The coal option

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The coal option

– A Canadian Perspective

The Canadian coal industry has achieved renewed prominence. There are two reasons:

First, coal is used to make coke, a vital ingredient in the steel-making process. Many countries, especially developing nations, are looking for sources of high-grade coal to feed new steel mills.

Second, with petroleum resources becoming scarcer, the world is searching for alternate forms of energy. Coal, the world's most abundant fossil fuel and the energy source that fired the industrial revolution, is recognized as having a part to play in fuelling the future.

Canada, with its vast coal resources, has the opportunity not only to meet its own needs, but to help meet the requirements of other nations, and thereby make a substantial contribution to the Canadian economy.

This briefing paper, prepared as an information service by Shell Canada, looks at coal and the role it will play in the coming years.

Conversion factors

1 tonne = 2,204.6 pounds = 1.102 ton
1 kilometre = 0.62 miles

The Nature of Coal

Two lumps of coal, each taken from a different mine in a different part of the country, may look alike but they can differ markedly in quality and characteristics. That is because coal is a reflection of the circumstances under which it was formed millions of years ago. Decaying surface vegetation was transformed into coal by tremendous temperatures and pressure generated as overlying sediments buried it beneath the earth's surface.

Coal taken from different areas will vary according to the amount of carbon it contains, the hydrogen and oxygen content, the moisture content, sulphur content, and the amount of trace elements present.

There are several classification systems for coal (the table below shows one of the most common). But for the purposes of this paper, two broad categories will be used: metallurgical coal and thermal coal.

Metallurgical coal, also known as coking coal, is most commonly used in the steel-making process. It is high in carbon and possesses particular properties important to making steel.

Thermal coal, also referred to as steam coal, is used to fire boilers and generate steam. In its most widespread application, the steam then spins turbines that generate electricity. Thermal coal generally does not contain as much carbon as metallurgical coal, and has lower heat content. In general, the more carbon and less moisture coal contains, the higher the energy-value, and hence the real value, of the coal.

Coal Resources

Most of Canada's coal is located in a broad crescent that sweeps down through a substantial part of Alberta and eastern British Columbia into the United States. There are pockets of low-carbon coal in Saskatchewan and commercial deposits in both New Brunswick and Nova Scotia. There are also substantial untapped deposits in the Yukon and Northwest Territories.

In 1979, the federal government published an inventory of Canadian coal reserves and resources. The report took into account two considerations: the level of assurance of their existence and the feasibility of their exploitation.

According to the survey's conservative estimates, Canada has more than 4.6 billion tonnes of thermal coal and 1.26 billion tonnes of metallurgical coal which can be recovered with existing technology at today's prices. At current rates of consumption, that's enough to last

Classification of Coal by Rank

CLASS	DESCRIPTION	USE
Anthracite	"Hard coal" with a brilliant lustre. Burns slowly with blue flame. Contains 86 per cent carbon and little moisture content.	Domestic fuel. Can be blended with bituminous coal to produce an improved coking quality for metallurgical use.
Bituminous	Black usually banded coal. Most abundant variety. Contains less than 86 per cent carbon. Moisture content higher than anthracite.	Domestic and industrial fuel. Medium to low-volatile coals used for producing coke for metallurgical use.
Subbituminous	Black coal. Contains 15 to 30 per cent moisture when mined.	Used primarily for thermal generation.
Lignite	Brown-to-black coal. Contains 30 to 40 per cent moisture. Disintegrates in air. Relatively low heat value.	Used in few areas for thermal generation.

Coal is generally classified according to its "rank". There are several classification systems for coal. The table above shows the one most common in North America. Here coal is ranked according to the degree to which the original plant material has been transformed into carbon.

