National Energy Board | Office national de l'énergie

Canada's Energy Future

Scenarios for Supply and Demand to 2025

Draft for Public Consultation

Canada's Energy Future:

Scenarios for Supply and Demand to 2025

The National Energy Board (Board) is an independent energy regulatory agency. The Board has periodically published a long-term outlook for energy supply and demand in Canada as part of its ongoing monitoring function. The Board has embarked on its next report, which is scheduled for release in May 2003. The key objectives of this report are to provide a comprehensive analysis of Canadian energy markets and a coherent framework for public discussion on emerging issues and trends.

This Consultation Package is intended to provide the framework for discussions during the public workshops. The objective of these sessions is to provide an opportunity to comment on the Board's analysis and preliminary results.

The package is divided into five sections:

1. Scenario framework
2. Overview of scenarios
3. Key assumptions
4. Preliminary demand results
5. Preliminary supply results

Of note, each section contains a series of issues and/or questions. Participants in the public workshops, as well as those who choose to provide written comments, are asked to use these issues and/or questions as a guide. You may submit written comments on the consultation package until 14 February 2003.

Following the consultations, the Board will review and consider comments received during the preparation of its final report.

If you require further information, please contact Nancy Bérard-Brown, Project Manager, at (403) 299-3199 or nberardbrown@neb-one.gc.ca.

1.0 Scenario Process and Framework

How to use these scenarios

The Board's goal is to develop scenarios that will describe alternative futures and capture a broad range of plausible outcomes with respect to energy supply and demand in Canada. They are intended to challenge and broaden our thinking about the range of possible future outcomes in an uncertain world. Scenarios are logically consistent and plausible, connected to recent events, explore new ground and new ideas, challenge conventional views and focus on the most important uncertainties facing the energy industry. It is not necessary to believe in any scenario, only that the scenarios are logical and believable – in other words, that they could happen and that they are useful for identifying the key issues.

As you read the scenarios there are two major questions for you to consider.

1) Are the scenarios logical and consistent?
2) What are the implications for my organization and/or the industry?

In considering the logic of the scenarios, you are encouraged to focus on the forces driving change in each scenario and particularly what is motivating key players in the energy field (e.g. industry, governments, consumers). Only in that context do individual events and developments make sense. The question is not whether you believe a specific event will occur, but whether that event is believable within that scenario.

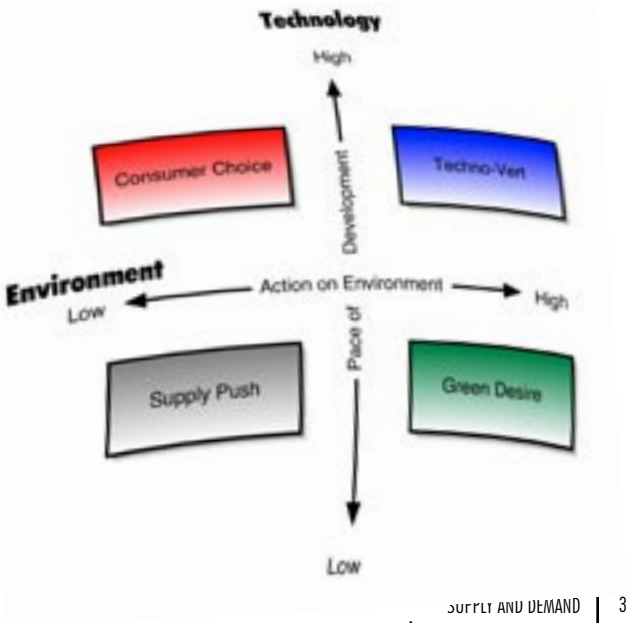
Ultimately, the real value of the scenarios occurs when your focus shifts from the scenarios themselves, to the implications for you. You are encouraged to read the scenarios twice. First, to understand the scenarios. Second, to identify implications for you and your organization. We hope you find them insightful, challenging and thought provoking.

Scenario Process

The Board's process began with the identification of the key driving forces that may impact the energy environment. These factors were then grouped and assessed according to their importance and uncertainty. Two key uncertainties were then selected: the pace of technological development and the degree of action on the environment. These uncertainties may be represented as continuums or dimensions forming orthogonal axes as shown below. They provide a framework for developing distinctly different scenarios.

Pace of Energy Technology Development

Technological change, which affects both supply and demand, is inevitable and will have an impact on the future energy environment. The **pace** of development, however, is uncertain. Will the pace of development be relatively "high" or "low" and what will be the implications on the energy environment? A more rapid pace (upper quadrants) may involve technologies focused on alternatives and renewables or on traditional forms of energy, or both. Low rates of change (lower quadrants), however, would suggest that current technologies remain dominant. Which will prevail is uncertain.



Action on Environment

Environmental outcomes are a key uncertainty. Action on the environment refers to cultural and policy changes that would take place over time. How will public concerns about the environment evolve and how will these be translated into action over the next 25 years? The key uncertainty here is **action**. Will actions on environmental issues by governments, industry and individuals be low or high in the future? Why, how, and the extent to which these actions occur depends on the logic underpinning each scenario.

Each quadrant represents a combination of **outcomes** based on the two critical uncertainties. For example, the Supply Push scenario represents a future in which action on the environment and the pace of technological development are both low relative to the other quadrants. The U.S. Energy policy, announced last year, might be viewed as a signpost indicating that we are moving in the direction of the Supply Push.

On the other hand, the Techno-Vert scenario represents a future in which action on the environment and the pace of technological development is both high relative to the other quadrants. Climate change, or more precisely, ratification and implementation of the Kyoto Protocol, would be a signpost for this scenario.

The Board will quantitatively assess the implications of the Supply Push and the Techno-Vert scenarios on energy supply and demand. These two scenarios offer very divergent views of the future. The Board's assessment of the Consumer Choice and Green Desire scenarios will be more qualitative.

Following the passage, by Parliament, of the ratification resolution in December 2002, the Government of Canada has informed the United Nations of its intention to ratify the Kyoto protocol. The government also released a plan to achieve a portion of Canada's commitment. However, additional elements of implementation would be required in order for the protocol to be incorporated in the scenario analysis.

The final report is scheduled for release in May 2003. In preparing the final report, the Board will take into consideration the feedback received during the public consultation process and significant changes in government policies.

2.0 Scenario Overviews

Supply Push

Within the scenario framework, Supply Push is captured in the area bounded by a low pace of technological development and a low rate of action on the environment. The main theme of the Supply Push scenario is the *push* to develop known conventional sources of energy. This is necessary because technology isn't expected to progress quick enough to either economically develop unconventional energy or significantly reduce energy use. Action on environmental matters is slowed, as necessary, in the pursuit of greater domestic energy supply. Energy demand continues to grow in accordance with well-established trends, with periodic advances in energy efficiency and slow implementation of new technologies.

Scenario Overview

Scenario Logic	Rising nationalism and security concerns drive energy policies focusing on expanding traditional supply in North America. Environmental concerns lose prominence. Rising energy prices and price expectations support massive investments in frontier areas, coal for power and LNG imports. Periodic global price spikes reinforce the sense of insecurity and stimulate rising price expectations. Production of oil, gas and coal increase to meet demand and displace imports.
Economy	Cyclical growth with an annual average growth rate of 2.2%.
Environment	Declining relative importance; limited new regulations.
Prices	WTI= US$22/barrel and NYMEX Natural Gas= $3.18 US$/MMBtu.
Technology	Incremental improvements similar to last decade.
Energy Demand	Rising demand driven by economic growth. Improvements in efficiency associated with capital stock turnover.
Energy Supply	Expansion of NA supply of oil, gas and coal. Nuclear plant life extension. Focus on large scale development of known resources such as MacKenzie Delta, oil sands, Alaska and highly prospective off-shore areas. Gradual production from non-conventional sources such as coal bed methane.

Scenario Characteristics and Drivers

The Supply Push scenario is characterized by global tension, unstable geopolitics and unpredictable acts of terrorism. Conflicts overseas continue to affect North America. Energy prices swing in response to these events; moreover, while OPEC is generally able to maintain its monopolistic control of oil markets, periods of conflict or lack of unity between OPEC and non-OPEC countries exacerbate energy price volatility. This volatility affects the North American economy; nevertheless, the Canadian economy continues to grow at an average rate of 2.2 percent annually with an accompanying increase in energy demand. Energy demand continues to grow in North America, spurred by many factors including: the growing number of households (relative to population growth) and appliances per household, as well as the

preference for comfort and power in their selection of vehicles. The market share of sport-utility vehicles, vans and light trucks expands at the expense of small and large cars.

Concern grows over energy security and reliability in North America to meet growing energy consumption. Governments, led by the United States, encourage and initiate policies to foster growth in North American energy supplies in the absence of a shift to use less energy. At a minimum, the goal is to reduce dependence on energy supplies from unstable sources. Various levels of government are also involved in a variety of other measures to reduce the impact of price volatility, including: rebates for consumers to offset high prices, the provision of information to increase public awareness, and voluntary programs to encourage conservation and to improve energy efficiency. However, without an economic motivation to focus policy and fund government programs, consumer behaviour towards energy consumption remains largely unchanged. The industrial sector continues to improve its energy efficiency albeit at a reduced rate. To deal with price volatility, industry tends to switch between gas, heavy fuel oil, diesel, coal or waste fuels rather than significantly reduce energy consumption.

The Beginning... (circa 2000 - 2005)

High energy prices during the winter of 2000/01 have elevated public and political awareness of energy matters. Clear trends emerged by 2001: first, growth in energy demand to fuel the North American economy is outpacing growth in North American supply as marked by increasing imports of oil into the United States; and second, supply basins across North America are becoming mature. The latter trend is especially noted in Canada as an increasing number of wells must be drilled annually to maintain the level of gas production from the Western Canada Sedimentary Basin (WCSB).

A new administration in the United States has been elected in 2000. One of its top priorities is the formulation of its energy policy, which quickly evolves into a 'North American Energy Policy'. While the proposed policy contains recommendations on conservation and research on energy efficiency and renewable energy, the central thrust is to step up development of known conventional sources of energy. This would be achieved by increased drilling for oil and gas, opening up previously restricted areas to drilling, such as the Alaska National Wildlife Refuge (ANWR), developing a pipeline to deliver natural gas from Alaska to the lower 48 states, and reducing restrictions on air emissions to allow further use of coal-fired generation. A main objective of the proposed policy is to reduce dependence on potentially unreliable foreign sources of energy and to increase energy trade between the United States, Canada and Mexico - the beginning of "Fortress North America".

The North American Energy Policy gains momentum following the events of terrorism on 11 September 2001. With the potential for further terrorism and growing instability in the Middle East, North American governments quickly endorse an energy framework to stimulate development of conventional energy supplies - a "supply push". This supply push does not come soon enough, as energy prices once again rise steeply in response to world events. High and volatile energy prices temper a North American economy which had shown signs of strength.

In a short period, the drilling rig fleet in North America is fully mobilized to increase production of oil and gas. Conventional gas production increases gradually in response to unprecedented drilling levels thereby providing temporary relief to the fears of an "energy crisis". Elevated levels of drilling in the WCSB are projected to continue for many years - mainly in the pursuit of natural gas. Plans are submitted to further develop the offshore Canadian East Coast, to consider exploration off the West Coast and to deliver gas from the Canadian North but, any incremental production is still years away. Similarly, despite plans to develop numerous liquefied natural gas (LNG) projects in North America, in the near term only recently expanded terminals can provide additional capacity. Pilot projects to produce coalbed

methane (CBM), that are already underway, are pushed ahead in the WCSB.

The supply push sets the stage for significant expansion of oil supply. With almost 300 billion barrels of recoverable bitumen, Alberta stands to benefit from aggressive development of its oil sands regions. After several years of development and the investment of billions of dollars, incremental production of upgraded or synthetic crude oil from oil sands is realized from the expansion of the existing facilities at Syncrude and Suncor, and with the commencement of a new surface-mining and upgrading operation, the Athabasca Oil Sands Project. As well, incremental in situ crude bitumen production is added through the expansion of existing projects at Cold Lake, and by the addition of two new steam-assisted-gravity-drainage (SAGD) projects, the Foster Creek and Mackay River projects. Because of its high viscosity and density, in situ bitumen requires the addition of significant amounts of blending agent, or diluent, to render it transportable in pipelines. Natural gas condensate, the traditional source of diluent, becomes in increasingly short supply as bitumen production expands, and becomes a serious concern for oil sands operators. While some Canadian refineries are modified to be able to process crude extracted from the oil sands, increasingly more bitumen blend and upgraded crude oil supply flows to the United States. These oil sands projects complement expanded oil production from the offshore East Coast (Terra Nova). Plans are also filed to further develop these supply sources.

Production of conventional light crude oil in the WCSB continues to decline at its long-term trend of about four percent per year. By contrast, production of conventional heavy crude oil continues to trend slightly upward, primarily as a result of improved recovery techniques and concentrated infill drilling in heavy oil pools. Domestic crude oil production in the United States continues its long-term decline trend. This decline, combined with increasing demand, results in a widening need for crude oil imports. Canadian heavy oil and oil sands producers compete aggressively to increase their share of this market. As well, imports to North America from non-OPEC countries increase as those nations expand production to fill the void caused by the periodic reduction of oil supply from some OPEC nations.

Economic growth continues; however, no effective efforts are made to curtail the attendant rate of increase in energy demand. Relatively inexpensive energy in North America continues to foster the pursuit of lifestyles involving larger vehicles such as sport-utility vehicles, larger homes, and electronic gadgets. Expectations of increasing demand for electrical generation lead to government and industry action to recover laid-up nuclear capacity in Ontario and to foster growth of coal-fired generation. Future large-scale hydro projects are also considered, but new generation facilities coming on-stream are predominantly gas-fuelled because of the relatively lower capital investment, the shorter time required for construction and higher efficiency.

Although an international agreement is reached on the reduction of greenhouse gas emissions, governments find difficulty in implementing meaningful measures to curtail behaviours. New environmental regulations are passed but they are unclear and lack adequate enforcement measures. Without this motivation, progress in energy efficiency and alternative and renewable energy doesn't progress quickly. However, some energy efficiencies are realized across all sectors as a result of previous technological improvements or existing emissions controls and fuel efficiency targets for new vehicles.

Fortress North America (circa 2005 - 2010)

Geopolitical turbulence and instability lead to continuing energy price volatility and the reinforcement of continental sentiment. The "Fortress North America" attitude is prevalent. Government policy through North America responds to high and fluctuating energy prices by encouraging the supply push. One of the promised benefits of such policy is that it would promote economic growth as well as

energy security. The seemingly erratic timing of policy initiatives, however, serve to exacerbate energy price volatility. Traditional exploration and production (E&P) companies reap the rewards of price spikes and make large investments in conventional energy development. Success in unconventional developments continues to be slow or non-existent. The necessary technological breakthroughs don't materialize.

In order to achieve greater domestic energy supply, action on environmental matters is slowed. Environment, while remaining a concern to many, is not a policy priority. Restricted areas are opened up in some cases in order to develop new energy supplies. Drilling in these areas pays off, particularly in the United States, as conventional gas production increases. The supply push is underway.

Total Canadian gas production expands for several years, along with an accompanying increase in ethane supply and other natural gas liquids, in response to the supply push. Producers continue to maintain gas production levels from the WCSB with the success of several CBM projects. At the same time, however, rapid growth in gas production is experienced off the Canadian East Coast, led by the connection of the Deep Panuke gas field and the development of satellite pools in the Sable Island area. Years later, volumes of solution gas from maturing oil pools near Newfoundland and Labrador are compressed at the offshore platforms and delivered to market by tanker ship.

Access to natural gas in Atlantic Canada has been lead by the power generation and industrial sectors. Now, increased availability of gas supply in Atlantic Canada enables natural gas use to expand in the residential and commercial sectors, primarily in urban centres in proximity to existing or planned pipeline infrastructure. However, market penetration rates are slow, especially for existing homes and buildings. Costs of converting heating systems to natural gas continue to outweigh the benefit of switching from traditional fuels. Similarly, natural gas use by the industrial sector in Atlantic Canada is limited by competition from fuel oil and electricity. As well, the increased gas production in Atlantic Canada does not contain an economic volume of ethane to support extraction; hence, ethane is left in the gas stream and, as a result, a petrochemical industry does not seem likely to develop.

Imported LNG supply from stable countries is considered as a reliable component of the North American energy mix. The construction of new LNG facilities begins in the United States, Mexico and Canada despite specific regional safety and health concerns. Similarly in the North, the promise of large economic benefits outweigh any perceived social costs; construction of a pipeline from the Canadian North commences and gas flows within a few years. Increases in ethane supply from the WCSB are supplemented by these additional volumes from the Mackenzie Delta. A similar, although larger, project from Alaska is under construction by the mid-point of this period to meet growing gas demand in the lower 48 States.

After a period of growth following the onset of the supply push, conventional heavy crude oil begins to decline in hand with the decline in remaining recoverable reserves. However, oil production receives a boost from previous investment in the oil sands projects. This leads to further investment, particularly from the United States, in new infrastructure such as increased refinery and pipeline capacity. Investment is also made to alleviate the tightening supply of diluent. Some refinery capacity in Edmonton is converted to run bitumen instead of light crude. Further, synthetic crude oil is increasingly used as a diluent. The economy in Atlantic Canada expands rapidly with the commencement of oil production from the White Rose and Hebron/Ben Nevis fields which join an earlier expansion of offshore natural gas production.

Natural gas-fired electricity generation continues to expand in Ontario to meet growth in demand from all sectors. Alberta also experiences growth in gas-fired generation in conjunction with the growing number of oil sands mining and in-situ bitumen projects. In addition, Prince Edward Island joins Nova Scotia and

New Brunswick with the establishment of gas service, anchored by an electricity generating plant.

Coal re-emerges with expanded use for electricity generation and some industrial use, especially in the U.S. Midwest, Alberta and Saskatchewan where there are large deposits of low sulphur coal. Nuclear facilities continue to be heavily relied upon in North America and a new policy to govern nuclear waste disposal is introduced. Electricity restructuring continues to progress in Canada although the pace varies by province.

Without any significant investment or policy to stimulate development, alternative and renewable fuels usage does not expand appreciably. Green generation technologies remain generally uncompetitive with the exception of small, niche locations such as biomass power plants in British Columbia and small hydro projects in Ontario, Alberta and British Columbia. Further, large-scale hydro capacity is added at Grande-Baleine in Québec and at Gull Island in Newfoundland and Labrador as well as sites in British Columbia and Manitoba.

Toward the end of the period, signs indicate that wider resource development is required to maintain the supply push. Conventional and readily accessible energy supplies in North America must be supplemented by reaching further into frontier areas. Development of these remote sources necessitates that the projects be large. Frontier development in the North and East Coast competes with oil sands and coal development for significant capital and especially labour. Intense lobbying of the government for favourable regulation, loan guarantees and investment conflicts with efforts to improve the economy through tax cuts and the elimination of fuel taxes.

Reaching Further... (circa 2010 - 2020)

A profound structural change in the Canadian economy begins to occur. As the population ages, growth in the labour force is slower than in previous decades; consequently, the service sector is unable to continue the level of growth experienced in the 1990s. Manufacturing and mining (including oil and gas extraction) industries, primarily serving the U.S. export market, start to become the principal engine for economic growth. Continued expanded trade within North America results in increased energy demand in commercial transportation and rail transport. Strong demand for durable goods such as motor vehicle parts and electronic products as well as strong growth in resource-based industries increase exports and subsequently, commercial road transportation energy demand increases in Ontario. Similarly, gains in resource-based industries in Quebec and Alberta contribute to growth in commercial transportation at rates above the Canadian average.

After only a few years in service, a pipeline from the Canadian North has expanded; however, most of the additional production is largely absorbed by oil sands projects in Alberta. Natural gas production from the WCSB commences a gradual decline as growth in CBM production cannot offset increasing declines in conventional supply. Ethane supply tracks the decline in conventional gas production from the WCSB. Access to an incremental supply of ethane, from Alaska or unconventional sources, will be needed to improve utilization of ethylene plants in Alberta; without this additional supply, one or two plants may have to close.

Natural gas production declines also occur in Atlantic Canada despite the development of another new gas discovery and the expansion of compressed natural gas (CNG) service from Newfoundland and Labrador. The hope for large domestic natural gas supplies rests with the deep waters offshore the East Coast, further Northern development and now, offshore British Columbia as the drilling moratorium is lifted. In the United States, the appetite for LNG from stable countries increases as the United States attempts to secure additional supplies of natural gas for power generation. New LNG plants are constructed and existing facilities expand. Similarly, further LNG facilities are also possible in Canada.

