COAL IN SASKATCHEWAN

A Technical Report Prepared by
Saskatchewan Energy and Mines

December 1994

SECURITY AND PROSPERITY
THROUGH RESPONSIBLE
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Miscellaneous Report 95-10

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1. INTRODUCTION

The province of Saskatchewan has an abundant supply of lignite, a low rank coal. The lignite reserves are located along the province's southern boundary in three coalfields: Estevan, Willow Bunch/Wood Mountain and Shaunavon. Production currently takes place in the Estevan and Willow Bunch basins in five strip mines. Four are located in the Estevan Coalfield (Shand, Bienfait, Boundary Dam, and Utility) and the fifth (Poplar River) is located in the Willow Bunch Coalfield near Coronach. A fifth Estevan area mine, Costello, suspended deliveries in September 1993.

The purpose of this paper is to examine the coal industry in Saskatchewan, to provide background information on reserves, production, and sales trends, and to identify issues facing the lignite industry today.

Section 2 details the key lignite characteristics and resources.

Section 3 describes production trends in the province, and outlines the environmental impacts of coal mining and the steps taken to alleviate these effects.

Section 4 presents the current markets for Saskatchewan lignite. Most lignite is sold to the Saskatchewan Power Corporation for mine-mouth power generation. The future outlook for coal production and the limits to expanded sales to non-power generation markets are discussed.

Section 5 contains a description of the current coal royalty/tax regime in Saskatchewan. This section summarizes the findings of an earlier internal review of the royalty system and the decision to maintain the status quo.

Section 6 summarizes the trends and issues presented in the report.

2.0 COAL RESOURCES AND CHARACTERISTICS

Saskatchewan lignite occurs in three geological formations: the Ravenscrag Formation of Paleocene age, the Swan River Group of Lower Cretaceous age, and the Judith River Formation of Upper Cretaceous age (Figure 2.1). Only the Ravenscrag Formation contains lignite deposits of current economic interest. The Swan River lignite is not economic because of an extended water table from La Ronge Lake. The Judith River Formation contains seams at deeper than 100 metres.[1]

The economic deposits of coal are located in a strip along Saskatchewan's southern border. The Ravenscrag Formation is an extension of the lignite bearing strata of the Fort Union Group, which is distributed through North and South Dakota, Montana and Wyoming. In Saskatchewan, the coal bearing strata cover over 25 000 square kilometres, while the thicker, surface-mineable coal zones cover approximately 3 800 square kilometres.[2] These surface mineable zones are confined to three coal basins: Estevan, Willow Bunch/Wood Mountain and Shaunavon (Figure 2.1). The Shaunavon basin is sometimes referred to as the Cypress Hills basin.

2.1 LIGNITE CHARACTERISTICS

All of the economic coal resources in Saskatchewan are lignite, which is a low rank (or relatively immature) thermal coal. The typical characteristics of lignite from each basin

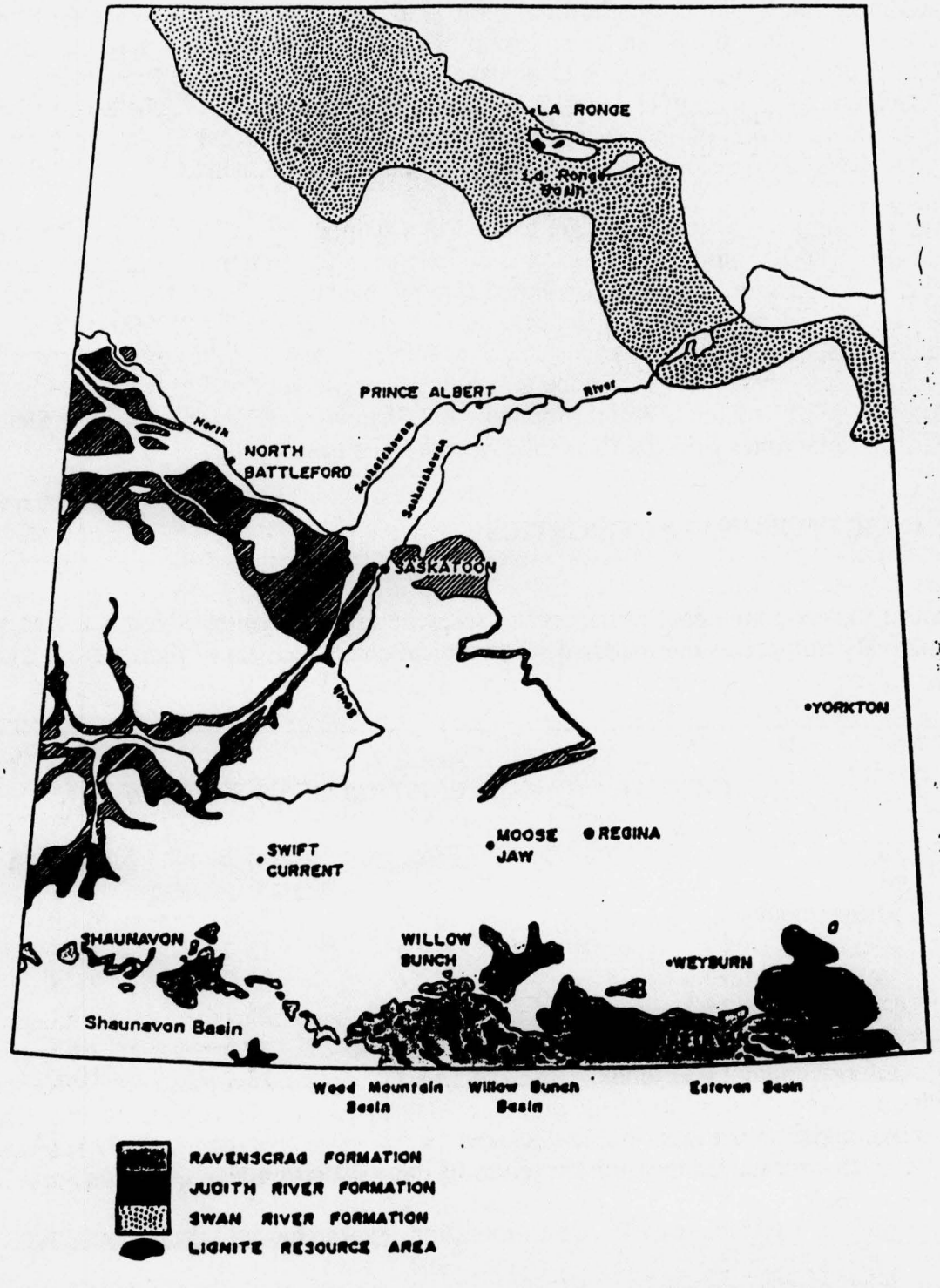
TABLE 2.1
TYPICAL CHARACTERISTICS OF IN-SITU COAL

	Estevan	Willow Bunch Wood Mountain	Shaunavon
Moisture (%)	37.5	39.5	40.9
Ash content (%)	9.1	13.7	17.5
Volatile Matter (%)	24.6	23.7	21.5
Fixed Carbon (%)	24.8	23.1	20.1
Sulphur content (%)	0.3	0.5	0.7
Energy content (GJ/tonne)	15.1	12.2	10.6
Estimated mean recoverable thickness (m) (based on measured reserves of immediate interest)	1.52	1.85	1.72

Source: Saskatchewan Power Corporation, Saskatchewan Lignite Resources, 1984; Geological Survey of Canada, 1993.

1 Saskatchewan Power Corporation, Saskatchewan Lignite Resources, March 1984.
2 Ibid.

FIGURE 2.1
SASKATCHEWAN LIGNITE DEPOSITS



(Table 2.1) show these coals to have a relatively high moisture content, variable ash content and low sulphur content. In comparison to the higher rank sub-bituminous or bituminous coals typical of Alberta and British Columbia, lignites have higher moisture content and correspondingly lower volatile matter, fixed carbon and energy content.

Certain properties of lignite increase its costs of utilization (handling, pulverization, ash disposal, and environmental control). Lignite has high reactivity, which can lead to spontaneous combustion. Handling costs can be high because of high moisture content and friability. Oxidation of lignite leads to slacking, under dry conditions lignite becomes dust and under humid conditions it becomes mud, which can become a concern for rail transportation and long-term storage. Lignite sometimes has high alkali content (particularly sodium), which can cause slagging and fouling of equipment. Its low heat value means that larger facilities are needed because more coal must be burned, which results in higher operating costs for handling, grinding and disposal.[3] These drawbacks are offset by the stable, low cost of lignite at the mine, its good combustion characteristics (also a result of its high reactivity), and by its low sulphur content, which makes lignite an economical fuel for mine-mouth power generation.

