

TRANSPORTATION AND MARKETING ASPECTS
OF THE CANADIAN PETROLEUM AND
NATURAL GAS INDUSTRIES

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INTRODUCTION

The industrialization of the Canadian economy started after the turn of the century and particularly after 1920. Industrialization was thus a relatively late phenomenon in comparison with that of Western Europe or the United States. The main reasons for this are to be traced back to the very sparse population and the large size of the country. The political evolution was also slow, with the federation of the British North American colonies taking place only late in the 19th century and full independence only in the second quarter of the 20th century.

Primary industries such as mining, smelting, wood and pulp, etc., developed at a fairly rapid pace while manufacturing remained for the greatest part limited to the extent of the small domestic market.

Aside from water power or hydroelectric energy which led to the development of the aluminum industry, the major drawback retarding the creation and development of heavy industry such as iron and steel, heavy equipment, machinery and tools was the lack of primary fuels. Coal, natural gas and petroleum along with such raw materials as iron ore, manganese, etc., had to be imported in order to create heavy industry in Canada. Limited by the size of the domestic market and unable to compete abroad with countries richly

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endowed with primary fuels or raw materials or both, the development of heavy industry in Canada was thus almost negligible.

Since 1947, however, with the discovery of extensive petroleum and natural gas resources in Canada, the picture has changed considerably. For the first time during its industrial history, Canada will soon be able to meet most of its energy requirements from domestic energy production.

In ten years the petroleum industry has become one of the most important in Canada and has contributed no small part in the intense industrial development which took place in the same period of time. The new industry has offered vast possibilities of capital investment and accumulation and opened new fields of industrialization which had thus far not been possible for reasons of economic nature mentioned above.

Perhaps even more important is the realization of the future possibilities demonstrated by the spectacular development of the oil industry. The question may well be asked how many other resources ignored thus far will revolutionize the Canadian economy as much as or even more than the discovery of oil at Leduc has? From the point of view of possible resource development Canada seems to be still highly under developed.

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In the first chapter of this thesis we have drawn a short summary of the historical development from the middle of the 19th century to our day. We have also tried to outline the general economic background in which that development took place. Chapter two deals with means of transportation, particularly the creation and development of a nation-wide pipeline network on which extensive exploitation of the western petroleum resources heavily depends.

In the third chapter special attention is paid to the marketing and distribution aspects and problems of the petroleum industry along with a short study of Canada's refining capacity and of the petrochemical industry.

Chapter four deals exclusively with the gas industry including transportation and the problems and difficulties attached hereto, marketing and distribution, reserves, and finally a detailed study of production and market prices.

The conclusion has been complemented and supported by briefs presented from different quarters to the Gordon Royal Commission concerning short and long-run trends of the petroleum and natural gas industries.

A tentative list giving a short analysis of different types and sizes of oil and gas concerns is placed at the end as an appendix.

CHAPTER I

HISTORY OF THE PETROLEUM AND
NATURAL GAS INDUSTRIES

The history of the Canadian oil industry is one of the most colourful chapters of the economic development of the country. We shall, in the next pages, concentrate our attention on the early phase of the industry, dating roughly between 1850 and 1900, not only out of interest for historical occurrences but particularly because it will help better comprehend contemporary development.

An old document of the early 18th century relates a conversation that took place between an Alberta Indian and a Hudson Bay Company agent and which contains a description by the Indian of large deposits of a sticky black substance along the Athabaska river. This was, in all probability, what is today known as the tar sand region with reserves estimated as high as 300 billion barrels of oil!

In 1858, the first oil well on the North American continent was dug at Oil Springs near Petrolia Ontario. A year later the famous Drake Well was drilled near Titusville, Pennsylvania, a few weeks before Dr. Tweedel accomplished a similar feat near Dover, New Brunswick, in what had been a

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race to bring "the first oil well in America in operation" (1).

"Gum oil" as the inhabitants of Oil Springs called the surface deposits was not at all a welcome phenomenon as it retarded vegetation and reduced the value of land! However, in 1858, J.H. Williams believed that these "gum beds" contained naphta as the wells of Baku in Russia. Processing this substance in a retort he managed to produce a light oil. As the oil proved to be more abundant at depths, he thus dug the first oil well in North America.

Williams' discovery soon induced an important exploitation scheme and in short time wells were drilled by means of the "spring pole" method worked by foot power and the centre of activity shifted to Black Creek near Oil Springs. Many wells produced over 2,000 barrels a day causing however much wastage as discovery wells could not be controlled, often flooding the surrounding area. Thus flowing wells after about two years often turned to pumpers with water eventually replacing oil.

The cost of drilling a well in those days ran to about 1,500 dollars or at a rate of 3 dollars per foot for the first 500 feet. "Time for drilling covered about three

(1) J.L. Irwin, "Canada's early Oil History", in World Petroleum, Vol. 21, No. 7, issue of October, 1950, pp. 52, 53, 54.

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months. In 1864, there were six refineries at Oil Springs. In 1867 the last one shut down due to failure of the crude supply." (2)

As the Oil Springs area became exhausted, ending the first oil boom in Canada, the centre of exploitation once again shifted to nearby Petrolia. According to an article in the Petrolia Topic of March 1, 1892: "Petrolia is surrounded by thousands of oil wells together with numerous refineries, machine shops, boiler shops and other industrial establishments. The Petroleum industry either directly or indirectly provides work for some 20,000 people". Until the end of the century Ontario remained one of the most important oil producing regions in North America.

In 1880, J.H. Williams, who had become one of the most prominent figures of the industry, formed a company known as Imperial Oil Limited which built the most modern refinery of the time in London, Ontario, "refining Canadian crude for Canadian trade"! It would be most suitable for our intention here to follow the development of Imperial Oil throughout the remainder of that period, through the interim followed and into the present.

(2) Fergus Cronin, "North America's Father of Oil", in Imperial Oil Review, Vol. 39, No. 2, issue of April, 1955, pp. 16,17,18.

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Imperial Oil as it appeared in 1880 was just one of many concerns operating in Woodstock, London and Petrolia. The new company was the latest venture of 16 local businessmen at a time when the Black Creek boom had just ended and the infant oil industry stood at a crossroad. The price of kerosene, the industry's major product, had dropped from one dollar to 12 cents a gallon. Entrepreneurs and technicians were leaving for more prosperous fields in the United States and Europe. The challenge was to create an enterprise with refining capacity and financial resources to supply a large market in order to survive. Imperial Oil started accordingly with a capital of 500,000 dollars and received a charter to find, produce, refine and distribute petroleum and petroleum products in Canada. The company almost immediately introduced a more efficient distillation process which reduced the amount of sulphur in the refined oils and made the Canadian product more competitive with the purer, sulphur-free kerosene from the United States.

Since securing large markets was a main condition of the company's survival, no effort were spared in that direction. "Two salesmen were sent to the West, their territory extending from the Lakehead to the Pacific. A salesman's average trip consisted of six weeks of driving horse and carriage over hundreds of miles of bad roads or

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no roads at all". However, the company lacked expansion capital and, in 1893, an agreement was made with Standard Oil of New Jersey whereby Imperial could expand marketing outlets in Eastern Canada and buy and enlarge a refinery in Sarnia. The new refinery, which became in due course the biggest in the Commonwealth, also remained the company's head office although the executive branch was moved to Toronto in 1916.

As difficulties increased and as the necessity for larger capital expenditures and market outlets became more evident, Canadians failed to cope with the greater requirements and had to be helped by increasing United States interests.

The year 1893 stands symbolically enough as the end of what could be called the "Canadian Phase". After the turn of the century a long period, sterile in result, set in during which constant exploration effort and expenditures came almost solely from the United States. The reward came in 1947 with the discovery of Leduc. This is an important aspect while dealing with the problem of the "too great U.S. participation in the oil industry".

At the turn of the century, a revolutionary change took place: the appearance of the motor-car. Until then, the most important product of the industry had been kerosene

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used as lamp fuel. Oil was also used to produce axle lubricant and medicine, or the so-called Seneca Oil, "used internally and externally for man and beast alike"!