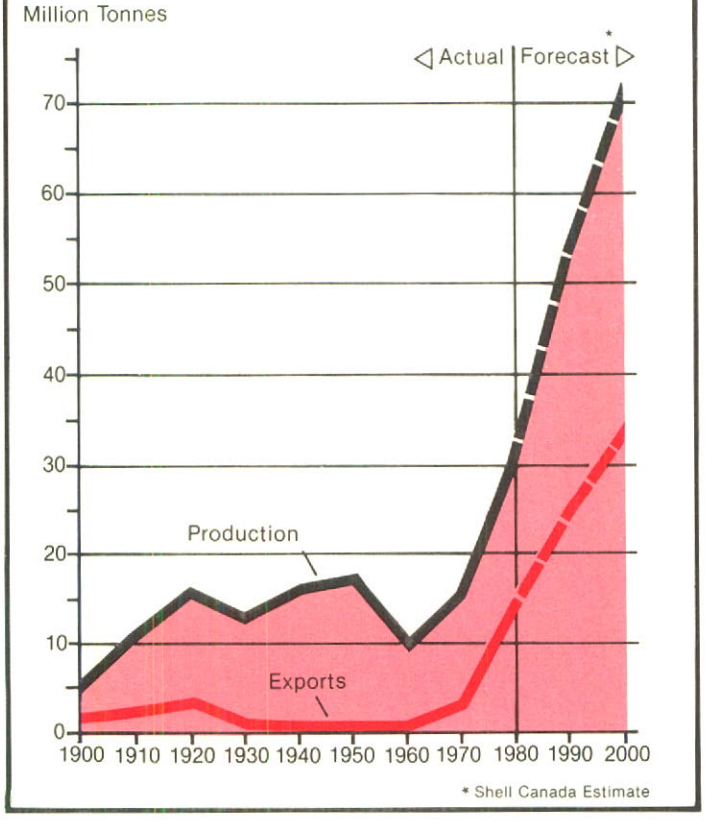
well into the next century. In addition, estimates show there may be as much as 475 billion tonnes of coal in Canada which, using advanced technology and with an improved cost-price relationship, could become economically recoverable sometime in the future.

Globally, Canada has about one to two per cent of the world's coal. The U.S., Russia and China together have almost 80 per cent.

Mining Production

In 1979, Canadian coal production totalled almost 33 million tonnes. Of that, about 16 million tonnes were delivered to Canadian power stations, more than one million tonnes were shipped to Canadian steel users, and almost 14 million tonnes were exported, principally to Japan, Korea and Brazil. The rest was used domestically in general industry.

Canadian Coal Production and Exports 1900-2000



In addition, 17.5 million tonnes were imported, mostly from the eastern U.S. About 10 million tonnes were destined for Ontario Hydro, and another 7 million tonnes were brought in by steel manufacturers.

Translating that into dollar terms, production at the minesite in 1979 was valued at almost $835.7 million compared with $54 million in 1968. Nearly half was exported bringing into the country almost $785 million from overseas sales.

The coal industry in Canada ranges from large mines producing over five million tonnes annually to small independent mines producing less than 100 000 tonnes annually. In 1979, there were about 40 mines in production. Many of them were small but 17 annually produced more than 500 000 tonnes each. In Western Canada private companies produce all the coal with the exception of a provincial utility in Saskatchewan whereas a federal crown corporation predominates in Nova Scotia and a provincial crown corporation in New Brunswick.

Altogether, there are 10,000 people employed in the Canadian coal industry with a total payroll of more than $200 million annually.

Coal Power

At the turn of the century, coal was Canada's major source of energy, supplying more than 80 per cent of the country's energy needs. By the 1940s, however, Canada had entered the petroleum era with large oil and natural gas discoveries in Alberta. Coal, which is bulky and hard to handle, was replaced with plentiful supplies of relatively cheap and easy-to-use oil and natural gas.

Today, oil supplies about 44.1 per cent of the country's energy needs, natural gas supplies another 18.6 per cent, and hydroelectric power provides another 25 per cent. Coal accounts for about 8.9 per cent while nuclear-generated power provides roughly 3.4 per cent.

Examining energy usage across the country, the Maritime provinces have become heavily reliant on oil-fired generating stations. Quebec, on the other hand, has massive amounts of hydroelectric generating capacity out of James Bay.

Ontario relies on a variety of sources. Ontario Hydro, the provincially-owned utility, has several coal-fired plants. However, most of its coal comes from the eastern U.S. because of transportation costs.