The high utilization costs and inconvenience of waste disposal reduces the attractiveness of lignite for industrial processes (such as steam raising, firing of kilns, and other drying and space heating processes) and have limited the use of lignite to power generation, although a small volume is used to produce char. The export market for Saskatchewan lignite is limited by its lower heating value per tonne of coal which makes transportation a large proportion of total cost. In comparison, B.C. and Alberta have export markets for their higher rank coals. Bituminous coal from British Columbia is almost all destined for export, for metallurgical usage. Some thermal bituminous coal is shipped to central Canada. Sub-bituminous coal in Alberta is used primarily for in-province power generation, while metallurgical bituminous coal is exported to offshore markets and thermal bituminous coal is shipped to offshore, U.S. and central Canadian markets.[4]

2.2 ECONOMIC RESOURCES

In 1978, a joint federal/provincial study identified the total in-place coal resource in Saskatchewan. The results are summarized in Table 2.2. The resources of immediate interest were determined to be 7.6 billion tonnes. The total in-place coal resources, including deep coal (at depths greater than 46 metres), was 35 billion tonnes. The resource numbers are considerably greater than what can be economically extracted, because of limiting factors such as: simplifying assumptions made for the analysis,

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3 Coal Mining Research Company, Techno-Marketing Study of Saskatchewan Lignite, prepared for Saskatchewan Energy and Mines, September 1987.

4 MacRae, K. Morgan and Shaun Hatch, Coal in Canada, CERI, Study No. 40, October 1991.

TABLE 2.2
TOTAL IN-PLACE COAL RESOURCE
1978
(Megatonnes)

Coalfield	Measured	Indicated Demonstrated	Inferred
Resources of Immediate Interest			
Estevan	309.9	496.7	437.7
Willow Bunch/Wood Mountain	1026.1	1777.3	2533.9
Shaunavon	162.2	406.4	465.5
Resources of Future Interest (at less than 46 m depth)			
Estevan	41.1	99.5	125.9
Willow Bunch/Wood Mountain	112.8	225.6	491.1
Shaunavon	7.8	22.4	44.8
Resources of Future Interest (at greater than 46 m depth)*			
Estevan		419.4	6872.5
Willow Bunch/Wood Mountain		2925.2	15562.3
Shaunavon		221.0	415.9
Totals	1659.9	6593.5	26949.6

Notes:

Measured = quantities of coal located less than or equal to 0.4 km from a borehole.
Indicated = quantities of coal which are located more that 0.4 km but less than or equal to 0.8 km from a borehole.
Inferred = quantities of coal which are located more than 0.8 km but less that or equal to 2.4 km from a borehole.

*For deep coal, demonstrated resources (includes measured and indicated coal quantities located less than or equal to 0.8 km from a borehole) were listed under indicated, whereas the inferred resources include quantities of coal more than 0.8 km but less than or equal to 4.8 km from a borehole.

Source: Irvine, J.A., S.H. Whitaker and P.L. Broughton, Coal Resources of Southern Saskatchewan: A Model for Evaluation Methodology, Geological Survey of Canada, Report 20, 1978.

TABLE 2.3
RESOURCE CRITERIA FOR SASKATCHEWAN COALFIELDS

Number of horizons in input model	
Estevan	24
Willow Bunch/Wood Mountain	31
Shaunavon	14
Type of mine	Two stage strip
Number of mining horizons considered	
Estevan	5
Willow Bunch/Wood Mountain	8
Shaunavon	3
Maximum mining depth cutoff (m)	35
Maximum incremental immediate interest ratio (bcm/tonne)	13:1
Maximum incremental future interest ratio (bcm/tonne)	20:1
Assumed in situ bed moisture (%)	
Estevan	35
Willow Bunch/Wood Mountain	40
Shaunavon	40
Heat content of ash-free coal at bed moisture (MJ/kg)	
Estevan	17.55
Willow Bunch/Wood Mountain	15.60
Shaunavon	15.60
Minimum coal bed thickness for immediate interest (m)	0.60
Minimum coal bed thickness for future interest (m)	0.45
Mining losses at top of mining zone (m)	0.10
Mining losses at base of mining zone (m)	0.10
Mining losses next to internal partings (m)	0.10
Maximum thickness of non-extractable partings (m)	0.10
Coal proportion of non-extractable partings (%)	0
Distance from control for measured resources (m)	0-450
Distance from control for indicated resources (m)	450-900
Distance from control for inferred resources (m)	900-2400
Distance from control for speculative resources (m)	2400-3000

bcm = bank cubic metres

Source: Geological Survey of Canada

geological and mining conditions, cultural features (towns, highways, reservoirs), environmental sensitivity in some coal areas, and land dedicated to other uses.

More recently, Saskatchewan Energy and Mines and the Geological Survey of Canada (through the Institute of Sedimentary and Petroleum Geology) have been conducting an assessment of the geological characteristics of Saskatchewan's coal resources. This

analysis does not include the deep coal seams (deeper than 46 metres) that were included in the earlier federal/provincial study figures.

A model of each coalfield was developed, using geophysical logs, cutting descriptions, and sample reports from 5000 exploration boreholes. Once the lithological layers were identified and correlated, a model of the coal field was created using a computer modelling program.[5] The model was then integrated with other information, including ash and sulphur content, cultural features and data from satellite photos.

To determine the economic resources of immediate interest, a number of criteria were used. These criteria are summarized in Table 2.3. The most important assumptions were: a mining cutoff of 35 metres; a maximum incremental stripping ratio of 13 bcm per tonne; a minimum coal bed thickness of 0.60 metres; a maximum thickness of non-extractable partings of 0.10 metres;[6] and mining losses of 0.10 metres at the top and base of recoverable seams. Each of these criteria decreases the level of resource for a better estimate of the tonnage that would be extractable under current mining technology and economic conditions. Larger volumes of economic resources would become available, at greater cost, if the criteria were to be relaxed.

TABLE 2.4
ECONOMIC RESOURCES OF IMMEDIATE INTEREST
(Megatonnes)

Coalfield	Measured	Indicated	Inferred	Speculative	Total
Estevan	207.0	208.6	112.9	17.4	545.9
Willow Bunch/ Wood Mountain	907.6	758.6	1026.6	234.5	2927.3
Shaunavon	205.3	118.4	79.2	14.7	417.6
Total Province	1319.9	1085.6	1218.7	266.6	3890.8

Notes: Refer to Table 2.3 for criteria used to delineate the resources.
Does not include resources occurring within currently mined areas.

Source: Geological Survey of Canada, September 1993

5 A more detailed description of the modelling method can be found in Hughes, J.D. and W.J. McDougall, *Computer Modelling Saskatchewan's Coalfields using an Expert System*, Summary of Investigations, Saskatchewan Geological Survey, 1990, and Hughes, J.D., *Interpretive Three-dimensional Modelling and Geological/Economic Analysis of Layered Sequences*, in press.

6 Mining cutoff: the maximum depth of mining; strip ratio: the volume of overburden to be removed for each tonne of coal mined; parting: a band of waste rock within a mineable coal seam.

Table 2.4 summarizes the coal resources contained within each coalfield. Resources within the current mining areas are not included in these figures. The economic coal resources (measured, indicated, inferred and speculative)[7] remaining in the Estevan Coalfield are estimated to total 546 Mt as of September 1993. The Estevan Coalfield is relatively well delineated as shown by the small amount of speculative resources. The coal resources remaining within its current mining boundaries are 134 Mt.[8]

The economic coal resources in the Willow Bunch/Wood Mountain basin are considerably greater than the Estevan and Shaunavon resources, and totalled 2927 Mt (recognizing resource estimation errors) as of September 1993. The Shaunavon Coalfield is the least explored. The economic resources present in Shaunavon as of September 1993 were 418 Mt (again recognizing the errors inherent in estimation).

The total estimate of economic resources of immediate interest for the province is 3891 Mt of lignite. Because of the more stringent criteria used in the GSC estimation of economic resources, the tonnage of "immediate interest" coal remaining is significantly less than the tonnage identified in the 1978 study; the current estimates are less than 50 per cent of the 1978 results for the Estevan Coalfield, 55 per cent of the results for the Willow Bunch/Wood Mountain Coalfield, and 40 per cent of the Shaunavon Coalfield results.

