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CANADIAN LOW-RANK COALS: RESOURCES, CONVERSION AND UTILIZATION

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CANADIAN LOW-RANK COALS; RESOURCES, CONVERSION AND UTILIZATION1/

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ABSTRACT

Canada's measured resources of lignite and sub-bituminous coal are conservatively estimated at 3,500 and 30,000 megatonnes respectively. Most of the sub-bituminous coals are located close to the surface in the Alberta plains and are now being mined for about $8.00/tonne. National production of low-rank coals, which totalled about 16 megatonnes in 1980, could escalate to over 80 megatonnes by 2000. About 95% of the present demand is used for electricity generation, but this percentage will gradually decrease as emerging conversion and utilization processes for industrial heat and energy mature over the next 20 years.

Two major pit-head power projects, one at Hat Creek in British Columbia and one south of James Bay in Ontario are under active study and new generating stations in Alberta, Saskatchewan and Ontario will increase electrcity production from low-rank coal from 3950 MW in 1980 to 5500 MW by 1982.

R, D and D activities, many of which are being done under shared-cost programs between the federal government, the governments of the producing provinces and industry, are being rapidly accelerated to reflect the high priority being given the national goals of independence from off-shore oil and the achievement of energy security by 1990. Some of the activities, now in progress include:

a) development of computer technology to evaluate the deep coal resources of the interior plains.

b) elucidation of the combustion, fouling and emission characteristics of new coal deposits.

c) technico-economic assessments for a 150 MW and a 300 MW combined-cycle power plant based on lignite and

d) pilot-plant liquefaction studies of low rank coals using bitumen and heavy oils as hydrogen donors.

Other areas of interest include lignite upgrading to reduce moisture content, in-situ gasification, pressurized fluidized-bed combustion for advanced electricity cycles and the use of low-rank coal for the extraction and upgrading of bitumen and heavy oil.

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CONTENTS

TABLES

FIGURES

INTRODUCTION

Production of Canadian low-rank coal reached about 16 Mt in 1980 and could exceed 80 Mt by the year 2000. Nearly all of this production is now being used or is being earmarked for electricity generation. It is anticipated, however, that more than 15% of future demand may be for coal conversion processes. Expanded use of lignite and sub-bituminous coals is an important option in Canada's quest for energy security and oil dependence by 1990.

The Department of Energy, Mines and Resources Canada (EMR), the lead federal agency for coal activities, works closely with provincial agencies, industry and universities to foster a broad range of complementary programs on low-rank coal, ranging from resource assessment to utilization technology.

This paper gives an overview of the role of low-rank coal in Canada with respect to:

a) potential resources and reserves,

b) present and future market demand,

c) current research, development and demonstration (R, D and D) projects and

d) future perspectives.

MAJOR DEPOSITS AND OCCURRENCES

Resources

Canada's low-rank coal resources (Figure 1), are concentrated mainly in the western provinces of Saskatchewan, Alberta and British Colubmia and north of 60° north latitude. Smaller coal fields are located in Ontario and Manitoba.

Table 1 shows that 30 Gt or almost 85% of the measured resources, i.e. those resources computed from observation points not more than 300 m apart, are sub-bituminous in rank and are located in Alberta; lignite located in Saskatchewan and British Columbia makes up most of the balance (1). The calorific values of the coals on a moist basis, Table 2, vary from 17.9 to 25.0 MJ/kg for sub-bituminous and from 8.8 to 15.4 MJ/kg for lignite. These Tables do not, however, include data for either

a) the Manitoba deposits which are too thin to be a viable resource,

b) those seams in Alberta, British Columbia and Saskatchewan that are too deep to be of near-term interest, or

c) the deposits north of 60° north latitude, which although believed to be large, are not well defined.

Table 1 - Canadian coal resources and reserves by area and rank

		Resources			Reserves					
					Mineable Coal			Recoverable Coal		
Area	Rank	Measured	Indicated	Total	Under-Ground	Surface	Total	Under-Ground	Surface	Total
British Columbia and Yukon	Lignite	1,845	91	1,936	---	839	839	---	397	397
Alberta**	Sub-bituminous	30,000	---	30,000	1,347	5,981	7,328	n.a.	n.a.	2,182
Saskatchewan	Lignite	1,499	2,681	4,180	---	2,150	2,150	---	1,720	1,720
Ontario	Lignite	218	---	218	---	218	218	---	---	---

*1978 Data. Source coal resources and reserves of Canada. Report ER 79-9, Energy, Mines and Resources Canada, Ottawa.

**Estimates for Alberta have not been prepared by EMR. The figures reported in this table are those reported by the ERCB (Alberta's Energy Resources Conservation Board.) The ERCB's "established resources" are reported as EMR "measured resources" and it is recognized these figures include some undetermined amounts that ERM would report as "indicated".

Table 2 - Rank and quality of Canadian coal resources (1978)

Area	Rank(1)	Proximate Analysis %(2) M	A	VM	Sulphur %	Heating Value (m.b.)*MJ/kg
ONTARIO	lig.	50.0	6.5	1.5	0.7	14.0
SASKATCHEWAN						
Estevan	lig	27-32	13-25	22-25	0.2-0.6	13.0-15.4
Willow Bunch	lig	25-32	14-30	20-25	0.2-0.6	12.1-15.1
Wood Mountain	lig	24-28	22-35	18-23	0.2-0.6	10.7-13.7
Cypress	lig.	20-28	22-45	15-23	0.2-0.6	8.8-13.7
ALBERTA (3)						
Plains						
a) Eastern	Sub C	24-31	5-10	27-30	0.3-0.7	17.9-21.2
b) Central	Sub B	17-23	6-12	26-32	0.3-0.7	20.7-23.3
c) Western	Sub A	14-16	11-13	30-32	0.3-0.7	22.1-25.0
BRITISH COLUMBIA						
South Central	Sub lig	20-23	8-33	24-30	0.4-0.6	11.6-22.1

*Moist basis:

(1) lig = lignitic; Sub A = sub-bituminous A; Sub B = sub-bituminous B; Sub C = sub-bituminous C;

(2) Proximate analysis is the determination by prescribed methods of moisture (M), ash (A), volatile matter (VM), and fixed carbon by difference (FC).

(3) Data provided by Alberta Energy Resources Conservation Board.

Reserves

Coal reserves, that part of the resources that can be recovered econmically using current technology, are divided at the federal level into two categories - mineable and recoverable. Mineable refers to coal that can be considered for mining using present technology and broad economic judgement whereas recoverable refers to that part of the mineable coal which can be recovered as run-of-mine coal at current prices for specific infrastructure in an area legally open to mining.

The mineable and recoverable reserves of Canadian low-rank coal, (Table 1) exceed 10 Gt and 4 Gt respectively [1]. These reserves typically contain less than 1% sulphur and more than 20% volatile matter on a moist basis. Moreover, most of the recoverable portion, being in flat or slightly inclined beds just below the surface, can be readily extracted by surface mining.

Figure 2 shows the coal resource to reserve categories used by the Department of Energy, Mines and Resources Canada.

PATTERNS OF LOW-RANK COAL USE

Present Production

Canadian low-rank coal reserves are generally developed over the long term because most mines are designated for captive markets such as pit-head generating stations. At present all producing mines,(Figure 1), are located in Saskatchewan and Alberta. As shown in Table 3, over 99% of the 1979 production, which toalled 14.5 Mt, came from surface mines. It was used almost exclusively for electricity generation. The quality of the marketed coal is also given in Table 3.

Mining costs for sub-bituminous and lignite coals in 1980 were about \$8 and \$10 per tonne or \$0.48 and \$0.54 per GJ respectively; transportation costs would add about \$0.50 and \$0.55 per GJ respectively for a 100 km journey by train or truck.

Future Demand

Electricity generation will continue to account for most of the future demand for low-rank coal [2] with the proportion for industrial use and synfuel production increasing from 5% in 1979 to possibly 25% by the year 2000, as shown in Figure 3. The industrial demand is expected to be relatively constant with synfuels production and bitumen co-processing possibly creating significant new demand by 1990.

The electricity generating capacity over the next decade, which will increase by over 250% from 3900 to 10,500 gross MW will be distributed regionally as shown in Figure 4 [2]. All of the utility increases in sub-bituminous coal demand will occur in Alberta with increased lignite demand occurring in Saskatchewan, Ontario and British Columbia. Between 1981 and 2020, the average capacity factors for the steam generators fired with low-rank coal are estimated at 80%, 70%, 65% and 55% for British Columbia, Alberta, Saskatchewan and Ontario respectively.