Hydro started using Canadian coal only recently and only in limited quantities after it decided a few years ago to diversify its coal supplies to protect against disruption. The utility contracted for coal from the Canadian Rockies and southern Saskatchewan. It arranged the financing for a $45 million coal-handling terminal at Thunder Bay. The terminal was opened in 1978 and has a capacity of 2.7 million tonnes, with provision for further expansion.

Manitoba relies almost exclusively on hydroelectric power while Saskatchewan and Alberta use coal-generated power, hydro-electric power and some natural gas. British Columbia relies on hydro-electric power.

Metallurgical Coal

Canada's steel industry is among the most advanced in the world. Canadian steelmakers, most of whom are concentrated in southwestern Ontario, have thus far found it cheaper to import metallurgical coal from nearby U.S. mines. About four-fifths of the coal used by the Canadian steel industry is imported.

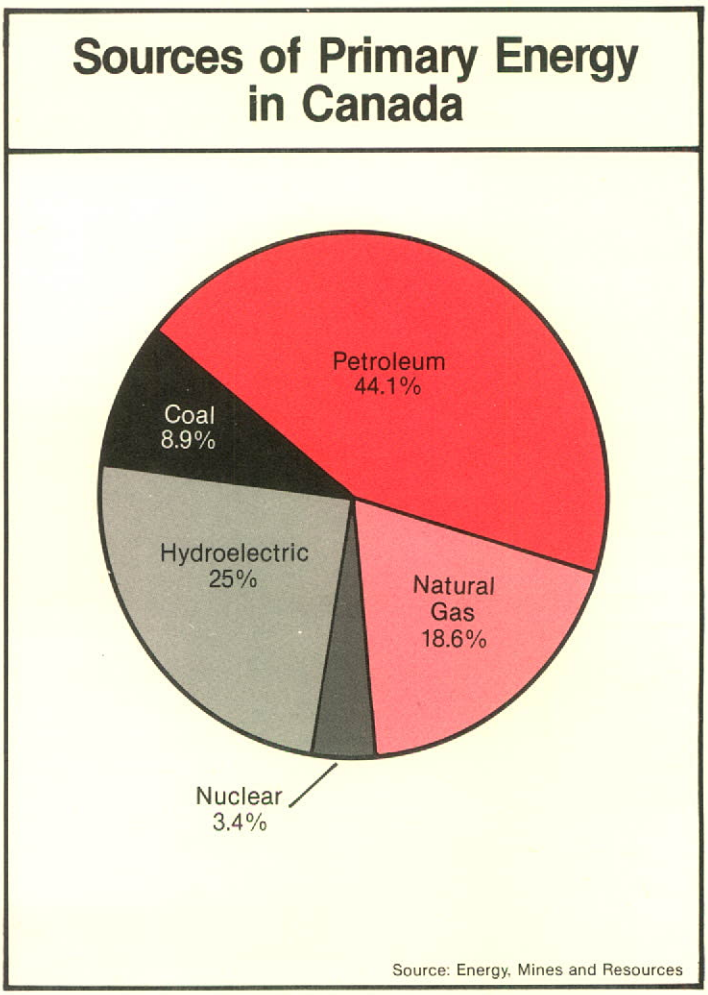
Nonetheless, Canada exports large amounts of metallurgical coal from B.C. This is how the export market developed:

The Canadian coal industry went into a serious slump when coal was replaced during the 1940s and 1950s by cheaper forms of energy, such as fuel oil in the home and diesel fuel on the railways.