Gas demand in Western and Atlantic gas markets continues to be met by supply sources in close

proximity. However, central Canadian gas markets, which are much further from the supply sources, must respond to tightening gas supplies as gas is absorbed by other markets en route to central Canada; Ontario is most susceptible to short-term imbalances and price volatility so it begins to further diversify its fuel mix. Natural gas use by the industrial sector peaks in Ontario and Quebec by 2012 and is supplemented by fuel oil and electricity use. There is a shift in the iron and steel industry to electrically powered mini-mills; similarly, the cement industry moves toward greater use of coal and waste products such as tires. The aluminum industry in Quebec increasingly imports aluminum alloy for fabrication as it requires less energy than the production of aluminum from imported bauxite.

Demand for petroleum products increases with the growth of the goods producing sector. Further, without a higher value placed on cleaner-burning fuels such as natural gas, the momentum which was driving a shift in fuel shares, to gas from oil and coal, in earlier decades begins to slow. North American oil production, with the exception of the oil sands, continues to decline despite the commencement of production from ANWR. Basins which have produced for decades, including the giant Prudhoe Bay field, are almost depleted. Even fields offshore eastern Canada are beginning to decline under high rates of production. Increasing reliance is placed on imports from non-OPEC countries, primarily Russia and Mexico, to meet growing North American requirements for oil.

Hybrid-electric vehicles operating on petroleum products begin to slowly penetrate the market; however, well below expectations of car manufacturers. Similarly, fuel cell vehicles are slow to commercialize. Impediments such as fuel choice, fuelling infrastructure and general lack of competitiveness, continue to plague their development and commercialization. Consequently, car manufacturers continue to rely on the internal combustion engine operating on traditional petroleum products. The efficiency of the internal combustion engine has improved over time in response to gains in conventional technologies.

Recognizing the limits for natural gas supply and domestic oil production, governments reduce restrictions on emissions to provide for greater use of coal. Expanded coal development for power generation and industrial use is quickly absorbed. The impact of increased coal development in Alberta and Saskatchewan is complemented by increased imports of coal from the U.S. into Ontario. Generating capacity also benefits from life extension programs for nuclear facilities in Ontario and Québec and the use of orimulsion in New Brunswick, and later, in Nova Scotia. In Canada, new hydro development also continues to be a viable option.

Energy prices continue to be volatile for short periods as a result of continued growth in demand and alternating periods of tight supply and the addition of massive energy projects which provide pulses of large incremental supplies. The United States increasingly competes for oil and LNG on world markets. By the end of the period, North America finds itself in a position similar to where it was decades earlier - facing increased dependence on global energy sources.

Back to the Future (circa 2020 - 2025)

Economic growth begins to slow in Canada as the population continues to age and many leave the workforce. The level of commercial travel falls off as the economy slows. However, the public's preference for personal-use car travel has left urban public transit underdeveloped.

Canadian economic growth during the supply push has been centred on traditional resource-based and manufacturing industries. Ontario, with its abundant resources and extensive manufacturing sector, led by the automotive industry, is the only province which continues to expand its share of the Canadian economy. The resource-driven economies in Alberta and Newfoundland manage to maintain their respective shares of the overall Canadian economy, as does Prince Edward Island. Total energy use in Alberta

has doubled over the period driven, in part, by the pursuit of increased energy supply, particularly from oil sands development. For Canada, energy use by the industrial sector has grown at a slower rate than the industrial sector itself because a larger proportion of industrial output is derived from less energy intensive industries such as automotive assembly, transportation equipment and manufacturing of electronic and communications equipment.

Eventually, tensions abroad turn inward within North America as exports of Canadian gas are reduced in light of declining conventional gas production from the WCSB - now at only one-half the level of production when the supply push commenced twenty years earlier. Industry is hard-pressed to find and produce smaller pools in a basin that has become mature; finding and development costs continue to rise. A number of the pools that had been developed in Atlantic Canada have been depleted. Exploration wells are drilled off the Canadian west coast resulting in commercial production. In the Canadian North, producers supplement production from the original Mackenzie Delta field by reaching out to satellite pools under the Beaufort Sea. Competition between Canadian and U.S. gas markets for reduced natural gas supplies may impact long-standing international trade agreements. Adjustments to tighter gas supplies occur. For example, oil sands producers examine the use of bitumen and coal as fuel sources and switch to more non-thermal extraction methods.

Conventional gas production in the United States begins to decline as incremental gas from previously restricted areas can no longer offset declines from traditional basins. LNG capacity in the United States increases but the limit has been reached for new sites. Further supplies flow to the United States from Mexico but a growing Mexican economy and internal need for gas to fuel power generation limits further exports. However, in the U.S. and Canada, declining conventional gas production combined with aging gas pipeline systems raises reliability issues for gas-fired electricity generation. In response, power generation facilities are becoming increasingly fuelled by coal in provinces with economical access to coal supplies. Governments provide financial assistance to quicken the development of rail networks to transport coal to those markets historically served by gas; potential energy crises in some areas are prevented.

Total Canadian electricity generation has risen significantly since the commencement of the supply push. Through this period, exports of electricity have remained within a historical range with an increasing proportion of the export market served by Alberta. The exports from Alberta require new transmission from the cogeneration facilities located at the oil sands developments. Over time, Alberta becomes the largest market for gas used in power generation. The Canadian power industry benefits from additional hydro power, which still accounts for almost one-half of total Canadian generation despite the rapid growth in gas-fired generation and increased coal generation over the past decade. Due to increased cost and reliability concerns, Ontario opts for further coal generation to meet future demand instead of gas.

Renewable fuels, such as wind power, have generally been limited to niche markets. The high cost of transporting fuel to the Yukon, Northwest Territories and Nunavut has made wind power, backed by internal combustion diesel, economically viable. Solar systems for hot water and space heating have experienced limited penetration in residential and commercial sectors across Canada. After a period of growing importance in British Columbia, uncertain supplies of biomass drive a reversal back to natural gas and oil products.

The oil sands remain one of the few means to significantly increase oil supply in North America provided that sufficient skilled labour is available; however, after witnessing a six-fold increase in mined/upgraded bitumen supply and a four-fold increase in in-situ bitumen supply over the past twenty years, the incremental production is insufficient to offset reduced conventional production across North America and satisfy growing product demands. In Canada, for example, combined conventional light and heavy crude oil account for only ten percent of total Canadian

oil production and petroleum product demands are increasing at the rate of about 1.7 percent per year. Despite the policy thrust two decades earlier toward increasing domestic supplies, North America heavily increases its reliance on oil imports.

The transportation sector, in particular, continues to rely primarily on oil because technology for most alternatives remains expensive. In some cases though, government subsidies have offset higher costs and resulted in the growth of such alternatives as ethanol-blended gasolines. Similarly, after decades of research, the technology for hybrid electric vehicles eventually reaches maturity and such vehicles have begun to penetrate the new vehicle market - up to five percent in Ontario and Quebec by 2025. At the same time, trucks, vans and sport-utility vehicles have enjoyed many years of increasing popularity and now account for more than half of the vehicles purchased in Ontario causing, in part, along with steady population growth, personal-use energy demand to exceed the national average. In contrast, Quebec continues to prefer the use of cars; moreover, despite strong growth and a large population, personal-use energy demand falls below the national average.

By the end of this period, the primary fuel mix has shifted heavily toward coal and imported oil as conventional oil and gas supplies in Canada and the United States have passed their peak. The supply push is showing signs that it may be unsustainable as coal and selective frontier projects remain as the only means to increase North American energy supply. Energy intensive industries and those relying on petroleum-based feedstocks consider moving their operations offshore. "Fortress North America" has begun to erode by the end of the forecast period.

Techno-Vert

Within the scenario framework, Techno-Vert is defined as the area bounded by a high pace of technological development and a high rate of action on the environment. The main theme of the Techno-Vert scenario is the heightened concern for the environment and the accompanying preference for environmentally-friendly products and cleaner-burning fuels. Any increased costs to head in this direction are offset by a vibrant and efficient economy that is driven by rapid technological progress.

Scenario Overview

Scenario Logic	Social / environmental concerns and a strong economy lead to increased investment in advanced technologies. Technology enables expansion of new sources of natural gas such as coal-bed methane and liquified natural gas and lowers finding and development costs for conventional sources.
Economy	Stable growth with an annual average growth rate of 3% .
Prices	WTI= US$22/barrel and NYMEX Natural Gas = $3.80 US$/MMBtu
Environment	Social concerns about the impacts of climate change, environmental health risks and quality of life issues.
Technology	Major increase in research and development investments supported by government incentives and reinforced by triple bottom line accountability. Domestic emission trading helps to focus or accelerate technological advances in some sectors / industries and support a more rapid pace of change.
Energy Demand	Rising demand driven by economic growth tempered by significant improvements in energy efficiencies and conservation measures.
Energy Supply	Growth in natural gas production from conventional sources – WCSB extended production profile – and unconventional sources. Significant expansion of renewable energy sources (e.g. solar, wind & biomass). Decline in market share of oil and coal. Fuel cells are introduced in transportation and stationary applications.

Scenario Characteristics And Drivers

This scenario is further marked by a stable international economic climate and a cooperative relationship between government and industry. While government assists with research and development program funding as well as some policy initiatives, reliance is primarily placed on market solutions. Adaptation of available improved technologies ("best practices") and even more breakthroughs results in diverse energy sources and significant improvements in energy efficiencies. The new technologies not only help produce and deliver goods and services more efficiently but are also more cost-effective. Consumers and producers both embrace the new products and equipments embodying new technologies. Widespread application of new capital and products lead to higher productivity in all sectors. The Canadian economy is projected to grow at a sustained rate of about 3 percent per year over the projection period. This results in an increase in energy demand particularly in the industrial and transportation sectors; however, the rate of increase is tempered by reductions in energy intensity. Further, improvements in technology provide for greater use of alternative and renewable (A&R) energy sources. Any additional costs to society are seen to be offset by benefits gained in terms of clean air and improvements in other aspects of the environment; hence, these costs are generally accepted by an affluent public.

Prolonged economic growth provides for increased investment in research and development, further encouraged by government incentives and reinforced by triple bottom line accountability (including social and environmental measures in addition to traditional accounting measures of profitability). International cooperation increases to effect a policy framework covering multi-national corporations. Companies embrace initiatives as an opportunity to develop technologies which provide a competitive advantage. This scenario witnesses, through a shift to greener energy, voluntary conservation and improved energy efficiency, a continuing trend to "blue skies".

A Growing Concern for the Environment (circa 2000 - 2010)

There is increasing evidence that the burning of fossil fuels is contributing to climate change. Accompanying broad global warming are increases in local weather extremes such as droughts and flooding. Several consecutive dry winters lead to summer drought conditions and the devastation of the agricultural industry across the central plains of North America. Planted crops wither without moisture and livestock is prematurely brought to market because of a lack of feed to sustain them. Some agricultural regions declare disasters and seek aid from the federal government. Consumers face increasing prices for agricultural products.

On another front, air quality also deteriorates in heavily populated regions. In Canada, urban centres, such as Vancouver, Toronto and Montréal, experience an increased number of "Smog Days" and must periodically endure air quality conditions that exceed health standards. This is not lost on the general public and the need to take action becomes real. A significant portion of the population becomes convinced that action to constrain the production of emissions that pollute the environment (e.g. volatile organic components, nitrogen oxides, sulphur oxides, as well as carbon dioxide)is needed.

Public awareness of environmental issues (global warming and air quality) intensifies. There is a growing consensus that action to mitigate current and potential environmental challenges must occur soon. Strong political leadership on environmental action emerges. Canada, along with many other nations, adopts an international accord to reduce greenhouse gas emissions and begins to consider policies to affect such reductions and stimulate research and development (R&D) for cleaner fuels and improved energy efficiencies. These regulations have an immediate impact as planned expansions of coal-fired generation and oil sands are delayed. A domestic emissions trading system is established and is used by governments and major industries. Municipalities and provinces set targets that require utilities to rely more

on green power. Other programs initiated by different levels of government promote energy conservation and improvement in energy efficiency as well as air quality.

The outlook for alternative and renewable energy improves with many green power initiatives gaining customers. In Alberta, Ontario and Québec, further wind generation is planned. Individuals look for EnerGuide and Energy Star ratings on appliances, electronics and vehicles when making purchases. The internal combustion engine, operating on petroleum products, continues to be dominant in transportation energy demand at this point in time; however, improvements in advanced technologies such as variable valve timing and direct fuel injection increases overall fuel economy. Moreover, cleaner gasoline and diesel are available beginning in 2006 and catalytic converter technology is becoming more efficient. Technological improvements also lead to the commercialization of hybrid electric vehicles during this period.

The natural gas industry begins to flourish in this new environment. Natural gas has become the preferred fuel for power generation for environmental and economic reasons. This is a particularly significant development considering the very large number of co-generation plants expected to enter service in North America over the next decade. In Canada, gas-fired generation grows in Alberta, in Atlantic Canada and in Ontario. Gas-fired distributed generation penetrates the market in 2005. At the same time, no new conventional coal plants are built.

Gas producers quickly respond to increasing demand. Continued technological improvements allow for the faster drilling of gas wells and, as a result, Canadian conventional gas production increases. Consequently, an anticipated decline in conventional gas production is deferred. Commercial success is experienced with coal-bed methane (CBM) in Canada, additional discoveries are made on the offshore East Coast and by 2010, natural gas commences to flow from the Mackenzie Delta. To supplement these supplies and to meet increasing gas demand, a liquified natural gas facility is constructed in eastern Canada.

Conventional light oil production in North America continues to decline early in the period at rates experienced over the last decade. Later in the period, in Canada, the effect of advanced technology is manifested through a wider application of horizontal drilling and improved recovery techniques, especially CO_2 flooding, slowing the decline in conventional light crude oil and improved production rates are observed.

The upward trending conventional heavy crude oil production loses momentum early in the decade in the face of more stringent environmental controls. Higher environmental costs and higher light/heavy price differentials discourage expansion of production. The Athabasca Oil Sands Project initiates production, but several other oil sands projects are postponed in a climate of greater concern for the environment, and some projects are eventually cancelled. To address the issue of cumulative effects of oil sands expansion, regulations are put into effect designed to limit environmental impact on a regional basis. No new oil sands projects are initiated until later in the period, by which time new cost effective technologies are developed that meet the higher environmental standard. Those operating oil sands and conventional heavy oil projects examine options that minimize steam usage, such as VAPEX. Tighter gas markets and environmental issues lead to increased research into alternative sources, such as bitumen, coke, and coal, to provide fuel and hydrogen for oil sands processes. Higher and volatile prices for oil and natural gas a few years earlier spurred the progress of several frontier projects. Early in this decade oil is produced from the Terra Nova and White Rose fields, followed by production from the Hebron/Ben Nevis field toward the end of the decade.

Moving from Heavy Carbons (circa 2010 - 2015)

North American economic growth continues to be strong. Demand for energy has increased, but at declining rates as efficiency gains dampen the effect of increased demand due to economic growth. The major beneficiaries of this growth have been the "greener" companies. Accordingly, the public invests heavily in green or ethical mutual funds. With increased investment and profitability for becoming greener, companies widely begin to pursue business practices which improve their triple bottom line accounting.

Natural gas demand, which is widely recognized as a clean fuel, begins to rise sharply. This demand is primarily attributable to growth in gas-fired electricity generation. Advanced Combined Cycle technology is commercially available by 2010. As natural gas becomes more widely available in Atlantic Canada, oil-fired generators are converted to gas. By 2015, all provinces in Canada have gas-fired generation. Fortunately, upstream technology has kept pace. Large new gas finds in the B.C. Foothills extends the production profile of conventional gas in the Western Canada Sedimentary Basin (WCSB) and also the supply of ethane and other natural gas liquids (NGLs). CBM production also increases as successful technology is now widely applied. The gas pipeline from the Mackenzie Delta is expanded by 2015 and at about the same time, a pipeline from Newfoundland and Labrador delivers gas being produced from oil fields.

Technology has also enabled the full recovery of nuclear power in Ontario. In Québec (Grande-Baleine), B.C. (Peace Site C), and Newfoundland and Labrador (Gull Island), further development of large-scale hydro proceeds.

North American conventional heavy oil and oil sands producers continue to adjust to a more environmentally restrictive world, and a number of new projects are initiated. SAGD production continues to expand, and VAPEX technology has been commercially proven and is being employed in both oil sands and conventional areas. Additional CO_2 sequestration through CO_2 flooding projects is achieved. Both conventional and oil sands operators are able to take advantage of technological advances in all aspects of their business to significantly reduce operating costs. Progress is made in introducing technology that utilizes alternative fuels for oil sands upgrading and in situ operations. Some success in partial upgrading of oil sands bitumen is also being achieved, resulting in a lighter more saleable product. The U.S. demand for light and heavy crude oil is strong and Canadian production responds but the light/heavy price differential stays relatively high, dampening the response of Canadian heavy. Better exploration techniques lead to the discovery of a new oil field on the East Coast offshore, with production beginning 2010.

North American conventional heavy oil production continues to decline in light of lower demand for this product; producers shift to higher natural gas drilling instead. Oil sands projects are operating under more stringent measures and have been reducing emissions per unit of production. However, the cumulative volume of emissions has been increasing. Additional oil sands projects, which have been postponed for some time, are eventually cancelled.

Accelerated investment in research leads to advances in technology which, in turn, results in new economic opportunities. Technology enables the growth in A&R energy supplies. Green technology is increasingly competitive, especially for wind, with solar and biomass applications aggressively pursued by research and pilot projects.

Similar advancements are being realized in curbing energy demand. General public acceptance of environmental responsibility enables governments at all levels to promote technology and improvements to housing and building standards by 2015. Not only do these new standards include better thermal efficiency for buildings and appliances, but also better designs which incorporate more passive lighting, heating and smart technology to control consumption based

on occupancy and the time of the day. In addition, fuel cell vehicles begin to replace cars in courier and taxi fleets; hybrid electric vehicles continue their penetration into both personal and commercial stocks.

By 2015, the domestic emissions trading is expanded to utilities and smaller end-users to achieve further optimization of energy consumption. This enables utilities and commercial operators to use a portfolio approach to improve energy efficiency through a growing share of new and more efficient stock without fuel conversion or expensive upgrades where uneconomic.

Further, steps are taken in the form of global trading of emissions credits, escalated financial support for research and more stringent environmental standards. The public has started to recognize local improvements in the environment, particularly for air quality. These results reinforce the commitment to environmental action.

Diversifying the Clean Fuel Mix (circa 2015 - 2020)

Despite improvements to air quality and other aspects of the environment, global warming continues to be a serious issue. Although the public is acutely conscious of environmental harm, greater demands are placed on electric generation for cooling. Distributed generation begins to have an impact with more applications. Advances are made in micro-turbines as well. With more local generating capacity, efficiencies are gained because less electricity is lost via transmission. Moreover, the footprint on the environment is markedly reduced. Greater reliance is placed on natural gas-fired generation. Most of the increased market share for gas is at the expense of coal as retiring coal-fired units are largely replaced by gas-fired units. At the same time, progress on emissions abatement technology leads to further applications of Integrated Gasification Combined Cycle (IGCC).

While gas has been the largest beneficiary of the gradual reduction in coal-fired generation, A&R fuels have also established a significant market share as green technologies become widely affordable and convenient. Wind power, for example, has been developed in most provinces and wherever wind resources are adequate for power generation. As well, nuclear power plants have also been extended and technology has advanced to allow for the development of new nuclear facilities, based on the Advanced CANDU reactor, in Ontario and New Brunswick. While feasible, public opinion remains split, recognizing advantages with respect to emissions but noting potential safety and waste disposal challenges. The experience gained with existing small hydro projects combined with further technological advances with small turbines and generators leads to an expansion of small hydro facilities in most provinces.

Unlike coal and oil, demand for natural gas rises sharply as it establishes itself as the primary fuel for power generation and industrial processes. Upstream technological advances have enabled producers to reduce finding costs thereby providing for the exploitation of smaller and smaller gas pools. Conventional gas production from the WCSB declines while CBM production increases. However, CBM does not contain NGLs, therefore the supply of ethane will decline following the profile of the conventional production. Future incremental ethane supplies are expected to come from new frontier projects and unconventional sources (e.g., oil sands off gas and propane).

Demand for oil and petroleum products is reduced by the turnover of the vehicle stock to more efficient engines and increases in the number of hybrid electric vehicles and the commercialization of fuel cell vehicles. Cleaner liquid fuels such as gasoline, diesel fuel, ethanol and diesel produced from emerging gas-to-liquids technology start to impact petroleum demand. Moreover, an aging population tends to drive less and conservation, through reduced speed limits, also reduces the demand for oil. Producers have responded to the changing market conditions by providing refiners with a wider range of choices, with various grades of bitumen blend or upgraded crude available.