Table 3 - Quality and production of marketed coal*

Area	Saskatchewan	Alberta	
Rank	Lignite	Sub-bituminous	
		B	C
Proximate Analysis, %			
Moisture	26.0-28.5	17.6-20.1	22.8-25.0
Ash	7.2-18.1	7.4-13.6	5.8-10.7
Volatile Matter	26.2-31.6	25.8-31.1	28.2-30.4
Sulphur	0.4-0.6	0.2-0.5	0.3-0.4
Calorific Value, moist basis MJ/kg	15.6-18.0	18.2-21.0	17.9-20.0
Run of Mine Production, Mt			
Underground-room and pillar			0.03
Surface - dragline stripping	5.06		7.17
- truck and shovel stripping			0.51
	5.06		8.31

*1978 Data

In Alberta, under present coal policies, the percentage of electricity produced from sub-bituminous coal will increase from 75% in 1979 to about 95% by 2006 (3). In Saskatchewan, where 67% of the electricity demand is now produced from lignite, recent coal policies favour a continuing reliance on low-cost lignite for a significant portion of potential electricity needs. British Columbia, which presently has about 11,000 MW of installed capacity, has no coal-fired generating stations but plans to have 2000 MW of electricity available from low-rank coal at Hat Creek by 2000 (4). The electricity produced in Ontario from Saskatchewan lignite is scheduled to increase from 0 in 1979 to 1720 MW or 5% of its total electrical capacity by 1990.

The demand for low-rank coal could increase dramatically, as shown in Figure 5 and 6, if contributions to the primary energy demand from nuclear or other energy sources do not materialize as forecast.

RESEARCH ACTIVITIES

A detailed list of current Canadian research, development and demonstration projects on coal (5) indicates that in addition to EMR, significant work on low-rank coal is being sponsored by the Coal Mining Research Centre (Edmonton), Saskatchewan Power Corporation, the Canadian Electrical Association, the Alberta Research Council and Ontario Hydro to name a few.

Highlights from broad spectrum of R, D and D subjects being studied are summarized below.

Reserve Assessments

The capability to conduct biennial assessments of low-rank coal, based on best available data, is being established in conjunction with a national data base for in-situ coal quality. Paralleling this work, methodologies are being developed to:

a) use open-pit mining models for improving reserve determinations.

b) log coal quality in bore holes and

c) develop computer technology for evaluating the resource potential of deep coals in the plains region.

Mining

Most of Canada's low-rank coal is being strip-mined, and the following projects reflect areas of present interest to the industry (6).

a) the use of infra-red sensors and vibration analysis to warn of component failures in equipment used in plains strip mining operations.

b) a technico-economic assessment of the use of bridge convyors to improve reclamation of upper soil layers removed during surface mining operations and

c) the feasibility of using bucket wheel excavators instead of draglines and shovels in the Alberta plains for overburden removal.

Preparation

Upgrading of coal quality by ash removal is essential for coal conversion processes and important for reducing transportation costs of thermal coal. In general, the plains coals, which contain inter-bedded clay, clean and degrade easily and the potential for recovery of calorific input can exceed 90%. Major research projects involve defining the washability characteristics of different coals, improving effluent water clarification by the use of flocculants and enhancing fine coal recovery. Data generated from these projects will be used to develop computer models for predicting the performance of new washeries or for tuning existing plants. Other studies have involved a review of the applicability of current dry cleaning processes to high-clay thermal coal, development of counter-current, fluidized-bed cascade to beneficiate low-rank coals and ash removal by water washing with concurrent reduction of sodium by ion exchange with calcium to control fouling of fireside surfaces.

Two of the major problems encountered in lignite conversion processes are addressed in separate experimental programs. These are

a) the high moisture content of lignite as mined and

b) the high oxygen content of the young coal.

Moisture creates a thermal penalty in all process uses of lignite; the high oxygen content can give rise to expensive hydrogen consumption if a hydroliquefaction process is being contemplated.

The removal of oxygen from lignites by reaction with reducing agents has been successfully demonstrated in the laboratory [7]. The de-oxygenated coal- after hydrogenation - gave a primary liquid product with markedly lower oxygen content than derived from the parent coal.

The thermal dewatering of lignites using preheated steam (300°C) has also been successfully demonstrated in the laboratory [7] where reductions of coal moisture content to levels below 10% can be achieved with minimum values of 2%. The water removal was accompanied by significant reductions in the water-soluble sodium content of the coal.

Combustion

The direct burning of low-rank coals under environmentally acceptable conditions is being extensively studied in pilot-scale rigs designed to duplicate or closely simulate practical pulverized-fired or fluidized-bed combustion systems [8]. Schematic illustrations of two pilot-scale systems at EMR are shown in Figures 7 and 8.

Pulverized-Firing

During the past few years, emphasis has been placed on expanding the application for low-rank coals by delineating the grinding, combustion, slagging, fouling and emission characteristics of coals and coal blends that have not previously been burned in process kilns or large generators. The wide scope and potential application of these evaluations, which have mostly been jointly funded by EMR and industry, are illustrated by the following examples:

a) Improvements in the burning properties of high-clay, sub-bituminous coal due to upgrading. These studies demonstrated that reducing the ash content of the raw coal from 52% to 18% by water washing significantly decreased both the carbon carryover and the fly ash loading of the flue gases. Beneficiation did not, however, decrease the degree of transformation during combustion of clayey ash to mullite, a very hard mineral that could cause severe abrasion to convection tubes; nor did it alter fly ash resistivity values.

b) Reduction of sulphur oxide emissions from lignite by lime addition. Typically, cations in lignite ash can neutralize up to 30% of the fuel sulphur and sulphur neutralization can be enhanced by adding lime to the pulverizer. Sulphur retention at 5% excess oxygen was found to increase from 32% for the raw coal to 47% when 1% by weight of lime was added to the fuel supply. This level of neutralization corresponded to 25% lime utilization by gas-phase sulphur and indicated that SO_2 emissions from this lignite can be virtually eliminated by a 2% by weight lime addition to the lignite.

c) Control of NO_x emissions from lignite by low-excess combustion air and externally recirculated flue gas. Decreasing excess oxygen levels in flue gas from 15% to 5% produced a 50% reduction in NO_x emissions and increasing recirculation ratios from 0 to 0.2 at 1% excess air produced a further 15% reduction in NO_x. Recirculation ratios above 15%, however, increased flame length noticeably and increased carbon carryover in the flue gas to unacceptable levels.

d) Blending high ash-fusion, low reactivity bituminous coal with low ash-fusion, high reactivity lignite to enhance average combustion performance, heat transfer characteristics and boiler availability. In one series of trials, a highly-oxidized bituminous coal was blended with 60% high-sodium lignite on a calorific basis, to produce a boiler fuel having excellent burning properties with no slagging or fouling tendencies.

Pilot-scale trials are generally followed by full-scale burns to validate the experimental results and to provide reliable design data for new units. Relative to bituminous coal, Canadian sub-bituminous and lignitic coals generally require combustion zone volumes that are larger by about 15% and 30% respectively.

Fluidized-Bed

Fluidized-bed combustion, although still an evolving technology, is of priority interest to Canada because it offers the potential to significantly expand the resource base for low-rank coal by allowing coaly waste and wet coal rejects to be used for fuel (9).

Experiments with a number of lignites and sub-bituminous coals have demonstrated that coals with moisture and ash contents totalling over 70% can be burned successfully and that acid gas emissions can be reduced by over 80% with limestone additions.

Two pilot-scale combustors - one at EMR and the other at Queen's University - are just being commissioned. The EMR unit will be used to define combustor design parameters and the Queen's unit will be used for graduate research projects on in-bed reactions and mechanisms for low-rank coals.

Work is also proceeding on the design of a bench-scale fluidized-bed combustor which will be used to elucidate the combustion reactivity effects of various coal properties.

Conversion Processes

Gasification

Saskatchewan Power Corporation is undertaking a bench scale gasification research and development program in support of the Shaunavon combined-cycle economic study (10). The objective of the study is to document the effects of natural lignite quality variations on the rate and quality of gas production in a Lurgi-type fixed-bed gasifier.

In support of this experimental program a bench scale program of gasification research and development coupled with petrographic study of both the feedstock and carbonaceous residue has been undertaken. The early results (11) show that inertinite macerals retard gasification. There is, amongst the reactive macerals, a preferential reaction of cell-wall derived material followed by liptinite and huminite macerals. Wide variations in maceral composition are known to occur in Saskatchewan lignites and are therefore expected to give rise to significant changes in the overall rates of reaction in both fixed and fluid-bed gasifiers.

