increase in demand. In the U.S., T. Boone Pickens, the consummate oil man, plans to build a 4,000-megawatt wind ranch in Texas. At a cost of US\$6 billion, 2,000 turbines spread across the 68,000-acre ranch could supply 1.3 million homes.

As with biofuels, small-scale models are making their way to market. If an industrial-size turbine isn't for you, watch for innovation in micro-turbines.



A kite for a cargo ship? The Sky Sail can save up to 40 per cent of fuel costs. With fuel costing up to \$50,000 a day, that's no small feat.

What other types of old energy or simple tools could be made new again?

Photo used with permission © SkySails



Solar power

There are many ways of harnessing solar power that lend themselves to agribusiness applications. Typically, we think of photovoltaic (PV)¹³ cells, but emerging industries are capturing solar energy in a wider variety of ways. In the U.S., a massive project called Nevada One uses curved troughs to concentrate the sun's rays 70 times to a beam, creating steam for turbines. Some methods are simpler and include solar heating of water or rocks and solar collectors like black pipes and solar walls. These can be incorporated into new buildings or roads as they are laid.

Changes are coming that will replace silicon in PV cells with inexpensive substances like cadmium. This will allow for many new applications using "thin film" PVs.

Solar power is the fastest-growing alternative energy outside of North America and shows promise for developing countries. Canada's largest solar farm in Sarnia, Ont., will consist of 60 megawatts, with hundreds of thousands of panels.

Solar power for transport won't likely break into the market any time soon, yet a solar car race between Texas and Alberta was held in summer 2008. At 95 per cent energy efficiency, they left conventional combustion engines, at 15-20 per cent, in the dust.

Poultry farms are making it work

Willem and Jacqueline Siebring continually think about alternative, low-cost energy solutions. When propane costs rose, the Siebrings transformed ideas into action. This winter, their Ontario broiler operation will be powered by three heating choices: solar, wood or propane.

A government grant helped to pay for solar walls in their two barns. When the sun heats air, fans pull it through the walls and circulate it to heat the barns. The Siebrings burn wood pellets or corn in a stove to heat water that runs through pipes above the chicks. They keep propane as a backup for cold winter nights. The couple did their research and opted for a unique energy mix.

Tired of rising energy costs? Lidner Farms in Ontario decreased heating costs in two poultry barns by using solar technology. Water is superheated in tubes, then distributed through pipes mounted in the walls of an older barn and the floor of a new barn. Not only is the poultry flock warm, the in-floor heating system eliminates the need for straw because it quickly dries manure. Less humidity means less use of fans and more savings on electrical bills.

Canadian Poultry Magazine – August 2008

Geothermal power

According to the Centre for Energy, the top six miles of the earth's crust contains 50,000 times more geothermal energy than all the oil and natural gas resources in the world. That sounds like an untapped resource! Not only can geothermal energy be tapped, new inventions are helping to store and convert the heat into many other useful functions. The upfront investment in geothermal energy is significant and the payback takes awhile. After that, it's fairly maintenance free.

Some new land developments and industrial areas incorporate the technology into every lot, along with energy-efficient building design that maximizes the geothermal investment. These energy-efficient carbon villages, sub-developments and other green field projects built from scratch have features that interest buyers. They are springing up all over the country.

Making it work

Granny's Poultry of Winnipeg runs an operation housing 12 million chicks. They created a customized energy management system projected to decrease energy costs by \$100,000 or more a year.

Sophisticated software regulates their three energy sources, automating the energy needs of a 36,000 square foot hatchery and new corporate offices. Water at a constant 7 C is drawn from 200 feet underground. It moves through the buildings with heat transfer plates, keeping them cool in the summer and warm in the winter. When the operation needs more heat, it comes from chicks developing inside the eggs or hatching. A boiler backup system kicks in on colder days.

Granny's has installed energy-efficient lighting, paying attention to details like efficient plug-ins for cars. The mix of geothermal, heat recovery technology and conservation is an ideal solution. What is the right mix for your operation?





What's next for transportation?

Energy experts see transportation possibilities heading a few different ways: plug-ins, natural gas,¹⁴ and hydrogen.¹⁵ It could be a combination of all three or even a scenario we haven't thought of yet.

Plug-ins

Developments in electric vehicle plug-ins will be the first to hit markets in a big way. It is likely that any auto industry aid will be linked to conditions for plug-in development. This has implications for electricity demand especially in big metropolises.

Natural gas power

Natural gas is another resource in Canada that can be used for heat, electricity or transportation.

Prices peaked in 2001 and 2005 after decades of stability (Fig. 12). At the time, many greenhouse producers depended on natural gas to heat their operations. The sector was hurt by the volatility in fossil fuel prices and took heed of the signals. Their experience provides a caution to others about depending on one source of power. The greenhouse sector provides inspiration for