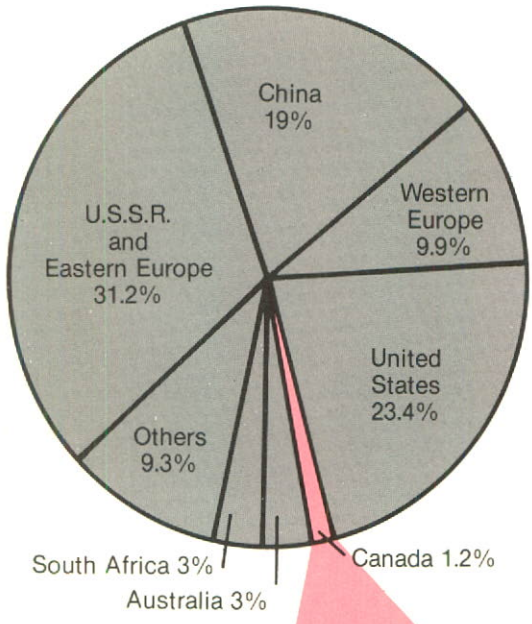
Then in the mid-1960s, Japan initiated an ambitious steelmaking program to support its burgeoning industrial enterprises. It went shopping on world markets for metallurgical coal. To protect itself against the problems of relying on a single supplier, Japan decided to buy from a number of countries, principally Canada, the U.S. and Australia.

Since the late 1950s, Canada had been making small test shipments of metallurgical coal to Japan from the Crows Nest Pass area of southern B.C. and Alberta. Within a decade, shipments had grown to 1.4 million tonnes annually and the first long-term contracts had been signed.

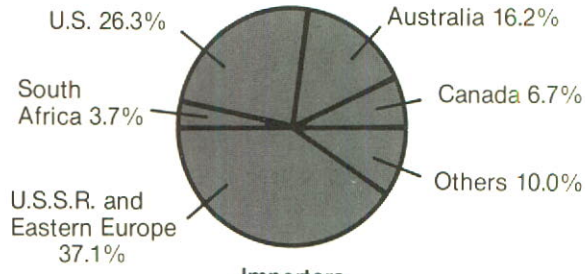
Until that time, Canadian coal mines had been relatively small, designed to feed local markets. With the opening of the Japanese market, the coal industry took on new significance. Mines grew in size and new port and transportation facilities were built.



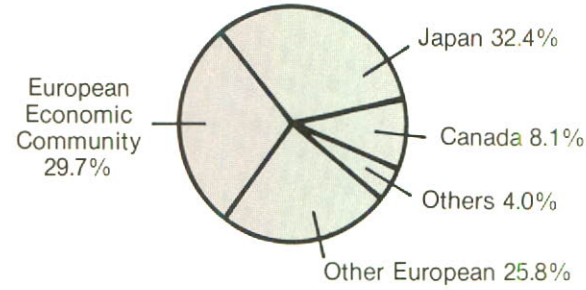
World Coal Production and Trade



Exporters

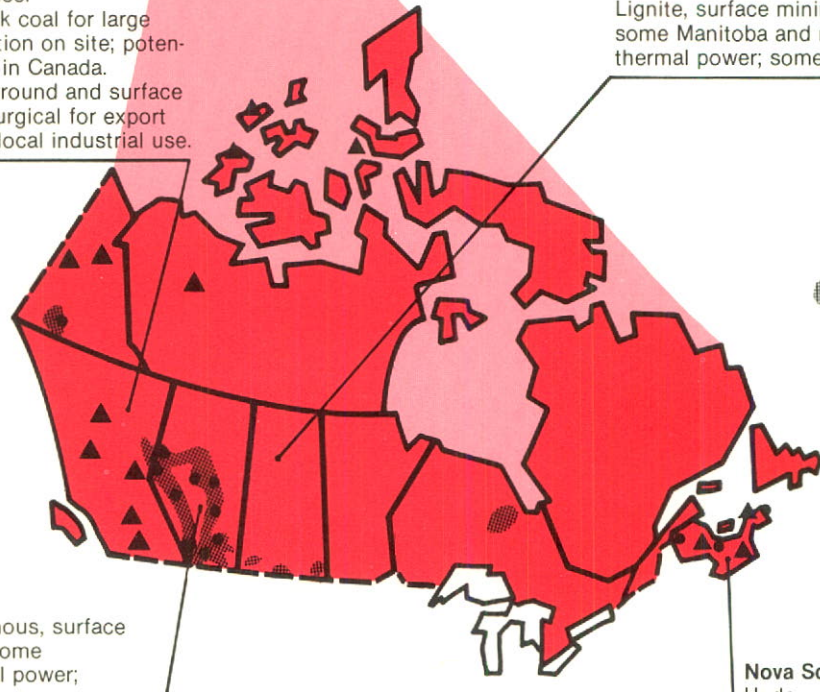


Importers



British Columbia
(a) Crow's Nest Basin: Mostly surface; mostly metallurgical for export and some Ontario use; some shipments for thermal power and industrial use.
(b) Hat Creek: Low-rank coal for large thermal power generation on site; potentially the largest mine in Canada.
(c) Other: Both underground and surface mining; mostly metallurgical for export and to Ontario; some local industrial use.