Demand growth in the buildings sector begins to

slow as broad conservation programs, jointly led by municipalities and corporations, begin to make an impact. These gains are supplemented by innovative building and urban design which further increase efficiency. Building materials that generate electricity, such as solar panels, are more widely used. Combined heat and power become more popular in the public sector to demonstrate advancements in energy efficiency. At this time, LED lighting begins to make a small penetration in the commercial sector.

A New World (2020 -2025)

After nearly twenty years of progressive action on the environment against a backdrop of continued technological improvement, there continues to be remarkable changes through all sectors of the economy, including the energy industry.

Vehicles look and operate differently than decades earlier. Most vehicles will operate on gasoline but the transportation sector is increasingly powered by diesel and alternative fuels. Fuel economies have improved significantly for all vehicles. For internal combustion engines operating on gasoline or diesel, improvements in weight reduction, engine/transmission enhancements and aerodynamics have improved efficiency by 40 percent since 2000. Growing use of hybrid electric vehicles and fuel cell vehicles offer even greater efficiencies.

Energy efficiency improvements driven by rising environmental standards and global competition have also occurred in the industrial sector. Strong economic growth has provided for increased capital investment in energy saving technologies as new plants and equipment are purchased and installed. Natural gas gains market share in the industrial sector. Natural gas gains are particularly strong in Atlantic Canada with continued offshore development.

Production of conventional natural gas continues to decline gradually from the WCSB. Drillers shift from small gas pools to CBM; as a result, CBM production continues its steady increase. Gas production also expands in the frontiers. Off the west coast, another deep water project comes onstream. In the North, the first production is experienced from the Beaufort Sea. Advances in drilling in other northern areas have allowed producers to drill longer and faster and, at the same time, to leave a smaller environmental footprint. Overall Canadian gas deliverability has increased from 17 to 22 Bcf/d by the end of the projection period.

New supplies of natural gas are quickly absorbed by electrical generators. IGCC coal generation becomes cost competitive and also replaces older coal units, mainly in Ontario. Clean coal technologies, including IGCC, have enabled coal to remain in the overall fuel mix. The IGCC plants are prime candidates for the adoption of carbon sequestration technology as their exhaust is rich in CO_2 and lack other pollutants such as sulphur oxides and nitrogen oxides.

The development of wind power in Canada is well-advanced and solar power facilities are present in some niche markets. Biomass is also a key fuel component in certain areas, particularly British Columbia. New nuclear facilities are located on the sites of existing nuclear facilities as breakthroughs in technology for safety and waste disposal provide for wider public acceptance of these plants. Over the past twenty years, Canada's generation portfolio has become noticeably more diversified.

Canada's oil producers have been able to utilize technology to rapidly ramp up production in the face of the challenge of more stringent environmental standards. Over the last 25 years, in spite of falling conventional WCSB production, total oil production has increased by 60 percent, with oil sands derived oil production increasing four fold.

There have been noticeable improvements in the environment as the public and private industry have increasingly considered environmental impacts in decision-making. Energy supply and demand in North America have shifted from oil and coal to cleaner fuels, led by natural gas. The growth of A&R energy has diversified the energy mix. At the same time, energy demand has been tempered by widespread conservation and increased energy efficiencies leading to lower energy intensity overall.

The North American economy has remained strong and continues to grow as clean fuels technology is exported throughout the world. Global climate and environment respond more quickly than expected, leading to worldwide "blue skies".

3.0 Macro Economic Assumptions

The economic projections, covering the period to 2025, are important inputs in the supply and demand analysis for the two scenarios. They provide the outlooks and fundamental assumptions for the main variables driving energy demand, including population, personal incomes, household formation and the structural and regional detail required to produce sectoral energy projections by region.

Informetrica Limited prepared the macroeconomic outlooks for both scenarios. The case that was used for the Supply Push scenario was a modification of Informetrica's *December 2001 Reference Outlook*, with NEB energy price and energy project assumptions (January 2002). Some of the main indicators, including historical trends and long-term projections at a national level are provided in Table 3.1. The Reference Outlook includes assessments of major capital projects likely to occur, especially within the next 10 years.

Table 3.1
Main Economic Indicators - Canada
(average annual percent change)

	1990-00	2001-05		2005-15		2015-25	
		SP	TV	SP	TV	SP	TV
Real GDP	2.6%	2.9%	3.1%	2.4%	3.0%	1.8%	3.0%
Inflation (CPI)	2.0%	1.9%	1.9%	2.0%	2.0%	2.1%	2.0%
C$ in US funds*	0.67	0.68	0.68	0.75	0.75	0.87	0.87
Population	1.0%	0.8%	0.8%	0.7%	0.7%	0.5%	0.5%
Unemployment rate*	6.8%	7.0%	6.8%	5.1%	4.7%	3.4%	4.0%
Households	1.6%	1.4%	1.4%	1.2%	1.2%	1.1%	1.0%
Real PDI per capita	0.8%	3.1%	3.4%	1.9%	3.1%	1.6%	2.7%

* end of period

Source: Informetrica, January, and June, 2002

Population is a key input to the projection and the demographic story is very important for differentiating economic growth between the provinces (essentially, the provinces with the fastest population growth will also experience the fastest economic growth). Informetrica's Reference Outlook projects population growth slowing considerably through the projection period. Household growth also slows; however, it remains about double the rate of the population expansion. Immigration is assumed to remain flat at 250,000 in-migrants per year from 2001 forward, a higher figure than in recent years. Out-migration is set to 30 percent of in-migration or 76,000 per year. (Net immigration being approximately to be 174,000). Looking at workforce participation, the aggregate participation rate will change little, or may increase slightly through the current decade. However, as baby boomers move into retirement years a decline in the participation rate emerges from about 66 percent to about 64.5 percent. Informetrica's Reference Outlook compensated slowing labour force growth with moderately increased labour productivity growth.

Real personal disposable income rises through the projection period and therefore, household disposable income also rises. However, falling consumption occurs in the latter part of the projection (in step with ageing population) as a large portion of the population is moving into their high savings years. Demand shifts from goods to service industries creating a shift in production from industries with high productivity levels to those with relatively low productivity levels.

Real GDP is projected to grow at an annual average rate of 2.2% over 2000-2025 period. Faster growth occurs in the first part of the projection period (2.4% growth 2000-2015) and slower growth occurs over the second part of the period at approximately 1.9% per year. The Reference Outlook also projects an appreciation of the Canadian currency with respect to US dollars. A central long-run feature of this outlook is that inflation is restrained over both the medium and longer term with some pressures emerging in later years as the unemployment rate nears 3 percent.

An alternative macroeconomic outlook was defined for the Techno-Vert scenario to provide a view of the economy under circumstances of more rapid growth. Recall Techno-Vert is a scenario where the pace of technological development is higher than historical trends. From past events we know that the development of a new technology in one area generally helps spawn new technologies and products in other sectors of the economy. The Techno-Vert scenario visualizes development and adoption of new technologies at a rapid pace spreading to all sectors of the economy including the energy demand as well as supply sectors. The Techno-Vert scenario represents an economy which, because of the rapid diffusion of new and efficient technologies embodied in new capital, is more efficient in the use of resources in the production and delivery of goods and services than the economy represented in Supply Push scenario. Thus all sectors of the economy including energy sector become more efficient i.e. use less resources per unit of GDP.

A more vibrant and efficient economy in the Techno-Vert scenario will generate, because of the use of more efficient capital and production processes, higher economic growth as greater productivity gains are realized, in various degrees, in all sectors of economy.

New technological developments also occur in the area of health and medicine. These developments are expected to translate into a healthier labour force and an increase in life expectancy compared to that in the Supply Push scenario. It was assumed that the participation rates to of both males and females to increase relative to the projection of participation rates in the Supply Push scenario. This will increase labour force supply without assuming any change in the present immigration levels and policies and Statistics Canada assumptions about fertility rates.

Regionally, the Techno-Vert average economic growth of 3 percent over the projection period is spread out according to the economic structure of each province; some provinces experience economic growth above the 3 percent average while others experience less than 3 percent. The long-term average growth rate for Supply Push scenario is 2.2 percent with corresponding lower provincial growth rates.

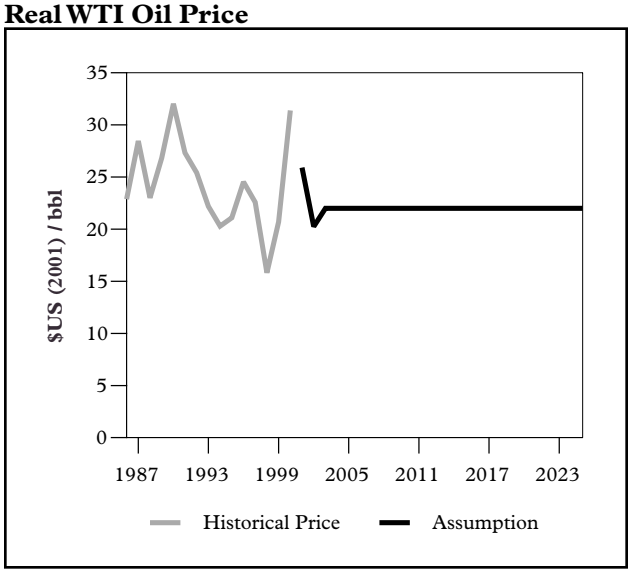
It is important to note that these projections portray long-term trends, which are guided by the principle of potential economic growth. There is no attempt to forecast business cycles, but it is recognized that growth may be above or below the trend projections in any given period.

3.1 Energy Price Assumptions

World Oil Prices

Based on preliminary work, a real oil price of US$22 per barrel (WTI at Cushing, Oklahoma, $US 2001) has been assumed over the projection period for both scenarios. In essence, this assumes that world demand will be met at flat real prices over the next 25 years. Canadian prices reflect the WTI price adjusted for transportation, quality and the exchange rate. The same oil price assumption will be used in both scenarios.

Real WTI Oil Price



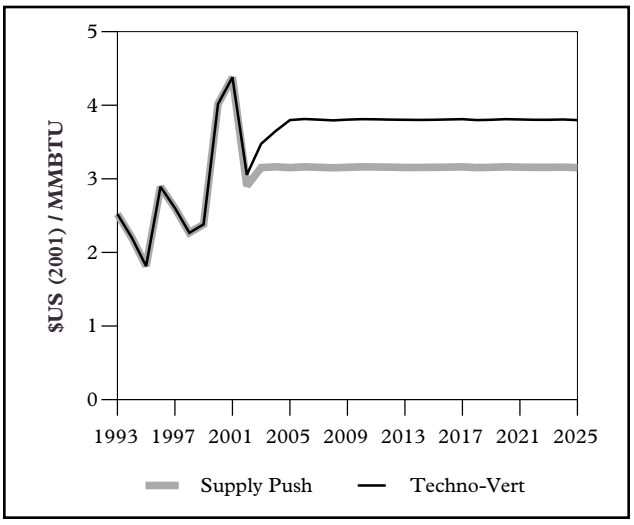
Natural Gas Prices

Inter-fuel competition, especially in some key U.S. regional markets, results in a general correlation between the price of fuels derived from crude oil and natural gas. The price of natural gas has generally tracked with heavy fuel oil (hfo) prices in these markets. However, the 'switching' market is finite, making this price relationship an imperfect one that breaks down when there is a significant swing in the supply or demand of either fuel beyond the ability of the market to adjust or switch to the alternate fuel.

For both scenarios continuing competition was assumed between natural gas and crude-derived fuel oils (in particular, between low sulphur (less than 1% sulphur) heavy fuel oil and lighter distillate fuel (lfo)). Historically, during times of relative gas abundance (or fuel oil shortage), the price of natural gas tracks at or below that of hfo (ratio of about 0.6 to 0.8 times crude oil price). While in periods of tight gas supply, the relative price of natural gas rises and at times may even exceed the higher priced lfo (approx. 1.2 times crude oil price) as seen during the winter of 2000/01.

Competition between fuels will continue in both the Supply Push and Techno-Vert scenarios. In both scenarios, the natural gas supply-demand balance is characterized as tighter (relative to historical periods of abundance). The Supply Push scenario assumes a natural gas to crude price relationship of 0.83. This ratio also incorporates recent trends (in the last decade to 15 years) toward lower sulfur fuel oil. In the Techno-Vert scenario, there is stronger preference for natural gas and cleaner fuel oils for environmental reasons (and possibly some disincentive to hfo). This results in a tighter gas supply/demand and slightly higher relationship with (approaching 1.0 times crude oil price over the projection period).

Real Natural Gas Price at NYMEX

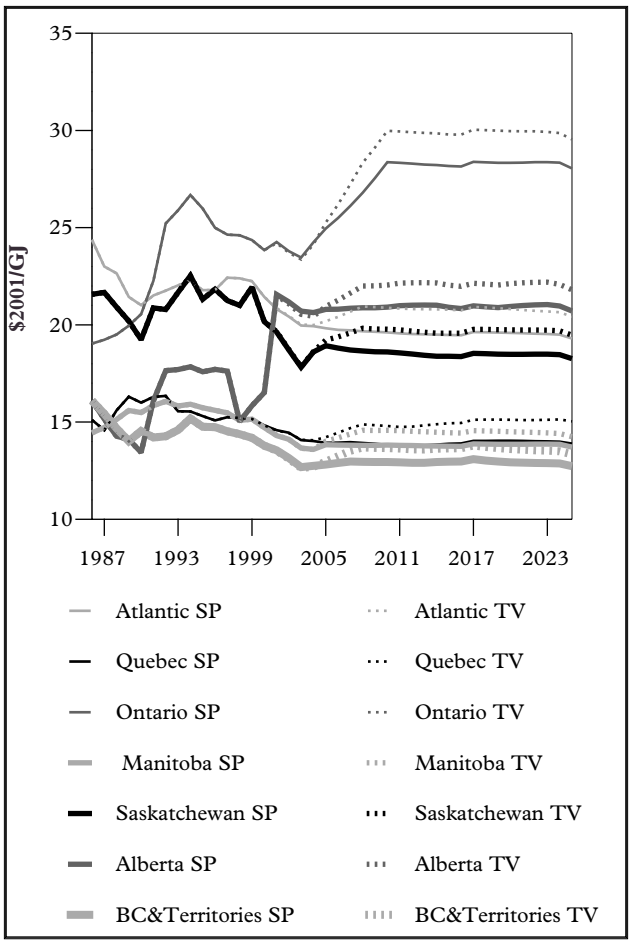


Electricity Prices

Looking out into the longer term, the regulated paradigm will not remain appropriate for determining electricity prices in all regions. In a restructured electricity market, it has been suggested that prices will fall over the long-term. In the near-term, however, prices could well rise due to supply/demand conditions and/or impacts such as stranded assets. In a continental context, regional price variations could

be dampened as utilities engage in trade to benefit from these differences; thus prices may rise in some areas and fall in others. In general, electricity prices in the Techno-Vert scenario are higher than in the Supply Push scenario, in keeping with the relatively higher cost of natural gas-fired generation in Techno-Vert and the move towards relatively more expensive alternative and renewable technologies

Weighted Average Real Electricity Prices



Coal Prices

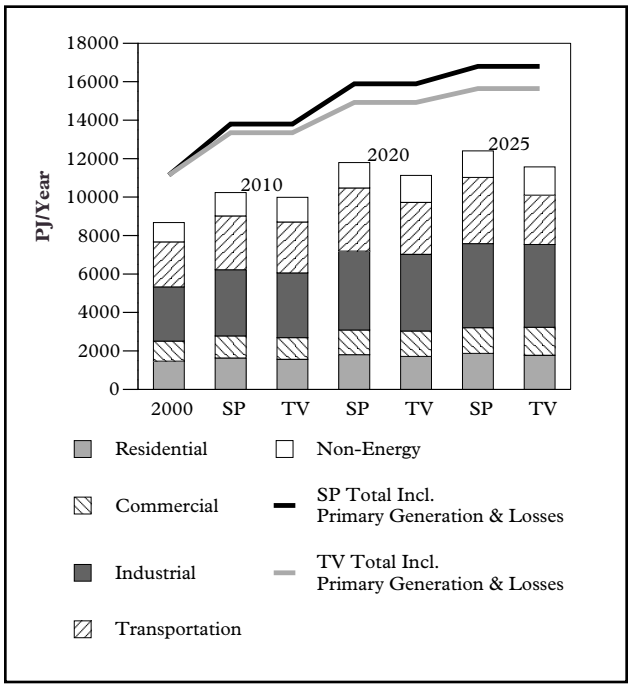
Coal is an inexpensive and abundant energy resource in any scenario. Prices for coal and its supply/demand dynamics are to a large extent determined in a very competitive world market. Coal prices have declined steadily over past 15-20 years, reflecting steady technological improvements and efficiency gains in mining and coal transport (rail). Part of these gains have come about from the consolidation (mergers) in the mining industry and rail transport that reduce unit fixed costs and improve economic reach (e.g., mergers and transportation agreements between Canadian and U.S. railways). In the Supply Push scenario, the assumption is that Canadian coal prices continue to decline in real terms (1 percent per year to 2015, then flat to 2005); this is much less than the decline of the past 15-20 years (about 2-4 percent per year in Canada and the U.S.). In Techno-Vert, the assumption is that Canadian coal prices decline in real terms as the result of continuing cost reductions brought about by technology and international competition; the price decline is closer to that experienced over the past 15-20 years. In Eastern Canada, this is a decline of 3 percent per year to 2015, 1 percent per year to 2020, then flat to 2025. The decline in western Canada is less, as the already very low costs have less room for improvement.

Questions for Consultation

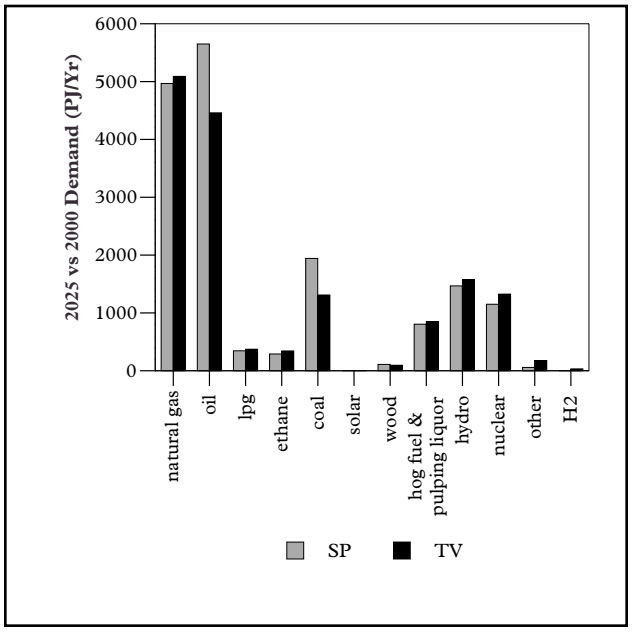
1. Do you have any comments on the economic assumptions?
2. Do you have any comments on the "flat" oil price outlook? Would an increasing or declining trend be more appropriate in one or both scenarios, if so, why? (You may wish to couch your response in term of the fundamental factors governing oil prices, e.g., the outlook for world energy demand, the supply developments in non-OPEC and OPEC countries and market developments in other areas of the world, i.e., the Far East.)
3. Does the natural gas-crude oil price relationship make sense in each scenario?
4. How will electricity prices be determined in the future as deregulation and restructuring begin to take hold? Will there be price differentiation between sectors? Will prices rise, fall or stay the same over the short and long term? Will prices change in a similar manner in all regions of the country?
5. What will be the main factors governing coal prices over the coming decades? Will prices rise or fall (in real terms)? Remain constant?

4.1 Total Canadian Energy Demand

Total Canadian Energy Demand by Sector



Growth in Canadian Primary Fuel Demand



- Canadian energy demand will increase over the forecast, but at a slower rate than the growth of GDP. Growth in energy demand averages 1.7% per year in SP, and 1.4% in TV, while the average annual GDP growth is 2.2% in SP and 3.0% in TV. Overall, total primary energy demand in 2025 will be 40 - 50% higher than levels of 2000, depending on the scenario.