The auto brought an important new institution with it: the service station: "Canada's first was erected by Imperial in Vancouver, it was a most primitive affair, made up of a kitchen hot water tank mounted on a concrete pillar, thumb and forefinger were used to control the flow of gasoline through a length of garden hose". From an insignificant by-product used mostly by laundries as a cleansing material, gasoline became the industry's most important product almost overnight. Imperial started a refinery building program and began importing foreign crude. In 1914 a pipeline was laid, linking Sygnet, Ohio (U.S. Mid-Continent) with Sarnia. An Imperial subsidiary was created the same year to exploit South American oil concessions, it was named the International Petroleum Co. Ltd. (3)

Imperial built its second and third refineries in Vancouver and in Regina respectively. The same year, 1915, the fourth refinery was erected in Montreal mainly to cope with increasing war needs which called for an urgent development of the industry. Finally, in 1918, Imperial's

(3) "The First 75 Years", in Imperial Oil Review, Vol. 39, No. 4, issue of September 8, 1955, pp. 9, 10, 11, 12.

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fifth refinery was built in Halifax. In four years the company had more than doubled its refining capacity. However, since German U-boats interrupted the crude supply from South America, production remained limited.

Imperial's interest in Western Canada could be intensified only after the war years. Turner Valley had been discovered in 1914 and now the company took active part in the exploitation of the historical oil field through a subsidiary. The Royalite Co. Fort Norman, just below the Arctic circle, also became from 1919 to 1923 an area of interest of the company and although oil had been struck in reasonable quantity, Fort Norman could not be exploited commercially because of tremendous communication difficulties. The project was abandoned until World War II.

Between 1924 and 1930, Imperial was a leader in chemical search and in managerial methods, bringing forth such discoveries as the phenol treatment for high grade lubricants, clay treatment to improve storage stability of gasoline, etc., the eight-hour working day and a system of employee-management joint council. With the outbreak of World War II, Imperial co-operated with the federal government in the establishment of Polymer, a crown corporation producing synthetic rubber at Sarnia and revitalized Fort Norman to supply the Arctic forces through the famous Canol(4) project.

(4) Abbreviation for Canadian Oil Project.

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During World War II Imperial Oil was one of the few concerns to pursue an oil exploration program which, in 1947, finally broke a 30-year search by the discovery of Leduc.

Leduc opened a new era and introduced the necessity to increase expenditure^s on an important scale. To secure additional capital the subsidiaries International Petroleum and Royalite were sold. Woodbend, Redwater and Golden Spike followed and reserves proved to be sufficient to supply the Prairie demand for oil.

The first discovery of natural gas in Alberta dates back to 1885, resulting from a well drilled at Alderson (Langevin), some forty miles northwest of Medicine Hat. Wells at Medicine Hat and Radcliff were drilled five years later by the Canadian Pacific Railway. Both these areas have now been active producers for over 67 years. Small industries could be created in the surrounding area and be supplied with cheap fuel. Pelican Rapids was the scene of another discovery in 1896. The Athabaska river area was again drawing attention after a long silence! The difficult terrain and problems of communications, however, finally forced the project to be abandoned.

A more important enterprise involved the gas fields of Bow Island and particularly Viking which were developed

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during the first world war. These along with Kinsella, which was discovered after the war, were to supply Edmonton, 80 miles away. Pressures declined fairly fast however and the plan could be realized only for a short period. A series of other attempts in different areas throughout the province were also unsuccessful (5).

The first important discovery in Alberta was made in 1914 in Turner Valley. Until the appearance of Leduc this field produced over 90 per cent of Alberta's and Canada's oil production. It has been and remains a major field recovering over a hundred million barrels of oil.

The history of the discovery of Turner Valley offers many good examples of early entrepreneurial spirit in Canada:

Very few of the promoters at the time had any accurate idea as to the cost of drilling a well. In addition to this there were very little geological talent available to guide them in selecting drill sites. Technicians to look after engineering problems were scarce. Any man who had trained as a driller, however slight that training might be, would command exorbitant wages and be regarded with respect. (6)

Exploitation methods were still most primitive and scientific research and processes lacked almost entirely.

(5) "Alberta was famous for gas before it was a Province", in Western Oil Examiner, Vol. 22, No. 32, issue of July 9, 1955, pp. 26, 27.

(6) J. L. Irwin, "Canada's Early Oil History", in World Petroleum, Vol. 21, No. 7, issue of Oct. 1950, p. 54.

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Different sites would be exploited until exhaustion and then the search for new deposits in the same area would go on again. Wastage was enormous in the first periods but slowly experience was gained, better methods introduced, such as recording geological formations of wells drilled, separating gas from oil, sampling drill cuttings, etc.

The most lucrative period of the field's history came in 1936 as the west flank of the formation was brought in production. Resulting from this event, the average 1.25 million barrels recovered annually jumped to nearly seven million. In 1942, it exceeded 10 million. After that production declined gradually until it fell to 1,375,966 barrels in the first eight months of 1955. It is expected to remain an important producer for the next ten years however.

The establishment of crude oil production in Turner Valley in 1936 must stand out prominently as an event of the most significant importance. In many respects it provided a definite incentive for the exploration programme that followed and which led a decade later to the discovery of Leduc, Redwater, Woodbend, etc.

The knowledge to be drawn from a short review of the history of the Canadian oil industry is of significance. The exploitation of petroleum and natural gas resources was carried out ruthlessly and unscientifically until the early

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1930's. This was above all, the factor that caused wide and irregular fluctuations during the Ontario era; booming prosperity followed almost without warning by the bleakest of depressions and often the abandon of an area that had been an important centre of production a few weeks before. The history of Oil Springs and Petrolia offers characteristic examples of this on a wide scale.

The production policy was simple; it consisted from the early 1860's to the late 1920's of getting the oil out wherever it was, regardless of wastage and of the simplest elements of rational economic procedure such as securing a market before entering production, transportation cost, etc. In the case of Turner Valley it is estimated that the life of the field was shortened by 10-15 years at a rate of 10,000 barrels a year due to the primitive methods employed at the time of its early exploitation.

On the other hand, at the time of the first discoveries, experience, techniques and equipment were badly lacking. They had to be acquired through expensive years of mistakes and failure. The pioneers of the industry were above all discoverers, not engineers and technicians. Countless examples of imaginative inventions, initiative, drive and organizational talent characterized people like Williams, Shaw, Brown and others.

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The early 1930's with the developments at Norman Wells and Turner Valley showed the first serious and successful steps taken towards rational conservations. In 1936, Imperial formed its first Conservation Board which introduced such measures as well-spacing, exact geological recordings and controlled production. Further developments have been carried out along these lines since to increase efficiency of production.

Another interesting point to be mentioned from the history of the industry is the very liberal policy of the Ontario Government to issue company charters, particularly before the turn of the century. Limited companies or corporations were formed to exploit oil fields, indeed even individual wells, and disappeared as soon as these particular resources were exhausted, often to appear again under new names but with the same shareholders.

Canada's wealth derives mostly from forestry, agriculture, manufacturing, mining and fishing - and in each of these oil is an important factor. In 1950, Canada consumed 844,391 barrels of petroleum daily or 13.4 barrels per capita per year. This compares with roughly 17.5 barrels in the United States and with about 2.5 barrels in the UK. Consumption is distributed mainly among more than four million motor vehicles (including tractors) and a power burner or space heater for every third home. Moreover, large amounts of oil are required for diesel and oil burning locomotives and in shipping. (7)

(7) John F. Fairlie, Developments and Prospects in Canadian Oil, Washington, School of Advanced International Studies, 1950, pp. 2,3.

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Since 1947 the demand for gasoline has almost tripled in Canada, following a corresponding increase in automotive production. Demand for heating oil has increased almost four times in the same period. From 1946 to 1954, total petroleum consumption increased by 150 per cent as compared with 58 per cent in the United States. Canada is gaining very fast but still lags 24 per cent (1954) behind the American per capita consumption.

The most important problems and difficulties to be overcome by the oil industry are of regional and seasonal nature. The seasonal factor is conditioned by the winter requirements of the market for heating oil and tends to result in a reserve concentration during the summer months, and by the closing down of traffic on the St. Lawrence which results in a storage concentration of crude from abroad during the summer months. This is of particular importance for the Montreal area. This seasonal drawback has been somewhat overcome since 1942 when the Portland-Montreal pipeline was laid but higher transport costs and the limited capacity of the pipeline still made it necessary to build up reserves.