Saskatchewan
Lignite, surface mining for local, and some Manitoba and northwestern Ontario thermal power; some industrial use.



▲ Coal Areas
● Production Areas

Alberta
(a) Plains: Sub-bituminous, surface mining for local and some Saskatchewan thermal power; some industrial use;
(b) Foothills: Surface mining for local power generation; and surface and underground mining of metallurgical grade, mostly for export.

Nova Scotia
Underground bituminous; expansion of local thermal generation, substituting for oil.

The Mining of Coal

There are two types of coal mines, surface and underground. When coal seams are relatively near the surface, the overlying soil and rock are stripped away, allowing coal to be recovered using large earth-moving equipment. The profitability of this method depends largely on how much rock or overburden must be removed to uncover the seam compared with the amount of recoverable coal in the seam.

Canada has an abundance of shallow coal deposits which may be mined by highly-productive and relatively low-cost surface methods. About 85 per cent of Canadian coal is produced this way – in the Rockies, on the Prairies, and in New Brunswick.

However, the most valuable of these surface mines, those where the highest-grade coal is located, are in difficult mountain areas. These surface mines face complex physical conditions, with variable thickness in the coal seams, rugged and unusual topography, and harsh climatic conditions.

A typical surface mine, producing about one million tonnes of coal a year, requires investment of about $200 million and takes anywhere from six to eight years to bring into production. That includes the cost of plant and mine equipment, pre-production expenses and site development, acquisition costs, rail links with existing railways and, when necessary, construction of townsites to house miners and their families. Inflation has added significantly to these costs in recent years.

All mines in Nova Scotia and several mine operators in Alberta and British Columbia must use the more costly underground method because the coal seams are at much greater depths. In Cape Breton Island, the mines extend under the Atlantic Ocean. Although mine entrances are near the coast, the actual mining takes place four to five kilometres from land at a depth of 800 metres below the ocean bottom.

At one time there was considerable concern about the safety of underground mines. The introduction of new mining techniques have reduced these concerns significantly.

Transportation

In any consideration of the economics of mining coal, the distance – especially the overland distance – between the minesite and the customer is of critical importance.

Historically, this is where Canadian producers have been at a competitive disadvantage with foreign producers. Coal from southeastern B.C., for instance, must either travel by rail 1100 kilometres to tidewater on the West Coast for shipment abroad or 2200 kilometres to the head of the Great Lakes where it is loaded on lake freighters for shipment to customers in southern Ontario and elsewhere.

The introduction of unit trains during the last decade has cut transportation costs significantly. Comprising about 100 cars carrying a total of 10 000 tonnes, the unit train travels from a single minesite to port in a continuous movement. Nonetheless, despite the savings from unit trains, transportation costs from the Rockies to the Lakehead can be double the cost of production.

By comparison, Australian producers, among Canada's major competitors, have only a few hundred kilometres to travel to tidewater and American producers are close to both Ontario and eastern seaboard ports.