Liquefaction

Research and development in coal liquefaction in Canada is continuing on a modest scale with activity currently being focused on a few continuous processing units located at research establishments around the country. These research efforts are funded wholly or in part by the federal or provincial agencies.

The state-of-the art of coal liquefaction and the levels of expenditure around the world make it unlikely that a totally Canadian coal liquefaction process will be developed; it is more likely that an existing process will be adapted to Canadian circumstances (12). Canada through its tar sands and heavy oil plant, is a world leader in bitumen processing and in the combination of coal expertise with bitumen processing in a co-processing mode of operation. This co-processing option represents a special opportunity for Canada and is receiving serious study in research programs.

There is evidence that the combination enhances the yield from both feedstocks although a number of technical questions remain to be answered. Where bitumen is not available refinery residues could be alternative co-processing feedstocks.

Canadian lignites are located near the heavy oil fields of northern Saskatchewan and the possible use of the co-processing option is a target for research and development.

Many of the coal liquefaction research activities undertaken on contract to the federal government (5) use lignite and sub-bituminous coals since they represent the initial stages on the coalification ladder.

Lignite hydroliquefaction studies using a syngas ($CO + H_2$) hydrogen carrier have been reported elsewhere (12). This work represents an attempt to minimize hydrogen consumption by preferential reaction of oxygen-containing functional groups in the coal with carbon monoxide.

The liquefaction behaviour of the Saskatchewan lignite used in this study was compared with two North Dakota lignites under the same experimental conditions. Table 4 shows the results of this comparison. The North Dakota lignites are in general more reactive, giving higher conversion and greater liquid yields at experimental conditions which were less than optimum for Saskatchewan Estevan lignite. Also, autoclave deposits were less and filtration of whole slurry product easier with the North Dakota lignite.

Table 4 - Batch liquefaction of Saskatchewan and North Dakota lignite

T = 420°C　　Initial Cold Pressure = 9.06 MPa (1314 psi)

Initial CO/H_2 Molar Ratio = 1　　Contact Time = 30 min

Lignite	Conversion (%)	Liquid Yield (%)
Zap Mine, ND	90.2	46.9
Gascoyne Mine, ND	90.2	64.9
Klimax Mine, Sask	82.7	45.5

The results of this initial study are currently being used as a starting point for design and construction of a nominal 10-kg/h, continuous-flow coal liquefaction unit at the Sandwell Beak Research Group in Toronto. The unit is now partially constructed and commissioning is expected to start before the fall of 1981. First experimental operations will be with lignite and sub-bituminous coals from western Canada.

Research Needs

In view of the expected increase in the demand for Canadian thermal coal, the following problem areas are suggested topics for priority research:

1. Reliable and preferably rapid in-situ techniques to sample and analyze trace elements and potentially undersirable hydrocarbons in flue gas.

2. Improved analytical methods to better evaluate coals with high ash, high moisture and high inertinite contents. Current standard methods for example do not indicate whether:

   a) the volatile matter is combustible or non-combustile.

   b) the moisture is associated with coal or the mineral matter.

   c) the major coal macerals are reactive or non-reactive, or

   d) the nitrogen is in the fixed carbon or the volatile matter.

3. Rapid, bench-scale methods for screening the burning performance of coals prior to implementing pilot-scale burns in pulverized-fired or fluidized-bed systems.

4. Rapid, bench-scale methods for predicting slagging and fouling characteristics of ash. Standard ash fusion temperatures, being subjective, do not provide definitive data for assessing ash behaviour during combustion and deposition.

TECHNICO-ECONOMIC STUDIES

Combined Cycle Power Production

Shaunavon

A study comparable to the Energy Conservation Alternatives Study (ECAS) (14) has been carried out to relate various gasification/combined-cycle technologies to Canadian lignite deposits in the Shaunavon area of Saskatchewan (15).

This study considered a small (300 MW_e) installation using the Shaunavon lignite as opposed to the Illinois No. 6 bituminous coal which was the feedstock considered in the ECAS study. The important technical and economic consequences of this change are shown below:

Table 5 - The effect of feedstock on cycle performance: Shaunavon Phase I

	Cycle Efficiency, %		Cost of Electricity*
	Illinois No. 6	Shaunavon Lignite	mils/kWh Shaunavon Lignite
Base Case (Pulverized Firing and Scrubbers)	-	28.6	35.2
Westinghouse:ECAS	46.8		36.2
G.E.: ECAS	39.6	34.3	41.9
G.E.: ECAS/NASA I	37.0	32.4	39.7
G.E.: ECAS/NASA II	39.3	-	-
G.E.: ECAS/NASA III	42.0	36.7	38.5

*Mid 1978 Canadian Dollars; reflecting differences due to both coal quality and price.

Later phases of the Shaunavon study compared the relative economics to full-fired supercharged boiler cycles with unfired waste-heat recovery cycles and a pulverized-coal-fired steam cycle. The gasifiers considered were Lurgi and Shell-Koppers. Both gasifiers were preceded by coal-drying facilities and, in the case of Lurgi, by a briquetting plant. The eventual moisture content of the Lurgi feedstock was 15% whereas that of the Shell-Koppers unit, which incorporated a nitrogen swept pulverizer, was 2%.

The most viable of the coal gasification combined-cycle options studied was Lurgi gasification with the regenerative combined cycle followed by the Steag pressurized boiler cycle with reheat.

For the most attractive combined cycle and the pulverized-coal-fired option a sensitivity analysis based on the cost of coal showed that, with all other costs remaining the same, these two plants of the 150 MW nominal size become equal in relative levelized cost of electricity with the coal cost increased by 127% above mid-1979 levels (174% for the 300 MW size). Any further increase, therefore, would show an advantage to the gasification combined-cycle plant.

Conventional design is therefore favoured for a mine-mouth plant located near Shaunavon. The gasification combined-cycle is more attractive when plants are at other locations where the coal transportation cost component is significant.

This study also suggest that overall capital costs could be reduced through a phased development. For an ultimate 300-MW capacity plant, the initial installation could consist of 115-MW gas turbine with full waste-heat boiler (i.e. capable for operation on two gas turbines), together with a 70-MW steam turbine operating at half load. Subsequent extension of the plant would therefore be limited to addition of a second similar gas turbine. If provision were made for directly firing the boiler, this would have the additional benefit of permitting the steam turbine to be used in the event of a gas turbine failure.

Any combined-cycle plant will be a new development based on the latest available technology. No savings can be anticipated in design and construction time. In fact, it would be wise to be cautious and allow a full five years whereas a conventional plant can be designed and constructed in four years.

Hat Creek

A further study of combined-cycle power generation examined the 400 million-ton Hat Creek deposit in British Columbia. Conventional pulverized-firing combustion, pulverized-firing combustion with scrubbers, fluid-bed combustion and combined cycle power schemes were compared.

The coal itself is lignitic (with a mean ash content of 25% and a low fines content); the ash has extremely high fusion characteristics which make it suitable for dry bottom utilization techniques.

The combined cycles have been compared with a reference 2000 MW_e power plant using conventional technology of mid-1975 vintage. The summary data is shown in Table 6. The G.E. cycle considered in this study incorporated a (relatively) low steam quality at 1250 psig/900°F without reheat.

Table 6 - Comparison of power generating schemes (Hat Creek coal)

	Pulverized Coal No Flue Cleaning	Pulverized Coal With SO_S Scrubbers	Steag (Supercnarged) Boiler	G.E. Cycle (Lurgi)	Advanced Cycle
Cycle Efficiency %	36.3	35.0	40.3	33.1	45.0
Relative Cost of Electricity	1	1.22	1.22	1.19	0.87

The developed costs were based on a coal cost of $3.00 (Canadian) per ton. As the price of coal increases, the advanced cycles assume a progressively more competitive position in regard to the cost of the electricity. This effect is illustrated for this deposit in Figure 9.

This conclusion is of particular importance. It re-emphasizes that although the degree of optimization affects cycle efficiency, coal cost can play a dominant role in establishing electricity cost and that the selection of a combined-cycle power plant may be dictated more by environmental constraints and water availability than by economic factors.

Onakawana

A joint Ontario Hydro-Onakawana Development Limited study to determine the feasibility of constructing a 1000-MW generating station in the Onakawana coalfield will be completed later this year [17]. Pilot-scale trials have demonstrated that the lignite burns readily and that the ash has a low fouling potential.