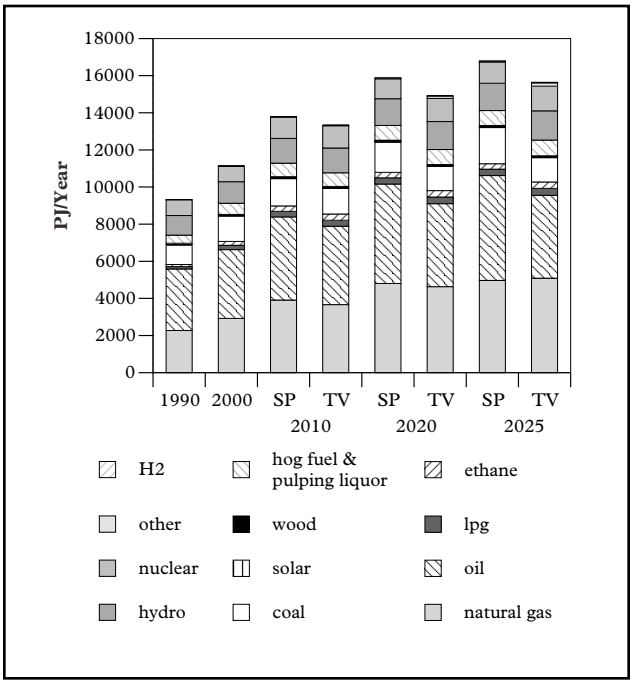
- Total primary energy demand in 2025 for the TV scenario is 7% lower than in SP despite having significantly higher economic growth. Energy efficiency improvements, conservation, and application of better technology enable the reduction in energy requirements.

- The greatest reductions in energy requirements between TV & SP are made in secondary energy production (primarily via improvements in electricity generation and transmission efficiency) and in the transportation sector. Along with smaller reductions achieved in the residential sector and some non-energy consumption, these more than offset increases in energy used to support the higher growth rates in other sectors.

- Fossil fuels will remain a key source of energy in both scenarios despite the emergence and application of alternate fuels and technologies. Although there is a preference for cleaner burning fossil fuels in the TV scenario, demand growth for natural gas is limited by the rate of supply development and regional supply/demand considerations.

- Environmental pressures will significantly limit the growth rate of some fossil fuels (oil, coal, etc.) during this forecast period. Efficiency improvements, new technology, and emissions trading will enable these fuels to retain their traditional markets. Hydro, nuclear, and other alternate forms of energy will gain in fuel share in the TV scenario.

Total Primary Energy Demand by Fuel

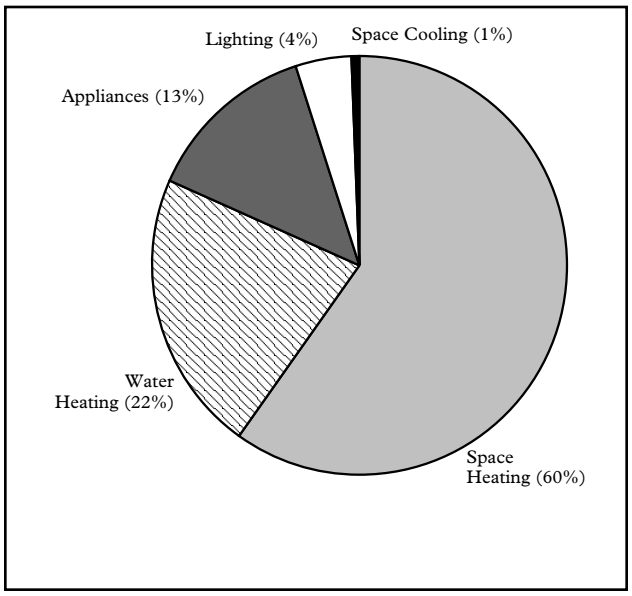


Key Issues:

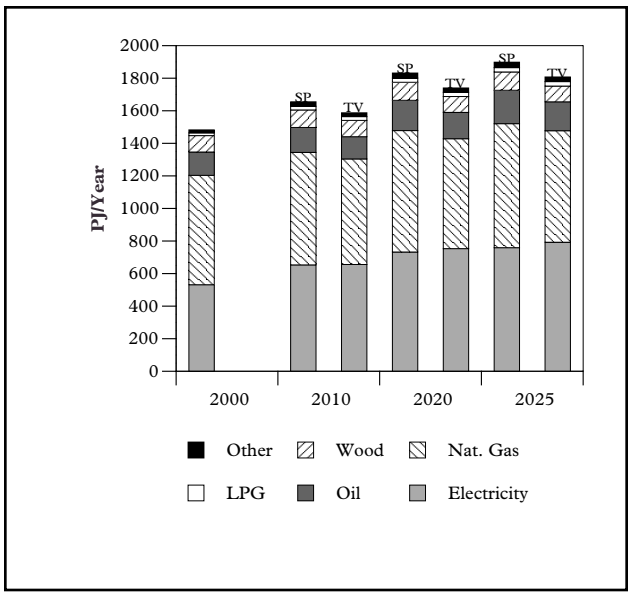
1. What will enable the industrial sector to out compete other sectors such as residential and commercial for key energy resources (e.g. natural gas)?
2. Which market sectors or regions would be most impacted by regional imbalances in energy supply/demand?
3. What is the fuel switching capability within each market sector? How will this change?
4. Are there structural changes in any market sector which may not be accounted for in this forecast?
5. Have we accurately reflected the trade-off between economic growth and environmental action?
6. There is an underlying assumption that improving energy efficiency will proceed or is more economical than development of other energy supplies (LNG, other). What is the potential for greater energy imports and supply development?
7. What are the key factors that affect fuel choice for each scenario and in each market sector?

4.2 Canadian Residential Sector Energy Demand

2000 Residential Demand by End Use

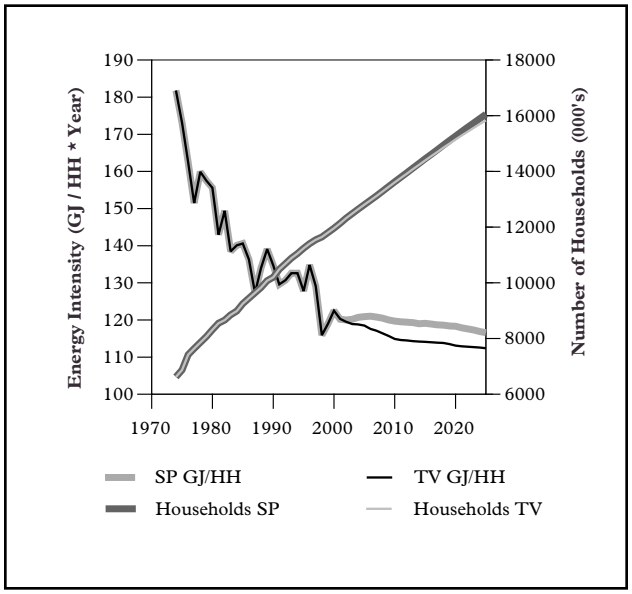


Canadian Residential Energy Demand (excludes DFO for farm use)

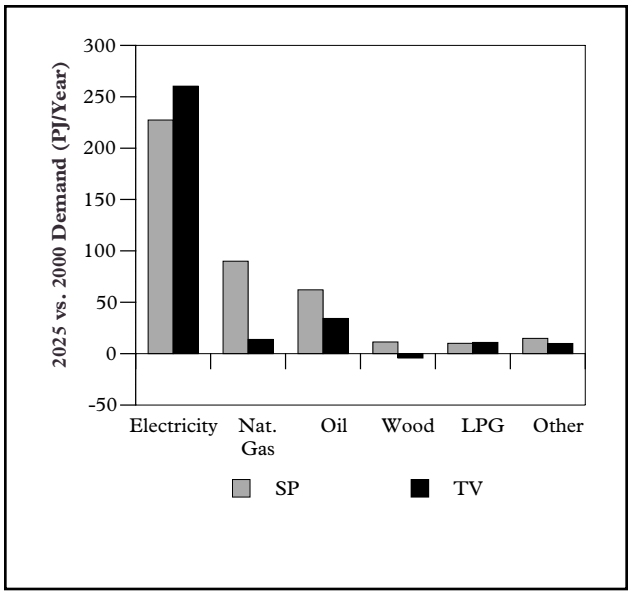


- Canadian residential energy demand reflects the number of households and fuel availability in each region. With regional housing numbers very similar across scenarios, differences in energy demand will then reflect any changes in energy efficiency, housing/equipment stock, and consumer behavior.
- This sector responds to higher fuel prices and environmental action primarily through conservation and energy efficiency improvement. Although significant efficiency improvements are possible through upgrades and new technology, these are limited by economics and the rate of new housing stock addition and equipment turnover.
- Continued efficiency improvements in housing stock and major household appliances do not fully offset the incremental electricity demand driven by greater consumer affluence and a rising energy requirement for small appliances. With lower growth rates for natural gas and oil demand arising from improvements to the thermal efficiency of housing and furnaces; there is a gradual shift in overall residential energy fuel share to electricity and away from fossil fuels.
- Environmental action in TV will accelerate efficiency improvements in all household applications, especially in space and water heating decreasing the demand for fossil fuels (vs. SP). Combined with a growing preference for electricity, driven by its' convenience and friendlier environmental image there is an accelerated shift in residential fuel share to electricity from fossil fuels in this scenario.

Canadian Residential Energy Intensity



Growth in Residential Fuel Demand



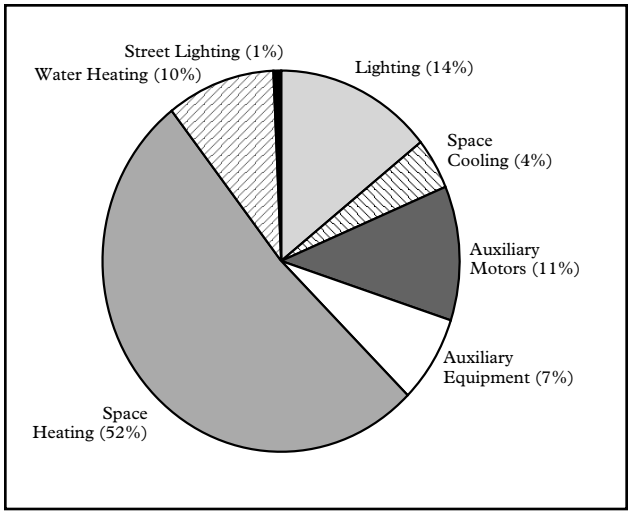
- Despite the environmental advantages of natural gas, in the TV scenario, it is only able to make significant fuel share gains in residential demand in the Atlantic region with the further development of east coast gas supplies. In all other regions, natural gas fuel share is even or slightly down with Supply Push due to regional supply constraints, higher prices, and increased competition for natural gas with other market sectors.

Key Issues:

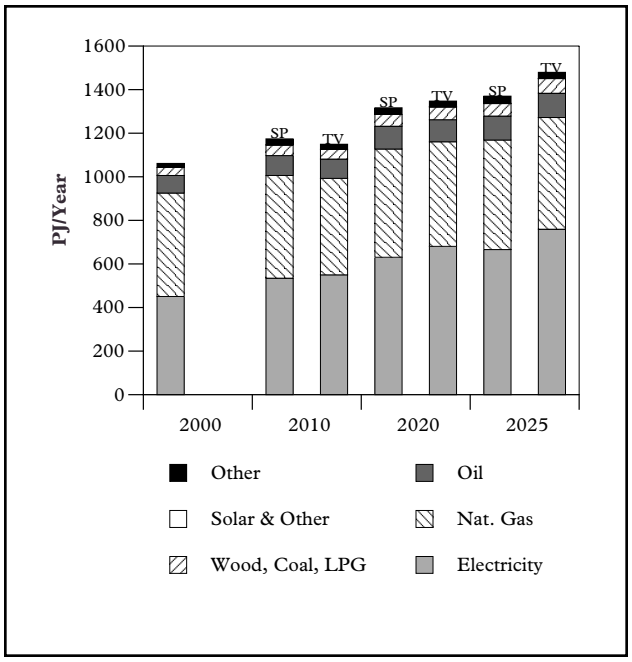
1. What changes are occurring or are required which will enable this sector to alter its' fuel mix in the future? Will fossil fuel technology advance to maintain historical growth rates?
2. What are other key drivers which could alter energy consumption behavior?
3. Will the residential sector be able to compete with other market sectors for limited energy supply (i.e. natural gas) or need to rely more on conservation and energy efficiency improvements?
4. What is necessary to enable a more rapid turnover of housing and equipment stock? To enable more significant change in housing/equipment efficiency standards? (e.g. U.S.A. endorsement of Kyoto?)
5. Will fuel prices become a greater influence on fuel choice in the future?
6. How could energy market changes affect consumption behavior? (e.g. hourly or time of day rates, peak services, further distinction of service class)

4.3 Canadian Commercial Sector Energy Demand

2000 Commercial Demand by End Use

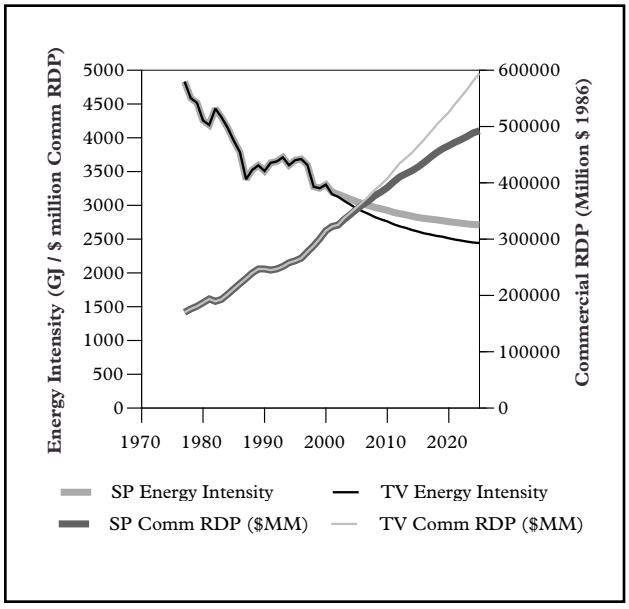


Canadian Commercial Energy Demand

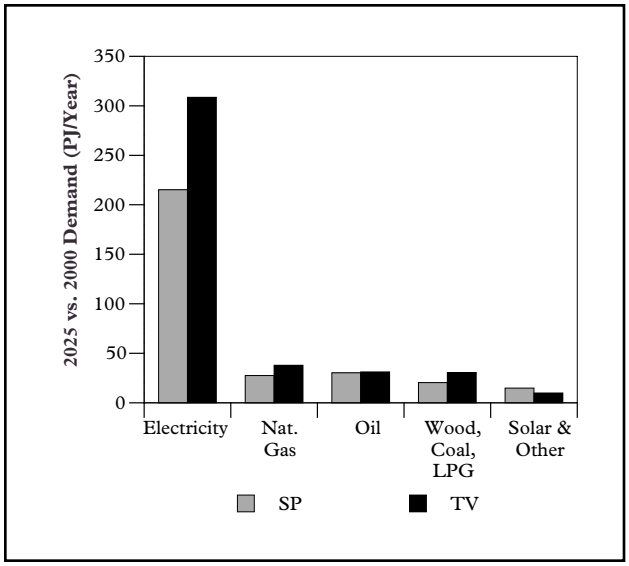


- Economic growth and consumer spending are key drivers for energy demand in the commercial sector. As indicated by commercial RDP, average annual growth in this sector is about 1.8% in SP, and 2.6% in TV. This economic growth, in turn drives an increasing need for commercial floorspace and energy demand for heating, lighting and equipment.
- Implementation of new technology and energy efficiency improvements are limited by economics and the rate of floorspace turnover and do not fully offset rising demand driven by economic growth especially in the TV scenario.
- Environmental action in TV will accelerate implementation of efficiency improvements, especially in lighting, thermal efficiency, and water heating to keep overall demand for fossil fuels only slightly higher than in Supply Push despite a significantly higher rate of economic growth.
- Alternate fuels and technology such as solar for hot water and Combined Heat & Power systems establish in niche markets, especially with the environmental motivation in the TV scenario. However, these occur later in the forecast and effects are not appreciable in this forecast period.
- Similar to the residential sector, there is a marked increase in growth and preference for electricity in TV, driven by convenience and its' friendlier environmental image, and a growing demand from electrical devices. Fossil fuels remain a key fuel source to this sector, especially in existing buildings where conversion costs may be prohibitive.

Canadian Commercial Energy Intensity



Growth in Commercial Fuel Demand



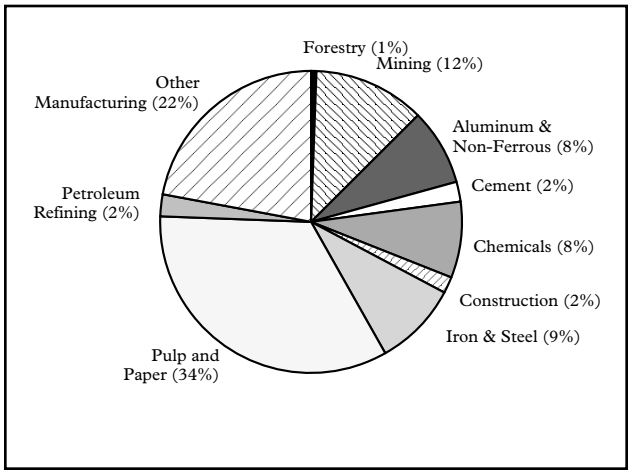
- Despite the environmental advantages of natural gas, it is only able to make significant fuel share gains in the TV scenario in the Atlantic region with the further development of east coast gas supplies. In other regions, natural gas makes only moderate gains due to regional supply constraints, higher prices, and increased competition for natural gas with other market sectors.

Key Issues:

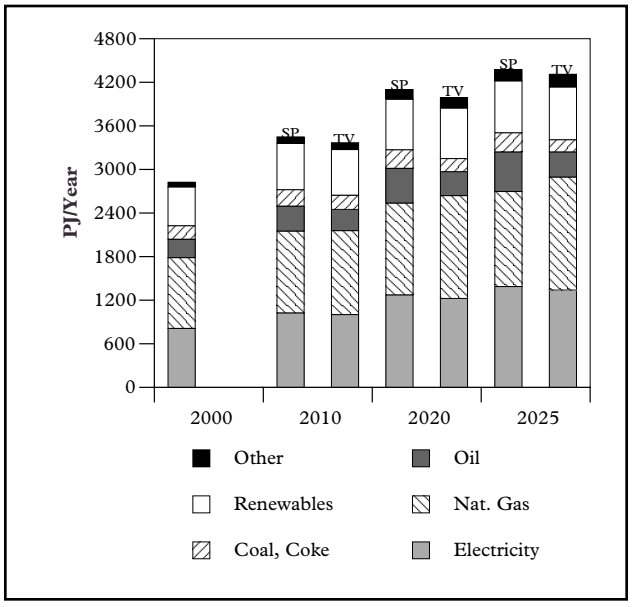
1. Will economic growth continue to drive the demand for commercial floorspace and energy at historical rates? Are there significant shifts in the structure and the use of floorspace in this sector?
2. What factors can significantly influence the rate of penetration for new technology?
3. Are there other technologies or structural changes that have not been accounted for?
4. Will fuel prices become a greater influence on fuel choice in the future?
5. How could energy market changes affect commercial consumption behavior? (e.g. hourly or time of day rates, peak services, further distinction of service class)

4.4 Canadian Industrial Sector Energy Demand

2000 Industrial Demand by Industry



Canadian Industrial Energy Demand by Fuel



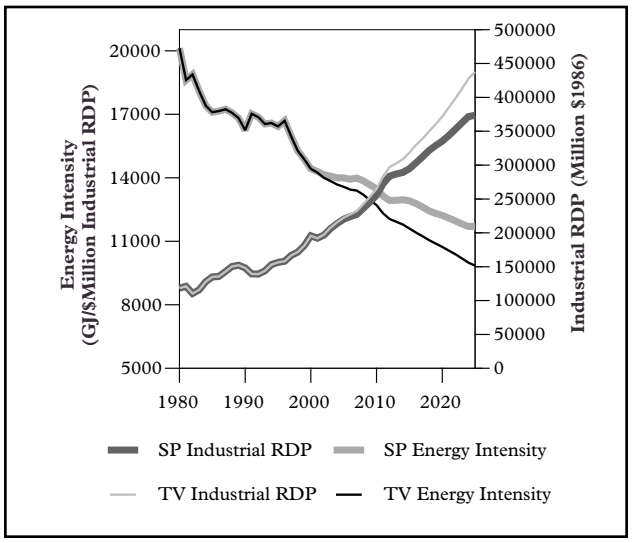
- Industrial energy demand is greatly influenced by the level of economic activity experienced in the major energy consuming industries. Economic activity, as indicated by the Industrial RDP continues to grow in the forecast and increases Canadian industrial demand for energy in the forecast period. Despite significantly higher economic growth in the TechnoVert scenario (3.3% per year vs. 2.7% in Supply Push); better technology and structural changes in key industries enable greater improvements to energy intensity to keep total energy demand roughly equal across scenarios.

- Energy intensity, or the amount of energy used by industry to create one dollar of output, can vary greatly across industries dependent on the nature and structure of each. A shift in the economy towards light manufacturing, importation of semi-finished goods, and energy efficiency improvements within industries all contribute towards a lower overall industrial energy intensity forecast.