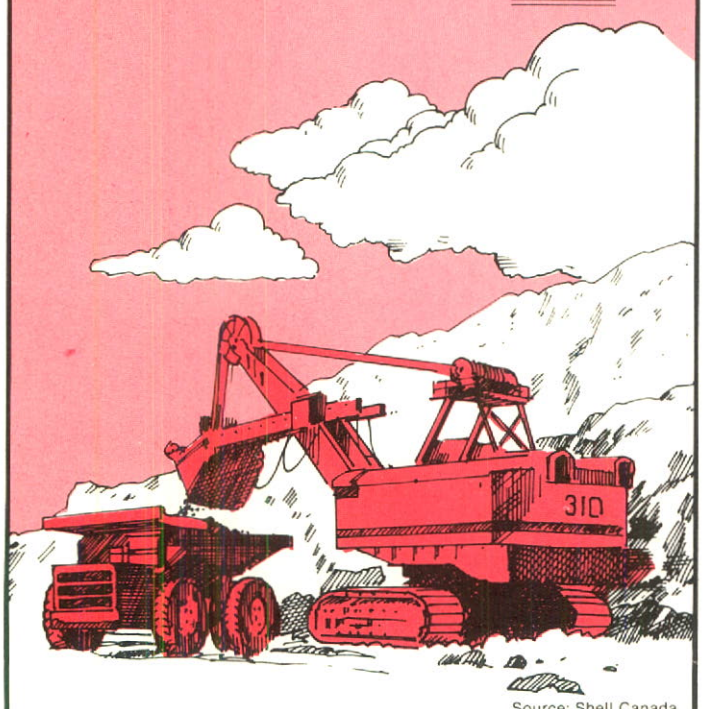
Port Facilities

There are three coal-handling terminals on the West Coast at Roberts Bank, Burrard Inlet, and Port Moody, all near Vancouver. Together they handle more than 12 million tonnes annually and are running near capacity. Expansion is planned at Roberts Bank to handle expected production increases from mines in southeastern B.C.

Further up the coast, the federal government is

Typical Costs for Bringing a Surface Mine into Production

	Cost ($Million/Million Tonnes per year)
Mining and Preparation	
Open Pit Mine	25
Preparation and Handling Facilities	35
Ancillary Buildings	10
Preproduction Expenses	10
	80
Transportation	
Unit Trains	15-25
Spur Lines	15-40
Port Facilities	20
	50-85
Infrastructure	
Townsite	25-40
Access Roads	10
Power Supply	10
	45-60
Total	175-225



Source: Shell Canada

This chart shows what it costs in millions of dollars to bring a mine into production which will produce one million tonnes of coal a year.

considering expansion of the Port of Prince Rupert to handle coal from fields in northeastern B.C., if market opportunities justify the considerable cost of building the infrastructure.

In Eastern Canada, the terminal at Thunder Bay was opened in late 1978. It is being used to supply western coal to Ontario Hydro.

Studies have also been conducted into the use of slurry pipelines, in which finely-ground coal is mixed with water to form a slurry and pumped through a pipeline. After the water has been removed, the coal can be burned directly.

Very high volumes of coal, together with long distances, are necessary to make a pipeline viable and there are only a few possible applications in Canada in the foreseeable future. For example, slurry pipelines have been investigated to fuel oil sands plants in northern Alberta and transport western coal to Ontario.

Environmental Impact

The industry and its customers recognize that they have a major responsibility in minimizing the social and environmental impact of coal. It is also recognized that the general attitude about coal in some segments of society is based to a considerable extent on past experience when community standards were different from those existing today.

In considering the question of environmental impact, there are two areas to examine: coal mining and coal use.

In mining, the main concern is the impact on the landscape and surrounding ecosystem. When surface mining has been completed, the land is restored as near as possible to its original state. Often reclaimed land is in better condition than the original land. When people's homes and farms are affected by mining development, resettlement and compensation programs are devised to minimize disruptions.

Today, coal developers involve local communities affected by development to ensure community standards are met and maintained. Both the federal and provincial governments have strict regulations governing land use.

Regarding coal use, it is recognized that burning coal without appropriate controls pollutes the environment. Once again, environmental regulations strictly govern coal use. New technologies have been developed and are continually being improved to control emissions and handle ash disposal.

A phenomenon sometimes referred to as "acid rain" has caused concern in many quarters. This occurs when sulphates and nitrates, created when coal and other hydrocarbons are burned, combine with atmospheric moisture to form a dilute acid. If this acid moisture falls in concentrated amounts over long periods, it can harm the environment. Scientists in both industry and government are working to overcome the problem and advances are being made.

It should be noted that coal from Western Canada is low in sulphur content and, as a result, it is especially attractive to domestic and foreign users.