Small Gasifiers For Fuel Gas Production

A recent study of the potential applications of small Wellman-Galusha gasifiers to the gasification of Saskatchewan lignite has been carried out to develop costs for four qualities of gas [18].

a) A low heating value raw gas from an air/steam blown gasifier supplying an uncleaned gas for direct use.

b) A medium heating value raw gas from an oxygen/steam blow gasifier supplying an uncleaned gas for direct use.

c) A low heating value gas, as for (a) above but with a clean product for transmission.

d) A medium heating value gas, as for (b) above but with a clean product for transmission.

The cost performance characteristics for the Wellman-Galusha system (January 1977 dollars) are summarized in Figure 10.

TECHNOLOGY INFORMATION

CANMET operates a technology information service for analysis and dissemination of scientific and technical information on coal throughout Canada and to other countries. The service is the contact for the coal services for the International Energy Agency, which include the Coal Data Base, technical reviews and international information exchange. A Coal Technology Information Centre recently established at the Alberta Research Council complements CANMET's activities through its service to the coal industry in western Canada. Mechanisms for cooperation between the two centres are under development.

FUTURE PERSPECTIVES

Canada's vast reserves of low-rank coal, being easily recoverable by surface mining, are expected to fill a significant portion of the country's future energy requirements. Most of the coal demand will be for mine-mouth power plants in the three western-most provinces using conventional combustion and pollution abatement equipment. However, beyond 1990, emerging technologies now being demonstrated will probably be available for using lower grade coals with improved cycle efficiencies and reduced environmental impact. Additional opportunities for low-rank coal use are in synfuels production.

The forecast expansion in low-rank coal use up to the year 2000 could, however, vary by as much as 20% because of uncertainties associated with continually changing energy supply options, land use policies, environmental considerations, requirements for specialized equipment, population growth and conservation strategies [19].

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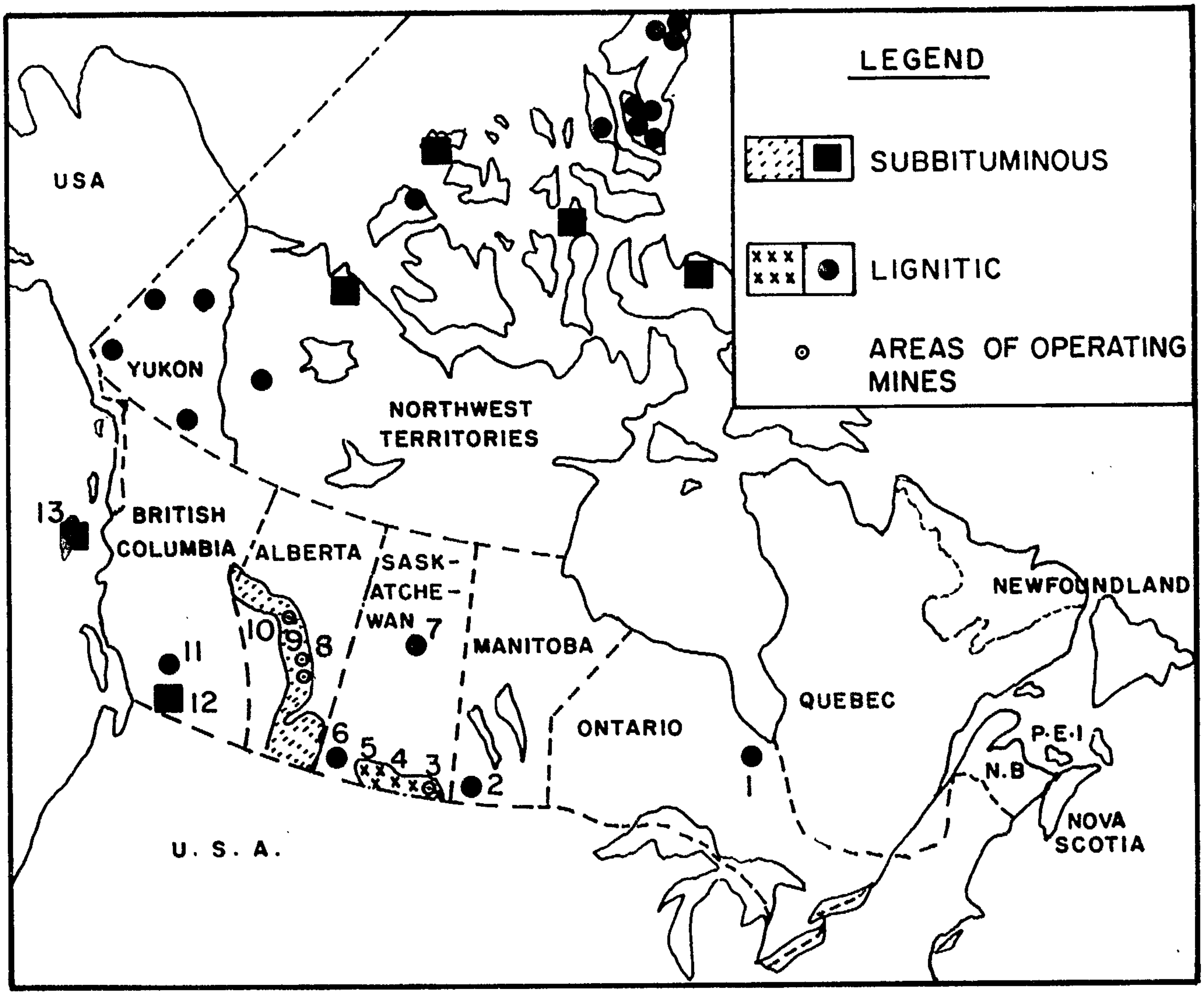


No.	Deposit	Age	No.	Deposit	Age
1	Onakawana	L. Cretaceous	8	Plains Region-Eastern	Upper Cretaceous
2	Turtle Mountain	Tertiary	9	Plains Region-Central	"
3	Estevan	"	10	Plains Region-Western	"
4	Willow Bunch	"	11	Hat Creek	Tertiary
5	Wood Mountain	"	12	Princeton	"
6	Cypress	"	13	Skonum	"
7	Wapawekka	L. Cretaceous	-	Arctic Lignite (North of 60°)	"