TABLE 2.5
ADDITIONAL ECONOMIC RESOURCES OF FUTURE INTEREST
September 1993
(Megatonnes)

Coalfield	Measured	Indicated	Inferred	Speculative	Total
Estevan	69.0	78.2	66.8	10.2	224.2
Willow Bunch/ Wood Mountain	165.5	219.3	438.2	101.3	924.3
Shaunavon	32.5	30.9	35.0	8.6	107.0
Total Province	267.0	328.4	540.0	120.1	1255.5

Notes: Future interest resources are the incremental resources available from mining coal seams with a stripping ratio of 13 to 20 bcm/tonne.

Source: Geological Survey of Canada, September 1993

7 It should be recognized that as the resources are less well-defined, the level of confidence in the resource tonnages drops. Measured resources have an assurance rank of ±10 percent; indicated resources, ±20 per cent; inferred resources, ±50 per cent; and speculative resources, ±100 per cent.

8 Geological Survey of Canada, September 1993.

The resources of future interest were also delineated, using relaxed resource criteria. The maximum stripping ratio was increased to 20 bcm/tonne; however, the depth cutoff criterion was kept at 35 metres. In addition, the minimum coal bed thickness was lowered to 0.45 m. The results are summarized in Table 2.5. The incremental tonnage of coal available in the province using the future interest criteria is 1256 Mt.

The depth cutoff criterion significantly reduces estimates of immediate and future economic resources in each of the coalfields. However, the deeper coals seams may be available if alternate methods of extraction were used (such as truck and shovel instead of the current dragline). Table 2.6 summarizes the incremental amount of coal that would be available in the Estevan Coalfield if the depth cutoff was changed to 40 metres.

TABLE 2.6
ADDITIONAL ECONOMIC RESOURCES IN THE ESTEVAN COALFIELD
40 M DEPTH CUTOFF

	Measured	Indicated	Inferred	Speculative	Total
Total tonnage (megatonnes)					
Immediate	257.6	246.7	117.4	17.4	639.1
Future	79.8	87.0	74.5	10.5	251.8
Incremental tonnage from 35 m case (megatonnes)					
(Per cent increase)					
Immediate	50.6	38.1	4.5	0	93.2
	(24.0%)	(18.3%)	(3.9%)	(0)	(17%)
Future	10.7	8.8	7.7	0.3	27.5
	(15.5%)	(11.2%)	(6.7%)	(2.9%)	(12.2%)

Notes: Immediate resources are available from mining coal seams with a stripping ratio less than 13 bcm/tonne, whereas future resources are available from seams with a stripping ratio of 13 to 20 bcm/tonne.
Source: Geological Survey of Canada, September 1993

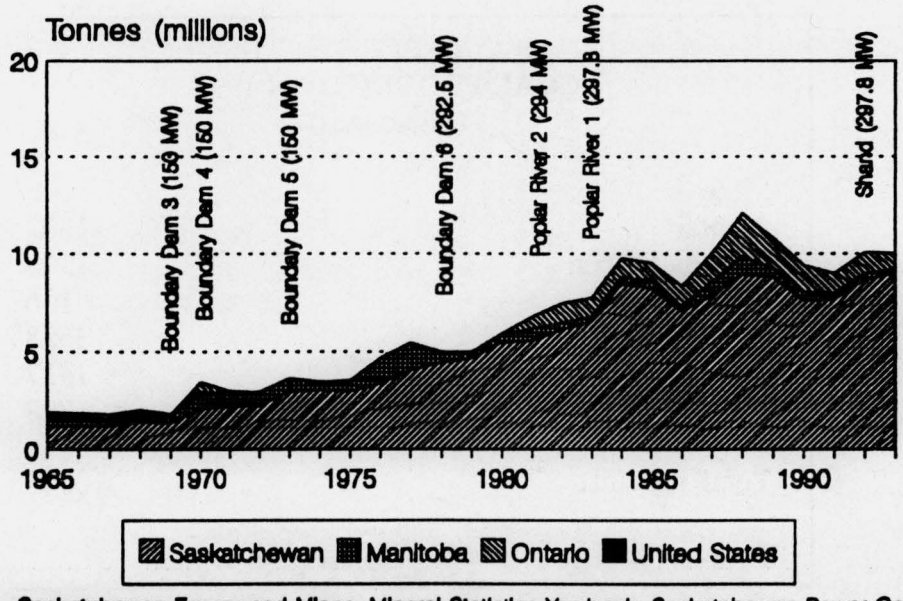
In the Willow Bunch/Wood Mountain Coalfield, the resources of future interest would be much higher without a depth cutoff. Earlier results for this area estimated that the economic resources of future interest without a depth cutoff would be approximately 3798 Mt. With the 35 metre depth criterion, the tonnage is decreased to 927 Mt. Similarly for the Shaunavon Coalfield, the estimated economic resources without a depth cutoff was 778 Mt, which dropped to 418 Mt with a 35 metre cutoff.

3.0 PRODUCTION

Coal mining in Saskatchewan first started in the early 1870s, along the banks of Willow Bunch Lake. Initially, coal was mined in underground operations, and it was not until 1927 that the first strip mine in the province opened. The underground mines could not compete against the more efficient surface operations, and by 1955-56 all underground mines had closed. In the Estevan area, it is estimated that there are more than 100 abandoned mines. In the Willow Bunch and Wood Mountain areas, 200 mines were abandoned. Most mines were small, and often unmapped or unrecorded. In the Shaunavon area, there are 60 abandoned mines. No commercial production has taken place since 1954 in this area.[1]

Coal production in Saskatchewan began to expand with the commissioning of the Saskatchewan Power Corp. (SaskPower) Estevan Generating Station units over the period of 1948 to 1957. By 1957, the total gross generating capacity of the Estevan

FIGURE 3.1
SASKATCHEWAN COAL SALES
BY DESTINATION



Source: Saskatchewan Energy and Mines, Mineral Statistics Yearbook; Saskatchewan Power Corp.
Note: Only a small volume of coal is exported to the U.S.

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1 A more detailed description of the history of Saskatchewan lignite production is found in: Bhargava, Abha, *Production and Utilization of Coal in Saskatchewan*, in Geology and Utilization of Fort Union Lignites, ed. R.B. Finkleman, S.J. Tewalt, and D.J. Daly, Environmental and Coal Associates, Reston VA.

station was 70 MW. The first two 66 MW units at the Boundary Dam Power Station were brought on in 1960 and 1961. Prior to the construction of these power plants, most coal was utilized for space heating or for industry processes. Coal production has risen steadily since the 1960s, as electricity demand increased and new power generating units stations were added, as shown by Figure 3.1.

Annual coal production in the province peaked in 1988 as a result of a drought that restricted hydro-electric generation. The power utility, SaskPower, had to rely on coal-fired electrical generation for a higher than normal proportion of power demand. For the same reason, demand for Saskatchewan lignite in Ontario and Manitoba was high in 1988.

There are currently five producing coal mines in Saskatchewan. One is located in the Willow Bunch/Wood Mountain area (Poplar River), and four are located in the Estevan area (Shand, Boundary Dam, Bienfait and Utility). A fifth Estevan area mine, Costello, suspended deliveries in September 1993 when Manitoba Hydro awarded a sales contract previously held by the Costello Mine to the Bienfait Mine. The 1993 production of each of these mines is summarized in Table 3.1. The production at Bienfait is destined for out-of-province markets (both Ontario and Manitoba) and a small amount is used to produce char, while the other mines' production is dedicated primarily to electrical power generation within Saskatchewan.

TABLE 3.1
COAL PRODUCTION 1993
(kilotonnes)

Mine	
Bienfait	1202
Boundary Dam	1904
Costello	106
Poplar River	3658
Shand	1317
Utility	1858
Total Province	10045

Source: Saskatchewan Energy and Mines

All five mines are strip (open pit) mines. The coversoil is stripped and stockpiled for later reclamation. The overburden is stripped using a dragline, then the coal is removed using shovels and haulers. At the Bienfait mine, an Easi-miner is utilized to excavate thin coal seams and allows the mine to meet the relatively strict quality requirements for its coal. The coal at the Estevan area mines is of better quality than the coal at the Poplar River mine, as described in Section 2. Moreover, the overburden in the Estevan area is more consolidated and competent than in the Willow

Bunch/Wood Mountain area, permitting steeper highwall angles and the use of draglines with shorter booms. In the Willow Bunch/Wood Mountain area, greater soil stability problems are experienced because the lignite seams are more water bearing.[2] However, problems with spoil stability and coal extraction can occur in all areas if groundwater is not controlled.