The advance of Canadian crude towards the east has brought about the construction of vast pipeline networks and with it, a larger measure of independence from the

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seasonal factor. The transport of crude can be carried out throughout the year, thus doing away with the necessity of large storage emplacements. This fact became particularly obvious after the last section of the Interprovincial pipeline was laid to Sarnia in 1953. The transport of crude to the Quebec and Northern Ontario markets is still mostly dependent on Maritime traffic, and therefore subject to the seasonal factor.

The regional factor is determined by the geography and the economic structure of the country. Canada is a large country and wide variations in population, geography, climate, economic development and income make it necessary to divide it into four areas, each of which possesses special characteristics and petroleum requirements in supply, production and specification.

In the Maritimes, the economy is mostly dependent on fisheries, ship building and forestry. The area is supplied from a refinery in Halifax and additional product imports from Montreal and from Caribbean refineries. The ports are open to traffic all year round and shipping is therefore free of the seasonal factor.

Gasoline refining is protected in Canada by a customs tax of 1c. per gallon. For other oil products, the tax consists of 1/3c. per gallon. This protection is

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necessary to permit small refining concern with limited output and high unit costs to maintain production.

In Quebec, the regional economy consists of forestry, mining, manufacturing and agriculture. The greatest refinery concentration in Canada is located in Montreal with an output of over 210,000 b/d (1956), that is, almost 40 per cent of Canada's total capacity. Crude from Venezuela and the Middle East is transported through the Portland-Montreal pipeline (see above and Chapter II) or directly via tankers. These crude imports are supplemented with product imports, particularly stove oil and fuel. The refining capacity in Montreal was vastly expanded after the war in order to supply the Prairie provinces. This offers a good example of the difficulties involved in long-term planning for the oil industry. Unexpected subsequent reserve developments have rendered this project obsolete.

Ontario is an industrialized area which is supplied from Montreal and other refineries in Toronto and Sarnia. The Sarnia refinery - with a capacity of 50,000 b/d is the biggest in Canada and until supplied by Canadian crude (1953-1954), drew its requirements from the United States Mid-Continent and Illinois fields. The smaller refineries in Toronto were dependent on crude from Toledo, Ohio.

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The supply of petroleum products in the Quebec-Ontario area is partly dependent on the huge water-way network using the Great Lakes and avoiding higher railway transport costs.

Until the discovery of Leduc, the Prairie economy centered mostly around agriculture. In relation to petroleum, it was largely a deficit area (despite Turner Valley that could supply only part of the Prairie requirements) heavily dependent on imports of crude and products. Two thirds of the local needs were satisfied by small refineries with capacities varying between 300 and 10,000 b/d. Roughly 50 per cent of the processed crude was supplied by Turner Valley and the remainder was imported from Montana and the Mid-Continent fields via rail. The remaining third was imported in product form from Montreal and Sarnia and transported through the Lakehead.

The transport costs between the Mid-Continent fields and Regina amounted to \$2.50 per barrel so that the price in Regina ran upward of \$5.00. Similarly, the transportation cost of a barrel of product between Fort William and Winnipeg run up to \$2.00. Thus the cost to transport one barrel of product from Sarnia to Winnipeg or one barrel of crude from the United States to Regina is about twice as high as the cost to transport one barrel of crude from the Persian Gulf to New York or for a distance of almost 9,000

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miles. The Rocky Mountains are an even bigger obstacle for rail transport to the pacific coast. The construction of an extensive pipeline network in British Columbia has, however, largely overcome this difficulty.

From the above, the importance for the Prairie provinces to change from a deficit to a surplus area can clearly be seen.

The B.C. economy is also mostly dependent on fisheries, mining and forestry. Manufacturing and other industries have concentrated particularly in the Vancouver area. Until Leduc the refinery capacity in this region was fairly limited and crude and products had to be imported from California.

From the above discussion, certain facts of paramount importance for the industry can be seen more accurately: 1) 60 per cent of the population and over 60 per cent of the oil requirements of Canada are located in the Quebec-Ontario area - roughly 2,000 east of Edmonton, the centre of the industry's oil reserves.

2) The Great Lakes form an important part of the Quebec-Ontario transportation system, in winter, however, the harbours freeze and activities have to be stopped. The seasonal factor must therefore be reckoned with, complicating transportation problems.

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3) Because of enormous distances the Alberta crude must be transported in great quantity via pipeline in order to compete economically with the already existing sources of supply in Eastern Canada.

The significance of self-sufficiency in supply is also important from the point of view of Canada's balance of payment vis-a-vis the United States. As crude imports from the United States can be reduced, payment conditions improve, so far as the industry is concerned! Before Leduc 90 per cent of Canada's oil requirements were met by supplies from the United States and the Caribbeans. A series of important discoveries took place within three years culminating in the discovery of Pembina in 1953 with reserves estimated at upward of one billion barrels. In all, Canada's oil reserves rose from 44 million barrels in 1946 to over 3 billion in 1955. In addition, the large tar sand area of northern Alberta and the North West Territories have been estimated as high as 300 billion barrels. (8) In 1956, Canada (9) disposed of over fifteen years of supply opposed to 13.8 in the United States.

(8) A. J. Barthelmes, "Prospecting in Western Canada", in World Petroleum, Vol. 21, No. 7, issue of July, 1950, p. 49.

(9) "Years of supply" is an expression arrived at by dividing total reserves by yearly requirements or production.

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After the presence of large oil reserves was established, the main problem became one of marketing. The first step in this direction was, of course, to supply the Prairie demand itself. Every effort ^{was} ~~were~~ made to increase refinery capacity to a level at least as high as the local product requirements. The important war-time Whitehorse refinery was moved by trucks to Edmonton. Additional expansion measures were taken and soon (1953) all Prairie requirements could be met with Canadian crude processed locally.

Since, however, the extent of the established reserves warranted large export movements, the finding of an adequate market became imperative. The most rational solution seemed to extend along the Canadian border and tap the important markets in B.C. and in Eastern Canada - to realize this project the Interprovincial and the Trans-Mountain pipelines were built. From the point of view of cost, transportation via pipeline is roughly three times cheaper than by rail.

Three years after Leduc, in 1950, the Interprovincial pipeline was laid from Edmonton to the Lakehead at Superior, Michigan, and in 1953, a final extension was built to Sarnia. The Trans-Mountain, which was completed the same year, now supplies British Columbia and the northern part of the state of Washington. At first (1950) it was planned to

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satisfy only half of Ontario's oil requirements, but as reserves increased, it became possible to supply almost all Ontario refineries with Western crude.

From Table I we see that the daily production in 1954 reached 262,000 barrels with a total yearly worth of \$250 million. Thus in 1954 the revenue of the oil industry ranked first of all industrial incomes.

Between 1946 and 1955 the demand for petroleum products more than doubled; however, domestic production could satisfy 57 per cent of all requirements by 1956 and somewhat reduce the import volume from abroad.

Secondary industries, particularly chemicals, have appeared in the wake of oil developments in Canada. The chemical industry, processing oil by-products, also tends to concentrate near refineries, that is, near the markets.

The provincial government of Alberta levies a royalty of 12.5 per cent (every 8th barrel) which makes up the largest part of provincial revenues. The province possesses 93 per cent of the mineral rights. Contrary to Eastern Canadian provinces and the United States where the land owner possesses full rights to the surface and to the minerals that may be present underneath the surface of his land, the West Canadian land owner may "cultivate his land, build on it, divide to earn profits (or suffer losses),

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Table I
OIL PROGRESS IN WESTERN CANADA
1946-1954 (10)

	1946	1948	1950	1952	1954
Area explored in Mill. acres	20	55	131	208	170
Geophysic. parties highest no in year	11	62	125	189	179
Cost of exploration & develop. mill. \$	12	77	194	326	394
Wells in production: drilled during year	64	250	834	1,254	1,300
in operation year's end	393	703	1,936	3,589	5,544
Reserves at end of year in mill.bbls.	72	512	1,216	1,745	2,414
Crude production: thousand b/t (average)	20	34	80	167	262

(10) "Facts and figures about Canadian Oil", p. 7,
publ. by Imperial Oil Ltd., 1955.