Fig. 1 - Low-rank coal regions of Canada

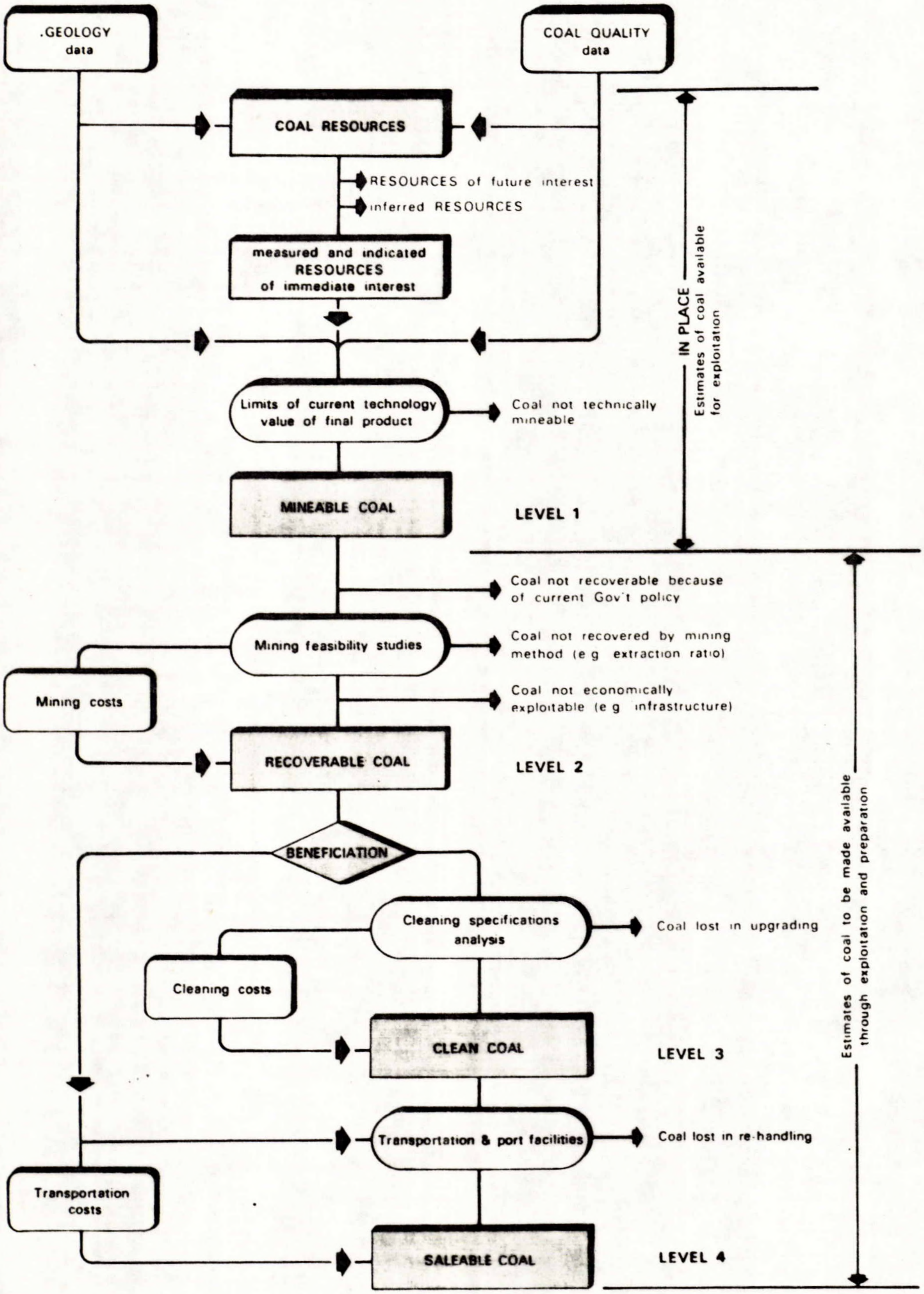


Fig. 2 - Coal resources to reserve categories (1)