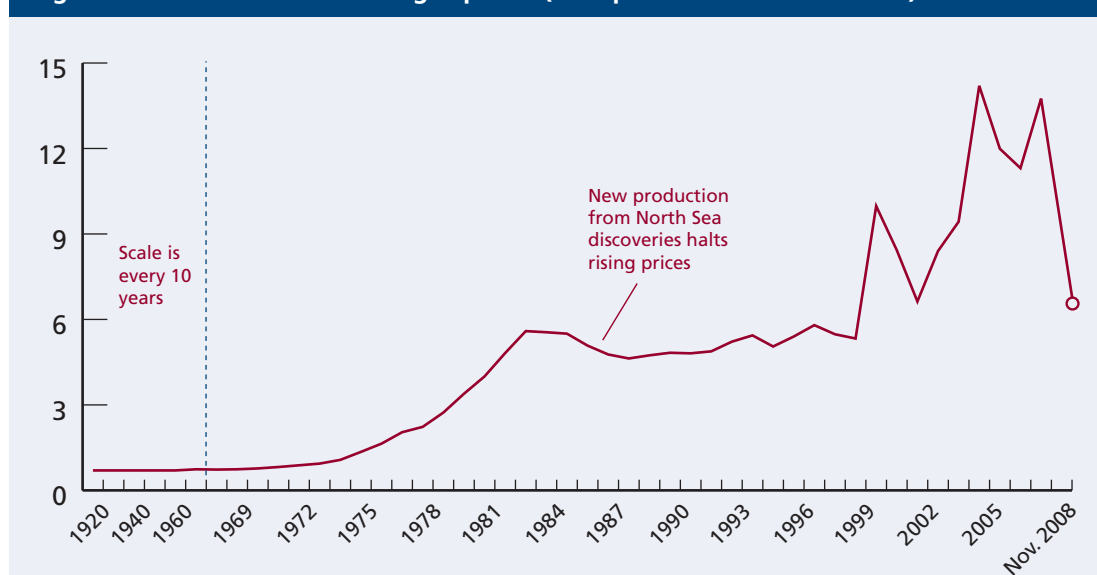
planning ahead and experimenting with alternative energy.

While natural gas could also hit its peak in the next half century, it is readily available, cleaner than coal and oil and relatively inexpensive compared to crude. While it is a non-renewable fossil fuel, it could be used as part of a long-term transition to new solutions.

Liquid natural gas (LNG) could potentially power all types of vehicles and fuel cells, relieving the auto industry from its dependence on crude. About 120,000 U.S. vehicles and 1.5 million each in Argentina, Brazil and Pakistan are powered by LNG. What's stopping us from moving to this fuel? Affordable vehicles and refuelling stations are scarce, and LNG-powered vehicles are challenged by cold weather. Experts predict by 2015, five per cent of vehicles on the road could be powered by LNG. LNG may be a solution for heavy vehicles, while plug-ins are focused on light vehicles.

With new U.S. production coming on stream, and prices already lower than their crude oil equivalent, natural gas could be an attractive energy alternative.

Figure 12: Commercial natural gas prices (USD per thousand cubic feet)



Hydrogen power

Hydrogen can be combusted as a gas, used to create electricity in a fuel cell and used as an energy carrier. Most scientists and environmentalists agree that hydrogen will become an important platform for the future. A significant number of fuel cell vehicles in the world use Canadian technology.

Hydrogen gas is a great source of energy but is never found naturally as a pure gas. It's always combined with other elements and needs to be extracted. Water (H_2O) is the cleanest source but electrolyzing the hydrogen out of it is expensive. "Cracking" it from methane (CH_4) is much cheaper, but releases GHGs. Other potential sources include algae and bacteria excretions.

Once hydrogen is isolated, it is fed into a fuel cell (battery) along with oxygen from the air to produce electricity, heat and water.

Unlike electricity, hydrogen can be stored until it's needed and converted to electricity upon demand. It can also be transported in containers or pipelines detached from the grid. It has a flexibility and independence that the electrons on the grid do not. It could revolutionize the entire grid and how we use it. It's already happening. If a windmill or small water turbine creates more electricity than your operation needs at any given time, hydrogen development is nearly at the stage where surplus can be stored as hydrogen and used later in a fuel cell.

Global demand for hydrogen fuel cells will double in the next five years. Tiny cells are already being made for laptops and cell phones. Small fuel cells can power electric cars and larger ones can provide electricity in out-of-the-way places with no power lines or backups for emergencies.

Most vehicle manufacturers have fuel cell development programs. Timing? It will be at least a decade before we see affordable, hydrogen-powered vehicles with the infrastructure to support the industry.

Other power sources

Nuclear power, hydro and coal are critical to Canada's energy mix. In their present form, they are mainly suitable for large-scale projects. All could potentially be used for smaller projects and indeed are already. Coal was once used for heating homes and in small engines; nuclear rods are used in submarines and rockets; privately held micro-hydropower setups are found across the country. Water has been converted into mechanical energy to turn mill wheels for thousands of years. It is realistic that they could be adapted for small-scale use again in future.

Although Canada is the top country for uranium production, the U.S. and France are the top users of nuclear energy. Canada leads the world in hydroelectricity production, created by harnessing the energy of big rivers, tides and waves.

Quebec's James Bay projects are well known, B.C. Hydro is looking to capture wave power near Canada's surfing mecca at Ucluelet and Nova Scotia Power produces electricity from the highest tides in the world. Denmark takes hydroelectricity a step further with wave dragons that resemble robotic water lizards, ride swells and create energy.

Hydro and nuclear are seen as green and coal is seen as dirty. Consumer acceptance varies for each.

Copying natural systems: cogeneration and biorefineries

All the talk of waste, feedstocks and energy sounds a little like ecology. Waste for one is food for another and systems operate in closed loops. Energy projects modelled on this principle are called cogeneration/poly-generation plants or integrated biorefineries.

Cogeneration and poly-generation occur when the same fuel is used for multiple purposes and produces two or more energy types or outputs. Steam is a byproduct of electricity generation that can be recaptured for heating, cooling or other uses. Before clean-burning and cogeneration

existed, coal-burning power plants only converted about one-third of the fuel inputs into useful energy. The rest escaped to pollute the air. Cogeneration increases this efficiency up to 80 per cent. Lower waste management costs, less pollution and more output equals cleaner energy alternatives.

TransCanada Energy has partnered with nitrogen fertilizer and potash companies in a cogeneration arrangement. The \$4-billion plant in Belle Plaine, Sask. represents the province's largest-ever investment into a single project.

Efficient engineering

From hybrid semi-trucks to direct seeders almost 90 feet in width, innovation is a hallmark of changing times. New ideas that save time and money and create efficiencies are bountiful on the energy front. Aircraft companies are using new composite materials that are strong, lightweight and drop fuel costs 20 per cent. Imagine a high-clearance sprayer made from Kevlar. Self-auditing heavy equipment that makes energy optimization adjustments is coming into production. What about energy-efficient green buildings with everything from light and water sensors to passive solar storage?

