Backgrounder

In this report we have adopted a scenario-based approach in which two different plausible energy futures for Canada are explored in detail: a ***Supply Push*** scenario and a ***Techno-Vert*** scenario. Neither of the scenarios represents a more probable or more desirable energy future. The scenario approach enables us to identify issues, constraints and uncertainties affecting energy supply and energy use in Canada. Scenarios are not forecasts; they are designed to challenge our thinking and to provide a framework for public discussion on emerging issues and trends.

Although there are many forces that will affect future energy use patterns, we considered **the pace of technological progress** and **action on the environment** as the two forces that are the most important and most uncertain. In any conceivable future, it is clear that there will be ongoing technological progress and actions will be taken to improve the way in which we use energy with respect to the environment. However, there is considerable uncertainty as to the scope for technological advancements in areas such as fuel cell vehicles, clean coal technology or advanced nuclear generation, which could radically change our energy use patterns. At the same time, there is equal uncertainty about the scope and range of real actions that might be taken to reduce the overall environmental impact of energy use, including emissions of air pollutants and greenhouse gases.

The ***Supply Push*** scenario represents a world in which technology advances gradually and Canadians take limited action with respect to the environment. The main theme of this scenario is security of continental energy supply and the push to develop known conventional sources of energy.

The ***Techno-Vert*** scenario represents a world in which technology advances rapidly and Canadians take broad action with respect to the environment and the accompanying preference for environmentally-friendly products and cleaner-burning fuels.

In November 2002, the Government of Canada released a plan to address Canada's commitment to the Kyoto Protocol. However, additional elements of implementation would be required in order for the Protocol to be incorporated in the scenario analysis. Therefore, the Protocol was not considered in either scenario.

The focus of this report is on plausible energy futures for Canada. However, Canada's energy economy is closely tied to that of the U.S. Thus, the scenarios necessarily imply that similar developments take place in the U.S. economy and, to a lesser extent, in the world economy.

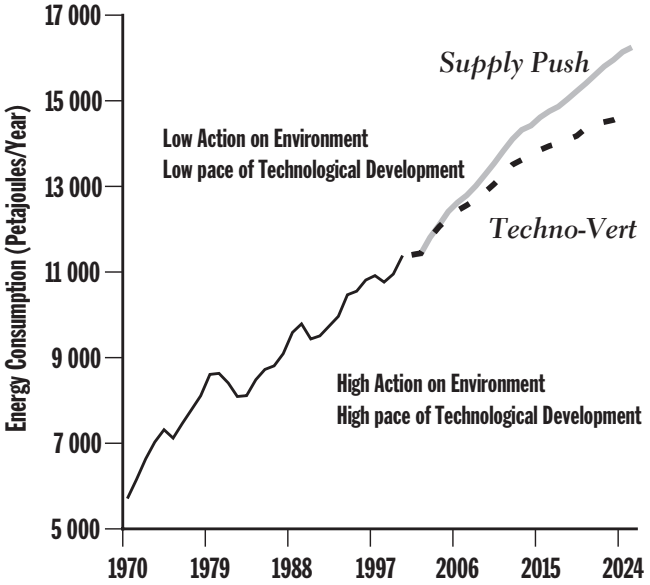
Key Findings

- There are significant obstacles to changing the fuel mix or achieving large gains in energy efficiency due to the structure of the Canadian economy. Energy use patterns change slowly and Canada will continue to satisfy the majority of its energy needs from fossil fuels until 2025 and likely for a considerable period thereafter.
- Natural gas will be in high demand as a premium clean-burning fossil fuel. However, a major uncertainty is the availability of supplies of natural gas. Tight natural gas supply relative to demand implies:

- natural gas prices will continue to be volatile;
- demand-side adjustments could occur in the industrial sector, including more efficient energy use, switching to other fuels and possible relocation of industries; and
- new electric power generation will come from a variety of sources, including coal, wind, large hydro and possibly nuclear.

➢ Oil sands production will increase significantly and will offset the decline in conventional crude oil production and become Canada's major source of oil supply. Exports will increase considerably through 2025.

How Will Canada's Energy Future Unfold?



Key Assumptions

There are a number of underlying drivers that are the same in both scenarios. First, energy demand is determined primarily by economic growth and income levels, and the efficiency of energy use. As economic output increases, there is increased demand for energy to produce a greater range of products and services. This can be partially offset by improved efficiency but the income effect still results in rising demand.