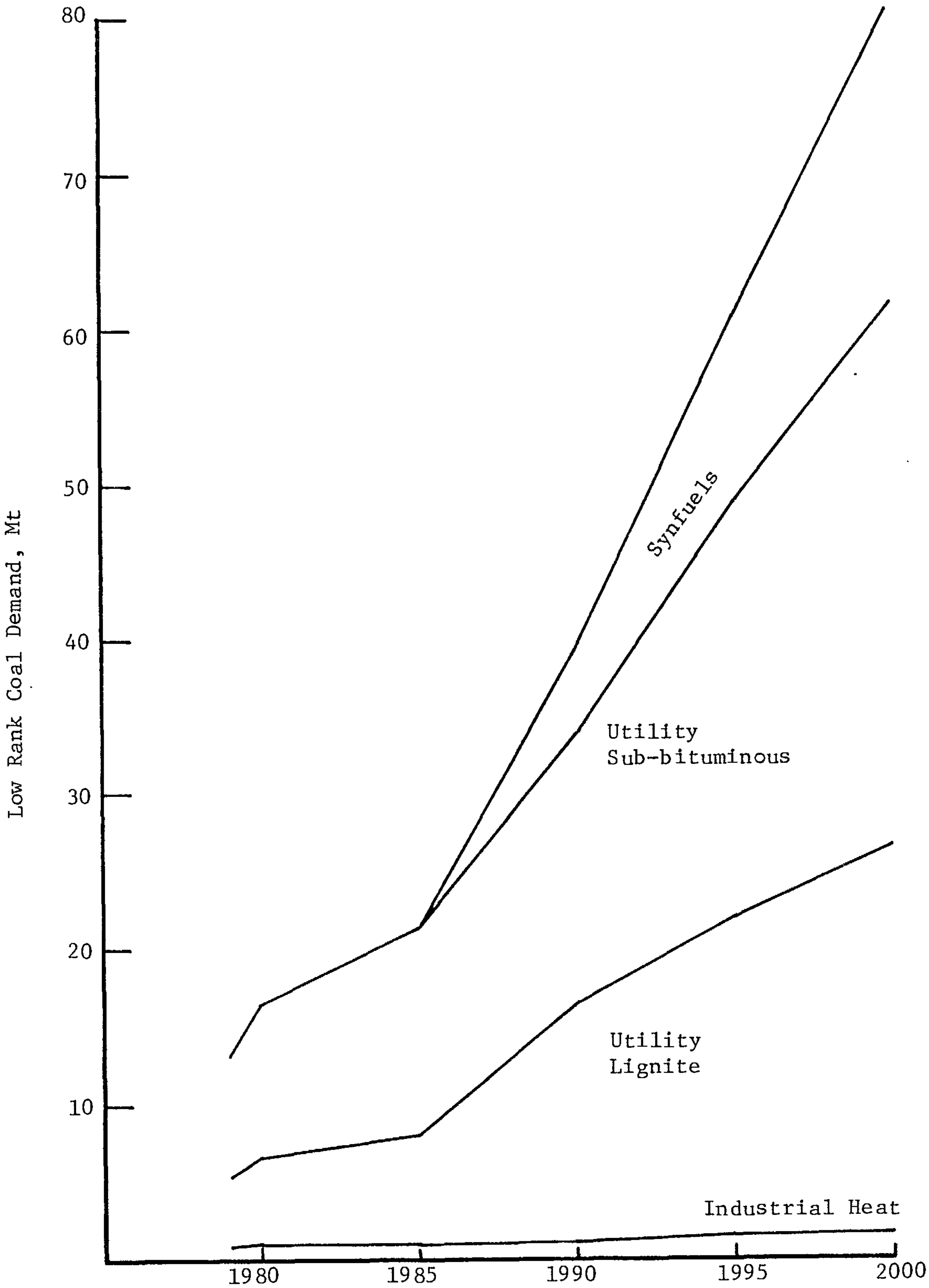


Fig. 3 - Market sector demand forecast

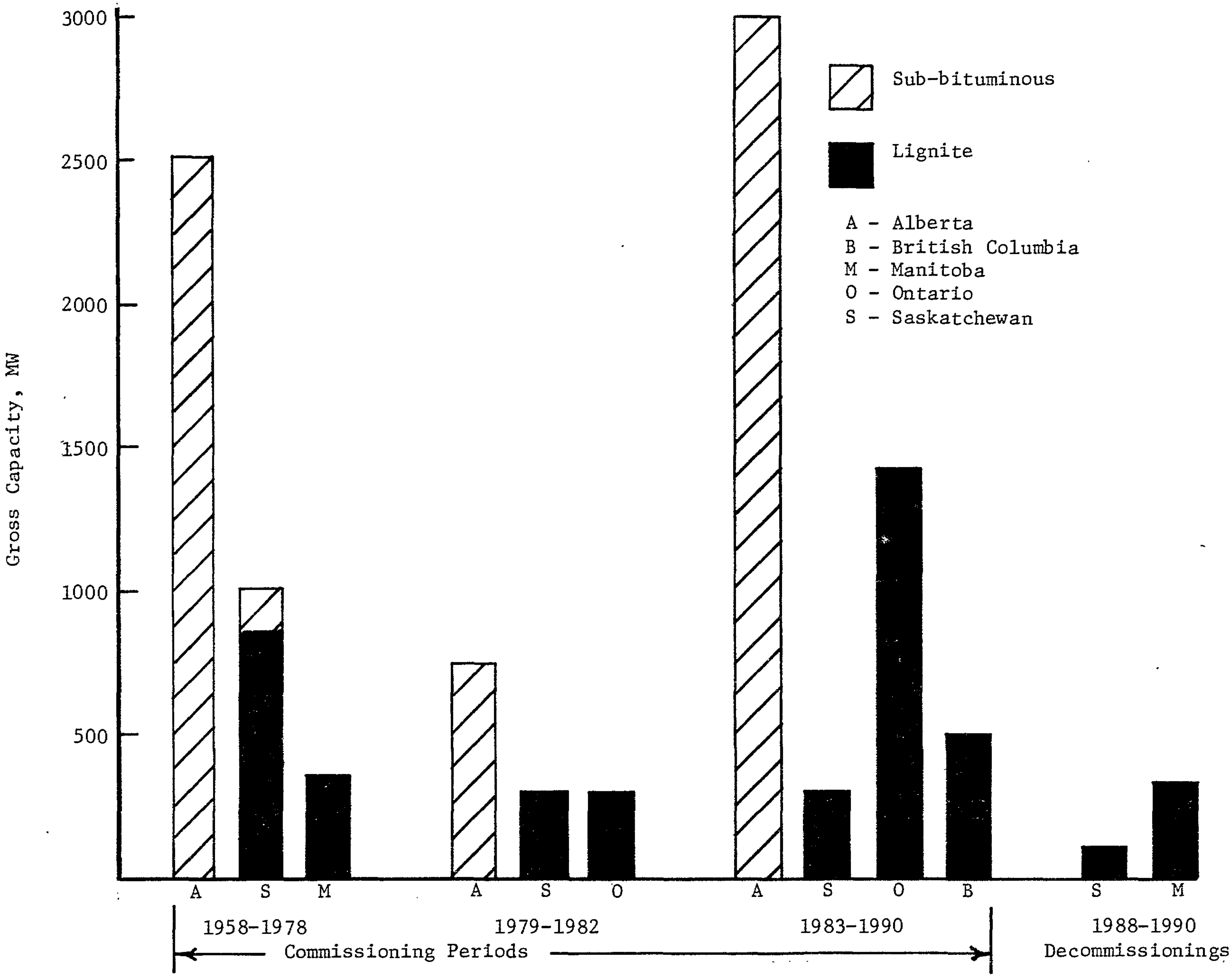


Fig. 4 - Growth in electricity generation with low-rank coal

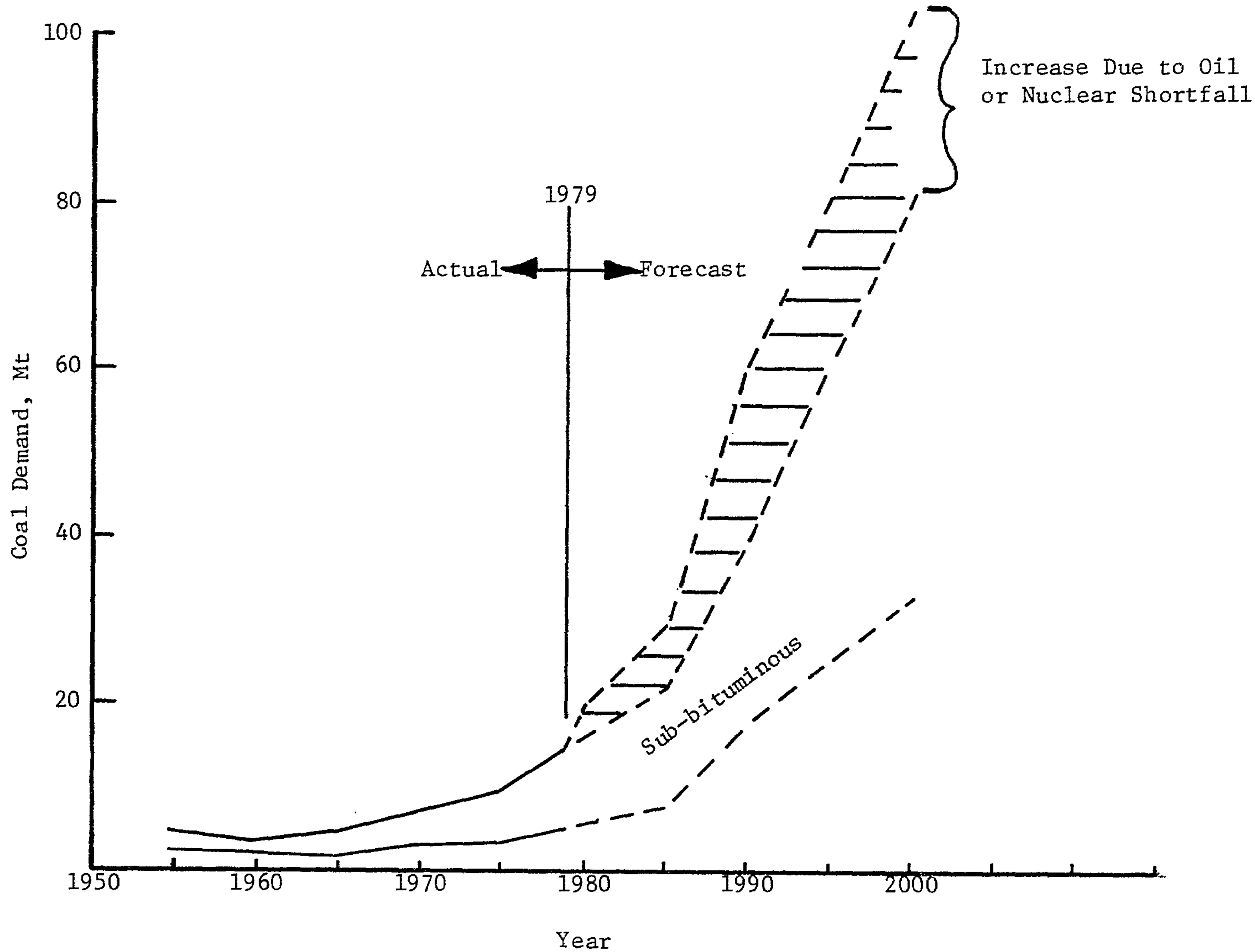


Fig.5 - Forecast for low-rank coal demand