Transitioning to a broader use of alternate energy sources (plug-in, LNG or hydrogen) will be felt across many industries. Combustion engines and powertrains will be modified. Parts of the transportation industry including refuelling and support infrastructure, services for fuel cells, and retrofitting large equipment will require overhauls of many value chains. Electricity demand in cities will increase markedly with the mass introduction of plug-ins. Perhaps some companies will build from scratch. Work is already underway. Peterbilt Motors launched road-ready hybrid trucks that feature an LNG powertrain. They're also experimenting with fuel cell technology.

Electric cars like the Chevy Volt, which is scheduled for a 2010 release, could serve the needs of 75 per cent of drivers who drive under 60 km per day. Currently, electric vehicles cannot deliver the power that those with traditional or LNG powertrains can. Promising breakthroughs will be made and traditional engines will be phased out over the next 25 years.

When an industry is in transition, switching to a new model at the right time can be tricky. Consider how long the old, oil-dependant models will be around for parts and what will it cost to fuel them. Will the cost of holding on and claiming tax depreciation be greater than the cost of switching to more efficient designs? Will the equipment manufacturers go down the electric path, LNG or hydrogen? A tax accountant or financial planner may help you budget.

Making it work

Mike Kotelko is the co-owner of Highland Feeders, an Alberta feedlot with capacity for 36,000 head of cattle. Mike believes climate change is here to stay, the cost to produce energy will increase and agriculture will have a role in the new energy economy. He's getting in the game now.

In 2005, Mike and others created a renewable energy company at the feedlot. Using anaerobic digester technology, manure is transformed to biogas. Now they're ready for the next phase, an ethanol plant that forms a closed-loop biorefinery. The inputs? Primarily manure and wheat. The outputs? Electricity, bio-based fertilizer, fuel ethanol and wet distillers' grain that will be fed to cattle to produce more manure so the cycle continues.

Mike's key learnings? Grants and government programs are worth the effort. Be prepared for higher costs than you anticipated and build partnerships that grow with the project. For Kotelko and his partners, investing in alternative energy means a more secure future.

Energy conservation

One way to reduce costs and dependency on fossil fuels is to use less.

Ask yourself whether you have done all the simple things first. It may seem trivial to read tips on tire inflation or changing light bulbs, yet these practices could reduce your energy bill. Before you invest in a new energy project, see if you have done everything you can to conserve by reviewing current practices.

Consider field work, trucking and transportation. Reducing transportation distance reduces cost and carbon emissions. Where is your market, what do you pay to move products and are there markets closer to home? Will consumer demand for conservation and a lower carbon footprint create markets that weren't previously viable for you?

If you're a producer, you might want to look at crop inputs and application practices. They depend heavily on the state of the fossil fuel market and are priced accordingly. Canola crop innovations allow for direct combining, eliminating the need for swathing and saving one pass on the field. Seed companies are working on technologies to improve nutrient uptake in plants and nitrogen fixation processes leading to less fertilizer application.

Do you need to drive as much as you do? One Toronto-area winemaker realized that the bill for automatically scanned toll booth charges of their delivery trucks was exorbitant. The charges flagged how inefficient their delivery system was. They sat down with maps, planned deliveries and negotiated sales calls. Toll charges and the fuel bill were greatly reduced. It can be as simple as charting out your operation's comings and goings. Larger, complex businesses can use software and logistics to help with supply chain management.

Use all the data at your disposal to analyze your work patterns. Did you plant your fields in order? Are different moisture levels and microclimates found in different areas that affect spraying, desiccating and planting patterns? Do you use the most efficient routes? Do you take advantage of

Making it work

Bernard and Martin Prince, a father and son team in west-central Saskatchewan, strive to minimize fuel, natural gas and power consumption on their grain farm.

The Princes plan in the pre-season by selecting field and seeding order, keeping mileage in mind. Travel for seeding, spraying, swathing and especially harvest are optimized and kept to a minimum. They ensure tire pressures are optimum for conditions and shut down engines after short cool-down periods. When grain trucks are emptied during harvest, the hoist is raised and the engine is turned off while the grain flows out. The same process is used in the spring or the fall when they fill the seeding equipment.

The combine holds 1,500 litres of diesel fuel and will run for over 25 hours. Full, that's 1,300 kg of weight. Depending on the weather, some harvesting days last only 12 hours, so half a tank is sufficient.

Electricity is shut off at the breakers on unused buildings, eliminating creep consumption and guarding against vandalism.

Running to town for errands is part of the equation. Large material and hazardous goods are hauled by truck. Small parts are hauled by a more fuel-efficient car or even motorcycle. Communication is important. By sharing trip-to-town intentions, the total number of trips can be minimized.

The Prince family finds new ways to conserve energy every day, right down to eliminating the one-toast-at-a-time practice for breakfast.

GPS and light bar technology, ensuring minimum passes over the field?

You can perform an energy audit on your farm or business site. There are many excellent resources to help. Some utility companies offer free consultation on ways to reduce total energy costs and increase efficiencies. Some offer incentives to encourage smart design.¹⁶ You could hire a professional from Leadership in Energy and





Environmental Design (LEED), a green building rating system.

Businesses that are energy intensive or dependent on transportation fuels have the most to gain with a comprehensive energy plan. Streamlining operations, reducing energy costs, improving process flow or increasing efficiency in the supply chain helps to maintain a competitive advantage in the marketplace. Some businesses brand themselves around energy and environmentally responsible practices.