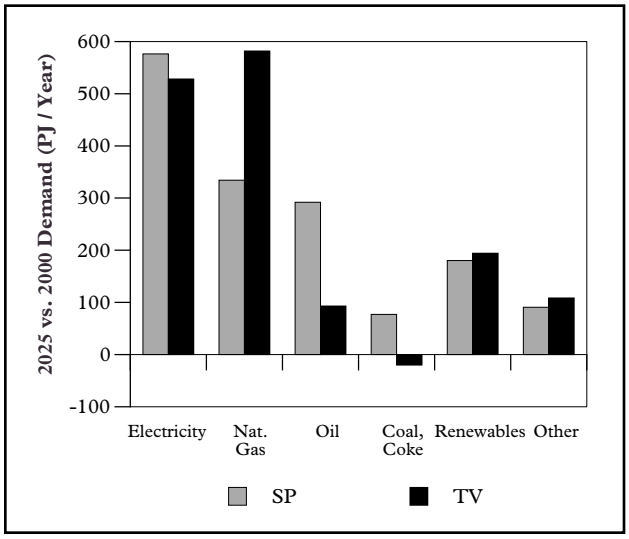
- In general, commodity based industries that process raw materials into semi-finished goods have higher energy intensity than industries associated with light manufacturing. Overall industrial energy intensity is forecast to improve in both scenarios, at an average annual rate of 0.9% in SP, and 1.5% in TV.

- In Supply Push, energy intensity is reduced through conservation and a continued shift in the industrial economy towards light manufacturing industries and the importation of semi-finished goods. The Supply Push scenario is also characterized by greater growth in oil demand due to its favorable pricing vs. natural gas.

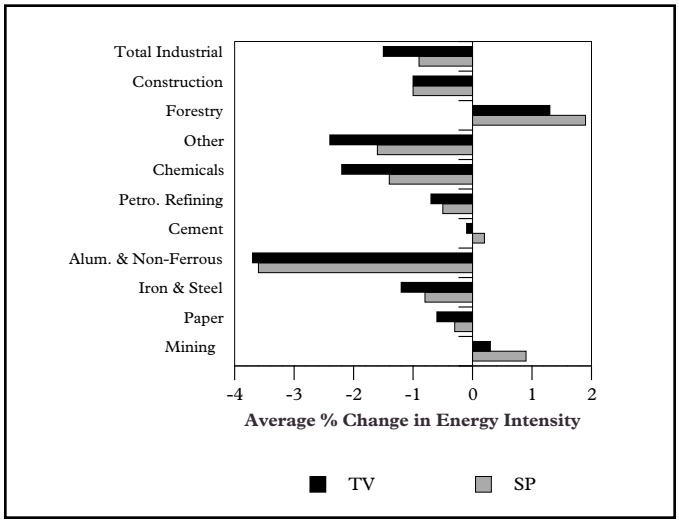
4.4.1 Canadian Industrial Energy Intensity



Growth in Industrial Fuel Demand



Industrial Energy Intensity Projection



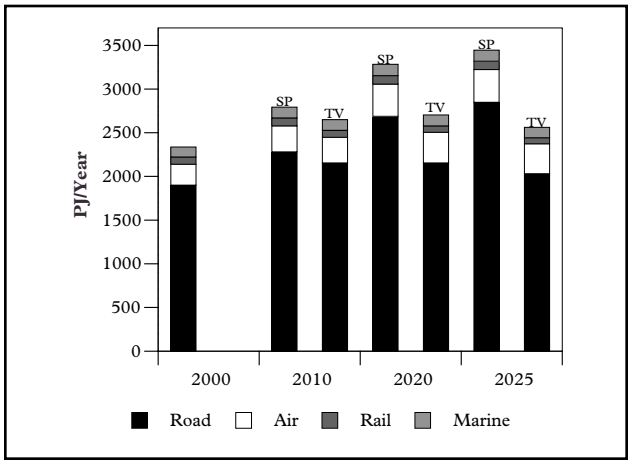
- In Techno-Vert, there is a more rapid adoption of energy saving technologies and a stronger shift to light manufacturing. The combination of rising environmental standards, strong economic growth, higher natural gas prices (than in Supply Push), and intense global competition in products, will drive greater improvement in energy intensity and lower energy demand to more moderate levels. Also in TechnoVert, environmental issues will limit the growth in oil demand in favor of natural gas.

Key Issues:

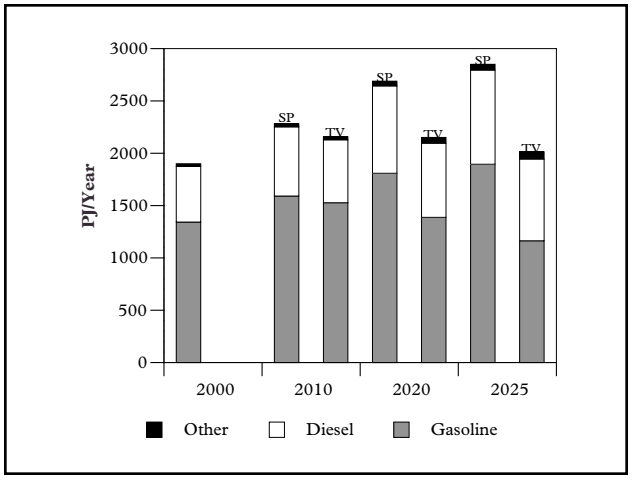
1. Are the annual rates for energy intensity improvement assumed for each industry and scenario appropriate? Can industrial energy intensity continue to improve in TV at higher rates than observed in the 1990s (1.2% per annum)?
2. What are the future technologies and structural changes in each industry that will enable these significant improvements to energy efficiency? Is it realistic to assume greater structural change in TV?
3. What fuel alternatives and/or fuel switching options are available to each industry? Are there other options to reduce cost of energy and operation?
4. What industries or regions may be most impacted by changing environmental standards and/or resulting energy prices? What will be their response?

4.5 Canadian Transportation Sector Energy Demand

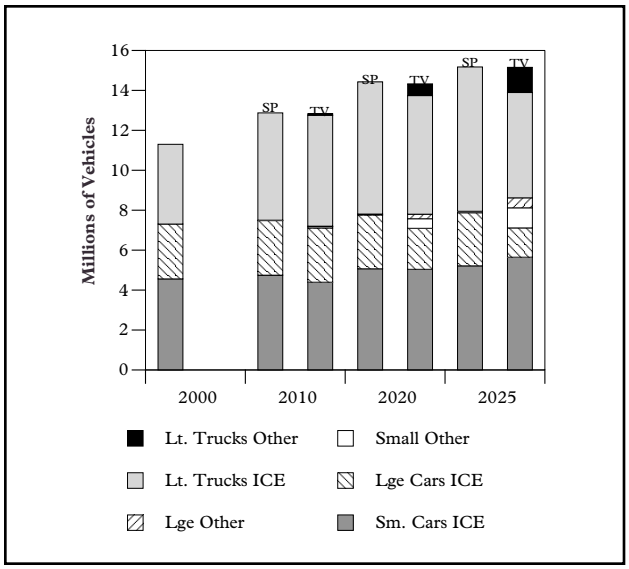
Energy Demand by Mode of Transport



Road Transportation Energy Demand by Fuel

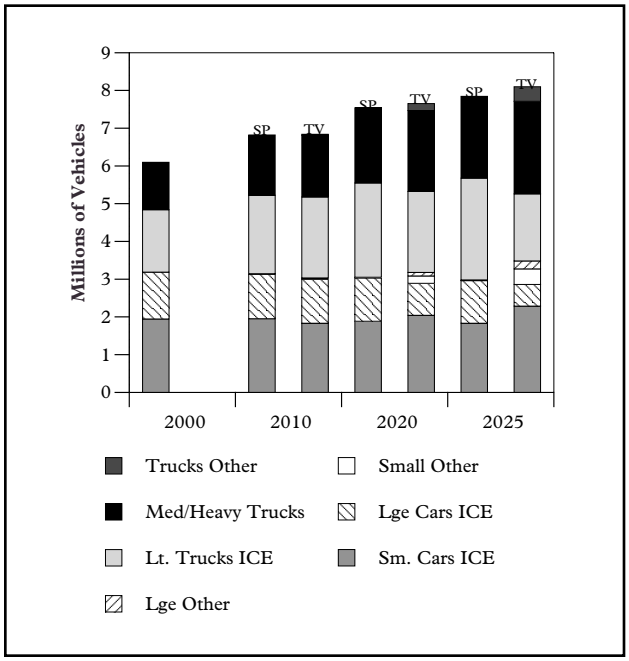


Personal Use Vehicle Stock

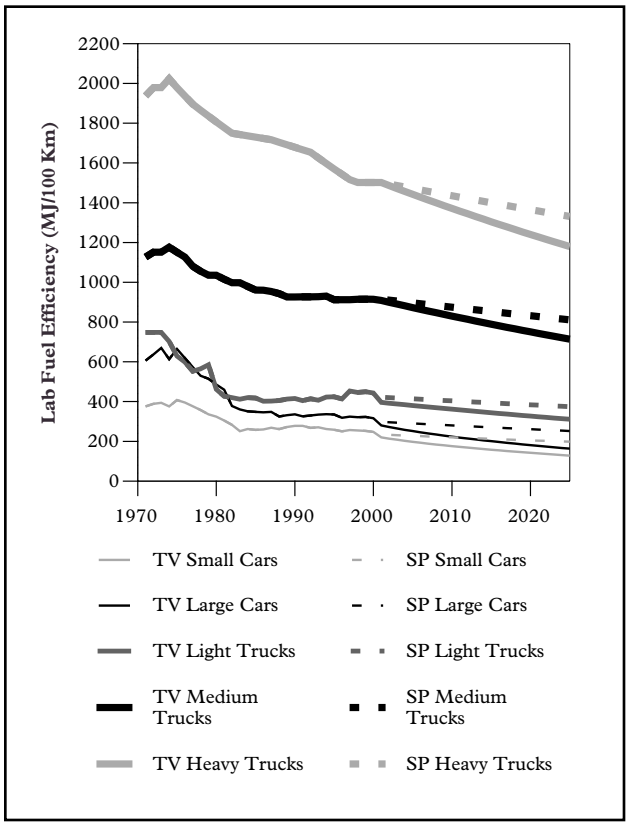


- Energy demand for transportation will grow in both scenarios to support a growing population and economy and makes up over 25% of total secondary energy demand. Although the highest growth rate will be seen in air transport, road transportation remains the dominant mode of transport accounting for ~80% of energy demand in this sector in both scenarios.
- The growth in energy demand for road transportation will vary greatly across scenarios, driven by changes to economic growth and the impact of environmental action on vehicle stock, efficiency, and fuels.
- While the number of personal use vehicles are the same across scenarios (based on population), greater environmental action taken in TV results in higher vehicle fuel efficiency, a shift in vehicle stock toward smaller cars, and more rapid implementation of alternate fuel technology (Hybrid and Electric) vs. Supply Push.
- The number of commercial vehicles will increase slightly in TV vs. SP in response to higher economic growth and a lower use of rail, especially for shorter haul transport. In TV, there is also a shift in vehicle stock to smaller cars for light duty and larger trucks for long haul transportation; and a greater use of alternate fuel technology (Hybrid and Electric).
- Although better vehicle efficiency and a shift in vehicle stock will reduce the demand for gasoline and diesel in TV (especially when compared with SP), the implementation of alternate fuel technology will be slow and occurs later in the forecast. As a result, energy from fossil fuels will remain the dominant fuel source for road transportation in both scenarios. Gasoline and diesel continues to supply over 95% of the total road demand, although increased use of bio-fuel (e.g. ethanol) blends may displace some demand on fossil fuels in TV.

Commercial Use Vehicle Stock



Average Vehicle Fuel Efficiency

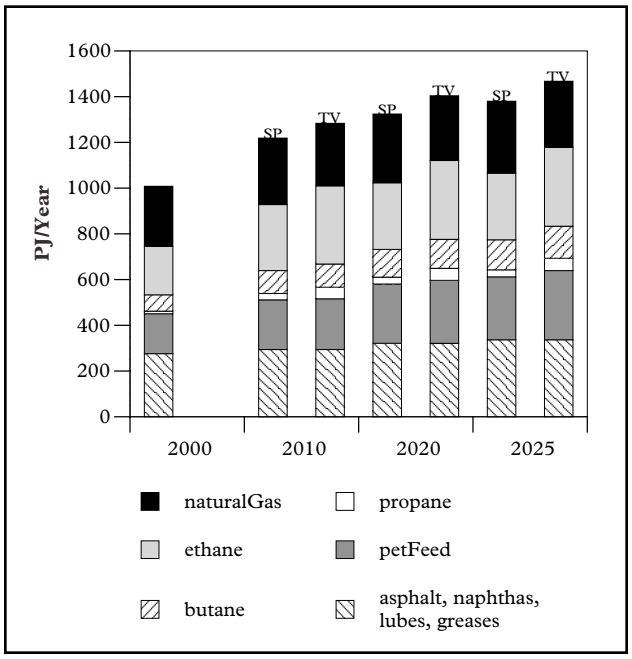


Key Issues:

1. What will enable a more rapid turnover of vehicle stock? To enable more significant changes in new vehicle standards? (e.g. U.S.A. endorsement of Kyoto?)
2. Are the changes in vehicle stock and the rate of alternate fuel implementation realistic? Slow? Aggressive?
3. Are there structural changes in the economy or in transportation trends which may alter the mix or choice in mode of transportation?
4. Will changing population demographics significantly impact expected energy demand for transportation? Can we expect a trend to decreasing driving distance as the Canadian population ages? Or will road travel increase vs. airline travel dependent on scenarios?

4.6 Non-Energy Use of Hydrocarbons

Non-Energy Use of Hydrocarbons



- Non-Energy demand for hydrocarbons includes the use of natural gas, natural gas liquids (NGLs) and/or other petroleum products as feedstock in the production of non-energy products such as, petrochemicals, fertilizers, lubricants, and asphalt.

- Canadian non-energy hydrocarbon demand continues to grow in both scenarios, largely driven by growth in the North American economy. The exception may be non-energy demand from ethane and natural gas intensive users in the west, which will face additional economic pressures from higher feedstock prices and volatility resulting from a tighter than historical natural gas supply outlook in both scenarios.

- This is especially true in TV where environmental pressures make natural gas a preferred fuel source in other market sectors. Thus, creates greater competition for an already limited regional supply and requiring users to enhance efficiency and/or reduce demand. As a result, ethane and natural gas feedstock demand in Western Canada will become constrained by available supply in both scenarios. The potential for incremental ethane demand for petrochemicals occurs in Atlantic Canada in conjunction with the further development of East Coast gas supplies, in the TV Scenario. In SP, a minimum threshold of feedstock supply is not maintained and a petrochemical industry does not develop.

- NGLs (propane and butane) are less susceptible to competition from the natural gas market and demand will be driven mainly by economic growth in the key end-use sectors; petrochemicals, manufacturing, and transportation. The majority of Canadian NGL production is currently derived from natural gas, with production from crude oil refining making up only about 15% share of propane and 40%

share of butanes. As natural gas supplies become constrained, NGL production share from refining is expected to increase in both scenarios to meet increasing demand.

- The supply of petroleum-based feedstock (naphtha, gas oil, asphalt etc.) is not constrained in the forecast, and demand is driven by the economic growth of the end-use sectors; petrochemicals, construction and manufacturing.

Key Issues:

1. Are there other sources of natural gas, NGL, or fuel alternatives that may be exploited?
2. What are possible consequences of a shortfall in ethane or other NGL supply on non-energy demand? (e.g. frontier & non-conventional supply, plant closures, feedstock changes?)
3. What are the practical economic and/or physical (refining & processing) limits to propane, butane and petroleum feedstock supply? Refinery production of propane and butane are assumed to grow in both scenarios and may require the expansion of refinery. Is this a reasonable expectation?
4. What are other influences that could impact the competitiveness and growth of natural gas and NGL intensive users?
5. What is the potential for development of a petrochemical industry in Atlantic Canada?

5.1 Electricity Supply

In the NEB energy supply and demand framework, the key driver for electricity supply in Canada is electricity demand. Using an in-house simulation model, provincial electricity generation expansion plans were developed for the SP and TV scenarios. In SP, the electricity supply outlook reflects the underlying assumptions of this scenario, namely a relatively slow pace of development of generation technologies and low rate of actions on the environment. In SP, electricity generators continue to rely mainly on conventional generation technologies to meet domestic load requirements because alternative and renewable (A&R) technologies remain, for the most part, uncompetitive. In TV, the electricity supply outlook reflects the combined effects of a technological pull and an environmental push. Electricity generators will face a business environment characterised by an increasing demand for "clean" energy, even with a "green premium", the need to internalize environmental costs, and the desire to demonstrate corporate responsibility through "triple bottom line" accounting and reporting. Investment decisions regarding new generating facilities will be facilitated by rapid technological progress which would make A&R economically more attractive. TV will experience a gradual shift toward "cleaner" generation options including clean coal technologies, advanced combined cycle gas-fired generation, advanced nuclear, wind, biomass and small hydro.

5.1.1 Key Assumptions

Hydro: Nearly 60 percent of total Canadian electricity generation is hydro-based. Both scenarios assume development of large scale hydro projects including Gull Island (Labrador), Grande-Baleine (Québec), Peace Site C (B.C.) and Gull Rapids (Manitoba). Small hydro is considered an A&R technology and is assumed to experience a limited growth in SP but an accelerated development in TV.

Nuclear: SP assumes that no new nuclear facilities will be built. It also assumes the decommissioning of Point Lepreau, life extension of Gentilly-2 as well as all units currently operating in Ontario. Plants presently at lay-up status will return to service, except for Bruce A1 and A2 due to prohibitive steam generator repair costs. In TV, the relatively high economic and operating performance of the Advanced Candu Reactor (ACR), the Nuclear Waste Fuel Act (in effect since 15 November 2002) and increased public/government concern about GHG emissions make new nuclear generation a viable option. As a result, new nuclear units would be built in Ontario and New Brunswick. TV also assumes refurbishment of Point Lepreau.

Coal: Due to its abundant supply and continued cost reduction, coal prices are expected to decline somewhat from current levels. In SP, the relatively low actions on the environment contribute to a re-emergence of conventional coal-fired power plants. TV assumes substantial improvement in coal's environmental performance, as brought about by the development and implementation of "clean coal" technologies. In particular, Integrated Gasification Combined Cycle (IGCC) coal-fired generation becomes cost competitive in the latter part of the projection period.

Natural Gas: The NEB industry consultations clearly point to the industry preference for gas as a prime candidate for new generation. In both scenarios, it is assumed that Nova Scotia and New Brunswick will have access to gas supply from the East Coast offshore. The preference for natural gas stems from the fact that it is a clean burning hydrocarbon fuel and that gas-fired generation requires relatively low capital investment and shorter lead construction time. Additionally, TV assumes that the Advanced Combined Cycle (ACC) technology will be commercially available by 2010. Areas where gas will be available for the first time (2006 in P.E.I. and 2010 on the island of Newfoundland in SP and 2015 in TV) will see some conversion from oil to gas.

Orimulsion: Orimulsion is a mixture of bitumen and water. Orimulsion-based electricity generation is economic due to the relatively low cost of the fuel, but it has relatively high GHG emissions. SP assumes Orimulsion use will expand in New Brunswick and emerge in Nova Scotia. In TV, there will be no further conversion to Orimulsion in New Brunswick and it will not be introduced in Nova Scotia.

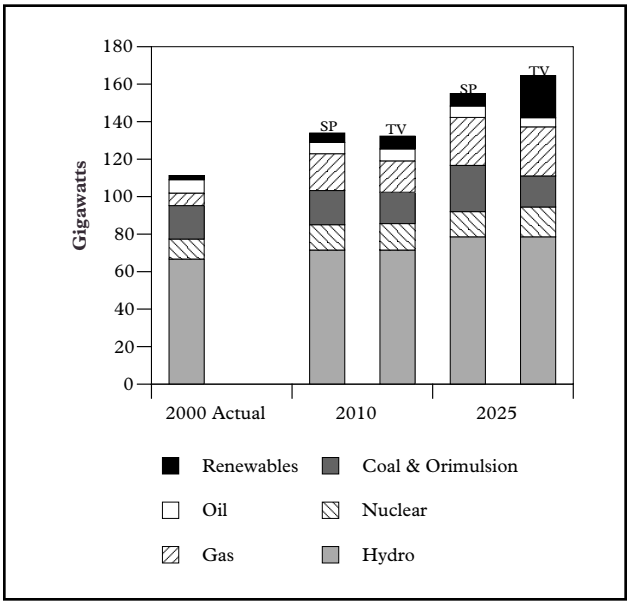
Alternatives and Renewables: In SP, A&R (mainly wind, small hydro, biomass, tidal, solar) remain, for the most part, economically unattractive except for niche markets. SP incorporates announced wind, small hydro, and biomass initiatives in Canada for the period to 2010 but assumes that growth in A&R in the 2011-2025 period will generally be constrained by economic and technological factors.