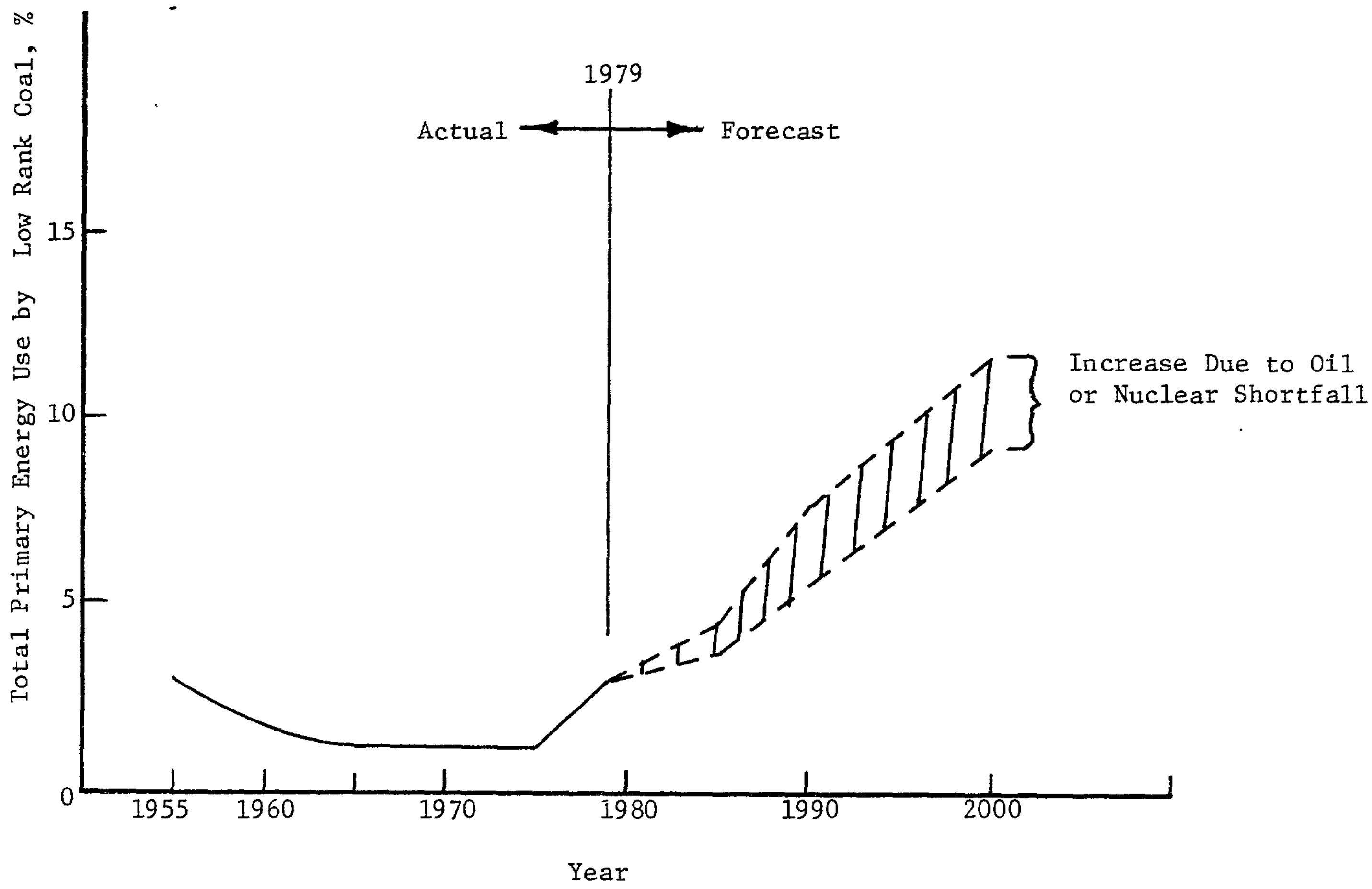


Fig. 6 - Forecast in primary energy use by low-rank coal

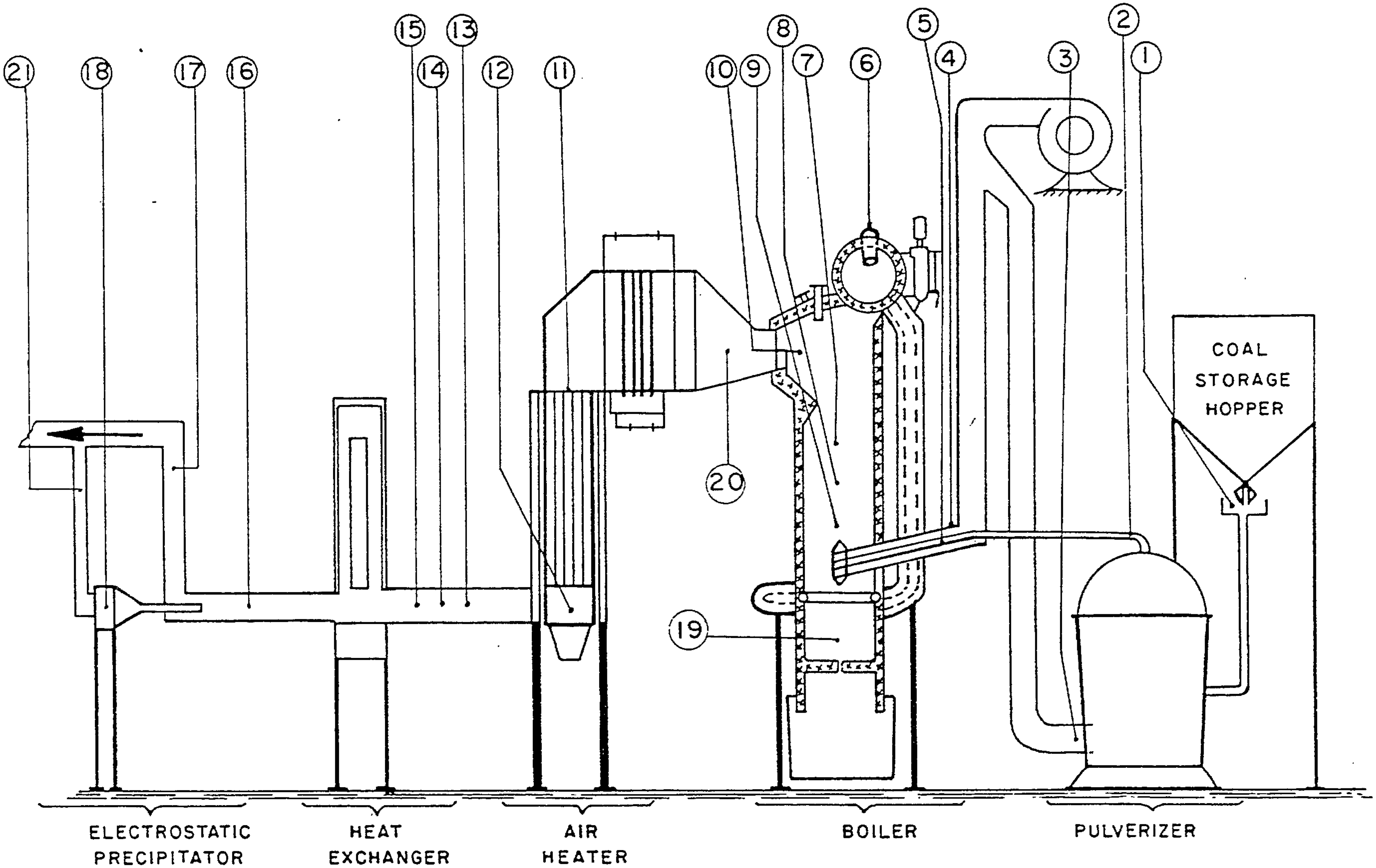


Fig. 7 - Schematic illustration of the pilot-scale boiler showing the sampling stations