Watch for new business opportunities

Energy transitions bring new opportunities. Keep your eyes open for new kinds of services and products. Watch for agribusiness services like:

- advising and energy audits
- equipment sales
- abatement
- production data services and analysis
- telematics – remote energy usage intelligence
- smart buildings
- mapping, GPS, logistical planning
- branding opportunities
- managing environmental or ecological services
- carbon credit and certification companies.

Early adopters could capitalize on being first, looking into side businesses or consulting. Some who have installed an energy project

“There are opportunities for many companies, large and small, to play a role in the coming era of new energy. Most of them will involve renewable energy, and many of them will involve decentralized or localized energy. And it will be lucrative, with many opportunities for innovation and exciting business possibilities.”

– Glen Hiemstra, founder of the Futurist Organization

find themselves helping and installing or dealing for others.

Jim Carroll, a leading international futurist, says “growers that make innovation one of their core values will find success, focusing on the triple need for growth, efficiency and ingestion of new science. It will be by adopting new methodologies, products, partnerships and ideas that they will thrive.”

Carbon credit markets are opening for business

Carbon is big news. The reduction of carbon is a tradable commodity and for industries involved in carbon cycles, such as agriculture, this could present an opportunity. Producers can earn carbon credits through biogas production, wind, carbon capture, production practices (nitrogen application), new projects in low-till and no-till and reforestation.

Making it work

Glen Jennings runs Bayview Poultry Farms in Nova Scotia. In 2007, he installed three on-farm wind turbines. Based on his cost savings, he expects a payback period of 12 years for the capital investment. Branded as environmentally friendly, his eggs are sold to specialty markets in Atlantic Canada.

Could green energy create new opportunities for your business?

Some producers involved in energy projects find that the financier of the project or the utility companies they sell to want carbon credits as part of the deal. As industry works out standards and common practices, there are implications to including future credits in negotiations. You need to be abreast of evolving terms, standards and conditions: whether credits are a one-off deal, transferable with property or include other considerations.

Although credits aren't likely to be a large source of income, they could provide some revenue to offset a project cost.

Compliance markets require emitters to purchase credits that offset emissions. Credits are purchased from those whose practices are approved as carbon reducing. Many regional groups are forming to trade carbon credits. Several provinces, including B.C., Ontario and Quebec, have signed an agreement with western U.S. states to join the Western Climate Initiative (WCI).

In voluntary carbon markets, credits are purchased by companies like News Corporation and Yahoo, intent on reducing their carbon footprint, even if they're not required to do so. Different standards of credits are sold at various prices based on the quality of the carbon reduction or a certainty that the action will reduce greenhouse gases in the long term.

Pay attention to the customer

Know what customers value about energy and the environment and you'll be in a better position to do business. Consumers and retailers are demanding traceability, specific animal husbandry practices, sound transportation methods and safe environmental practices. They want low carbon footprints in the supply chain. Governments are increasingly regulating pollution, carbon credits, taxes and environmental practices.

Russel Marcoux, CEO of Saskatchewan's Yanke Group of Companies,¹⁷ says it's in our best interest to understand these demands and where they will lead over the next five to 10 years. "Environmentally sound decisions will be the table stakes," he says. "We will lose our businesses if we don't get on board and be proactive about these shifts."

Parma, Italy is transitioning to a net zero-carbon city. Their key products (Parmigiano and provolone cheeses, prosciutto ham) will be branded as carbon responsible. As a strong pork and dairy centre, Quebec could look to Parma to learn where others are headed with these trends. Some of Canada's export markets like EU and Japan, are years ahead of North American consumers when it comes to food advocacy.

Green companies, clusters, villages and cities can save money, proactively embrace trends, be a model for rebuilding after disasters, or in the case of Parma, align a brand with customer values by selling zero-carbon products.

Have you ever had an idea that seemed like such a bright idea, you couldn't believe you hadn't thought of it before? For us, that idea was using solar power. Seems obvious, doesn't it? We make SunChips®, after all. So we've started using solar energy instead of fossil fuel to help make SunChips® in California. And although it's only one of the eight plants we use to make SunChips®, it's a small step in the right direction.

www.SunChips.com

WARNING

**Hydrogen 350 bar
(5000 psi)**



ble, High pressure gas.
motor. Dispense only
ct pressure vehicle tanks.

to comply may result in
r bodily injury.





What's on the horizon?

No one knows for certain what's coming. However, we can paint some likely pictures by watching the actions of those who shape and invest in things beyond today: investors and venture capitalists, architects, corporations, governments, self-organized citizens, scientists and pioneers.

Nanotechnology scientists are close to creating artificial photosynthesis. This could produce

hydrogen for vehicles and be used as a sink to mop up carbon dioxide from the atmosphere. A new form of energy called "dark energy" has been discovered and it's behind the expansion of the universe. It could be an energy we learn how to harness. Frozen, jelly-like gas hydrates have been found on the continental shelves and contain more carbon than any other source. Incorporating energy and life forms into buildings will become common.

The future of agribusiness is already here

Po Kim gets up in the morning to go to work. She hops on a high-speed MagLev train that floats on a magnetic field, is propelled by a linear induction motor and follows guidance tracks with magnets. There is no train conductor.

She crosses an ocean causeway going to the Shanghai Greenport,¹⁸ a river delta that was particularly vulnerable to urban sprawl. Deltas are among the most fertile and ecologically diverse lands.

She smiles at the tourists and locals getting off the train to board a state-of-the-art sky train or canal boat. Stops along the way include many different learning and recreation stations or simply enjoying the waterways, animals, nature, landscape and green spaces.

Her workplace is not Disney World. It's a 27-km² agro-park combining an entertainment complex, an environmental preserve and enough agriculture resources and processing facilities to feed an entire city. Tens of thousand of pigs, chickens, crops and biomaterials, are housed in aesthetically beautiful surroundings. All buildings are powered by the most advanced ecological and energy-efficient technologies. It is a circle economy, every waste and byproduct is an input to another part of the cycle. It has zero waste, zero emissions and is a net energy contributor to the city.