TV is the scenario that maximizes the development of A&R. This scenario assumes that beyond 2010 the experience gained with the announced projects, combined with technical advances with small generators and turbines, leads to an expansion of small hydro facilities in most provinces. Wind generation will improve significantly as a result of a continued reduction in capital cost due to aerodynamic improvements, strong, light weight materials and small generator technology. Furthermore, TV assumes that biomass generation will expand to include biogas from feedlot operations as well as municipal solid wastes (large urban centers) and that there will be some development of landfill gas, tidal pilot projects and solar in niche markets.

5.1.2 Highlights of Electricity Supply

Capacity: Over the projection period, generating capacity in Canada is expected to increase by approximately 42 percent in SP and 51 percent in TV. As a result, total Canadian generating capacity is projected to reach 147 GW in SP and 157 GW in TV by 2025.

Generating Capacity by Fuel



Total hydro-based capacity (excluding small hydro), is projected to reach 74 GW by 2025 in both scenarios. The increase will occur mainly in hydro-rich provinces. Nuclear capacity will be higher by the end of the period in TV compared to SP as a result of construction of new nuclear units in Ontario and New Brunswick and early retirement of Point Lepreau in SP.

Both scenarios project a steady and substantial increase in gas-fired generation capacity. Several factors favour its development, including the short construction lead time, relatively high efficiency of cogeneration and combined-cycle plants. Much of the increase in capacity occur in Alberta (mainly because of oil-sands development in the Fort McMurray area) and in Ontario. Other provinces, e.g., Québec, Nova Scotia, New Brunswick and BC will also need to rely on new combined-cycle power plants to meet increasing electricity demand. In TV the improved efficiency of gas generation technologies combined

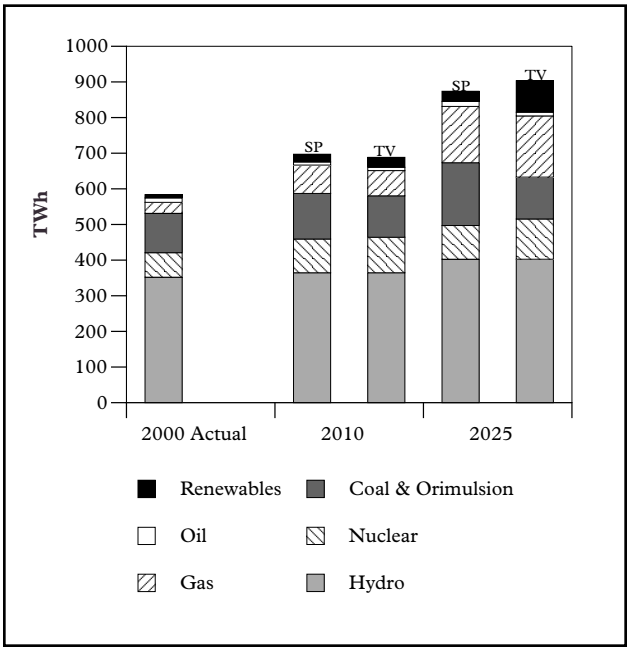
with its relatively low GHG emissions and the desire for clean fuels make it an even more attractive fuel for power generation than in SP. Over the period, there will be about 17 GW of new gas-fired capacity in SP and 18 GW in TV.

In SP, due to relatively low environmental actions and concerns, coal will re-emerge as an attractive and economic generation option, especially in Alberta and Saskatchewan where coal, due to stable and low prices, can successfully compete with gas. Even British Columbia, a hydro-rich province, is expected to construct a new coal-fired power plant. In TV, due to heightened environmental concerns, some existing conventional coal power plants in Ontario will be phased-out and replaced by clean coal-fired power plants (IGCC) or converted to gas. In Alberta and Saskatchewan, IGCC power plants will be added while existing coal-fired units will be extended.

In SP, the projected increase in A&R capacity will primarily be in wind farms. Overall, A&R development will be constrained by the slow pace of technological development, making it unattractive compared to conventional generation. Although the environmental benefits of A&R are widely recognised, the low level of government actions coupled with low public concerns, justify consumer's continued reluctance to pay a premium for green energy. In TV, in response to a relatively high public demand for environmentally-friendly sources of energy, and with continued support from governments (e.g., financial/tax incentives, incentive regulations, and Renewable Portfolio Standards), this scenario will see significant development of generating capacity using A&R. Wind and small hydro will register the biggest expansion in most provinces. Biomass will also expand in most provinces, while tidal development will occur in B.C., Nova Scotia and New Brunswick. A&R capacity is expected to rise from about 1 GW in 2001 to 21 GW in 2025, accounting for 13 percent of total Canadian generating capacity in 2025.

Generation: Over the period, total Canadian electricity generation is projected to rise by 2.2. percent annually in SP and 2.4 percent in TV. The SP scenario will be characterised by further expansion of hydro generation in most hydro rich provinces, a resurgence of coal-fired generation as new coal-fired facilities are built in Alberta, Saskatchewan and Ontario, an increase in the use of Orimusion for electricity generation in New Brunswick and in Nova Scotia, and a limited penetration of A&R. SP is also characterised by a substantial increase in gas-fired generation for which the share will rise from about 5 percent currently to 18 percent by 2025.

Generation by Fuel



In addition to an even stronger expansion of gas-fired generation compared to SP, TV will register an accelerated development of A&R generation. As a result, A&R generation will account for 9.5 percent of total Canadian generation by 2025, compared to 2.5 percent in SP. In both scenarios, the shares of nuclear and coal-fired generation are expected to decline over the projection period.

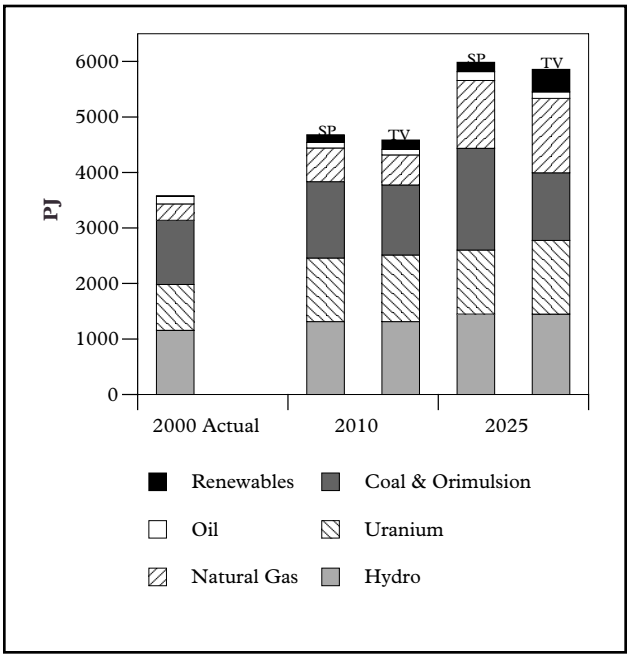
Table 5.1.1: A&R Penetration Rates (as % of generation)

		Supply Push			Techno-Vert	
		2010	2025		2010	2025
NFLD		1.4%	1.4%		1.7%	3.4%
NS		4.2%	4.6%		5.4%	12.5%
PEI		31.6%	27.5%		33.7%	33.8%
NB		0.5%	1.3%		1.6%	8.5%
QC		2.6%	3.1%		3.6%	11.2%
ON		1.2%	2.3%		1.8%	8.8%
MN		0.3%	0.8%		1.2%	8.7%
SK		0.8%	1.3%		1.8%	8.8%
AB		3.0%	2.0%		4.3%	6.0%
BC		3.3%	3.1%		5.4%	14.8%
YK		55.9%	52.0%		56.6%	51.5%
NWT		52.2%	39.3%		55.0%	39.3%
NU		0.0%	2.7%		0.0%	2.6%
Canada		2.2%	2.5%		3.1%	9.5%

Gas Demand: In SP, as a result of the projected generation expansion, natural gas demand for power generation rises from approximately 370 BCF in 2001 to 1163 BCF annually by 2025. With a significant increase in gas-fired co-generation power plants due to the oil-sands expansion, Alberta will become the largest market for gas used in electric power generation in Canada (about 410 BCF annually by 2025), followed by Ontario (270 BCF). Other provinces with access to gas will also experience increasing gas demand for power generation.

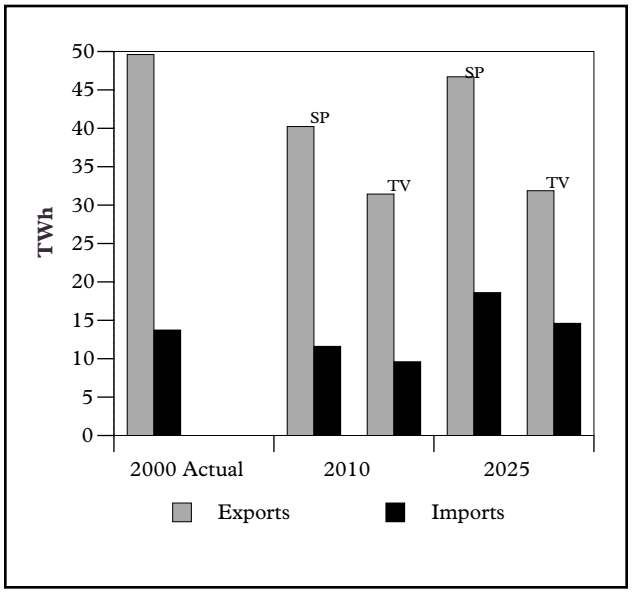
In TV, with an even higher increase in gas-fired generation, gas demand for power generation will reach 1280 BCF annually by 2025. Alberta will remain, throughout the period, the largest market for gas used in power generation in Canada (450 BCF annually by 2025), followed by Ontario (370 BCF).

Primary Energy Demand for Electricity Generation



Exports: Canada has historically been a net electricity exporter. The share of electricity exports has historically been between 6 to 8 percent of total generation. Canadian generators have relatively lower average generation costs than in the US adjacent markets and are expected to remain competitive in the export markets. Exports are projected to fluctuate within the historical range of between 30 to 45 TW.h annually. It is assumed that surplus electricity from the oil sands plants will be exported in SP but will be used to serve domestic loads in TV. Export levels will continue to be largely influenced by surplus availability. In both scenarios, the long term competitiveness of Canadian exporters may be eroded because gas-fired generation will be at the margin even in hydro-rich provinces (e.g. Québec and B.C.). Exports are projected to be lower than in SP, fluctuating between 25 to 35 TW.h annually. By 2025, the share of electricity exports will fall below 4 percent of total generation.

Electricity Exports & Imports



5.1.3 Other Electricity Issues

Transmission: In light of the projected increases in generation in both SP and TV, there may be a need for new transmission infrastructure over the projection period. While the electricity industry is undergoing structural changes as a result of provincial restructuring, transmission will remain a regulated business due to its monopoly nature as well as for related possible environmental issues. Additionally, Canadian transmission is interconnected with US systems and therefore, may be impacted by FERC RTO and other market design initiatives.

Nuclear: Although nuclear is an attractive option with respect to GHG issues, public opinion is expected to remain divided on its relevance for electricity generation because of concerns related to nuclear wastes and nuclear safety. A shift away from new nuclear facilities would most likely imply more gas-fired capacity and/or coal-fired capacity. Assuming there is no new nuclear facilities, gas-fired capacity will need to increase by 1800 MW. Accordingly, the derived demand for power generation would increase by about 100 BCF annually.

Gas Supply and Prices: Over the projection period, natural gas availability is expected to remain a key issue for power generators in Canada, and more particularly in Atlantic Canada. The high gas demand for power generation is expected to put upward pressures on gas prices unless gas supply keeps rising at a relatively fast pace. The substantial increase in gas demand for power generation raises the long term issue of gas supply and prices. Will there be enough gas for power generation? What would be the long-term outlook for gas prices for generators?

Distributed Generation: We assume distributed generation will penetrate the market starting in 2005 and will steadily increase its market share especially in the commercial and institutional sectors. Based on the current technological developments, we expect most DG systems to be gas-fired. DG is expected to reduce transmission losses and network load requirements.

Market Restructuring: Electricity restructuring is expected to continue in Canada although the pace will differ from province to province. The impact of restructuring on supply, demand and prices remains uncertain. Electricity prices in Ontario and Alberta are assumed to be more volatile than in other provincial markets, since they are influenced by marginal pricing. The future evolution of electricity prices is a key determinant of its competitiveness over time, which in turn, will have an impact on total electricity demand.

5.1.4 Issues and Questions

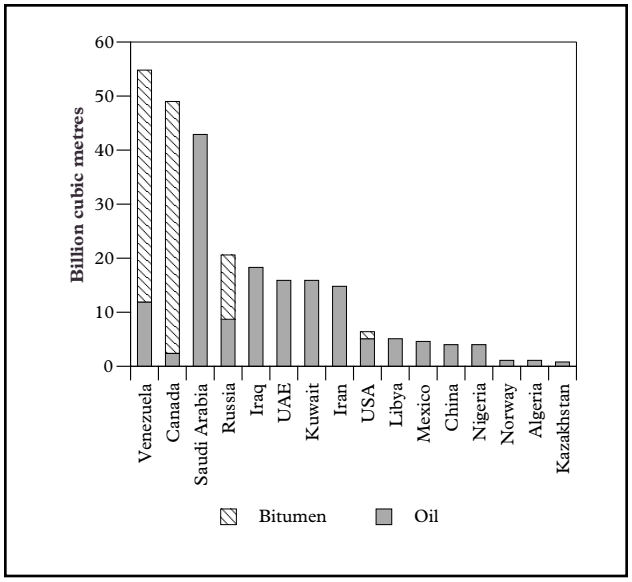
1. Do you have any comments on the Board's electricity assumptions and preliminary results?
2. What impact might market restructuring in Canada have on electricity demand, supply and prices?
3. What are the prospects for new interprovincial and international transmission interconnections? How would the creation of Regional Transmission Organizations affect this in any way?
4. What are the key market developments over the next 10, 20 years that might affect the generation profiles in SP and TV?
5. Would the projected A&R expansion in SP and TV be achievable?
6. To what extent will the development of fuel cells and/or distributed generation affect electricity supply, demand and consumers?
7. What is the long term future of nuclear power? Will new nuclear facilities be encouraged in the context of either the SP or TV scenarios?

5.2 Crude Oil and NGLs

5.2.1 Crude Oil and Bitumen Resources

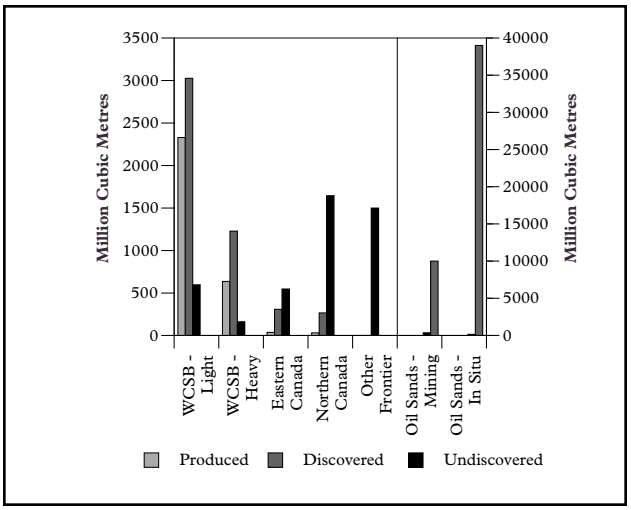
- Canada ranks first in the world in terms of bitumen resources and second in the world, behind Venezuela, in terms of total discovered recoverable resources of crude oil and bitumen. (Saudi Arabian values represent proven reserves, a term implying a higher degree of certainty.)

Comparison of World Oil & Bitumen Resources



- The crude oil and bitumen resource estimates are the same in both scenarios. The bitumen resources are those published by the Alberta Energy Utilities Board, while the conventional resources are based on estimates published by the provincial energy agencies, offshore petroleum boards, the Geological Survey of Canada, and the NEB.

Conventional Crude Oil and Oil Sands Resources



The Alberta Oil Sands deposits contain an estimated 49 billion m^3 of recoverable bitumen resources, which is about 12 percent of original bitumen in place. About 10 billion m^3 are considered to be amenable to surface mining methods, with 39 billion m^3 assigned to in situ recovery methods. At year-end 2000, only one percent of the bitumen resources had been produced.

In contrast to the bitumen resources, the WCSB conventional resources reflect a more mature producing basin. For light conventional, some 64 percent of ultimate recoverable resources are produced, for conventional heavy this figure is 46 percent.

In Eastern Canada, ultimate recoverable resources are estimated to be 856 million m^3, with the bulk of this situated offshore Newfoundland and Nova Scotia. Some 547 million m^3 are undiscovered, and only 37 million m^3 have been produced.

For Northern Canada, only a small portion of the resources estimated to exist have been discovered, with discovered resources of 266 million m^3 and undiscovered resources of 1646 million m^3. The bulk of this resource is assigned to the Mackenzie Delta-Beaufort Sea and Arctic Islands regions.

"Other Frontier" resources pertain to regions where potential is thought to exist, but no confirming discoveries have yet been made. This category includes the Laurentian Basin and the BC Offshore regions, for instance.

5.2.2 Crude Oil Supply Projections – Major Assumptions

The major assumptions common to both scenarios are listed below:

- The oil price assumption, $US22 (2001) for WTI, provides for robust economics for the majority of oil projects considered, allowing sufficient return to the operator for many oil sands projects and improved recovery schemes in conventional oil pools. Recognition is given to the fact that oil price volatility will sometimes delay the onset of additional production.
- The pace of oil sands production expansion will be limited by the availability of skilled labour and sufficient capital. Figures of $C3.5 Billion capital expenditure per year yielding 110,000 bbl/d of incremental production are assumed as the upper limit of annual expansion.
- Production is not unduly constrained by pipeline takeaway capacity. From time to time, productive capacity could exceed pipeline capacity, but for the most part, pipeline capacity is added in a timely manner.
- Production is not unduly constrained by availability of condensate for blending heavy crude oil. If condensate for diluent falls short of demand, industry will adjust, potentially by blending with light sweet crude or synthetic crude, or by manufacturing specialty diluent products.
- Oil sands projects will have access to sufficient quantities of natural gas throughout the projection period. Natural gas is an important source of fuel to provide steam and process heat for oil sands upgrading and in situ operations.
- No oil production from West Coast offshore, due to environmental issues.
- No oil production from the Mackenzie Delta/ Beaufort Sea region, because of high oil transportation costs.
- Production and reserves expansion not limited by available drilling rigs or oil field services.

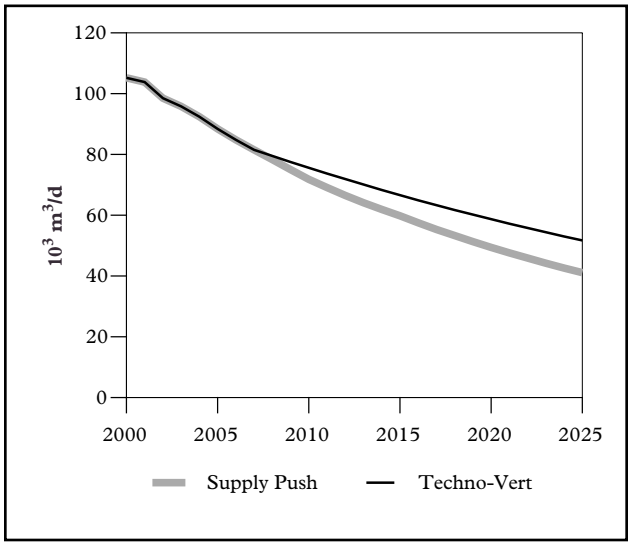
Major assumptions specific to each scenario are outlined below:

Supply Push	Techno-Vert
• Differential price between light and heavy crude oil as defined by Edmonton Par Light minus Hardisty Heavy remains constant at it's long term average of $US4 per barrel. • Governments initiate policies that encourage Canadian crude oil and bitumen production. • Production not unduly constrained by environmental issues. • Technological advancement moves at same pace as last decade.	• Differential price between light and heavy crude oil, will increase with time, but will average $US6.50 per barrel, about $US2.50 above its average over the last decade. • Governments initiate policies that encourage environmental protection. • Production is constrained by environmental considerations. • Technological advancement moves at an accelerated pace.