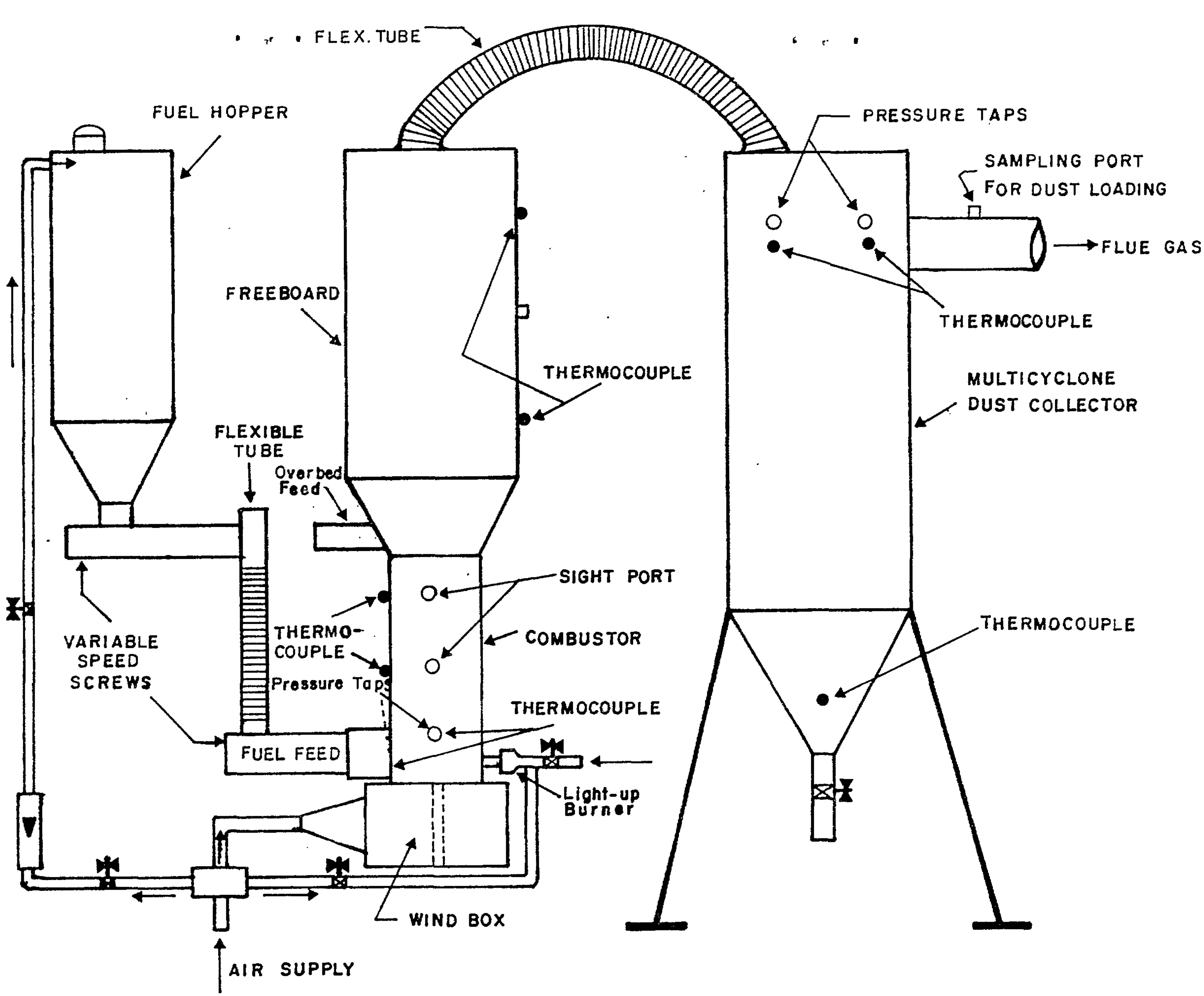


Fig.8 - SCHEMATIC OF PILOT-SCALE ATMOSPHERIC FLUIDIZED BED COMBUSTOR

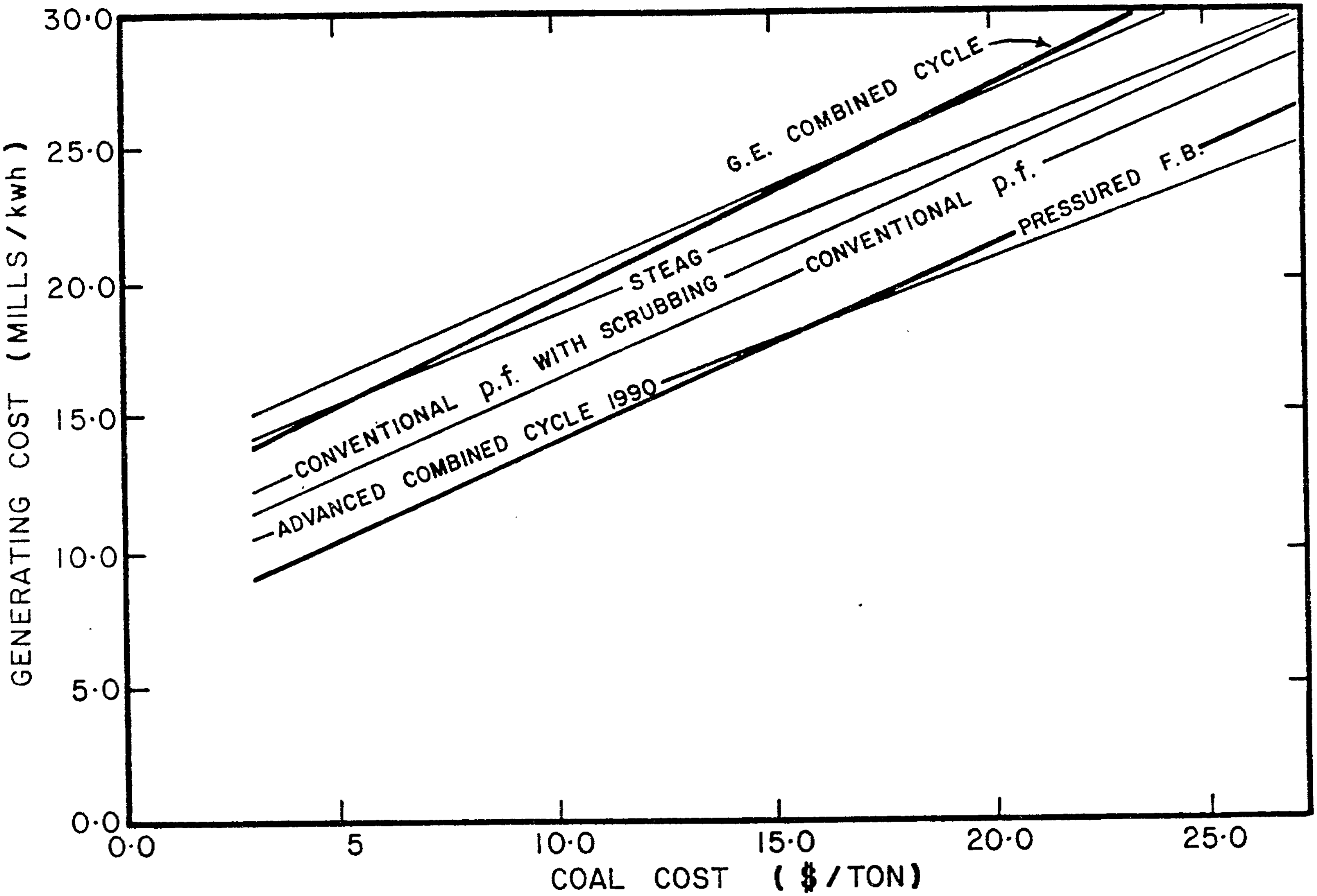
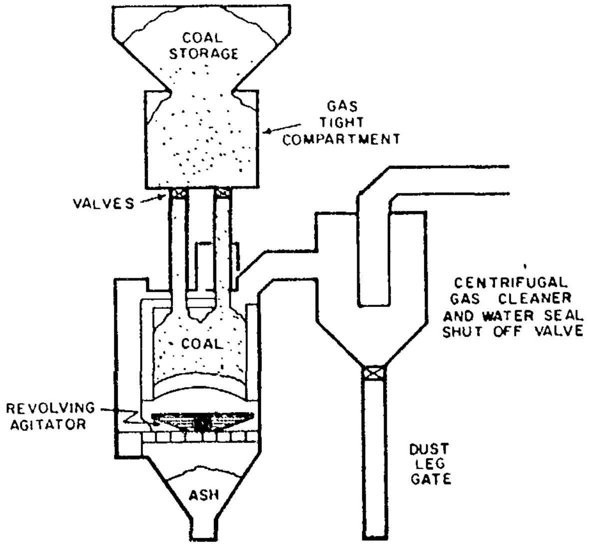
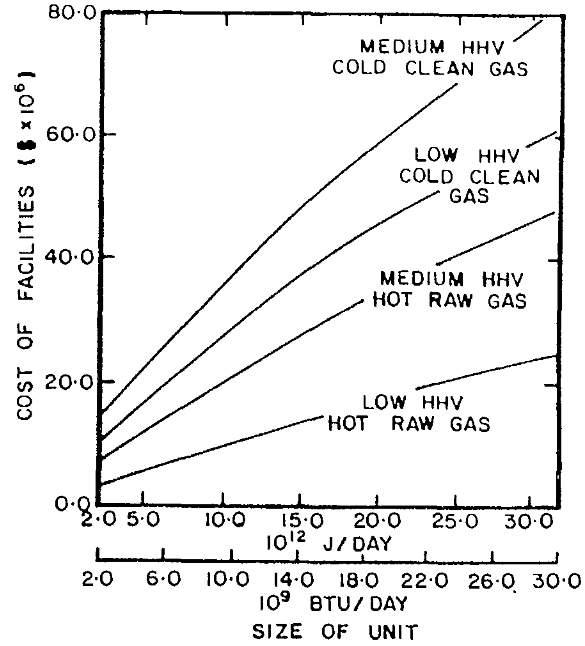


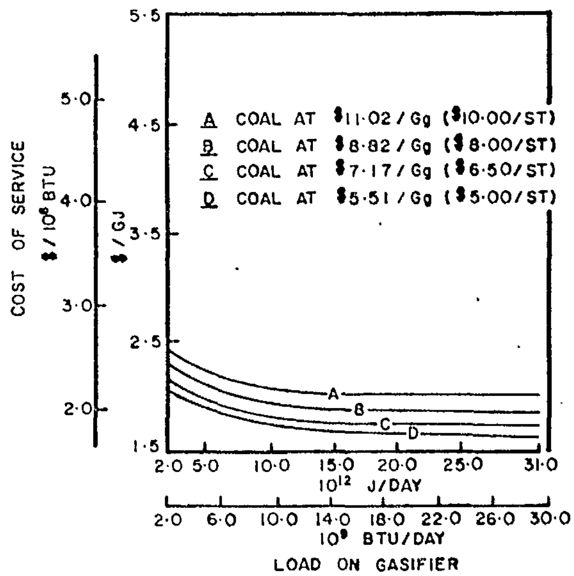
Fig. 9 - The influence of coal cost on electricity cost for various cycles at Hat Creek



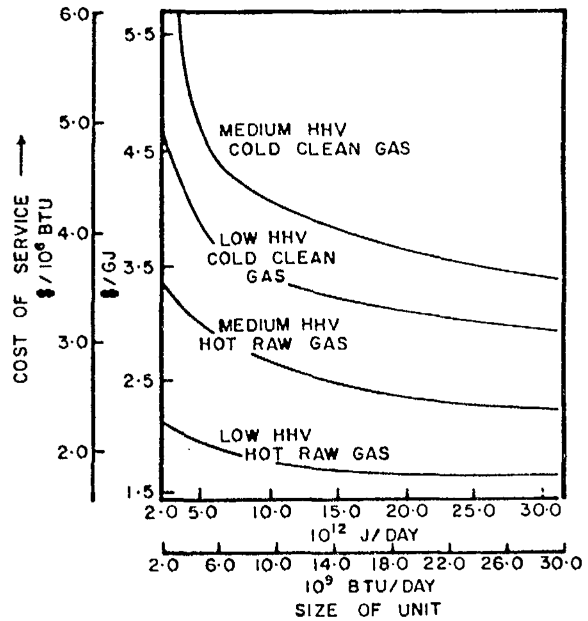
The Wellman-Galusha fixed-bed gasifier.



The cost of facilities: Wellman-Galusha gasification.



The effect of coal price on the cost of service: Wellman-Galusha gasification.



The cost of service: Wellman-Galusha gasification.

Fig. 10 - Cost performance for various gas qualities from the Wellman-Galusha system using Saskatchewan lignite