Amazingly, it isn't a government-subsidized demo site. It's a profitable venture with returns to employees and agri-food entrepreneurs. This is what metropolitan agriculture could look like as part of a solution to feed the cities of the world.



Managing through transition

We live in challenging times. We've seen dizzying energy prices, a world teetering on the edge of financial collapse and a volatility that has economists and analysts saying they just don't know what the next year will bring. In a culture that has known little but steady progress for the last 50 years, this is a dramatic shift. What could it mean to the values of society? People may search more often for local food supplies, decentralize power generation and increase self-sufficiency.

One of the greatest skills you can have is to be capable of resiliency and expanding your capacity for change. A key to success will be the ability to generate positive visions of future, to harness the power of engaged optimism,¹⁹ no matter what the short term looks like. This frame of mind helps you see things that others do not and take advantage of opportunities

It is said that in good times we reach in the pocketbook, in rough times we reach into heart and character. Can you be a source of positive transition for your family, business, community and professional organization?

Power your future

Agriculture is uniquely positioned to influence a sustainable energy future. Whether growing crops for biofuels, using rural land for wind and solar installations, or simply having easy access to waste materials for biogas, producers and industry entrepreneurs understand biomass, food energy

and living systems. The agri-food industry and your role as a steward are part of the answer. Who is better positioned to find answers and leverage know-how and resources?

Against this backdrop, we will reach peak oil. The demand for conservation and reduced carbon footprints will increase, and there will be more government regulation.

Understanding long-term trends is an important first step. While these trends can slow because of shorter-term events and blips, planning with a long-range view will help you shape your future. Mitigating strategies, capitalizing on opportunities and avoiding crisis-driven decisions will keep you in good standing.

Some will transition to save money, decrease risk and improve comfort-levels for their business. Some will be motivated by personal values, believing it's the right thing to do. Others see huge opportunities in a time of transition. For some, the best decision is to do nothing. Some answers will come through technology revolutions like the smart grid. Others may come from those who remember what it was like to live in a world that used less energy.

Those who deal with energy challenges early will be better positioned for success in the next energy era. Darwin said it wasn't the strongest or the most intelligent species that survive, but the ones most responsive to change.

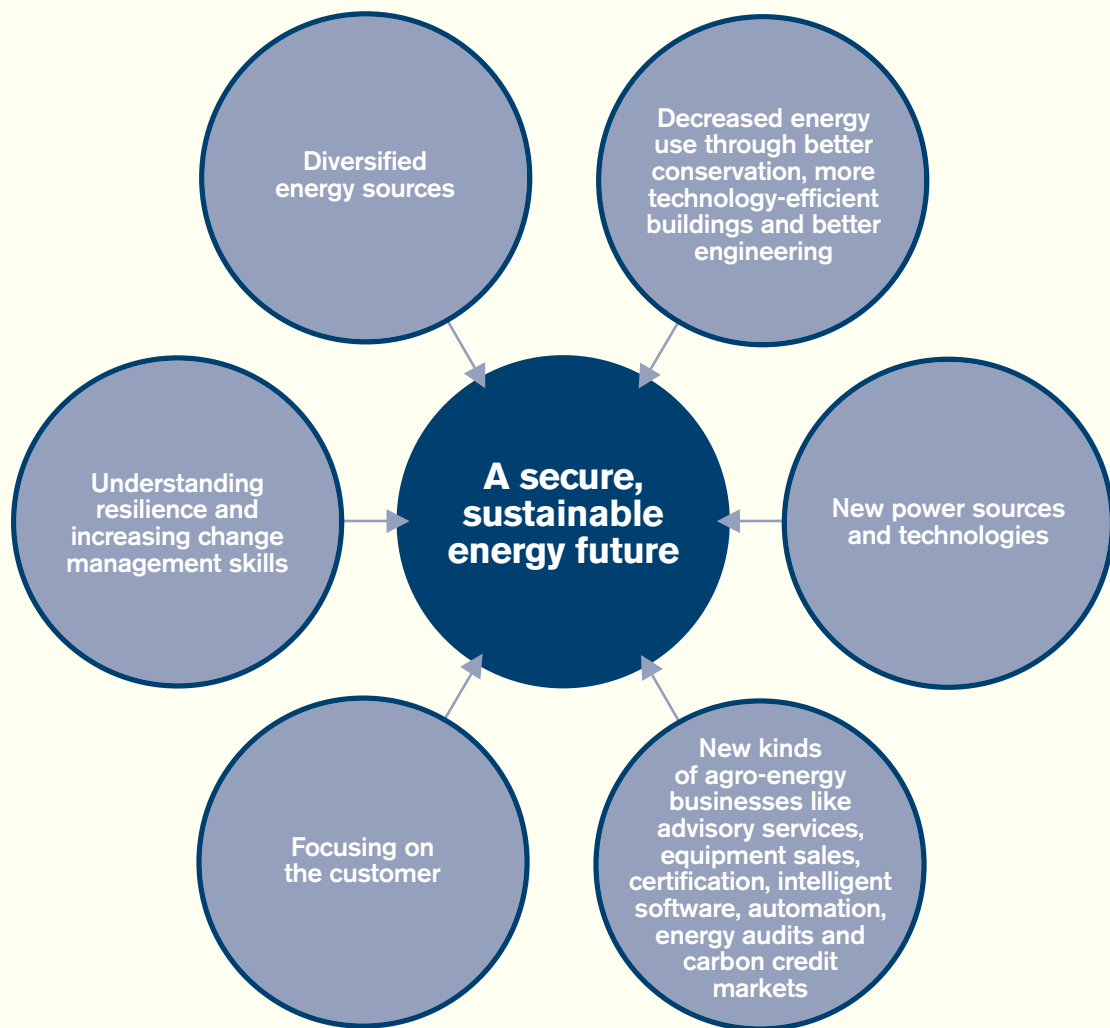
What will your response be?