Trucks are used to transport coal from the Shand mine to the Shand power plant, and from the Boundary Dam and Utility mines to the Boundary Dam power plant. A dedicated rail system, in conjunction with truck and conveyor haulage, is utilized at Poplar River to transport coal from the mine to the power plant. The coal sold to out-of-province markets is transported via rail, by unit trains to Ontario or by mixed product train shipments to Manitoba.

Labour productivity in Saskatchewan lignite mines improved through the 1980s due to staff reductions and utilization of larger equipment. In 1980, the production per employee was 12 915 tonnes per year. Due to the high production in 1988, the production per employee grew to 24 917 tonnes per year. In 1993, the provincial productivity was approximately 21 103 tonnes/person-year (Table 3.2).

TABLE 3.2
MINE PRODUCTIVITY
(tonnes/person-year)

Saskatchewan (1993)	21 103
Bienfait	17 431
Boundary Dam	21 879
Costello	
Poplar River	20 439
Shand	35 592
Utility	21 606

Source: Calculated by dividing yearly production by number of mine employees as reported to Saskatchewan Labour in the fourth quarter.

Table 3.3 summarizes the estimates of coal production costs at Alberta and Saskatchewan Plains mines provided by Jamieson. It should be noted that the costs of production vary considerably across coal mines, and depend of the scale of the mining operation, the strip ratio, the thickness of the coal seam, the mining method (dragline or truck and shovel) and costs of reclamation. These features also affect the productivity of a mine, which in turn impacts the cost of mining. Royalties and other

2 Saskatchewan Power Corporation, Saskatchewan Lignite Resources, prepared for Saskatchewan Energy and Mines, March 1984.

taxes also vary with jurisdiction. Land costs may be different at different mines, depending on the pre-mining use.

TABLE 3.3
ESTIMATED COAL PRODUCTION COSTS

	Capital charges $/tonne	Salaries & Materials $/tonne	Taxes $/tonne	F.O.R Cost $/tonne	$/GJ
Alberta/Saskatchewan Plains Adjacent power stations	4	3	1	8	0.36
Saskatchewan Plains Out-of-province sales	4	4	2	10	0.66

Note: Heat conversion factor used 22 GJ/tonne for Alberta subbituminous coal, 15.1 GJ/tonne for Saskatchewan lignite.
Source: Jamieson, Eric, Coal supply prospects in North America, IEA Coal Research, March 1993.

3.1 ENVIRONMENTAL IMPACTS OF MINING

The coal mining companies in Saskatchewan have made tremendous advances in mitigating and alleviating the environmental impacts of coal mining. Saskatchewan Environment and Resource Management (SERM) regulates the environmental impacts of coal mining under the Mineral Environmental Protection Regulations, which became law in July 1991. These regulations adopt a "cradle to grave" approach, and pertain to all mining activities from exploration, development, production, decommissioning, reclamation, and post-decommissioning and monitoring.

Prior to mining, a company must submit a mine plan and an environmental impact assessment (EIA). The EIA includes a description of the current vegetation, wildlife, fisheries, water resources, soil and hydrogeology; an assessment of the project's impact on the environment; and the company's plans for reducing this impact. At this time, the company must also include a plan for decommissioning the facility and reclaiming lands disturbed by mining.

The bonding or other security requirements for decommissioning and reclamation were not included in the regulations. This matter is being considered by Saskatchewan Energy and Mines and Saskatchewan Environment and Resource Management in conjunction with industry representatives.

Coal mining can have a profound effect on the land. At one time, spoil piles were simply left once mining was completed. However, reclamation now occurs simultaneously with coal mining, and land is generally returned to productive use within a few years following mining.

Reclamation generally proceeds as follows. The first step of mining strips the coversoil, which is set aside for use in later reclamation. As the overburden is removed in the mining process, it is usually used to backfill the adjacent trench previously excavated by the dragline. The resulting spoil piles are recontoured by bulldozers, and the coversoil replaced. Reclamation progresses in a continuous manner; generally the coversoil removed from one mining area is used immediately to cover a previously mined and backfilled trench. The greatest costs of reclamation are associated with backfilling mined-out trenches, depending on the depth of overburden that was initially removed.

In 1993, SERM released Reclamation and Licensing Guidelines for Saskatchewan Strip Mined Coal Lands. The objectives for reclamation are: to return lands disturbed by surface mining to an acceptable, predetermined land use; to ensure physical stabilization of the soils; to achieve a sustainable land use so that the land is returned to a productive state in a timely manner; and reclamation is to be carried out concurrently with mining. In general, land is to be returned to its pre-mining uses. Guidelines are provided for re-grading, surface drainage, coversoil, and revegetation. Once the land has been reclaimed and revegetated, the company may apply to the Minister for a release from further reclamation requirements.

Another problem associated with mining is dusting of coal. Although lignite itself is chemically inert, and is in fact beneficial to the soil, dust on the surrounding vegetation can reduce the plant's ability to photosynthesize. This problem has been minimized by careful handling and storage of coal. Coal destined for export is sprayed with a latex sealer during rail transportation. Dust raised by heavy trucks on haul roads is reduced by water spraying.

There is only a small amount of methane emissions during mining, because the lignite deposits are shallow and of low rank. As well, acid mine drainage, a significant problem in eastern North American mines is not a problem in Saskatchewan because of the coal's low sulphur content and other properties.

4.0 SALES OF SASKATCHEWAN LIGNITE

4.1 INDUSTRY STRUCTURE

The lignite industry in Saskatchewan is characterized by a small number of producers and one primary buyer, the Saskatchewan Power Corp. (SaskPower). The Crown power utility purchases almost all of the coal consumed in Saskatchewan. There are two coal mine operating companies in Saskatchewan. Estevan Coal Corporation (owned by Luscar Ltd.) operates the Shand, Bienfait, and Boundary Dam mines, which accounted for 44 per cent of production in 1993. Prairie Coal Ltd. (owned by Manalta Coal Ltd.) operates the Costello, Utility and Poplar River mines, which accounted for the remaining 56 per cent of production in 1993.

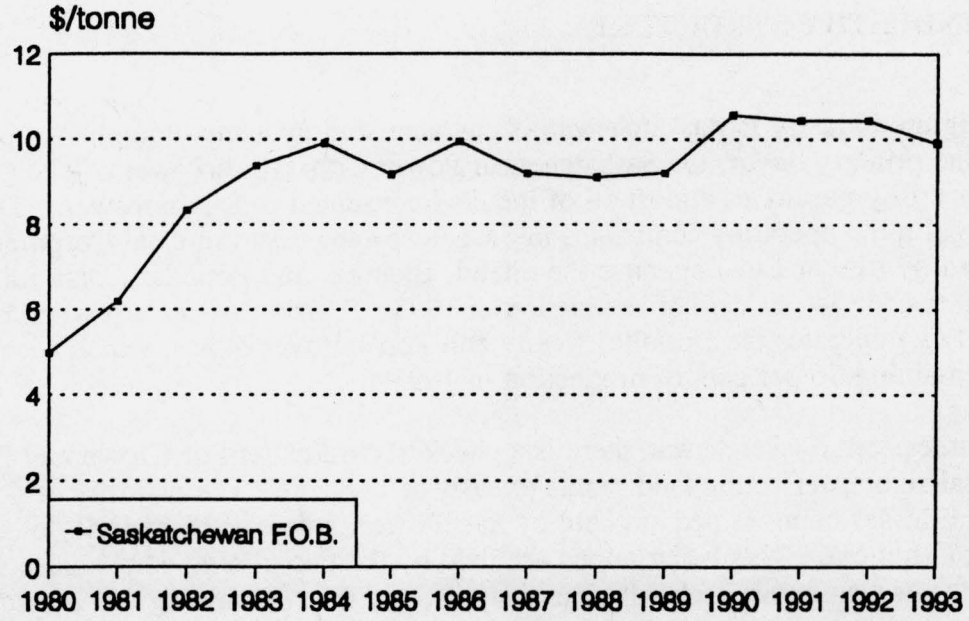
In southeastern Saskatchewan there is a checkerboard pattern of Crown and freehold mineral rights, reflecting land grants to early settlements. The majority of Crown coal mineral leases being mined are held by SaskPower, whereas the majority of coal freehold mineral rights being mined are held by the two mining companies. However, SaskPower also owns freehold mineral rights, and the coal mining firms hold some Crown coal mineral leases. SaskPower contracts out the mining of coal from its leases to the two coal mining companies.