5.2.3 Scenario Roll-up

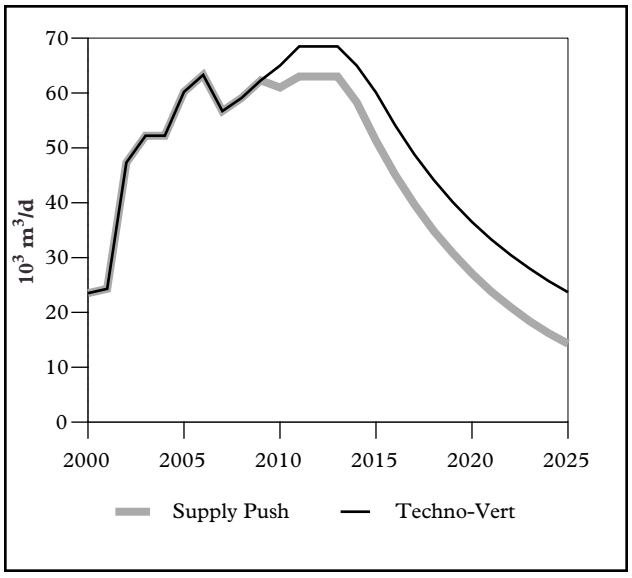
The highlights of the supply projections for each crude oil category are briefly discussed below. For ease of comparison, the projections for the Supply Push (SP) and the Techno-Vert (TV) scenarios are shown on the same charts.

Conventional Light Crude Oil – WCSB



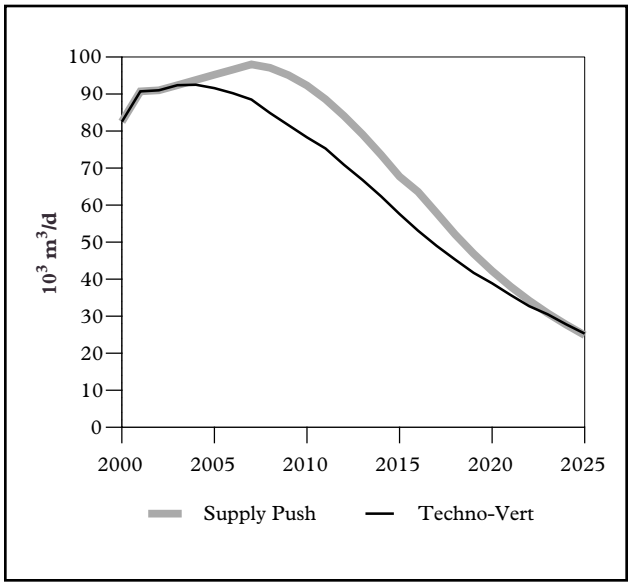
- In SP, the long-term decline trend of four percent is maintained, consistent with a mature supply basin.
- In both scenarios, significant reserves additions are required, through new discoveries, infill drilling, and the application of improved recovery techniques, to maintain the production levels shown.
- In TV, the effects of advanced technology and the bias for light crude versus heavy leads to higher production than in SP, after 2007. By 2025, the two projections differ by 20 percent, or about 10,000 m3/d.
- Better finding rates, wider application of infill drilling and improved recovery methods, especially CO2 flooding, lead to higher production

Eastern Canada Light Crude Production



- Current production is almost entirely from offshore Newfoundland, with minor amounts from Ontario.
- Hibernia and Terra Nova are already producing, onset of White Rose in 2005 and Hebron in 2008 are common to both scenarios. Contributions from smaller satellite pools in the Jeanne d'Arc Basin are also included.
- An additional Terra Nova sized pool is assumed to be found in the relatively unexplored regions of the East Coast, potentially in the Deepwater Scotian Shelf, Laurentian Basin or Flemish Pass regions. This pool would come on-stream in 2010 in TV and 2012 in SP
- The decline in production levels after 2013 reflects the natural decline in the producing pools combined with a dearth of discovered resources.
- By 2025, TV production levels are 9,400 m3/d greater than in SP.

Conventional Heavy Crude Oil – WCSB

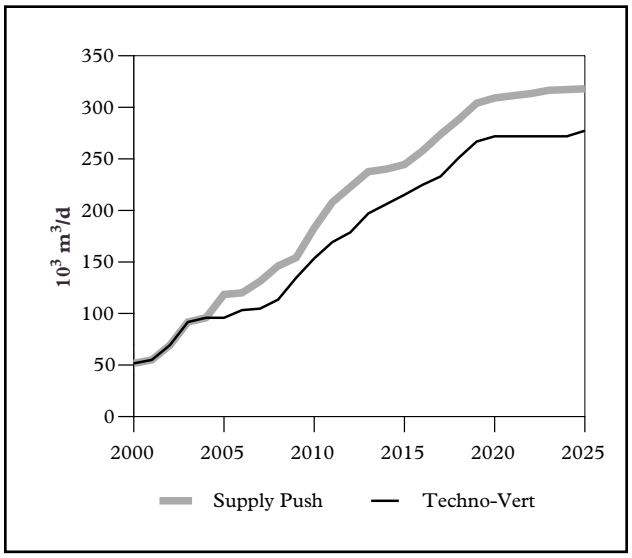


- Alberta and Saskatchewan are the primary sources of conventional heavy crude oil, with B.C. contributing minor amounts.
- Production has been trending up at about two percent per year over the last two years. In SP, this trend is continued and production peaks at nearly 100,000 m3/d in 2007. The subsequent decline is based on the remaining resource picture.
- In TV, the early momentum is lost due to the costs of meeting more stringent environmental conditions, higher light/heavy differentials and tighter markets for heavy crude. This is countered by greater uptake of technology, through a wider application of horizontal drilling, especially multi-laterals, and wider application of improved recovery methods such as SAGD and VAPEX to conventional oil pools.

Mining/Upgraded Bitumen Supply

- The $US22 price for WTI generates sufficient cash flow for oil sands operators to expand production levels in a fairly aggressive manner, in both scenarios.
- The rate of technological advance has a direct bearing on operating costs. In SP, operating costs are assumed to be in the range of $C12 -$C14 per barrel, compared to $C8-$C10 in TV.
- In TV, the greater environmental hurdles facing oil sands mining operators slow the pace of expansion.
- In TV, by 2007, operators adjust to the new rules, and the effect of more rapid technological advance serves to lower costs and encourages expansion of production. The overall effect is that mining/upgraded production in TV remains well below that of SP, and is less by 40,000 m3/d by 2025.

Oil Sands Mining/Upgraded

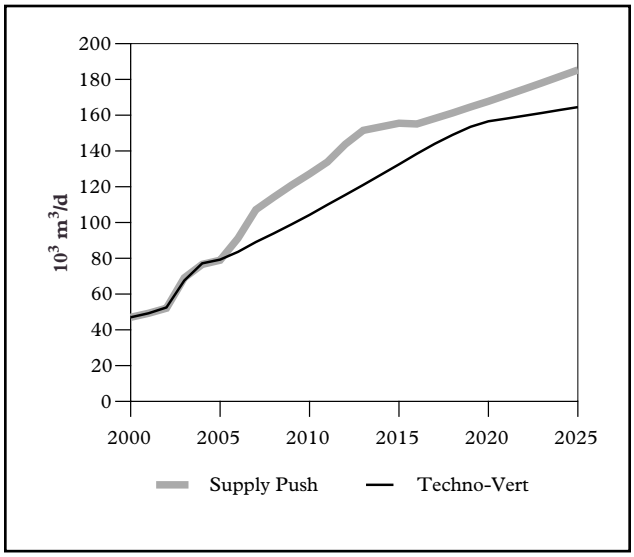


In Situ Bitumen Supply

- The $US22 price for WTI, and assumptions on light/heavy differentials, generates sufficient cash flow for oil sands in situ operators to expand production levels in a fairly aggressive manner, in both scenarios.
- Primary or "cold production" levels are held at current production levels in both scenarios.
- The SP scenario features rapid increases in production from thermal projects, primarily SAGD and CSS, but some application of VAPEX as well.
- In TV, production expansion is slowed by higher costs related to meeting enhanced environmental conditions, by higher light/heavy differentials, by tighter gas supplies and tighter markets for bitumen blends.

- In TV, producers respond through a greater application of advanced technology that lowers costs of production, and by wider application of less energy intensive, and more environmentally benign recovery techniques, such as VAPEX. TV production levels are about 21,000 m^3/d below SP levels, in 2025.

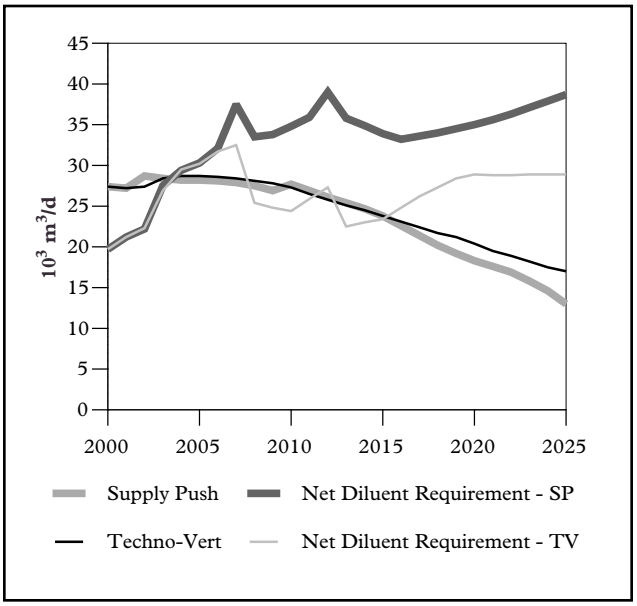
Oil Sands In Situ



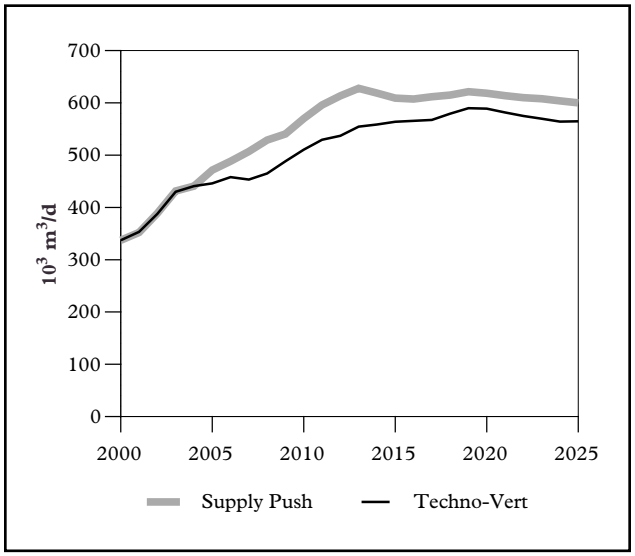
Condensate Supply & Diluent Requirement –WCSB

- The bulk of the condensate supply is derived from the processing of natural gas, so the projections are directly related to the natural gas projections for both scenarios.
- On average, conventional heavy oil blends contain about 7 percent condensate diluent while oil sands bitumen blends contain about 33 percent.
- SP and TV assumes a Husky Upgrader expansion in 2006 and 2008, respectively, and Petro-Canada Strathcona Refinery conversion in 2008 with an additional phase in 2013.
- The condensate for diluent shortage that appears in both cases by 2004 is based on current condensate usage patterns. Condensate supply can be augmented by re-directing other-use supply to diluent usage, and by utilizing light crude, refinery naphtha or synthetic crude as blending agents.

WCSB Condensate



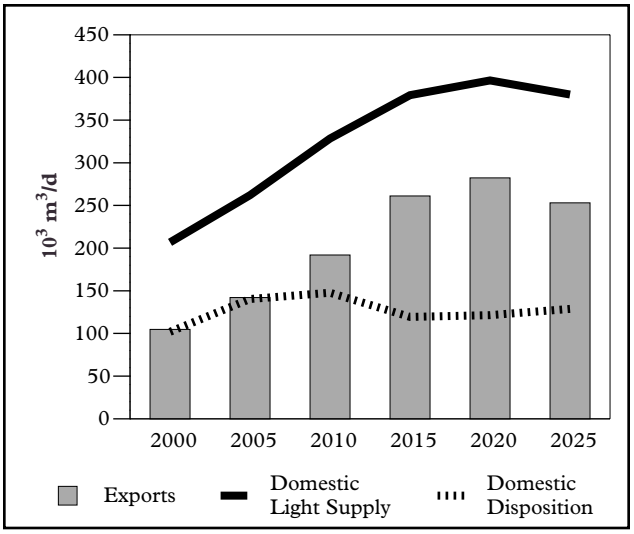
Crude Oil Production – Total Canada



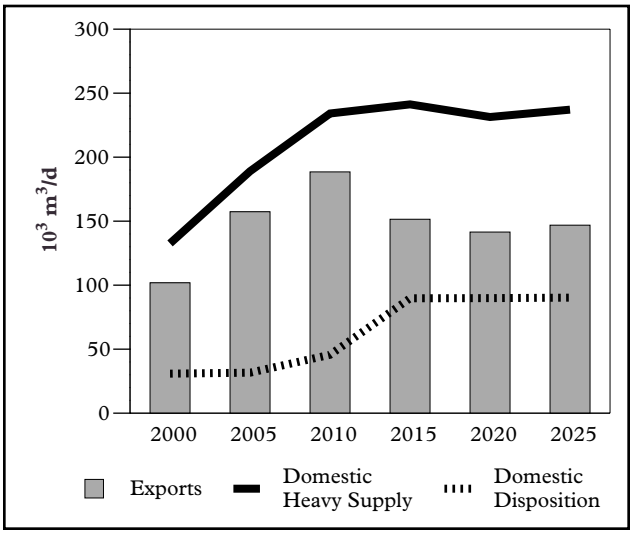
- In SP, production levels rise until 2013, supported by increasing oil sands mining and in situ production, and by the East Coast offshore. After 2013, declining production in the East Coast offshore offsets the increasing oil sands derived production.
- In TV, production levels plateau between 2004 and 2008 as oil sands and heavy oil producers adjust to a more environmentally protective setting, and to higher light/heavy differentials and tighter heavy oil markets. After 2008, production increases are roughly parallel to those of SP.
- By 2025, TV production levels are about 37,000 m^3/d below SP levels.

5.2.4 Supply/Demand Balance

Supply/Demand Balance – Light Crude Oil: Supply Push



Supply/Demand Balance – Heavy Crude Oil: Supply Push

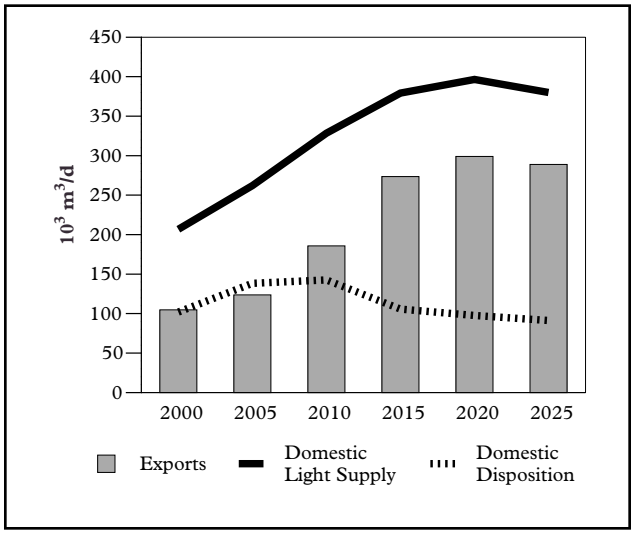


- Exports of light crude oil rise from 105 10^3 m^3 per day in 2000 to nearly 200 10^3 m^3 per day in 2010 and to 280 10^3 m^3 per day in 2020 and then begin to decline. Exports of heavy crude oil increase from 100 10^3 m^3 per day in 2000 to a peak of about 180 10^3 m^3 per day in 2010 and drop to 150 10^3 m^3 per day in 2015, and remain relatively flat thereafter.
- In 2015, the decline in the use of Canadian light crude oil, and corresponding increase in heavy

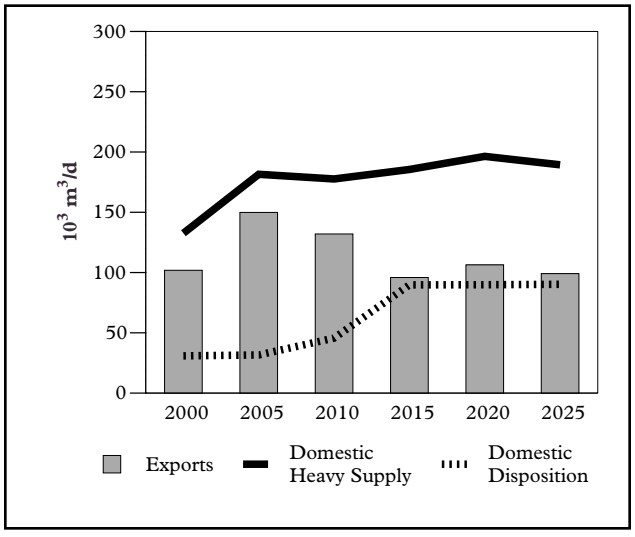
crude oil usage, reflects refinery conversions in Alberta to process blended bitumen.

- In the SP scenario, security of supply is a key driver and, therefore, it is expected that the US market will absorb the bulk of the increased exports from Canada. It is recognized, however, that refinery investments will likely be required to accommodate the growing outputs and that price discounts could be required from time-to-time.

Supply/Demand Balance – Light Crude Oil: Techno-Vert



Supply/Demand Balance - Heavy Crude Oil: Techno-Vert



- Exports of light crude oil will be nearly 125 10^3 m^3 per day in 2005 climbing to a peak of 300 10^3 m^3 per day by 2020, then will start to decline. Heavy crude oil exports peak at the beginning of the forecast period at 150 10^3 m^3 per day. By 2025 heavy crude oil exports will decline to 100 10^3 m^3 per day.

- In the TV scenario, the emphasis on cleaner burning fuels results in lower heavy crude oil production and corresponding export levels.

- The refinery conversions in Alberta to process blended bitumen will also take place in the TV scenario reflecting the demand for cleaner fuels.

5.2.5 Issues and Questions

Issues

The rapid expansion of non-upgraded bitumen production results in a corresponding rapid increase in demand for condensate for blending purposes. Given current condensate usage patterns, a shortfall could occur as early as 2004. Some steps could be taken to augment the condensate supply, such as:

- Re-direct condensate volumes previously sent to Sarnia area for use as petrochemical feedstock
- Direct Caroline condensate to condensate pool
- Direct more light crude to the condensate pool

Even with these measures in place, a shortfall of condensate for use as diluent is projected to occur in the 2006-2007 time frame. In the SP scenario, the shortfall reaches 20,000 m3/d by 2025.

Questions

1. Recent oil sands mining/upgrading projects have experienced significant cost over-runs during construction, due in large part to projects competing for a limited supply of skilled labour. About $C6 Billion was spent in 2001 on three separate projects. We have used a figure of $C3.5 Billion per year of capital expenditure as a sustainable upper limit, and $C30,000 per barrel of daily capacity as the cost of adding capacity. Are these assumptions reasonable?

2. One of the proposed solutions to the pending shortage of condensate for blending of heavy oil and bitumen is to use synthetic crude oil as a blending agent to create a synthetic/bitumen blend, or SynBit. Is SynBit sufficiently attractive to refiners to make this a viable solution?
3. We have not assumed any oil production from the Mackenzie Delta/Beaufort Sea area in either scenario because of high pipeline transportation costs. Is this reasonable? Would the start-up of a natural gas pipeline from the North make an oil pipeline more likely?
4. In both scenarios, there are growing volumes of both light synthetic crude oil and blended bitumen available for export. The assumption has been made that US refineries will be upgraded to accommodate these larger volumes. Is this a reasonable assumption?
5. It has been assumed that pipelines will be expanded, as required. Is this reasonable?