Concern about the environment varies considerably from country to country. Within the industrialized nations, like Canada, there is a high degree of public awareness about coal, which has resulted in strict regulations to minimize its environmental impact. However, in developing countries, the concern for the environment sometimes comes second to the more urgent, immediate need for energy.

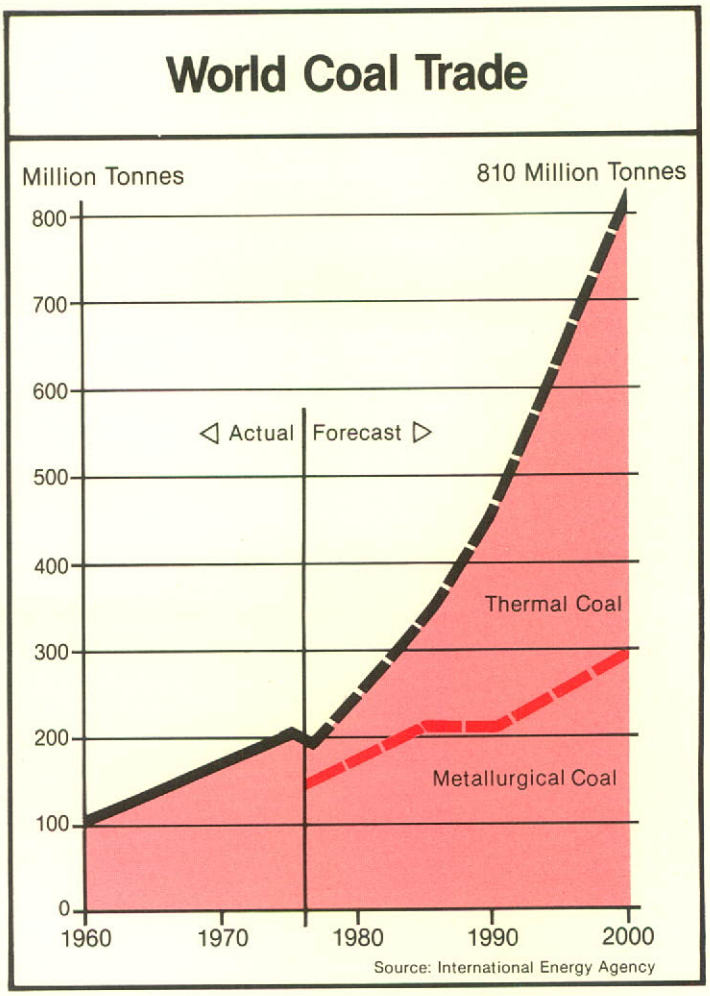
Government Policies

In Canada, the provincial governments are responsible for policies affecting resource development. Almost all provinces that use coal have developed specific policies governing security of energy supply, and the economic and social benefits from coal development.

The federal government regulates the transportation industry and controls the development of port facilities.

Furthermore, there are many areas in which both the provinces and the federal government are involved, such as taxation, environmental protection, and research and development.

The role of government in providing the right kind of climate for the coal industry cannot be overstated. World coal markets are highly competitive and Canada faces stiff competition from other countries such as Australia and the U.S. in selling its coal resources. A healthy investment climate and an efficient transportation and port structure are essential if Canadian coal producers are to compete successfully in world markets.



The Future of Coal

Canada, with its abundant coal resources, is in an excellent position to help satisfy world needs for both metallurgical and thermal coal in the coming years.

Metallurgical coal demand, ultimately linked to steel demand, will be determined by the pace of economic development around the world, especially in the countries of eastern Asia and South America. Those countries want a diversity of suppliers and Canada will be one country they look to.

Meanwhile, thermal coal demand will escalate dramatically. There is little prospect of bringing on significant new or renewable sources of energy, other than nuclear, before the year 2000. Coal has the potential to be a versatile source of energy. It is destined by sheer necessity to take the place of oil in many parts of the world as the "swing" fuel for the remaining part of this century, and possibly beyond.

Within Canada, low-sulphur coal mined in the West will be an important source of energy on the Prairies, especially in Alberta, where the government has directed that thermal coal be used for electrical generation in place of oil and natural gas. Meanwhile, Maritime coal will satisfy some of the energy needs in that part of the country.