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but he has no right to minerals or mines ("downward rights") found on his property". (11)

The entrepreneur searching for oil or natural gas must first obtain a lease title from one of the provincial land offices, specifying the length of the time and the exact area in which he is entitled to operate. He must further secure the right of entry from the land owner (if the case applies) which may be quite expensive and finally, he must obtain a permission to drill from the local (or district) conservation board. While drilling, he must remain in contact with the board and forward to it cut samples, log copies and in certain cases, the entrepreneur must follow the instructions of the board.

The developments of the Canadian petroleum industry have also helped the Western farmer indirectly by assuring him of an abundant supply of cheap fuel for mechanization purposes. The presence of such oil resources also represent an invitation to industry to make use of the available energy supply and petroleum by-products to free the Prairies from an overdependence on agriculture as the sole industry.

It may be of interest to mention that the Canadian oil industry was subsidized for over 20 years in order to

(11) F. K. Beach, "History of Land Regulations and Land Grants in Western Canada", in Canadian Oil and Gas Industries, Vol. 7, Nos. 5-6, May and June, 1954.

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foster development. In 1905, 332,900 dollars were paid out to the oil producers in Ontario. This practice was discontinued in 1925, however, after 3.5 million dollars had been paid out. The subsidy amounted to roughly 1.5c. per Imperial gallon.

The development of the Canadian oil industry is also of great significance from a continental point of view.

Three facts explain the situation best: (12)

1. The United States will increasingly be dependent on foreign sources of supply to satisfy domestic consumption.
2. The north-central states form a large deficit area.
3. It is expected that within the next decade California will cease being a self-sufficient area and will have to be partly supplied from abroad.

These facts clearly show great possibilities for the future development of the Canadian oil industry. Transportation problems, in the long run, cannot be solved however to permit a 100 per cent displacement of foreign supply by Canadian crude on the domestic market.

Strategic considerations also play an important role. In the case of another conflict, it is expected that Canada

(12) John F. Fairlie, Developments and Prospects in Canadian Oil, Washington, 1955, p. 30.

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will join resources and facilities with the United States as both countries did in World War II. An extension of the continental reserves towards the north decentralizes even further North America's resources and insures self-sufficiency in case other supply sources should be no longer available.

The exact knowledge as to the presence, quantity and quality of oil reserves is now becoming increasingly possible without having to draw them from the earth. Their natural underground storage is not only of military importance, but also permits to reduce expensive storage tank facilities.

The question as to whether the volume of petroleum import-export between the United States and Canada should be increased is to be countered by the question as to which measures to supply the North American requirements would contribute more to the development and maintenance of reserves within the continent.

It is, however, beyond doubt that the increase in West-Canadian oil reserves has already contributed no small part to the military security of the continent.

CHAPTER II

PETROLEUM PIPELINES AND INTERNAL
WATER TRANSPORTATION

The first pipelines in Canadian history were built in the 19th century, during the Ontario period. They were primitive affairs, often improvisations to move petroleum short distances from well areas to refineries. The two most important pipeline projects before Leduc, however, were the laying of the Portland-Montreal and Norman Wells-Whitehorse lines at the beginning of World War II. The purpose of the first project was to supplement the longer tanker route to Montreal and to avoid seasonal stoppages. The pipeline has a length of 236 miles and a daily capacity of 158,000 barrels. The Norman Wells-Whitehorse line was built as a part of the Canol project to move crude to the wartime Whitehorse refinery and from thence to supply northern defence echelons. The operations were discontinued after the war.

Not until Leduc, however, did a nation-wide pipeline network become a necessity as eastern, central and western Canada could be supplied by water routes and the prairie market was not large enough to warrant a change in

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transportation via rail. After Leduc market expansions eastward and westward could not be planned on the basis of the discovered reserves alone. Projects had to be undertaken in the belief that substantial new reserves would be discovered by the time transport facilities were completed. The decision to build the Interprovincial pipeline for instance was made on assumptions which at the time appeared highly optimistic. Subsequent developments proved them to be quite conservative.

Petroleum, by its nature, is one of the most movable products and the most movable of all minerals. Either as crude or in product form it can be moved great distances from centres of production to markets. There is a score of different means of transportation ranging from tankers (the cheapest) to rail movement (the most expensive). The geographical location of Canada's petroleum resources does not permit the use of tanker movement over long distances; however, for those resources to be used economically transportation costs must be kept at a minimum. Next to tankers the most economical means of transportation is pipeline. Since Leduc, pipelines have been used extensively and today over 90 per cent of all oil movement is done through pipelines. (1)

(1) "Active Pipeline Construction Continues in Canada", in World Petroleum, Vol. 25, No.5, issue of May, 1954, pp. 106-109. "Canadian Pipelines", in World Petroleum, Vol. 26, No. 5, issue of May, 1955, pp. 162, 164.

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Table II indicates that out of the six lines which constitute the most important part of today's oil pipeline network, three are used for product and three for crude. The three product lines are able to deliver currently 110,500 b/d of gasoline and other refined products into the Hamilton-Toronto-Ottawa area. Deliveries can be greatly expanded however, by the addition of pumping stations along the lines. Total crude line capacity amounts to over 486,000 b/d of which 189,000 b/d consist of foreign crude movement to Canadian refineries and 297,000 b/d are available for Canadian crude movement to refinery plants and markets. Here again capacity may be vastly increased by adding more pumping stations.

The spur and gathering line system currently totals over 700 miles and is in a state of constant expansion. Some of the most important late developments involved gathering and delivering facilities for Pembina crude to Interprovincial trunk lines in Alberta. Similar projects have been carried out for the Foreston and Smiley fields in Saskatchewan.

The initial Interprovincial pipeline project was planned as a relatively small diameter line from Edmonton to Regina, as the first step towards the ultimate extension to the Ontario market. Before the pipe was constructed for

Table II
 BASIC PIPELINE STATISTICS
 1955-1956 (2)

	Length (miles)	Capacity ('000 b/d) (3)
Trans Mountain	750	150
Interprovincial	1,772	217 (ex Edmonton) 147 (into Sarnia)
Montreal-Portland	236	189
Trans-Northern (product)	440	54
Sarnia Products (I.O.L.)	203	55
Sun Canadian (product) Sarnia-Toronto	211	17.5

(2) Imperial Oil Limited, Facts and Figures About Canadian Oil, issue of 1955, p. 10.

(3) b/d = Barrels daily.

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this project, the project was expanded to run the pipeline as far as the Great Lakes at Superior, Wisconsin. However, it was not possible to cancel the order for the small diameter line already made. This accounts for the 16-inch pipe in the line running east of Regina to the United States border.

This first phase in the development of the Interprovincial pipeline project depended mostly on an Imperial Oil commitment to move 35,000 b/d to the company's refinery at Sarnia. This was part of a large transportation facility programme undertaken by Imperial Oil which also involved the construction of two super-sized lake tankers to bridge the gap between Superior and Sarnia. All producers using the pipeline facilities were committed by the Interprovincial programme to enter in competition already existing or which might later develop with the foreign crudes in the Ontario market to assure full use of the line on a long-term basis. Moreover, substantial storage tankage had to be built at the refinery and at Superior to provide for accumulation during the closed season of navigation.

Total investment in the Interprovincial pipeline project amounted to 84 million dollars in 1949 including 73 million in pipe facilities, 8 million in tankers, and 3.4 million in harbour facilities including tankage. The

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total capacity of this project was well above what was warranted to transport the then proven reserves of Western Canada.

The project continued to grow combining pipeline and tanker transportation to supply the Ontario market. The capacity of the line was increased to 95,000 b/d up to Superior during the summer months. Tankage capacity at Superior was also increased to five million barrels, while two more tankers were put in operation and two more were built. As the programme took form in 1952, it appeared indispensable to further expand tankage capacity to about 10 million barrels. As the whole project neared completion in 1952 on a 1949 basis of expectation, it had become obvious that the transportation facilities thus provided no longer matched the continually increasing reserves of the western fields which permitted a much greater saturation of the Ontario market.

Albeit plans were made to build a pipeline to the western coast, much greater quantities of crude should be moved to the east, bringing about lower unit transportation costs. Because of the above reasons and in order to avoid the seasonal factor, a decision was made to extend Interprovincial from Superior to Sarnia. This move involved laying 30-inch pipe between the two cities, together with substantial additions between Edmonton and Superior. Tankers and

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storage capacity were thus idled and had to be scrapped.