4.2 SALES OF SASKATCHEWAN LIGNITE

The primary destination for most of the lignite produced in Saskatchewan is mine-mouth power plants. Approximately 87 per cent of coal is purchased by SaskPower, while 10 per cent of Saskatchewan production is sold outside the province, largely to generating stations in Manitoba and Ontario. A small percentage of lignite (less than one per cent) is sold to North Dakota, where it is used by a school board and a cement plant. There is also a small amount of coal (224 800 tonnes in 1993 or 2 per cent) sold within the province to industrial and domestic users. Most of this volume is used for the production of char, which is used both within the province and in the U.S. for briquette fabrication. In the past, sales were made to industrial users in Manitoba and Ontario, but these users have since converted to either natural gas or waste products.

The value of coal sales in Saskatchewan over the past ten years has remained relatively constant, as shown by Figure 4.1. In 1993, the average value of coal sold in Saskatchewan was $9.35/tonne at the mine-mouth, or approximately $0.62/GJ. The cost of coal on a per gigajoule basis is quite low and stable, especially compared to other fuels such as natural gas.

FIGURE 4.1
SASKATCHEWAN PRICES



Source: Saskatchewan Energy and Mines, Mineral Statistics Yearbook.

4.2.1 THE IN-PROVINCE MARKET FOR SASKATCHEWAN LIGNITE

SaskPower operates three coal-fired generating stations in Saskatchewan: Shand, Boundary Dam, and Poplar River. The Queen Elizabeth plant in Saskatoon has multi-fuel capability (coal, oil, natural gas). Coal-fired generation stations account for 67 per cent of all electricity generation capacity in the province (because of their high capacity factor, coal-fired units produce 70% or more of the electrical energy generated in the province). The reason for the province's dependence on coal is that it is the most economical form of thermal power generation, particularly where mine-mouth generation can be used.

- The Boundary Dam plant in Estevan consists of 6 units, for a total gross capacity of 875 MW. The first unit was commissioned in 1960, while the most recent and largest unit was commissioned in 1978.

- The Poplar River plant in Coronach consists of 2 units of 298 MW and 294 MW, commissioned in 1983 and 1981 respectively.

- The Shand plant was commissioned in 1992 and has a gross capacity of 298 MW.

- The Queen Elizabeth units capable of burning coal have a total gross capacity of 132 MW. The station uses natural gas to provide peaking capacity at present. Any coal used is sub-bituminous imported from Alberta.

The Boundary Dam, Poplar River, and Shand power plants all utilize conventional pulverized coal boilers, burning run-of-mine lignite. The Shand plant is equipped with low NO_x burners and limestone injection (LIFAC), which reduce the plant's emissions of nitrogen oxide and sulphur dioxide. Future power plants may utilize fluidized bed combustion or integrated gasification combined cycle technologies, which are cleaner burning and more energy efficient, but higher cost.

4.2.2 THE OUT-OF-PROVINCE MARKET FOR SASKATCHEWAN LIGNITE

Ontario

Ontario Hydro uses coal-fired electricity generation primarily to meet peak electricity demand, and relies instead on nuclear power and hydro-generation for its base load electricity requirements. In 1992, coal generating capacity accounted for 31 per cent of total generation capacity in Ontario.[1] As shown by Figure 4.2, the electricity generated from steam dropped significantly from 1992 to 1993, from 22 to 14 per cent.[2,3] Ontario Hydro's coal requirements have declined since the Darlington nuclear station units were brought in-service in the early-1990s.

There are five coal-fired generating stations in the Ontario Hydro system: two in the northwest (Atikokan and Thunder Bay) and three in the south (Nanticoke, Lambton, and Lakeview). The south power plants burn primarily imported bituminous coals from the United States, and some Alberta bituminous coal. Only the two northwest plants use Saskatchewan lignite; the Atikokan plant is designed only to use lignite, whereas the Thunder Bay plant uses both lignite and sub-bituminous coals. Ontario Hydro purchases Saskatchewan lignite under long-term contracts from the Bienfait Mine, operated by Estevan Coal Corp., for use in the two power plants.

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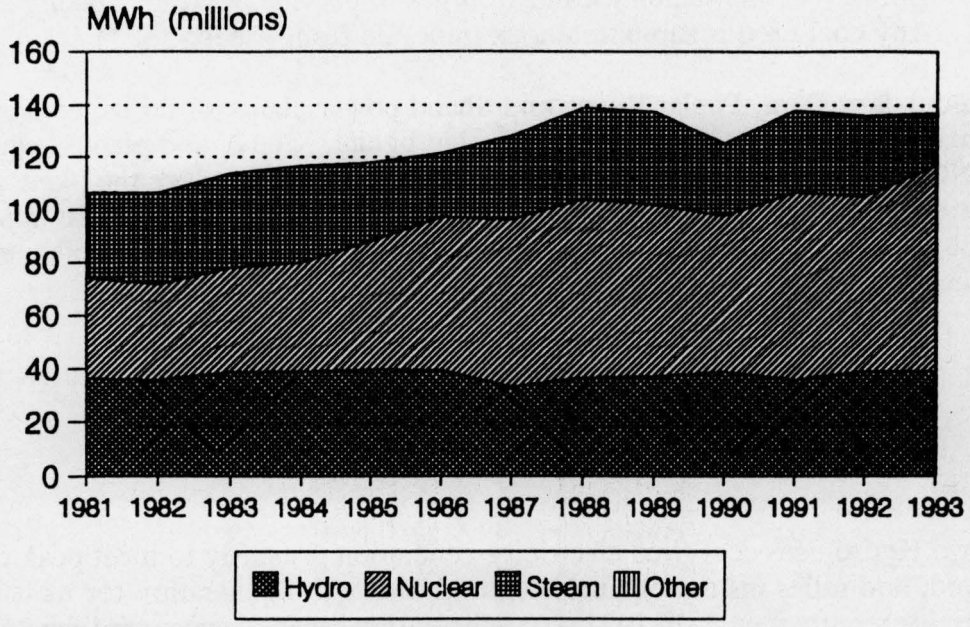
1 Energy, Mines and Resources Canada, Electric Power in Canada, 1992.

2 Statistics Canada, Electric Power Statistics, 57-202, Table 2.

3 "Steam" refers to electricity generation from coal, petroleum and natural gas boilers. Over 90 per cent of steam generation is from coal-fired boilers.

FIGURE 4.2
ONTARIO ELECTRIC GENERATION



Source: Statistics Canada, Electric Power Statistics, 57-202
Net generation of electricity

The volumes taken by Ontario Hydro for the two power plants have declined recently as the contract expiration in 1996 nears (Figure 4.3). In 1993, 832 734 tonnes of Saskatchewan lignite were sold to the Ontario market. As the sales of lignite to Ontario Hydro have dwindled, so has the amount of electricity generated. At the peak, in 1988, 3 311 GWh of energy was generated (gross) by the northwestern Ontario power plants, accounting for 9 per cent of coal generated electricity. In 1992, 1 461 GWh of energy was generated (gross), or 5 per cent of coal electricity generation.[4]