Canada is a large country with a cold northern climate and large distances between population centres: this translates into high demand for energy for transportation and space heating. Energy demand is also affected by the density of population. There is more scope for efficiencies in energy use in densely populated areas where economies can be realized in mass transit, heating of apartment buildings and large commercial centres. However, Canadian cities tend to be relatively spread out with a very high rate of single detached home ownership. In both scenarios, we assume that climate and living patterns remain largely unchanged over the projection period to 2025. Both scenarios contain the same demographic assumptions; i.e. the Canadian population will age over the projection period, and the overall population will grow slowly.

We assume that world oil prices will average a constant real US$22 per barrel in each scenario, which is the low end of OPEC's target price range. This implies that there is adequate oil in the world at that price to meet energy demand and that price will be largely depend on the production policies of the OPEC nations. Due to the high demand for natural gas as a clean-burning fuel, we assume the price of natural gas will grow from 83 percent to 90 percent of the crude oil price in the ***Supply Push*** scenario by 2025. In ***Techno-Vert,*** the natural gas price reaches parity with crude oil by 2010. While there will undoubtedly be considerable volatility in both oil and gas prices, we believe that $22 per barrel is a reasonable assumption for oil prices and that gas will not be priced above crude oil, on an equivalent energy basis, for any sustained period of time.

Outlook for Energy Use

In the **residential sector,** space heating accounts for over 50 percent of energy demand, followed by water heating, and electricity for appliances, computers, lighting and home entertainment systems. The Canadian population grows slowly in both scenarios, thereby limiting change in the composition of the housing stock over the projection period. Because it is more practical to implement energy efficient features in new homes than to refit existing homes, the degree to which energy efficiencies can be implemented in this sector is limited.

Due to rising incomes and attendant rising demand for goods and services, energy demand in this sector increases by about 20 percent in the ***Supply Push*** scenario and by about 10 percent in the ***Techno-Vert*** scenario by 2025. Electricity and natural gas account for a greater share of the fuel mix in both sectors, while alternatives such

as passive solar power make minor inroads only in the ***Techno-Vert*** scenario. Energy demand could be reduced further if there were a marked shift in living patterns away from large detached homes to multi-family residences and smaller bungalows; however, this is not expected to happen in either scenario.

There is more scope for implementing energy efficiencies in the **commercial sector** due to the average larger size of buildings and the importance owners place on economizing on energy bills. Nonetheless, energy efficiency gains are limited by turnover in the existing stock and also because, similar to the residential sector, it is relatively expensive to retrofit existing buildings. Natural gas and electricity are expected to account for over 90 percent of the fuel mix in this sector, as is the case today.

Energy demand in the **industrial sector** is roughly equal to that in the residential and commercial sectors combined. Industrial energy demand grows only by about 50 percent in the ***Supply Push*** scenario and by 55 percent in the ***Techno-Vert*** scenario, while economic output grows by 90 percent and 120 percent respectively. The pulp and paper and mining sectors are the two largest energy users and energy costs are a very high component of overall costs to these industries. They are highly motivated to implement cost savings and have been leaders in searching out efficiencies. However, further efficiencies are limited by the need to exploit more remotely located resources in the forestry, mining and oil and gas sectors, and by the limited options for alternative fuel sources in these industries.

Road transportation accounts for 80 percent of energy demand in the **transportation sector,** with marine and rail transport accounting for the remainder. Oil dominates energy use in this sector, accounting for close to 100 percent of energy use. Accordingly, there has long been a search for alternatives to oil, with the primary candidates being a hybrid electric vehicle or a vehicle powered by a fuel cell. Both are attractive due to energy efficiencies and the reduction or complete lack of hydrocarbon emissions.

The demand for energy for passenger vehicles depends on the total stock of vehicles, the average fuel economy of the stock and the average number of kilometres travelled per vehicle. Each of these is, in turn, affected by factors such as consumer preference and urban living patterns. In our scenarios, we assume no fundamental changes in urban living patterns and, hence, high demand for personal transport persists.