These final changes in the Interprovincial system were completed in 1953 and make it possible to supply the Ontario markets for years to come, allowing for a fairly rapidly increasing demand. (4)

Oil pumping out of Edmonton started in October, 1950, and tanker traffic began at Sarnia with the opening of navigation in 1951. The crude movement to the east has grown to roughly 120,000 b/d in 1956, of which some 10,000 barrels are diverted to two refineries at the Lakehead. The rest is forwarded to Sarnia. We have seen that when the Interprovincial line was laid in 1950, it was not visualized that discoveries in western Canada would approximate what has been achieved. Western sections of the line consisted of 20 and 18-inch pipe as far as the Saskatchewan refineries and thence eastward the line was only 16-inch. In 1951, Interprovincial delivered an average of 35,000 b/d at Superior. As production increased, the pipeline company looped (5) 100 miles of line and built five new pump stations to bring deliveries at Superior or to an average of 58,621 b/d

(4) Fred G. Cottle, in an Address to the Canadian Institute of Mining and Metallurgy, Edmonton, May 11, 1955, pp. 3-5.

(5) The expression "looping" means: adding to pipeline throughput by laying parallel lines of varying diameters.

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in 1952. In 1953, it was necessary to continue the looping programme by laying 135 miles of 24-inch loop east of Regina and to install additional horsepower at the pump stations.

The same year the extension Superior-Sarnia was laid using 30-inch pipe for a distance of 643 miles with a potential capacity of 300,000 b/d. The cost of this particular project was 74 million dollars.

At the close of 1953, the Interprovincial system had a capacity of 171,000 b/d east of Edmonton and 126,000 b/d at Superior. The first deliveries into Sarnia averaged about 100,000 b/d. In 1954, Interprovincial spent 51 million dollars to install 455 miles of 24-inch loop in Canada and 196 miles of 26-inch loop in the United States. In 1956, the last extension of the line between Sarnia and Toronto was made and the company's total investment in the line reached over 250 million dollars. A further extension to Montreal is not economically feasible for the time being as the transport handicap could not permit Canadian crude to compete successfully with cheaper Latin American and Middle East crudes.

These developments have permitted to supply well over 80 per cent of the Ontario requirements with western crude. Imports of foreign crude into Ontario run to about 25,000 b/d (1956). The Lakehead refinery capacity is saturated to 1/3 with Interprovincial crude, the remainder

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being supplied by the Williston Basin in Montana.

The Portland-Montreal line capacity was also increased in 1954 from 158,000 b/d to 190,000 b/d by adding four new pump stations on the 18-inch line. Expansion in the refinery capacity of Montreal will force a further capacity increase of the line or additional tanker traffic.

Trans Mountain Oil Pipe Line Co. owns and operates a 718-mile pipeline transporting crude from Edmonton to refineries in the Vancouver area and the state of Washington. The present capacity of the line is 150,000 b/d with four pumping stations installed. The ultimate capacity of over 300,000 b/d is large enough to take care of any growth in market demand that could materialize within a reasonable period of time without resorting to major construction projects. The main line was completed and "placed on stream" in October, 1953, and an extension to a new refinery at Anacortes, Wash., was completed in July 1955. The demand of the British Columbia Market was large enough, however, to warrant the debt incurred to finance the pipeline and the venture was undertaken on that basis. The first profits (over 2 million dollars) were recorded in 1955.

The Pembina Pipe Line Co. owns and operates a pipeline transporting crude from the Pembina field to Edmonton. The main line which has a capacity of 115,000 b/d was placed on stream in November 1954, but the 200-mile gathering

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system is not expected to be completed until 1958 or 1959. The cost of the entire system including gathering facilities is estimated at approximately 14,191,000 dollars. Throughput now averages 45,000 b/d (1956). (6)

Aside from the above-mentioned pipeline companies, which are of major importance, the following enterprises own and operate trunk lines and lines created for a specific purpose only. They include the Peace River Pipe Line Co. which transports crude from the Sturgeon Lake field to the Trans Mountain at Edson, Alberta. The line consists of 106 miles of main trunk and of about 57 miles of gathering lines. The Trans Prairie Pipe Line Co. connects the Daly and Virden-Roselea fields in Manitoba with the Interprovincial line. The Saskatoon Pipe Line Co. operates 56 miles of line between the Interprovincial and the Saskatoon refinery of Royalite Hi-Way Ltd. Numerous other small concerns complete the operations of the present pipeline network.

To the 1954 figure in Table III could be added 1,165 miles of line, including looping, of the Interprovincial system in the United States and 27 miles on the Washington State extension of the Trans Mountain pipeline. Thus the total mileage at the end of 1954 of all lines within

(6) R. B. Toombs, "Pipeline Link", in Canadian Oil and Gas Industries, Vol. 8, No. 11, issue of Nov. 1955, pp. 72, 73, 76.

Table III
PIPELINE MILEAGE (7)

Year	Mileage at end of year
1947	435
1948	455
1950	1,659
1951	1,751
1952	2,870
1953	3,924
1954	4,656
1956	5,807 (8)

p. 74. (7) Canadian Oil and Gas Industries, November, 1955,

p. 43. (8) A Survey of the Petroleum Industry in Canada, 1956,

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Canada carrying crude and products and of U.S. Lines carrying Canadian crude was 5,848 miles - a 16-fold increase since December 1948. Deliveries totalled 172 million barrels in 1954, and 187 million barrels in 1955. Barrel miles totalled 5,881 million and the average haul was 306.2 miles. In 1954, people employed in pipeline operations numbered 1,185.

It should well be mentioned that in order to be economical on long distance movements, pipelines must operate on a large scale which, in last resort, in Canada, will be determined by the size of the population. Marketing thus has become and remains the greatest problem of the industry.

CHAPTER III

MARKETING CANADIAN CRUDE AND PRODUCTS,
WITH REFERENCE TO MAIN DISTRIBUTORS

Marketing represents the most important problem of the Canadian oil industry. The rapidly increasing maximum efficient recovery of the last few years has greatly widened the gap between the productibility of the western oil fields, which reached almost 800,000 b/d in 1956, and is expected to top one million b/d in 1957, and the much slower increase in demand of the geographically accessible markets (450,000 b/d in 1956). Table IV illustrates the break-down of markets supplied in 1955. Canadian crude moved into those markets in three successive phases. First came the Prairie Provinces themselves which requirements were saturated by mid-1949 as refinery expansion programmes reached completion. The construction of the Interprovincial pipeline opened up the Ontario market to western crude which had to compete with the many and varied supplies entering the Great Lakes market. Supplies from the Carribeans, Venezuela, the Middle East and from the United States Gulf and Mid-Continent fields strongly affected the price structure of Canadian crude in that area. The "landlocked" feature of Canadian crude, competing with off-shore supplies can be best

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Table IV
BREAK-DOWN OF DEMAND FOR WESTERN CRUDE, 1955 (1)

	Barrels Daily	
West Coast:		
British Columbia	49,000	
Puget Sound	37,000	86,000
The Canadian Prairie Provinces:	123,000	123,000
Eastern movement:		
The U.S. Lakehead-Minneapolis area	21,000	
Ontario	107,000	128,000
		<hr/>
TOTAL		337,000

(1) W. O. Twaits, in an "Address", Canadian Oil at the Eight Milestone, 1955, p. 8.

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expressed as follows. Canada's crude must adapt itself economically to pipeline transport costs. That is, it must move at costs of roughly 3c. per 100 barrel miles in big inch pipelines. Tanker-transported crude, travelling at 1c. per 100 barrel miles can be moved well over 5,000 miles for as much as it costs to move western Canadian crude 1,770, or the Interprovincial distance from Edmonton to Sarnia. This transportation penalty is reflected in the price of Canadian crude movements to the Ontario market and thus influences very much on the determination of the well-head price. This, in view of the fact that the majority of the land rights in the Prairie Provinces are in the hands of the provincial governments which seek to gain the best possible return for oil at the well-head, further complicates the transportation penalty. Furthermore, any decision affecting markets and the construction of pipelines to reach them, will have very lasting effects and contribute a great element of rigidity in transportation patterns as opposed to tanker traffic which routes can be changed at will. The differential of 22c. and more between well-head prices of Canada crude and other supplies clearly express the "backward" effect of the transportation handicap that must be borne by oil enterprises. (2)

(2) W. O. Twaits, in an "Address", Canadian Oil at the Eighth Milestone, 1955, pp. 7-8.