A man in a tan shirt is shown in profile, looking out over a vast rural landscape at sunset. The sky is a deep blue, transitioning to a bright orange and yellow glow on the horizon. The landscape below is green and rolling, with a few small buildings and a road visible in the distance. The man's head is in the upper right corner, and his torso extends down the right side of the frame.

Knowledge Insider

Tips, tools and strategies | **Energy edition**

Solutions for your business



Energy planning

- Map out your as-is state. Plot your work flow. Draw your farm or agribusiness buildings and activities. Include transportation, driving, heating, field work, pumping water and anything else that consumes energy. Conduct your own energy audit.

While you look for better energy solutions, watch for other opportunities that may open up. In times of change and where challenges are significant, the world is looking for people with innovative ideas. You could find a solution that benefits your business, agriculture and rural Canada.

[illegible]

- What have other Canadians done to help their business and what can you learn from their work?
- What's happening in other countries that might inspire ideas?
- Do you have the base of knowledge you need to adapt machines for your use?
- If you partner with other companies, what is their reputation?
- If you adapt equipment or machinery, what happens if it fails?
- Can the equipment and process adapt to a change in feedstock, such as a dietary change that affects the manure constitution for biogas?
- Learning from others provides insight to challenges and benefits, from cost overruns, broken machinery, engineering, innovations and other unanticipated issues that cropped up.

Learning from others

Creating an alternative energy source has been a challenge and an opportunity for one B.C. hog producer. Peace Pork's 8,000 hogs produce 20 million gallons of manure a year. Little wonder investing in a biodigester made sense. By turning all that manure into energy, costs would decrease. Nutrient management would improve with an environmentally friendly fertilizer product. Water could be recycled to get through local shortages. And government funding made start-up easier.

The digester ran well for two months. Then part of the internal structure collapsed when technology failed and the entire system needed revamping. To add even more challenge, one of the suppliers went out of business.

Peace Pork had a “summer of construction and retooling.” They hired a new consulting firm and travelled to Denmark to learn about biogas. Now, they’re treating water again and ready to switch on the biogas production. Peace Pork’s lesson? Understand the science, carefully choose your experts and suppliers, research your options and always be prepared for the unexpected. Peace Pork is solving their challenges through innovation and hard work.

Notes

[illegible]

Working with others: partners, value chains and alliances

- Do you belong to an association that looks at agriculture issues including energy alternatives?
 - Could you partner or form a co-operative to make your own biodiesel?
 - Is your business large enough to go ahead on your own?
 - Are there opportunities to collaborate with industry, government or educational institutions?
 - Is the way you manage your supply chain strategic, focused and efficient?
 - Are you delivering to the best markets for your product?
- What value chain could help you minimize costs and distance to market?
 - Is co-location an option for you?
 - Is sharing equipment and technology with neighbours or a co-operative practical and possible?
- Work with industry associations to encourage others to get involved. You can influence discussions, decisions, and local and national solutions.

Work with industry associations to encourage others to get involved. You can influence discussions, decisions, and local and national solutions.

Notes

This image shows a full page of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page, leaving small margins at the top and bottom. There is no handwriting or other markings on the paper.

Plan for change

Anticipating change, planning ahead and looking at potential outcomes makes your ability to change more positive and productive.

- What is your planning horizon?
- Are you retiring or winding down in five years? If your horizon is 40 years, your energy plan may be different.
- What are your business strengths and weaknesses?
- What is your personal tolerance for change and risk?
- What are your core competencies? If you're an engineer, perhaps an installation is for you. If you're a natural with project management and numbers, perhaps a GPS and field planning is up your alley.
- How would you respond if oil prices were US\$200 a barrel? What else might be happening

in the world if oil is at an all-time high and how could it impact you?

- What if oil is priced at US\$60 a barrel or lower and the economy is in recession?
- How can you prepare while you have time?
- What if you did nothing? Would your family, business and business sector respond with resilience and agility?

Can you afford to invest in a big project today? What do you need to do to get there? Could you implement in phases or partner with others?

Know when to focus on your core business and when your side project can transform your business. Both can be valid, profitable options.

Notes

This image shows a single sheet of white paper with horizontal blue or grey ruling lines, typical of notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Knowledge Insider tools

What you'll find	Web address
Biofuel specifics	
Alternative Fuels in Canada, Office of Energy Efficiency	http://oee.nrcan.gc.ca/publications/infosource/pub/transportation/fuels-in-canada.cfm?attr=16
Natural Resources Canada discusses next generation biofuels	http://oee.nrcan.gc.ca/transportation/next-gen-biofuels.cfm?attr=8
Canadian Renewable Fuels Association	http://www.greenfuels.org/
Understanding Commercial Opportunities in the Biogas Sector in Canada, commissioned by Alberta Agriculture, Food and Rural Development	http://www.climatechangecentral.com/files/attachments/OpportunitiesInTheCanadianBiogasSector.pdf
A biogas commercial website that reviews solutions for agribusiness and agri-food	http://www.bioterre.com
Growing the Margins Conference and First Annual Canadian Farm and Food Biogas Conference and Exhibition, held in March 2009	http://www.gtmconference.ca/site/index.php/canadian-farm-and-food-biogas
Alternative energy specifics	
Wind energy resources, Canadian Wind Energy Association (CANWEA)	http://www.canwea.ca/index_e.php
Solar energy resources at the Canadian Solar Industries Association	http://www.cansia.ca/Default.aspx?pageld=139835
Geothermal resources from the Canadian Geothermal Energy Association	http://www.cangea.ca/
Government of Canada hydrogen economy portal, moving towards a hydrogen and fuel cell future	http://www.hydrogeneconomy.gc.ca/home_e.html
Programs or subsidies	
Integration of Renewable Energy on the Farm website is a one-stop shop for on-farm renewable energy information and includes a summary of financial programs and other resources	http://www.farm-energy.ca/IReF/index.php?page=funding-programs-incentives
The Pembina Institute offers Sustainable Energy Solutions including resources for programs and provincial policies	http://re.pembina.org/canada/policies
If you're experimenting with new technology or new methods, you may be eligible for significant tax credits through Scientific Research and Experimental Development. If you prefer working with a consultant, check out Incentive Access Group.	http://www.cra-arc.gc.ca/txcrdt/sred-rsde/menu-eng.html http://www.incentiveaccess.com/pages/aboutsred.html
Check out incentives to get gas guzzlers off the road including the National Vehicle Scrappage Program	http://www.ecoaction.gc.ca/news-nouvelles/20080604-eng.cfm