In the ***Supply Push*** scenario, there is considerable progress made in improving the efficiency of the internal combustion engine and gasoline and diesel continue to supply almost all road transportation fuel needs. In the ***Techno-Vert*** scenario, hybrid electric and fuel cell vehicles become competitive. By 2025, they account for 14 percent and 10 percent of the vehicle stock, respectively. During this period, continuous progress is made in using oil cleanly and efficiently; hence, oil still retains a large market share. Overall, transportation demand for energy grows by 50 percent in the ***Supply Push*** scenario, while in the ***Techno-Vert*** scenario it initially grows, but then falls back, finishing close to initial demand levels.

Energy Production

Canada has enormous reserves of oil in the Alberta oil sands. This resource acts as the major source of growth in domestic oil production, and corresponding growth in oil exports to the U.S. in both scenarios. The assumed price of US $22 per barrel provides adequate returns to support investment in the oil sands and offshore oil development. Production from the oil sands increases five-fold in the ***Supply Push*** scenario and about four-fold in the ***Techno-Vert*** scenario. In both scenarios, light crude production from the Atlantic offshore increases, with slightly higher increases being achieved in ***Techno-Vert*** due to the more successful application of technology to offshore exploration and production engineering. Canada continues to be a net exporter of oil throughout the period, with growth in exports outpacing growth in imports, especially in ***Techno-Vert.*** The result is that net exports of crude oil almost double in ***Supply Push*** and triple in ***Techno-Vert.***

The size of Canada's natural gas resource base is a major uncertainty, particularly for the frontier regions and unconventional natural gas sources, such as coal bed methane. There are signs that the Western Canada Sedimentary Basin is maturing. It will be necessary to develop unconventional and frontier sources to maintain, or potentially increase Canadian production. However, since there has been little development of unconventional gas or frontier gas to date, there is considerable uncertainty about future potential production. In the ***Supply Push*** scenario, natural gas production peaks at about 18 Bcf/d whereas production reaches about 19 Bcf/d in the ***Techno-Vert*** scenario, primarily due to more success in expanding the resource base through successful application of technology.

Electricity generation is expected to grow by about 1.8 percent per year in both scenarios, but the mix of generation will be quite different. Natural gas is a preferred fuel due to its clean burning properties, efficiency, the short lead time required to build gas-fired power plants and significant lower up-front capital investments than are required for coal, large hydro or nuclear. Nonetheless, price volatility will be a concern that will lead generators to consider alternatives.

In the ***Supply Push*** scenario, in addition to gas-fired generation, there is a resurgence of coal-fired plants, particularly in Ontario and the western provinces. Coal continues to be relatively inexpensive and will thus always be an option to consider. In the ***Techno-Vert*** scenario, there is a shift towards "cleaner" generation options such as clean coal technologies, wind power and advanced nuclear reactors. Overall, renewable fuels (wind, biomass and small hydro) account for almost ten percent of the generation mix in 2025 in ***Techno-Vert***, compared to only three percent in the ***Supply Push*** scenario.

Coal is an abundant resource on a world basis and in North America. In Canada, reserves are equivalent to 90 years of current production. Future production will be governed primarily by the use of coal in domestic power generation. As with oil, continuous progress is made in burning coal cleanly and efficiently and, consequently, coal continues to retain a significant market share of twelve percent of total energy demand in ***Supply Push*** and eight percent in ***Techno-Vert***. In the ***Supply Push*** Scenario, coal production rises from 70 million tonnes in 2001 to over 90 million tonnes in 2025 and declines to 63 million tonnes in ***Techno-Vert***.

Key Uncertainties

Examination of our scenarios appears to indicate that Canada's energy future will continue to be based on fossil fuels, at least until 2025. However, there are a number of key questions that remain:

- How will technological development impact economic growth and energy demand?
- How long will it take to achieve significant changes in Canadian energy consumption patterns given the structure of the Canadian economy?
- How soon can new transportation technologies such as hybrid electric and fuel cell vehicles become commercially competitive with traditional gasoline-powered vehicles?
- What concrete actions will be taken to address environmental concerns and what impact will these actions have on our choice of energy sources?
- Will OPEC be able to maintain oil prices within its target band of $22 - $27 per barrel or is it possible that prices will be outside this range for prolonged periods of time?
- What is the impact of future environmental measures on oil sands development?
- How will gas supply from conventional sources including the WCSB, and offshore sources and new sources such as CBM respond to increased demand?

The answers to these questions will have a major impact on Canada's energy future to 2025.

Next Steps

As part of its ongoing assessment of energy markets, the Board will continue to monitor developments in Canadian energy supply and usage patterns and from time to time, will release its findings.