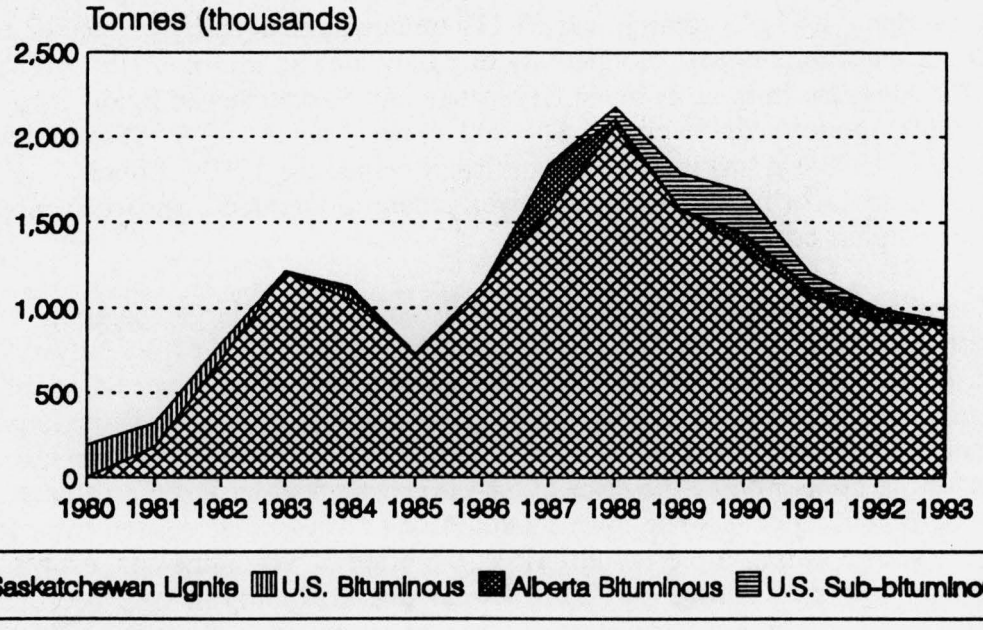
The 227 MW Atikokan plant began operation in 1985. The reference fuel for the Atikokan plant has a heat content of 16.7 GJ/tonne, moisture content of 37.8 per cent, ash content of 10 per cent, and sulphur content of 0.3 per cent.[5]

The first Thunder Bay unit was commissioned in 1963, whereas the other two units were commissioned in 1981 and 1982. Unit one was designed to burn U.S. bituminous coal. This unit ceased operation in 1984 and has since been mothballed. Units 2 and 3 use Saskatchewan lignite or Alberta sub-bituminous. The total gross capacity of the two units at the plant is 230 MW. The reference fuel for the two lignite burning units

4 Statistics Canada, Electric Power Statistics, 57-202, Table 6.
5 Ontario Hydro

at Thunder Bay has a heat content of 16.3 GJ/tonne, moisture content of 34 per cent, ash content of 9 per cent, and sulphur content of 0.6 per cent.[6]

FIGURE 4.3
ONTARIO HYDRO COAL PURCHASES FOR NORTHWESTERN POWER PLANTS



Source: Ontario Hydro

Ontario Hydro has made periodic spot purchases of sub-bituminous coal from the Powder River Basin (PRB) for use in its Thunder Bay units. The tonnage is shown on Figure 4.3. This coal is favourably priced compared to the contracted lignite, and the cost of railway/laker transportation from the Powder River Basin to Thunder Bay is comparable to costs from Bienfait to Thunder Bay (approximately $19/tonne versus $18/tonne).[7] However, partly because of the high Canada/U.S. dollar exchange rate, Ontario Hydro has not purchased any Powder River Basin sub-bituminous coal recently.

The Powder River Basin is located in southeastern Montana and northeastern Wyoming. The coal mined from the basin is sub-bituminous, with a heat content of

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6 Ontario Hydro

7 Jamieson, E., Coal supply prospects in North America, IEA Coal Research, 1993. Coal is transported from the Powder River Basin by rail to Superior Wisconsin, where it is shipped by laker to Thunder Bay.

17.3 to 21.1 GJ/tonne and very low sulphur content, from 0.2 to 1.2 per cent.[8] The coal reserves in the Powder River Basin are of superior geology. The average thickness of the Wyodak coal seam, which is the primary producing coal seam in the Basin, is 22.5 metres,[9] compared to a average thickness of approximately 1.5 metres in the Estevan Coalfield (2.5 metres for the Estevan seam).[10] The stripping ratios are much lower; in the Powder River Basin, the ratios are only 0.25 to 3.0 bcm/tonne,[11] in contrast to 6 to 7 bcm/tonne in the Estevan Coalfield.[12]

Powder River Basin mines lead the world in productivity; in 1993 the average surface mine productivity in Wyoming was 65 110 tonnes/person-year[13] in contrast to the 21 103 tonnes/person-year productivity of Saskatchewan mines in 1993. The average Powder River Basin mine is much larger than any Saskatchewan lignite mine (7 494 000 tonnes/year[14] versus 1 988 000 tonnes/year in 1993). Production in the Powder River Basin has increased significantly since the 1970s, from 9.1 Mt in 1970 to 207 Mt in 1993[15], due to increased power generation demand, particularly out-of-state, for low sulphur coal.

The combination of thick coal seams, low stripping ratios, large operations with economies of scale and competition in the transportation sector (two railways serve most of the Powder River Basin), makes the price of Powder River Basin sub-bituminous coals very competitive. Figure 4.4 compares the per gigajoule price of Saskatchewan lignite with that of northeastern Wyoming sub-bituminous coal. Since 1988, at the mine-mouth, the price of Saskatchewan coal has been greater than the price of Wyoming coal. The mine-mouth price of Wyoming coal fell from 1988 to 1993. Despite falling mine-mouth prices, the price of Wyoming coal expressed in Canadian dollars, as shown on Figure 4.4, increased slightly in 1993 because of the falling U.S./Canadian dollar exchange rate. More recently, the price of PRB coal has risen in 1994 (especially southern PRB high calorific value, low sulphur) and is expected to rise still further as more U.S. utilities require low sulphur coal to be in compliance with the U.S. Clear Air Act Amendments of 1990.

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8 Jamieson, E.D., Coal supply prospects in North America, IEA Coal Research, March 1993.

9 Energy Information Administration, Coal Production 1993, DOE/EIA-0118(92), Table 8.

10 Geological Survey of Canada, based on measured reserves.

11 Weakly, Alan, *Powder River Basin: Mother Lode of the nation's compliance coal*, Mining Engineering, pp. 939-942, August 1994.

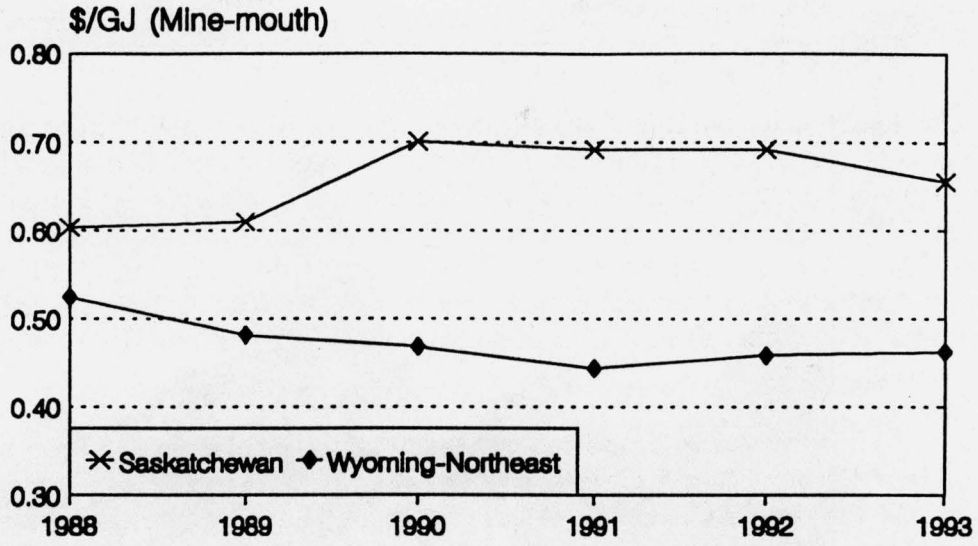
12 Geological Survey of Canada, based on measured reserves.

13 Calculated by dividing surface production by number of miners, Energy Information Administration, Coal Production 1993, DOE/EIA-058(93), Table 4 and Table 44.