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One important fact to be drawn from these considerations is that western crude will probably never be able to supply the Maritime market. The shortest pipeline route from Edmonton to Halifax would be over 3,000 miles and from Edmonton to Montreal, 2,300 miles. When one considers that the longest non-Canadian pipeline in the world (Interprovincial being the longest), supplies the Great Lakes with West Texas crude, a distance under 1,500 miles, the eastern markets situation is placed in a most realistic light, and the Montreal area market of over 200,000 b/d (1957) tempting as it may be, would require drastic well-head price deductions in order to be supplied with Canadian crude.

However, development in the Ontario demand for crude permits a fairly optimistic forecast of some 190,000 b/d within the next few years. Demand requirements for 1955 averaged 107,000 b/d. This will require further expansion in the refinery capacity of the Niagara peninsula area and probably further developments in the transportation facilities.

In reaching Ontario the Interprovincial pipeline runs through a potential market in Michigan, which along with Minnesota and Wisconsin form a deficit area. These three states are still largely dependent on U.S. supplies but increasing costs of production and dwindling reserves

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should permit Canadian crude to enter this market within the next few years. The area represents one of the most promising outlet for Canadian crude faced with rising productivity and lack of markets.

The development of this area was first envisaged before the Interprovincial pipeline was built. Many obstacles, however, such as long-term supply guarantees, firm commitments to finance pipeline capacity, etc., forced to postpone the project until finally oil was discovered in the Williston Basin ending all hopes of supplying the area with Canadian crude. The subsequent discovery of medium gravity sour crude oil in Saskatchewan revived the issue. It could not be marketed in Canada and producers were under extraordinary pressure to find an outlet. Consequently, a trunk pipeline was built to supply a newly erected refinery at St. Paul's. The line joined Interprovincial at Clearbrook. Williston Basin, however, still denied access of Canadian light crude to the area until a pipeline was built to move excess Williston Basin crude to Wyoming. St. Paul once again became an interesting proposition for Canadian crude. Further developments have assured a market of 55,000 b/d including refineries operating at Superior, Wisconsin. (3)

(3) F. G. Cottle, in an "Address" to the Canadian Institute of Mining and Metallurgy, Edmonton, May 1955, pp. 11-14.

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The Prairie provinces themselves, with a demand of 123,000 b/d in 1955 are expected to absorb over 170,000 b/d by 1960. Refinery capacity to cover the increase is in great part available and will be expanded as fast as long-term growth requires it.

Farther west, the combined British Columbia Puget Sound market has also been rapidly increasing and justified forecasting a total area demand of some 173,000 b/d by 1960. The increase is expected to take place within the area now supplied rather than in a geographical expansion. This has been caused mainly by the failure for the expected shortage of crude in California to materialize and by the unexpected ability of other sources to supplement the dwindling Californian reserves.

Summarizing market expectations for 1960, the total outlet for Canadian light and medium crude should run closely to 600,000 b/d. The eastern markets (Ontario, North Central states) are expected to grow to roughly 250,000 b/d, a 90 per cent increase from 1955. The Prairie market demand should reach 170,000 b/d, and the west coast, to 173,000 b/d from 83,000 b/d in 1955 for a 108.4 per cent increase.

This most important growth pattern of 70 per cent within five years, does not depend on the construction of major transportation projects. The growth is rather a

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consequence of the achievements and planning already made and depends largely on the development of additional and new refining capacities in areas previously supplied by other sources but in which Canadian crude can now successfully compete. Total exports to the United States are expected to reach 174,000 b/d by 1960. (4)

The problem of marketing Canadian crude probably no longer exists in the long run. Continental requirements in 15-20 years should be as high as 14 million b/d and in face of increasing U.S. difficulties to meet its own demand, the prospects for maximum use of Canada's petroleum resources are optimistic indeed!

There are three basic influences determining the value of crude oil, two of which are relatively easy to evaluate. They are the effects of accessibility to markets and the inherent qualities of crude itself. These two factors concurrently determine the well-head price. The third influence, the speed with which crude reserves can be produced, is much more difficult to establish. Let us deal with each of these influences as they affect Canadian crude.

First, the distance from markets. In Table V, Redwater crude is taken to be a representative product and

(4) Ibid.

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Table V
COMPARABLE CRUDES (5)

	Gravity	Price per bbl.(US)
California-Greeley	37°	3.24
Mid-Continent	36°	2.82
Texas - East	39°	2.90
- West	36°	2.69
Venezuela Oficina Puerto La Cruz (f.o.b.)	36°	2.88
Illinois	36°	2.90
Redwater	35°	2.53

(5) Facts and Figures about Canadian Oil, Imperial Oil, 1955, p. 8.

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its well-head price is comparable to that of other sources. We see from Table V that Redwater crude sells at a discount to counterbalance the heavy transport tariff it must meet before being refined and marketed. The existence of such a transport handicap produces a strong incentive to plan most efficiently in other instances.

Second, within a major producing area, differences in quality and accessibility will account for varying well-head prices. Additional factors such as the sulphur content and other impurities are also reflected in the price schedule (See Table VI).

Generally, the quality factor reflects the difficulty of refining heavy and sour crudes into gasoline and other light products. Recent research developments, however, have reduced these difficulties and consequently the value gap between the two types of crude has decreased considerably.

The third influence, the rapidity with which oil can be produced, is one which leaves the greatest room for individual judgment, and where the possibilities of error are correspondingly large. To illustrate this, a list of withdrawal rates authorized by the Alberta Conservation Board is shown in Table VII. Misjudging the oil reserves of a well or field is perhaps the most common error in the industry. It often happens that as more knowledge of the

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Table VI
CANADIAN FIELDS (6)

	Gravity	Price per bbl. at well-head (Can.\$)
Alberta:		
Leduc	39°	2.60
Sturgeon Lake	38°	1.97
Stettler	27°	1.97
Golden Spike	37°	2.54
Redwater	35°	2.53
Pembina	39°	2.48
Turner Valley	40°	2.80 ₅
Lloydminster	15°	1.46
Saskatchewan:		
Coleville	14°	1.50
Smiley	33°	2.24
Manitoba:		
Daly	33°	2.34
Virden	34°	2.32

(6) J. R. White, in an "Address" to the National Federation of Financial Analysts' Societies, New York, May, 1955, p. 5.

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Table VII
WITHDRAWAL RATES AUTHORIZED (7)

Fields	Ratio of Annual Production to Ultimate Reserves - Jan.1, 1955
Redwater	3.6 per cent
Leduc D-2	12.1
Leduc D-3	7.3
Bonnie Glen	2.3
Fenn Big Valley D-2	4.7
Joarcham	10.3
Wizard Lake	1.9
Acheson	3.8
Golden Spike	1.4
Westeros	1.6
Average: 3.75 per cent (weighed according to reserves)	

(7) Ibid., p. 6.

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reservoir is gained, the apparent cost of the crude proves to be quite different from what the entrepreneur expected it to be at the time of the discovery.

Actually, active oil companies must sell a considerable portion of their crude at much lower than ceiling prices. It is only by earning an adequate margin that they are able to invest in the search for oil, an occupation which involves great risks and expenditures. Every year at least 50 million dollars are lost in dry holes by the oil industry in western Canada. If unsuccessful drilling were not compensated for it is obvious that exploration would come to a halt. However, we shall not dwell on the exploration and production aspects of the industry but rather study briefly the refining of crude and the development of secondary industries which constitute the link between production and consumption of final products.

Canadian Refining Capacity (8)

Great changes have taken place in the refining industry since 1947. Total refining capacity has steadily increased to keep pace with developments in demand. Many new processes have also been introduced to meet new and more complex quality requirements. Much of the new capacity,

(8) H. McLeod, "Refining in Canada-Statistics" in Canadian Oil and Gas Industries, Vol. 8, No. 11, issue of November, 1955, pp. 63,64,67.