Energy statistics and general information	
Canada's Energy Future, reference case and scenarios to 2030 from the National Energy Board	http://www.neb-one.gc.ca/clf-nsi/rnrgynfmrn/nrgyrprt/nrgyfr/2007/nrgyfr2007-eng.html
The World Energy Council presents annual survey of energy resources around the world	http://www.worldenergy.org/publications/115.asp
Energy Information Administration offers a comprehensive list of official energy statistics from the U.S. government	http://www.eia.doe.gov/
Check out these links or use a search engine like Google or Copernic to learn more about peak oil	http://www.peakoil.net/Publications/20040201ExxonMobil.pdf http://www.energybulletin.net/primer http://www.peakaware.com/
Planning for energy project	
Canadian Renewable Energy Network offers information on renewable energy sources, technologies and applications	http://www.canren.gc.ca/using/index.asp#about
The Canadian Centre for Energy Information covers a range of topics from oil and natural gas, to solar, wind and alternative energy	http://www.centreforenergy.com/Silos/ET-CanEn01.asp
The Integration of Renewable Energy on Farms website helps you assess and plan renewable energy options for your farm	http://www.farm-energy.ca/iref
Will your alternate energy project pay for itself? Find out with free Retscreen software that offers technical detail and benchmarks most alternate energies and technologies around the world	http://www.retscreen.net/ang/home.php
Information, tools and resources will help you assess the renewable energy opportunity in your business	http://farmenergyonline.com/
Publications and buyers guides for renewable and electrical energy resources from Natural Resources Canada	http://www.energymanagementcanada.com/index.php/Digital-Editions.html
For urban agribusiness, LEED information, check out the free Energy Management online magazine	http://strategis.ic.gc.ca/epic/site/dsib-logi.nsf/en/h_pj00115e.html
The Small Farm Energy Primer includes information about solar collectors, panels, passive solar, wind and biogas	http://www.cfra.org/node/680

Planning a green company or community	
Check out the Bio Village in Strathmore, Alberta. Energy TV features the village and other Canadian developments	http://crfuels.com/index.php/bio_village http://energytv.com/videos/view/310/
Using local goat and sheep milk, Ontario's Fifth Town Artisan Cheese Company is an environmentally and socially responsible producer of handmade cheeses. Their carbon neutral production and retail facility is aiming for LEED platinum.	http://www.treehugger.com/files/2007/10/green_cheese_fr.php
Some towns turn to sustainable energy through a transition plan and others, like Greenburg, Kansas, start from scratch.	http://www.inhabitat.com/2007/07/23/leonardo-di-caprio-to-build-eco-town-in-kansas/
A network dedicated to significantly rebuilding resilience and drastically reducing carbon emissions	http://transitiontowns.org/TransitionNetwork/12Steps
An organization dedicated to energy reduction through exploration into the head, heart and hands	http://transitionculture.org/
Shanghai Greenport, metropolitan agriculture in China	www.greenportshanghai.com
Conservation	
The Ontario Ministry of Agriculture, Food and Rural Affairs looks at on-farm energy generation and conservation	http://www.omafr.gov.on.ca/english/engineer/energy.html
This excellent energy audit from Quebec's Agriculture and AgriFood reference centre has guides for poultry, cash crops, pork and dairy (French only)	http://www.craaq.qc.ca/UserFiles/file/Visuel_Web_CRAAQ_IACA319_audits.pdf
Michigan State University offers information about improving tractor performance	http://www.msue.msu.edu/objects/content_revision/download.cfm?revision_id.490364/workspace_id.65638/Tractor%20Efficiency%20Fact%20Sheet.pdf/
Information from FarmEnergy.org (Canada) and the National Sustainable Agriculture Information Service (U.S.)	http://attra.ncat.org/ http://www.farmenergy.org/aboutce/index.php
Reading list	
<i>The Hydrogen Economy</i> by Jeremy Rifkin, converting from oil dependence to a hydrogen-based system	http://www.amazon.com/Hydrogen-Economy-Jeremy-Rifkin/dp/1585422541
<i>Hot, Flat and Crowded</i> by Thomas Friedman, globalization, climate change and competition for energy	http://www.thomasfriedman.com/bookshelf/hot-flat-and-crowded
<i>A Thousand Barrels a Second</i> by Peter Tertzakian, meeting the challenges of the oil break point in an energy-dependent world	http://www.1000barrels.com/aboutthebook.html
<i>Who Moved My Cheese</i> by Spencer Johnson, managing through times of transition	http://www.whomovedmycheese.com/gaining_change_skills/view.php?id=who_moved_my_cheese

Futurists speculate on what will happen in the future and generally have good track records. For more immediate term developments, look through company websites and speeches, presentations or publications.	
Dr. Patrick Dixon offers British perspectives and future trends for science, consumers and energy	http://www.globalchange.com
Dr. James Canton at the Institute for Global Futures discusses harnessing the power of innovation	http://www.globalfuturist.com/
Futurist Jim Carroll focuses on agriculture. Check out his 10 words for business owners to keep their businesses relevant and adapting	http://www.jimcarroll.com/weblog/archives/000716.html
Lester Brown, a former producer, agriculture economist and president of the Earth Policy Institute, The Washington Post calls him one of the world's most influential thinkers	http://www.earth-policy.org/