14 Energy Information Administration, Coal Production 1993, DOE/EIA-0118(92), Table 4.

15 Energy Information Administration, Coal Production 1993, DOE/EIA-058(93), Table 4.

FIGURE 4.4
SASKATCHEWAN AND WYOMING PRICES



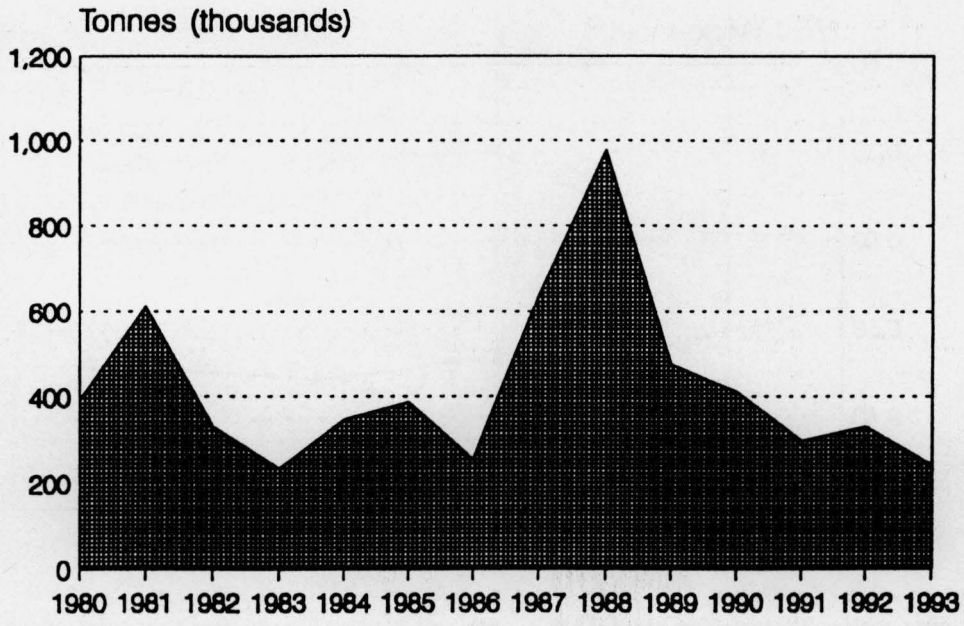
Assuming 19 GJ/tonne heat content for Wyoming, 15.1/tonne for Saskatchewan
Source: Saskatchewan Energy and Mines, Mineral Statistics Yearbook; The Geological Survey of Wyoming, Wyoming Geo-Notes.

Negotiations for the 1996 renewal of the Ontario Hydro lignite contracts will be influenced by a number of factors: competitive prices for Powder River Basin coal; excess hydroelectricity from Manitoba, which provides an alternative to electricity generated at the Thunder Bay and Atikokan units; Ontario Hydro's surplus capacity for electrical generation and its recent reduction of the amount of electricity generated using coal; and the extent of economic growth in northwestern Ontario and its effect on electricity demand.

Manitoba

Until 1993, Manitoba Hydro was supplied lignite from the Costello mine, operated by Prairie Coal, primarily through contract purchases. However, this market is now supplied from the Bienfait mine, operated by Estevan Coal. The Costello Mine has since suspended production. Figure 4.5 shows the tonnage of lignite sold to the Manitoba market from 1980s to 1993. In 1993, 241 487 tonnes of lignite were sold to Manitoba.

FIGURE 4.5
MANITOBA COAL PURCHASES



Source: Saskatchewan Energy and Mines, Mineral Statistics Yearbook.

Coal-fired generation accounts for only 7 per cent (369 MW) of the total installed generating capacity in Manitoba; most electricity is generated using hydropower.[16] There are two lignite-burning power generating stations in Manitoba: Brandon and Selkirk. The five units at the Brandon generating station were installed between 1957 and 1970, and have a combined plant capacity of 237 MW. The two units at the Selkirk generating station were commissioned in 1960, and have a combined capacity of 132 MW.[17]

4.3 COAL TRANSPORTATION COSTS

Currently, the only method of transportation for out-of-province sales of coal is by rail. Numerous studies have been conducted examining the costs of rail transportation in Saskatchewan. There have been a number of suggestions for how to alleviate the

16 Energy, Mines and Resources Canada, Electric Power in Canada, 1992.
17 Statistics Canada

burden of higher costs for Saskatchewan producers of all the major commodities, including coal:[18]

- Introduction of intramodal competition.

- Intermodal competition could be increased through facilitating higher weight truck transportation. The possibility of building a coal slurry pipeline to other markets has also been investigated, although at this time it is not feasible because of high capital costs, and concerns about water supplies.

- Opportunities to reduce the cost burden on coal transportation through tariffs more closely tied with the cost of service and/or reduction of various taxes paid by railways.

Examination of these suggestions has not led to any interventions by governments in the marketplace. Rather, it is expected that pressure from competing sources will encourage coal producers and railways to address their tariffs and rates during negotiation for renewal of Ontario Hydro coal supply contracts in 1996.

4.4 FUTURE OUTLOOK

Coal-fired generation at mine-mouth power plants will likely continue to be an economical option for base load power generation into the near future. Coal is the least expensive option for future large scale (300 MW) additions to the power grid.[19] Technologies such as fluidized bed combustion and integrated gasification combined cycle offer the prospect of burning coal more efficiently and cleanly. The future of lignite production thus depends primarily on the growth in demand for electricity in the province, and the timing of new generation capacity additions.

Expansion of markets for Saskatchewan lignite centers primarily around the issues of its economic transportation range and the lower quality of lignite. Alternatives for reducing the costs of transportation include: lower rail costs (tariffs and/or taxes); development of alternative transportation, such as coal slurry pipelines; and lignite upgrading. Upgrading generally refers to any process that results in a more favourable product, and can lower utilization costs in addition to lowering transportation costs.

The physical characteristics of Saskatchewan lignite that constrain its use for industrial processes could be mitigated by upgrading, through the removal of moisture, ash, and/or alkalis, which raises the heating value and lowers the transportation costs on a per gigajoule basis. Certain upgrading processes also remedy the storage and handling

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18 Saskatchewan Highways and Transportation, Saskatchewan Burden Study, 1989.

19 Saskatchewan Energy Conservation and Development Authority, Evaluation of Saskatchewan's Electric Options, 2003 to 2020, Publication No. G800-94-P-006, June 1994.

problems associated with lignite's friability and tendency towards spontaneous combustion.

The choice of upgrading process depends on the nature of the coal resource, the process costs, and the desired end product, which may range from a powder, briquettes, oil-coal mixture, slurries, liquid fuels, to synthetic gas. The following list broadly categorizes upgrading processes, in order of increasing thermal severity: coal cleaning, evaporative drying, pelletization or briquetting, oil agglomeration, hot water and steam drying, pyrolysis, liquefaction, and gasification.[20] A large range of upgrading processes have been investigated over the years by many agencies, although commercial viability has yet to be demonstrated.

Other developments that could provide options for larger markets for lignite include:

- Upgraded-lignite-water slurries allow the product to be moved as a liquid along a pipeline and to be used as a feedstock into industrial oil-fired boilers with relatively low retrofit costs. Although the operating costs of a pipeline would likely be low, the capital costs are prohibitive, and a large demand for the slurry would be required. Also, water is relatively scarce in the coal mining areas of Saskatchewan.

- The co-production of useful by-products, such as carbon dioxide and chemical feedstocks, with electricity, is a area of interest and could increase coal utilization. Carbon dioxide as a by-product is of particular interest because of the proximity of coal fields to light and medium oil reservoirs, where it could be used to enhance oil recovery.

Currently, the high transportation, utilization, capital and environmental control costs associated with coal-burning make coal unattractive for industrial processes and cogeneration. Industrials have determined that conversion from natural gas to coal would be uneconomic, especially given the relatively low cost and convenience of natural gas. Natural gas prices would have to rise considerably, and commercially viable lignite upgrading technologies made available before conversion to coal becomes economic.

Saskatchewan lignite is unlikely to make any further inroads into the central Canadian power generation market beyond its current market at the lignite burning facilities in Manitoba and Ontario Hydro. The lower quality of the lignite makes it difficult to compete against higher quality coal from other areas such as Alberta and the Powder River Basin in Montana and Wyoming. Even in parts of the industrial market within Saskatchewan, Alberta sub-bituminous coal is closer than the southern coalfields. Any upgrading process would have to cost less than Saskatchewan lignite's small transportation advantage to central Canada over Alberta coal.

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20 Coal Mining Research Company, Techno-Marketing Study of Saskatchewan Lignite, prepared for Saskatchewan Energy and Mines, September 1987; Couch, Gordon R., Lignite Upgrading, IEA Coal Research, May 1990.

5.0 SASKATCHEWAN'S COAL ROYALTY/TAX REGIME

There are four components to the Department of Energy and Mines' fiscal management of the province's coal resources: Crown royalties, freehold taxes, bonus bids, and lease rentals. The rationale for levying these charges is the province's ownership of mineral deposits. The goal of the fiscal management system is to promote development of the province's coal resources, while ensuring that the province receives its share of the profits or rents.