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specially that installed since 1950, has taken the form of completely new refineries. The greatest gains, however, have been achieved by expanding plants which had been established for 20-30 years in centres such as Montreal, Sarnia and Vancouver. Total capacity of Canadian refining stands at roughly 750,000 barrels per stream day (9) (mid-1957). It appears that capacity will reach 850,000 bbls. per stream day by 1960, if forecasted demand increases prove correct.

The total refining capacity of the industry has always closely corresponded to total demand and increased with it contrary to the United States where a considerable capacity surplus has been encouraged by government and tax incentives, Canada's construction activities follow short-run, foreseen demand increases. An important programme has been underway for some years to equip Canadian refineries with catalytic cracking units to produce high octane gasolines. This enterprise should soon permit Canadian refineries to produce octanes comparable to United States products.

Canada's refining industry now ranks among the

(9) Stream day capacity represents the refineries' ability to process crude when all units are "on stream". As processing units must be shut down for inspection and maintenance regularly, their average capacity over a given period of time is less than the figures quoted.

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most modern in the world, behind England and France which have rebuilt since the war, and operates on a very high efficiency basis.

The rate of growth in demand, averaging 8-10 per cent over the last few years, has been caused mostly by rapid developments in automobile, farm, railroad and other usage of petroleum fuels and lubricants. This rate of growth is not expected to be sustained, however, and a more realistic rate of 6 per cent is suggested for the years to come. Total demand averaging roughly 15 barrels per capita per year, put Canada second only to the United States in per capita and total consumption. (10)

In gross value of production the petroleum refining industry now stands third among Canada's manufacturing industries, being exceeded only by pulp and paper and non-ferrous smelting and refining. The gross value of production from petroleum refineries was over one billion dollars for 1956. In 1940, the value of output was only 121 million dollars and 222 million in 1946. Some 12,000 persons were employed in the industry in 1954 drawing salaries and wages of over 50 million dollars.

(10) List 5-2, Petroleum Refineries in Canada, Department of Mines and Technical Surveys, Jan. 1956, pp. 2-3.

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In 1954, some 40 refineries operated in Canada processing 464,200 b/d. Refineries were distributed as follows: Alberta 10, Saskatchewan 9, Ontario 6, Quebec, British Columbia and Manitoba 4 each, and 1 in each of Nova Scotia, New Brunswick and the North West Territories. Quebec's four refineries (Montreal area) with a daily capacity of 180,000 b/d accounted for 32 per cent of total capacity. Ontario with 147,000 b/d for 26 per cent, and the Prairie Provinces with combined daily capacity of 158,000 barrels accounted for 28 per cent. Between 1946 and 1954, the refining capacity of the eastern provinces almost doubled from 183,000 b/d to 345,000 b/d. The Prairie provinces witnessed a four-fold increase from 40,000 b/d to 158,000 b/d. British Columbia advances from 22,000 to 56,000 b/d.

Refining activities for the year 1954 consisted of processing the following product quantities: 68 million barrels of motor gasoline, 1.4 million barrels of aviation gasoline, 31 million barrels of heavy fuel oils, 14 million barrels of diesel oil, 23 million barrels of light furnace oil, 10 million barrels of stove oil, 1.6 million barrels of other light fuel oils, 0.6 million barrels of kerosene (the chief product before 1900!), 1.6 million barrels of aviation turbine fuel, 1.6 million barrels of liquefied petroleum gases, 1 million barrels of petroleum feed stocks,

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1.6 million barrels of lubricating oils as well as other products such as coke, asphalt, naphtha, etc.

Consumption of motor gasoline totalling 70 million barrels in 1954 represents a 100 per cent increase over 1946. Consumption of aviation gasoline was 2.7 million barrels compared with 0.5 million in 1946.

Secondary Industry: Petrochemicals

The most important raw materials of the petrochemical industry are hydrocarbon gases from oil refining and natural gases. The two most important refining centres in Canada are located at Sarnia and Montreal, in the population and industrial heart of the country. These circumstances and sustained increases in the volume of throughput in both areas and the consequent increases in the volume of the by-product hydrocarbons, made it possible to create and expand a Canadian petrochemical industry, which has taken place during the past 15 years or so in eastern Canada. On the other hand, the discovery of large natural gas reserves in the west has enabled the industry to overcome high transportation costs to markets and to establish itself in the Prairie provinces using available and cheap raw materials.

Canada's small population and markets did not make it possible until 1942 to establish even a minimum size petrochemical plant that could operate economically. Synthetic rubber and the urgency of war requirements combined

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to secure the industry a footing in Canada. The average rate of growth has been 18 per cent per year since 1945, being particularly high between 1950 and 1953. Over 50 petrochemicals are now produced commercially in Canada, including acetic acid, acetone, ammonia, phenol, polyethylene, synthetic rubber, sulphur, etc. A number of plants are now operating in Sarnia, Montreal, Edmonton and Calgary, involving some fifteen companies. As mentioned above, synthetic rubber was the main reason determining Canada's entry into the petrochemical field.

As most of the natural rubber sources had fallen into the hands of the Japanese in World War II, it became imperative for North America to achieve independence from that source of supply to assure successful prosecution of the war. In 1942, 20 synthetic rubber plants were built on the North American continent, 19 of these in the United States and one in Canada, these numbers were in the ratio of both countries production capacities. Thus was created the famous Polymer crown corporation producing 39,000 short tons of rubber in 1944 and 90,000 tons in 1953. Some important oil companies are also involved in the production of petrochemicals, among them Shell of Canada, British American Shawinigan and Royalite in Turner Valley.

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Others are Canadian Industries Limited, Dominion Tar and Chemicals Company, etc. (11)

The most important problem impeding the industry remains the fact that the domestic market, though expanding, is often still too small to permit economical use of minimum size plants. As new methods and processes are introduced, this limitation can be removed for an increasing number of products. It is thus expected on the long run that an increasing range of products will be introduced and produced economically.

(11) A. W. Hutchison, and R.G. Stevens, "Petrochemicals", in Canadian Oil and Gas Industries, Vol. 8, No. 11, issue of November, 1955, pp. 111, 118.

- R. H. Hall, "World's First Phenol-From-Cumene Plant Completes Two Year Operation", in World Petroleum, Vol. 26, No. 5, issue of May, 1955, pp. 88-90.

CHAPTER IV

NATURAL GAS, TRANSMISSION SYSTEMS AND MARKETS

The years 1956 and 1957 have been decisive in the history of the natural gas industry in Canada. Very important acts of legislation have taken place to finally permit the execution of two essential pipeline projects to secure urgently needed markets for the rapidly increasing reserves of the Prairie provinces. These reserves have accumulated during the past years at an increasing rate to a point where the limited Prairie market constitutes only a fraction of their potentiality.

The annual increases of natural gas reserves, roughly 2.5 trillion c/f per year, have been found almost solely incidental to the discovery of oil. Proven reserves could now supply a market three or four times the size of eastern Canada's industrial concentration. The short-run problems here, as well as in the petroleum industry, point in one direction, marketing. Natural gas is expected to fill 25 per cent of Canada's total energy requirements by 1980, compared with only 4 per cent in 1953. This expectation depends of course on such variables as the relative costs of competing fuels at that time, cost of extraction

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in the field and transportation. A domestic demand of some 1.2 trillion c/f annually by 1975 represents, however, a fairly conservative estimate. Trans-Canada officials have estimated a minimum marketing expansion of 500 per cent in the first ten years of pipeline operations, which represents sales in Canada of at least one billion c/f daily. (1)

The cold Canadian winters will probably boost the growth pattern of natural gas far beyond that of the United States where industrial uses account for roughly 75 per cent of all gas consumption. There is little doubt that domestic and heating demands will far outweigh industrial requirements in the first years at least. Such has been the development of the demand structure in the Prairie Provinces to which we shall return later in this chapter. The seasonal factor, advantageous as it may be in this instance, will bring about the troublesome problem of balancing out load factors over the entire year. Because of climatic conditions leading to heavy loads in winter for heating purposes, full economic uses will have to be made of available off-season storage facilities and interruptable industrial markets. The substantial gas storage fields in southwestern Ontario owned by Union Gas Co. of Canada and Imperial Oil Ltd. will be integrated into the over-all Trans-Canada system, and expanded as requirements increase.

(1) F.K. Beach, "Natural Gas in Western Canada", in World Petroleum, Vol. 26, No.5, issue of May, 1955, pp.70-72.