Around the world, scientists in both industry and government are searching for more effective ways of transporting and using coal. In fact, the processes to transform coal into liquid and gaseous forms have existed for decades. South Africa obtains much of its energy from coal liquefaction and gasification, but it is costly. The task now is to make the technology more economical and efficient. Certainly, the days of a householder shovelling coal into a furnace are long past.

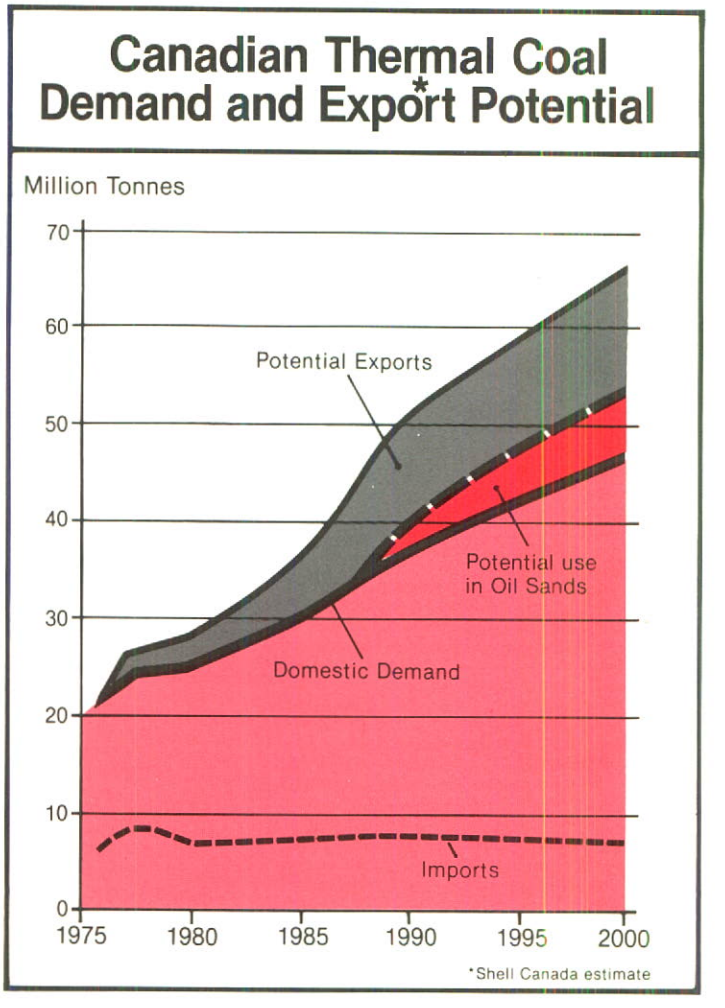
For instance, Shell companies are carrying out a number of coal-related research programs including work on developing commercially viable coal slurry pipelines; technology for treating and using slurry particles; reducing the pollution potential of low-grade, high-sulphur coal; and recovering coal from waste material produced in the coal preparation plants.

A Shell company plans to construct a 1000-tonne-a-day coal gasification plant in the Netherlands. It will use the Shell/Koppers process, which handles a wide variety of solid fuels.

Since the process requires a solid fuel to be in dust form for gasification, the entire output of a mine is acceptable as feed. Heat losses to the atmosphere are small and the process has negligible effect on the environment.

Furthermore, gasification is just the starting point for the further synthesis of ammonia, methanol, liquid hydrocarbons, and a host of petrochemicals which can be transformed into anything from carpet fibres to packaging materials.

That exemplifies just one company's efforts. Similar efforts are being made by government and industry around the globe.



In Summary

- The world faces a serious energy gap between now and the time when new alternative forms of energy begin to make a contribution.
- Until then, the world will rely, in varying degrees, on several sources of energy to fill that gap. Coal, an abundant resource, will be a major option.
- Coal's role in the coming decades will depend on the commitment by consumers everywhere to the use of coal on a wider scale, based on the assurance that the environment and community will be safeguarded.
- It will also depend on the commitment by governments to strategies which encourage the development of coal and the infrastructure – notably rail and port facilities – needed to support that development.

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