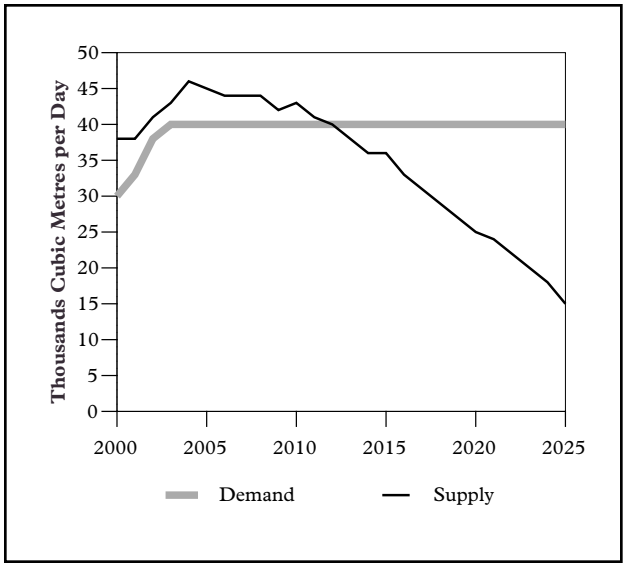
5.2.6 Western Canadian Sedimentary Basin (WCSB) Ethane Supply and Demand 2000 to 2025

Drivers

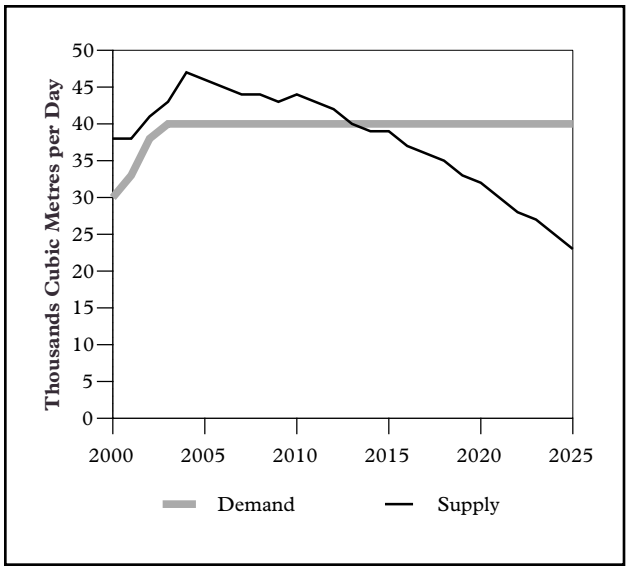
- The gas supply outlook does not include B.C. offshore or Arctic (Beaufort Sea) resources. Liquids transported on the Alliance pipeline are not included.
- About 51 Mb/d of incremental ethane is added early in period due to straddle plant capacity expansion.
- Mackenzie Delta gas supply adds 15 to 25 Mb/d of ethane (2010 & 2015, respectively).
- Solvent flood demand is not included (approximately 15 Mb/d, terminating 2014 when the last enhanced oil recovery project ends).
- Ethane supply remains tight throughout the forecast period, with no supply available for export, under both scenarios.
- Over the long term, extraction of liquids is expected to be economic.
- With respect to the Atlantic Provinces, under the SP scenario it is assumed that a minimum threshold volume of ethane will not be available for an extended period of time. As a result, it is assumed that an East Coast petrochemical industry is not developed and ethane is left in the gas stream. Under TV, an economic threshold volume for ethane is expected to be available for an extended period of time. However, the ethane volume would have to be supplemented with propane as an additional feedstock source. As a result, it is assumed that an East Coast petrochemical industry is developed and ethane is extracted and added to the Canadian supply total.

5.2.7 Ethane Supply and Demand

WCSB Ethane Supply and Demand: Supply Push



WCSB Ethane Supply and Demand: Techno-Vert



Supply Push

- Demand exceeds supply about the middle of the forecast period, with the shortfall increasing to about 150 Mb/d by the end of the period.

Techno-Vert

- Demand exceeds supply about the middle of the forecast period and the shortfall increases to about 100 Mb/d by the end of the period.
- The decline in ethane supply tends to track the decrease in conventional WCSB gas supply in both scenarios; however, the decline is steeper in SP.

5.2.8 Issues and Questions

Issue

- Long-term supply of ethane.

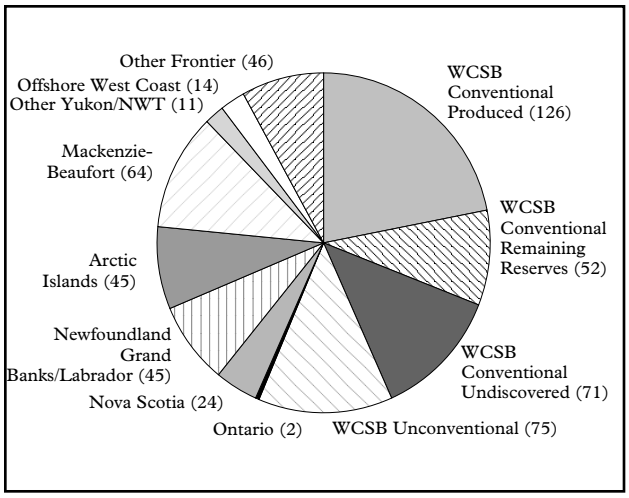
Questions

- How will the Alberta ethane shortfall be met (e.g., oil sands off-gas ethane, propane supplementing the feedstock slate, ethane supply from Alaska and/or B.C. offshore)?
- What are the consequences of the shortfall not being met?

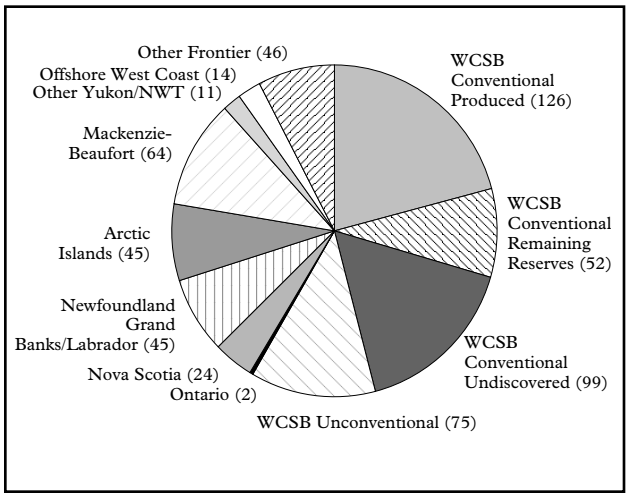
5.3 Natural Gas Supply

5.3.1 Canada's Natural Gas Resource Endowment

Total Gas Resources – Supply Push: 575 Tcf



Total Gas Resources – Techno-Vert: 603 Tcf



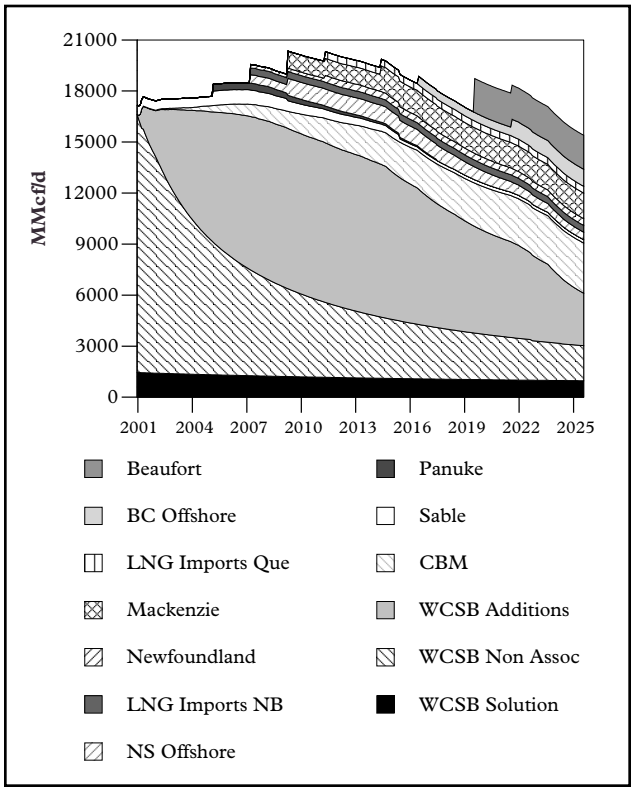
- Canadian marketable gas resources, including undiscovered resources, total 575 Tcf in Supply Push whereas in Techno-Vert the resource base would be 603 Tcf. Additional undiscovered resources in the WCSB account for this difference; the superior upstream technology expected in Techno-Vert should allow industry to locate smaller pools and pools situated in deeper portions of the WCSB more efficiently.
- Both scenarios include 75 Tcf for unconventional gas resources such as coalbed methane, tight gas, shale gases, etc. These resources would be primarily situated in Alberta and British Columbia.
- In both scenarios, approximately one-half of conventional marketable gas resources in the WCSB have already been produced. Undiscovered resources are expected to be discovered eventually in thousands of Cretaceous pools.

5.3.2 Implications of Scenario Drivers for Gas Resource Development

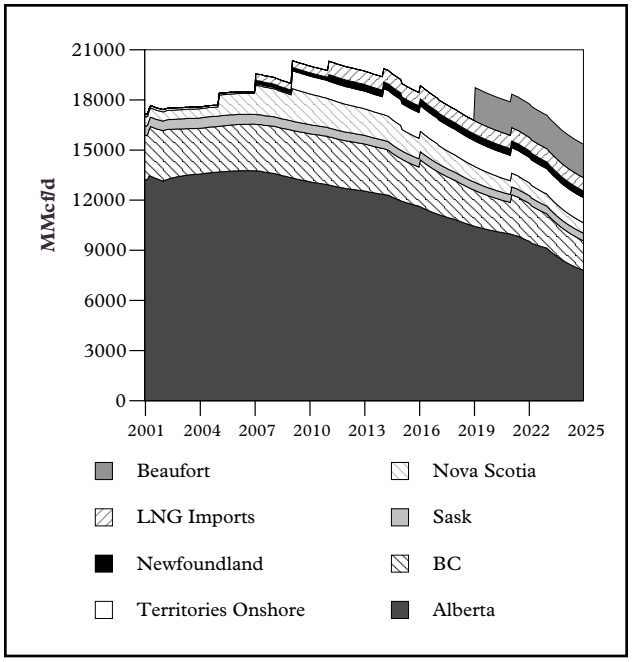
- In Supply Push, the drive to rapidly develop conventional gas resources is accomplished initially through the drill bit with activity maintained at levels experienced in 2001.
- Removing restrictions to land access in the WCSB has a marginal impact on overall supply in Supply Push. This would seem to be a more important issue for U.S. gas supply.
- Frontier resources are added aggressively in accordance with expected exploration success and some continued improvement with existing technology to support, for example, compressed natural gas development at the discoveries near Newfoundland.
- Coalbed methane development is considered to be consistent with Supply Push as issues surrounding this unconventional resource tend to be resource-oriented rather than technological. However, a greater pace of improvement in upstream technology could enhance CBM recovery.
- Improved upstream technology provides for an increased level of resource development from the WCSB in Techno-Vert, driven by a somewhat larger resource base due to deep discoveries and further discoveries of small pools.

5.3.3 Profiles for Resource Development

Supply Push Deliverability Outlook by Resource Category or Project

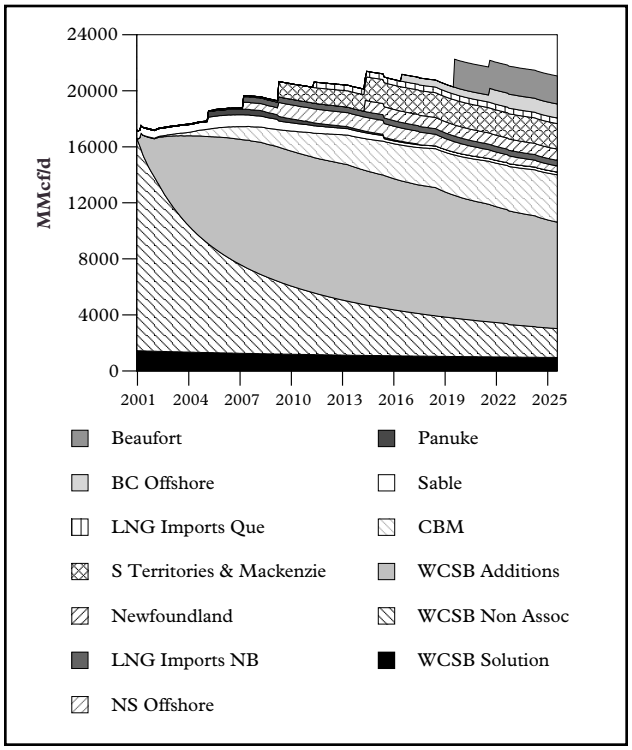


Supply Push Deliverability Outlook by Region

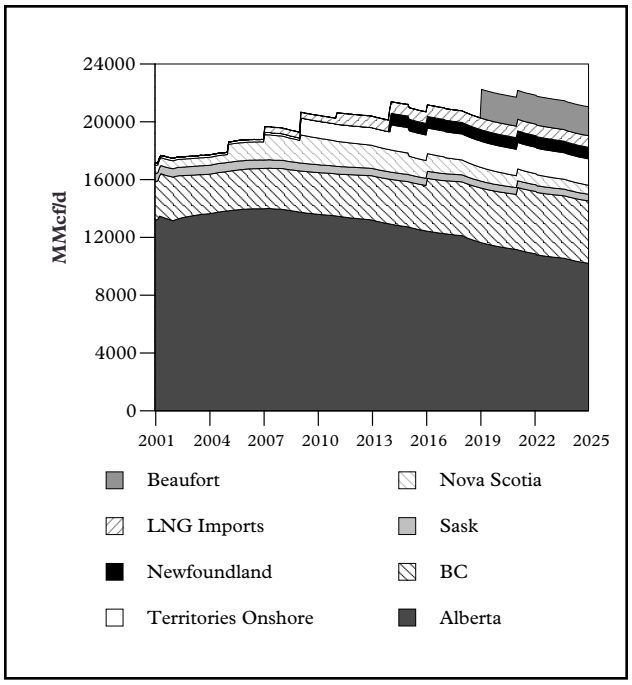


- Canadian natural gas deliverability peaks in Supply Push around 2010 at a rate of about 19 Bcf/d. At this point, unconventional gas and frontier areas have begun to significantly supplement supply from the WCSB. By the end of the period, unconventional gas and frontier areas provide a third of Canadian deliverability.
- The profile of supply from the WCSB is based upon drilling levels experienced in 2001 and producing characteristics of individual wells being unchanged from current observations.
- Coalbed methane development is expected to gradually increase from 300 wells in 2002 to 3000 wells annually by the end of the projection period. Each CBM well is expected to commence production at a rate of 100 Mcf/d and to recover 0.375 Bcf.
- Frontier supply includes two additional projects offshore East Coast of 500 MMcf/d each and two similar projects offshore B.C. by 2022. The Mackenzie Valley pipeline system is estimated to flow by 2010 at a rate of 1 Bcf/d with an expansion to 1.5 Bcf/d by 2015.

Techno-Vert Deliverability Outlook by Resource Category or Project



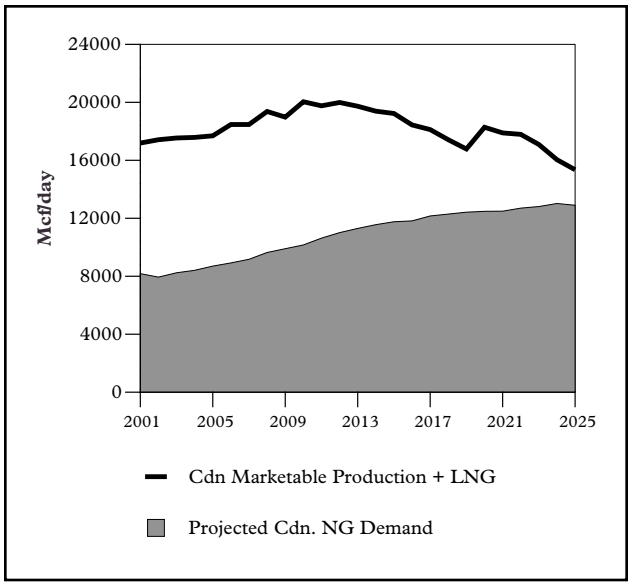
Techno-Vert Deliverability Outlook by Region



- Canadian deliverability gradually increases in Techno-Vert from 17 Bcf/d to 21 Bcf/d (excluding LNG imports) by the end of the projection period.
- Deliverability from the WCSB is maintained longer in Techno-Vert as more gas resources are available for development
- Production from coalbed methane is expected to reach 4 Bcf/d by the end of the projection period. While the number of wells is expected to be the same as in Supply Push, improved technology will result in higher productivity (150 MMcf/d) and gas recovery (0.5 Bcf) per well.
- Frontier supply is projected to have a similar profile to Supply Push.

5.3.4 Meeting the Market's Needs

Supply Push – Canadian Natural Gas Production vs. Domestic Demand

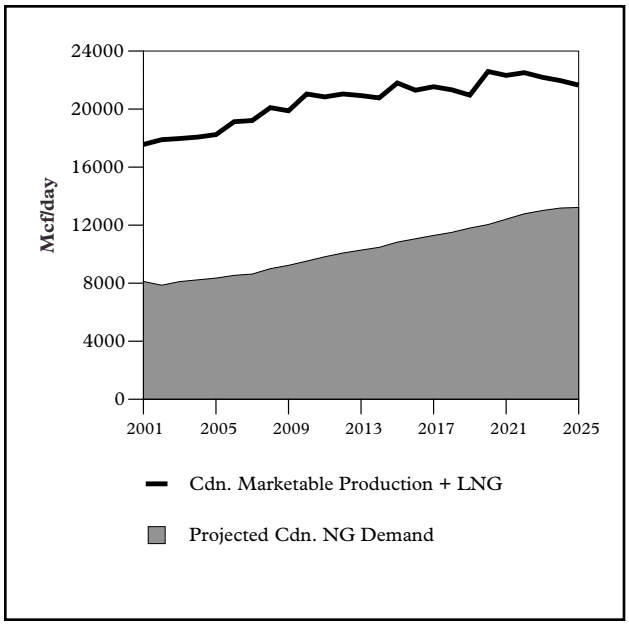


Supply Push

- There is growing upward pressure on natural gas prices in Supply Push as supply/demand fundamentals tighten throughout the forecast period. By the second decade, natural gas production can not keep pace with the ever growing demand for natural gas.
- In response to more frequent regional and periodic imbalances, the natural gas market will respond through fuel diversification and temporary shut-down or demand reduction where possible in the affected regions and sectors.
- Atlantic Canada will be less affected, as further development of offshore East Coast gas supply and possible LNG import facilities will serve to increase natural gas availability into that region and fosters expansion of the market for natural gas. The growth in East Coast supply, however, is not sufficient to offset a decrease in western Canadian gas supplies. The result, is an overall tightening of the natural gas balance in Canada, placing increasing pressure on certain natural gas markets to reduce consumption or switch to alternate fuels.
- With likely impacts to transportation cost and

overall supply reliability, end use markets with limited fuel options (e.g. residential, commercial, natural gas intensive industries, certain exports, etc.) that are distant from the supply source are most susceptible.

Techno-Vert – Canadian Natural Gas Production vs. Domestic Demand



Techno-Vert

- Successful implementation of upstream technology enables further development and exploitation of natural gas resources, which sustain production growth through the forecast period.
- Environmental action in this scenario encourages accelerated implementation of consumption technology which lowers overall energy intensity, and enables more users to use natural gas without significant impact to total gas demand (vs. Supply Push).
- East Coast natural gas development and LNG import facilities enable substantial increases to natural gas availability in the Atlantic region and allows a greater expansion of the natural gas market. Technology advances also enable further exploitation of western Canadian sources sustaining production levels through the forecast. Overall, a moderate supply growth in TV will still limit growth of natural gas markets. Although environmental benefits make natural gas a preferred fuel, higher costs and regional imbalances from increased competition force many users to reduce consumption.
- Market sectors unwilling or unable to use higher priced natural gas will reduce consumption through conservation and shut down, especially during periods of extreme imbalance. This, combined with accelerated energy efficiency improvement in all sectors, helps to keep a reasonable balance between natural gas supply and demand through the forecast. With likely impacts to transportation cost and supply reliability, end use markets with limited fuel options (e.g. residential, commercial, natural gas intensive industries, certain exports, etc.) and distant from the supply source are most susceptible.

5.3.5 Natural Gas Issues and Questions

1. Are estimates of resources for the WCSB, frontier areas and unconventional gas reasonable over a twenty-five year period?
2. Development of unconventional resources is typically uncertain. What would be a reasonable timeframe for significant commercial development of CBM? Tight Gas? Shale Gas? Hydrates?
3. Restricted lands were considered to have a minimal impact on the amount of resources available for development, but land restrictions may increase costs. Do you have any other views?
4. Is the deliverability profile for the WCSB reasonable in both scenarios considering increased funding and development costs? Similarly, is the pace of development of frontier areas consistent with assumed gas prices?
5. LNG is assumed to set the price cap for natural gas in North America. To meet growing gas demand, are further imports of LNG probable? If so, would further LNG imports negate some Canadian frontier development?

6. Which market sectors or particular industries are most impacted by high natural gas prices? What will be their response? What sectors or regions may be least affected?
7. How could actions in the USA impact the Canadian supply/demand balance? (i.e. with respect to Kyoto, LNG, and other fuels)

Canada