The province's current coal royalty/tax regime has been in place since 1984. There are two types of ad valorem taxes. A Crown coal royalty is levied on all production from Crown lands and a freehold coal tax is levied on production from privately owned leases. The provincial revenues from coal royalties and taxes for the 1993/94 fiscal year totalled $15.3 million.

Since 1979, Saskatchewan's Crown coal royalty has been set at 15 per cent of the mine-mouth selling price of lignite. Costs such as transportation from the mine-mouth, other ex-mine costs, and treatment costs are allowed as deductions in the calculation of the royalty. Ex-mine costs include costs which are not directly related to producing coal, such as rail load-out facilities, tipples, trucks for moving coal to power stations. In calculating ex-mine costs, a company can also include a certain percentage of the total maintenance costs, overhead, and depreciation based on how much of each was dedicated to the ex-mine costs.

The selling price is considered to be the gross amount received from the coal shipped; however, where sale of the coal is considered to be non-arm's length (for instance, when it is disposed of for a consideration other than money, or where a producer of coal consumes his own coal), the Government of Saskatchewan deems a fair market value for the coal. The Crown royalty is then levied on the fair market value, which is the average weighted value for gross sales of coal from all mines. In most instances, the deemed fair market value is applied to production from SaskPower held leases, where SaskPower has contracted out mining to other producing companies, but uses the coal from these mines for its own power generating stations.

The current freehold coal tax was put in place in 1984 as part of the new Mineral Taxation Act. The new 7 per cent ad valorem tax replaced the old freehold coal tax, which was a property tax based on remaining recoverable coal reserves on freehold tracts. The tax base for both the Crown royalty and freehold coal tax is the same - the difference is the level of the two rates. This difference in tax rate allows for the differential costs of the freehold producers: real costs if a second party holds the mineral rights; opportunity costs if the producer holds the mineral rights. On freehold land, the producer pays a freehold royalty to the mineral owner, for example a royalty of 15 per cent. This payment is deductible in the calculation of federal and provincial corporate income taxes, and can translate into an effective freehold royalty payment to the mineral owner of 7 to 8 per cent. The current freehold tax of 7 per cent plus the after income tax cost (7 to 8 percent) of a freehold royalty, was designed to equate

returns at the margin for coal producers from Crown and freehold lands. If the producer owns the mineral rights then the 7 per cent freehold tax allows the producer an after income tax freehold royalty return of 8 per cent.

In comparison, British Columbia has a two stage profit-based coal mineral tax, which was implemented in January 1990 and amended in 1994.[1] The mineral tax system replaced the old system of coal royalty on Crown production, freehold tax, and profit-based mineral tax on both Crown and freehold production. Two per cent is charged on the net current operating profit, which is the current revenues less operating costs. If the current operating profit is negative, no tax is charged. Thirteen per cent is applied against net revenue, which reflects all revenues and expenditures (including capital costs) since the start of mining activities. If the net revenue is negative, no second stage tax is applied, and the amount is carried forward with interest to subsequent years. Thus, no tax is paid until all capital expenditures have been recovered. In 1994, the province also introduced a five-year incentive program, which provides an additional allowance for new mines and expansions.[2]

In 1992, the Government of Alberta introduced separate royalty systems for sub-bituminous and bituminous coals. Alberta does not charge any freehold taxes on coal production from freehold leases. The sub-bituminous royalty is a severance royalty, calculated as a fee per tonne. The fee has been set at $0.55/tonne from 1994 to 1998. Sub-bituminous coal is primarily consumed for power generation. Sub-bituminous coal mines may be located near the utility, or have no alternative markets, which created a problem of determining market value under the old profit-based royalty system.

The bituminous royalty is two tiered. The first tier is an ad-valorem tax, which is 1 per cent of project revenue from Crown leases. The second tier is a profit-based royalty. This royalty is not applied until "payback", when all capital expenditures have been recovered. Thirteen per cent is applied against net revenue, which is mine-mouth revenue less operating costs, the first tier royalty, allowed capital costs, and the previous year's loss (if any).[3]

Both these provinces receive insignificant revenues from the profit-based royalties, largely because of low profitability of coal mines in these jurisdictions.

In the late 1980s, the Department of Energy and Mines conducted an internal review of the royalty system to examine the possibility of changing the system. The result of the review was that the status quo, the ad valorem royalty, was maintained. It was concluded that specific taxes (or fee per tonne) did not meet equity and efficiency

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1 Province of British Columbia, Ministry of Energy, Mines and Petroleum Resources, Mineral Tax Act, A Guide for Industry, January 1991; Province of British Columbia, Ministry of Energy, Mines and Petroleum Resources, *Mining Program-1994/95 Budget-Mineral Tax Amendment Act*, BC Information Letter.

2 Province of British Columbia, Ministry of Energy, Mines and Petroleum Resources, *Mining Program-1994/95 Budget-Mineral Tax Amendment Act*, BC Information Letter.

3 Alberta Energy, Coal Royalty Guidelines, February 1993.

criteria, and were insufficiently sensitive to business cycle fluctuations. As well, there were concerns about the possible redistribution of tax burden between coal mining companies. A profit-based tax was considered, which would require cost data submissions to the department, but there was no support for this change from the coal companies.

6.0 SUMMARY

A. COAL IN SASKATCHEWAN

- Saskatchewan has an abundant supply of lignite, which is a low rank of coal. Lignite has a relatively low heat content, and high ash and moisture content. Coal from the Estevan area has an average heat content of 15.1 GJ/tonne, ash content of 9.1 per cent, and moisture content of 37.5 per cent. Coal from the Willow Bunch area has an average heat content of 12.2 GJ/tonne, ash content of 13.7 per cent and moisture content of 39.5 per cent.

- The economic resources (measured, identified, inferred and speculative) of immediate interest delineated by the Geological Survey of Canada in each of the three coalfields (including coal within current mine boundaries) in Saskatchewan are as follows:

Coalfield	Economic Resource (Mt)
Estevan	680
Willow Bunch/Wood Mountain	2927
Shaunavon	418

- In 1993, 10 Mt of coal were produced. There were five operating surface mines in the province: Bienfait, Boundary Dam, Poplar River, Shand, and Utility. A sixth mine, Costello, suspended deliveries in 1993. All of the mines, with the exception of Poplar River in the Willow Bunch Coalfield, are situated in the Estevan Coalfield.

- The Saskatchewan Power Corporation purchased 87 per cent of the coal for use in its three coal-fired power stations (Boundary Dam, Poplar River and Shand). Eight per cent was sold under long-term contracts to Ontario Hydro, and 2 per cent was sold to Manitoba Hydro. Two per cent was utilized to produce char, which is used to manufacture briquettes. The remaining 1 per cent of coal was sold to North Dakota and Saskatchewan industrial, commercial and residential users.

- The current royalty system for coal in Saskatchewan imposes an ad valorem royalty rate of 15 per cent on the value of production from Crown leases. The freehold tax rate is 7 per cent.

B. COAL ISSUES

- The low cost of lignite at the mine, its high reactivity and good combustion characteristics make it an economical fuel for mine-mouth power generation. Technological developments such as fluidized bed combustion and integrated gasified combined cycle power generation are more efficient and cleaner, addressing the concern regarding the environmental effects of coal-fired power generation. At this time, coal-fired power generation will continue to be the least cost choice for base load power generation in Saskatchewan.

- The two fundamental barriers to increased out-of-province sales of lignite are transportation costs and lignite's low quality. These issues are intertwined because the lower quality means that transportation costs are higher on a per gigajoule basis. Transportation costs could be lowered through reduced rail tariffs, alternative transportation methods, or by lignite upgrading. Upgrading can also reduce the costs of coal utilization.

  Lignite upgrading improves quality, by reducing the moisture or ash content of the lignite. Commercially viable processes for upgrading Saskatchewan lignite have not yet been proven.

- The government of Saskatchewan has examined the issue of changing the royalty system to a profit-based royalty structure. Profit-based taxes are generally more efficient (or neutral) and equitable than severance taxes (specific or ad valorem), and recognize the differences in costs between mines. However, the status quo has been maintained, because historically mining companies have been hesitant to release cost information and any change in system would increase complexity and result in higher administration costs.