Footnotes

- ¹ Hoffman, Jane and Michael. Green – Your Place in the New Energy Revolution. Palgrave, MacMillan 2008; presentation from PLASCO, Ontario, FITT Conference June 1 2008.
- ² Tertzakian, Peter. One Thousand Barrels a Second. McGraw Hill 2007, p. 107.
- ³ Sovereign wealth funds come from budget surpluses in countries with little foreign debt, largely from oil proceeds. They are invested into equities, money and futures markets. They are separate from a country's foreign reserve and the liquidity it must hold to manage its currency and monetary policies. The biggest ones, in order, are United Arab Emirates with almost US\$1 trillion. Norway, Singapore, China, Kuwait and Russia each hold several hundred billion.
- ⁴ Economist James K. Galbraith says speculative demand for oil futures in summer 2008 was five times the actual stockpile and orders couldn't be met. Mother Jones, Sept 2008.
- ⁵ Report by the Science Applications International Corporation for the U.S. Department of Energy 2005 (Hirsch Report).
- ⁶ Climate Change 2007: The Physical Science Basis. Inter-government Panel on Climate Change: United Nations Environment Program (UNEP) and WMO, Paris.
- ⁷ Seth Borenstein, Associated Press Science Writer, Sept. 26, 2008.
- ⁸ One producer recalls the advent of electricity in his 1950s home and says he had less money then, than during the Great Depression! As soon as there were plugs in walls, he bought a fridge and stove. In those days, appliances easily cost double a month's income. Although expensive, it increased the quality of life. Lionel Kambeitz, CEO HTC Purenergy, family story.
- ⁹ Dahl, Eric J. Naval innovation: from coal to oil. Joint Force Quarterly, Winter 2000.
- ¹⁰ http://attra.ncat.org/attra-pub/PDF/biodiesel_on_farm.pdf
- ¹¹ Known for its medicinal properties, a jatropa plant is a small tree or shrub that will grow in gravel, sand and saline soils. Jatropa oil is seen as an excellent input to biodiesel.
- ¹² "Who will reap the wind?" – The Montreal Gazette, Sept. 08 2007.
- ¹³ Photovoltaic cells are usually made of specially treated silicon, which transfers solar energy from the sun to electrical energy.
- ¹⁴ Peter Tertzakian, Chief Energy Economist at ARC Financial Corporation client seminar, Sept. 17, 2008, Calgary and T.Boone Pickens (www.pickensplan.com) are proponents of natural gas.
- ¹⁵ Jeremy Rifkin, The Hydrogen Economy. 2003; Thomas Friedman, Hot, Flat and Crowded. 2008; and Lionel Kambeitz, CEO HTC Purenergy envision a hydrogen future.

¹⁶ Ed McCallum, Senior Principal, McCallum Sweeney Consulting, Inc.

¹⁷ One of Canada's 50 Best Managed companies, Yanke operates a fleet of 400 trucks.

¹⁸ The Shanghai Greenport is in Phase 1 of construction and will be showcased to the world at the 2010 World Expo. www.greenportshanghai.com/film.php

¹⁹ www.transitiontowns.org/Totnes

Sources

Figure 1 – World Energy Council: 2007 Survey of Energy Resources

Table 1 – Natural Resources Canada Reference Case, Centre for Energy, U.S. Department of Energy; "The Future of Energy". Mother Jones. May/June 2008.

Figure 2 – oil barrel data: U.S. Department of Energy (DOE); farm-level data: Centre de référence en agriculture et agroalimentaire du Québec (CRAAQ).

Figure 3 – www.lifeaftertheoilcrash.net

Figure 4 – www.opec.org

Figure 5 – World Energy Council: 2007 Survey of Energy Resources; Energy Information Administration

Figure 6 – Adapted from OPEC, Petro Canada, Energy Information Administration (U.S.), and CNNMoney.com

Figure 7 – www.globalfirepower.com/list_oil_prod.asp

Figure 8 – www.ucsusa.org/global_warming/science_and_impacts/science/each-countrys-share-of-co2.html; World Energy Council: 2007 Survey of Energy Resources

Figure 9 – Adapted from Natural Resources Canada; The Economist. "The Power and the Glory – a special report on energy", June 21, 2008 and Tertzakian p.166

Figure 11 – Adapted from www.inflationdata.com; www.farmdoc.uiuc.edu/manage/pricehistory/PriceHistory.asp; www.Globeinvestor.com; Energy Information Administration; www.wtrg.com/prices.htm

Figure 12 – Energy Information Administration and www.tradecorner.ca



Farm Credit Canada is proud to present Knowledge Insider, a semi-annual publication offering thought-provoking information to producers and other agriculture entrepreneurs. Trends described in this document are supported with facts and figures and examined in the context of what's on the horizon for Canadian agriculture.

Please direct questions and comments to FCC's Customer Service Centre at 1-888-332-3301 or email csc@fcc-fac.ca

Knowledge Insider is produced by Strategic Intelligence at FCC
Brenda Frank, Senior Director, Strategy and Business Insight
306-780-7666

Our special thanks for contributions from all of our FCC partners and industry experts who generously contributed their time, talent and knowledge to the creation of this document.

This report presents forward-looking statements and is intended for educational and general reference purposes, only. The authors have attempted to provide useful information and analysis however FCC does not guarantee accuracy or necessarily share the views of authors. Links to other websites are offered as reference to the readers of this report, based on the information provided. The report is not intended to be used as a substitute for professional advice.

© 2008, Farm Credit Canada

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, without the prior written permission of Farm Credit Canada.