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It would be difficult indeed to find comparable examples of the success or failure of an important industry depending so much on transportation facilities. Moreover, rarely have pipeline planners had such difficulties to overcome as in the case of Canadian natural gas:

- First, there was no previous worthwhile gas pipeline experience in Canada on which to base cost and market estimates.

- Second, compliance with federal aims and regulations on one side and provincial on the other, often at cross-purposes, has further complicated planning.

- Third, international complications were raised by planning to export gas to the United States.

- Fourth, the project faced an even bigger disadvantage than the Interprovincial pipeline, in that some 80 per cent of the potential Canadian market is on the remote end of the pipeline, where carrying costs are heaviest and competition from other fuels the greatest. (2)

Here we touch upon one of the greatest elements of risk inherent to the project: whereas Canadian crude and products were but displacing foreign crudes and products

(2) W. L. Dack, "Gas: Our Billion Dollar Pot at Rainbow's End", in The Financial Post, Vol. L, No. 48, issue of December 1, 1956, pp. 63-64.

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from the Canadian market, western natural gas must compete with and replace other types of fuel. In other words, the complete success of the scheme entails the acceptance of industry and individuals to change from other forms of fuel consumption to natural gas. This means that natural gas must offer worthwhile advantages in price and otherwise.

However, it is only by making full use of transportation economies, moving large volumes through big-inch lines, that eastern markets can be supplied with western gas and gradually displace other fuels.

Natural Gas Pipelines:

The two major projects constituting the envisaged pipeline network in Canada are either being implemented or nearing completion at the time this is written.

The first project involves a 650-mile big-inch pipeline moving gas from the Peace River Valley fields, in northwest Alberta and northeast British Columbia, to supply the Vancouver market and the northwestern states. This project has been linked with the name of Frank McMahon and the West-coast Transmission Co. This concern sought to develop Pacific coast outlets as soon as western gas became abundant enough to warrant export. In 1923, the first discoveries were made in the Peace River area, but were soon abandoned because of transportation difficulties. The

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present development, however, started in 1949, and in 1952 permission was granted by the Alberta and British Columbia provincial governments to export gas. Tapping U.S. outlets was quite another story, however, and after years of hearings, the company's submission was finally rejected by the U.S. Federal Power Commission on the following grounds:

- 1) It was a national aim of the commission to assure that no sector in the United States became solely dependent on a foreign source of energy supply,
- 2) it was suggested that the company had no firm contracts with distributing companies that could assure economies of large movement transport, and,
- 3) that Canadian statutes did not assure continuity of supply on a long-term basis.

The Westcoast Transmission Co. tried to eliminate these objections in order and succeeded in 1956. The company's pipeline was to contact the Pacific Northwest Pipeline Corporation system at Hintingdon, B.C. on the United States boundary, and from there supplement American gas flowing into Colorado and adjacent states. The company further closed firm contracts with B.C. Electric Co. and Inland Natural Gas Co. serving British Columbia. Provincial statutes were also changed to assure continuity of supply into the United States and the Federal Power Commission finally agreed to permit Canadian gas import. The project

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is to start operation this year. (3)

Even more controvertial was the Trans-Canada pipeline project to move western gas to the main eastern markets in the Toronto and Montreal areas. The general plan to transport and distribute gas includes the following components:

1. A 2,250-mile big-inch pipeline would transport gas from western fields, across the prairies to Winnipeg, thence north of the Great Lakes to Kapuskasing, Ontario.

2. A smaller diameter line would link Kapuskasing with the already operating Toronto-Niagara section of the line.

3. A branch line from Winnipeg would run south to Emerson, Manitoba, on the international border. This would feed gas into the 1,250-mile pipeline of the Tennessee Gas Transportation Corp.

4. The Toronto-Niagara line could be extended to Montreal. Plans for 1956 were to build the 700-mile section from eastern Alberta to Winnipeg and the 325-mile section between Toronto and Montreal.

The original 1951 plan did not foresee any important export outlet in the United States and it was thought that the company was financially in a position to build the line.

(3) "House of Commons Debates" (Hansard), Vol. 98, No. 84, 3rd Session, 22nd Parliament, issue of May 15, 1956, pp. 3911-3913.

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First, however, it had to be established whether Alberta gas reserves warranted large scale export movements. This was done towards the end of 1953 when the Alberta government, on the recommendation of the provincial conservation board, disclosed that reserves totalled some 11.5 trillion cubic feet. Trans Canada Pipelines Co. ran into financial difficulties, however, and was no longer capable of carrying out the 350,000,000 dollar project alone.

Between the time of its incorporation in 1951, and 1954, the company had closed contracts with potential customers and had invested over 12 million dollars in surveys, pipeline purchases and orders and sought to obtain an export licence for some 200 million c/d daily into the United States from the Federal Power Commission. The decision of the commission was negative on the grounds that there was no certainty the company could meet such a commitment.

By 1956, the company had invested over 20 million dollars in preparatory work, but no headway was made with the construction of the pipeline. Finally, Trans-Canada turned to the Canadian government for financial support which was granted after stormy political hearing. An act of parliament was passed and read as follows:

It is expedient to introduce a measure to provide for the constitution of a corporation to be known as Northern Ontario Pipeline Crown

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Corporation for the purposes, amongst others, of constructing, maintaining and operating a natural gas pipeline between the Ontario-Manitoba border and Kapuskasing, Ont., and of leasing with an option to purchase such natural gas pipeline to Trans Canada Pipe Line Limited and carrying such leases, including the disposal by the corporation of such pipeline in connection with such purchase option, and to provide that the minister of finance may lend money to the corporation for such purposes.

To provide also that the corporation may, on behalf of Her Majesty, out of moneys advanced by the minister of finance, make short-term loans to Trans Canada Pipelines Limited for the construction of a natural gas pipeline from a point on the Alberta-Saskatchewan border to the vicinity of Winnipeg, such loans not to exceed in the aggregate eighty million dollars or ninety per cent of the cost of construction of the said pipeline, whichever is the lesser, and to be made upon such terms, conditions and security as approved by the governor in council.

To provide also that the corporation may do such things as are conducive to the attainment of the foregoing purposes, and that in the event of default of Trans Canada Pipelines Limited in carrying out any agreement for the foregoing purposes, the corporation may take possession and control of any or all assets, rights and undertakings of Trans Canada Pipelines Limited and conduct the business and operations of Trans Canada Pipelines with respect to such assets rights and undertakings and that if such default should occur prior to completion of the pipeline mentioned in the last preceding paragraph hereof the corporation may complete its construction and manage and operate it and that it may, out of moneys advanced by the minister of finance acquire shares of the capital stock of Trans Canada Pipeline Limited.

To provide that the aggregate outstanding at any time of the amounts authorized by the measure to be advanced by the foregoing purposes

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by the minister of finance to the corporation together with the loans authorized to be made by the minister of finance to the corporation shall not exceed one hundred and thirty million dollars.

And to provide further for the appointment and remuneration of directors, officers and employees necessary for the administration of the act. (4)

From the above act, the greatest difficulty in laying the pipe comes to light. From the Alberta fields to Winnipeg Trans-Canada follows a route similar to that of Interprovincial but while the oil pipeline turns south of the Great Lakes and crosses potentially rich markets before reaching Sarnia, Trans-Canada is to cross the barren area of northern Ontario before turning down towards the Niagara peninsula and eventually Montreal, its most important markets.

In other words, the gas pipeline must travel some 1,500 miles without any worthwhile outlet.

The hearings of the Ottawa Parliament in committee revealed sharp opposition particularly on matters pertaining to economic control of the pipeline. The Act passed by Parliament contained provision to guarantee that 51 per cent of the shares of the corporation would be available to the Canadian public and that the majority of the directors would

(4) "House of Commons Debates" (Hansard), Vol. 98, No. 84, 3rd Session, 22nd Parliament, issue of May 15, 1956, pp. 3894-3895.

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also be Canadian. Nevertheless, Trans-Canada had undergone important financial changes since the time of its incorporation and was now mostly controlled by U.S. interests, particularly by the Tennessee Gas Transportation Corp. to which the company was to deliver 200 million c/f daily at Emerson. The opposition to government help to Trans-Canada rested mostly on the fear that the enterprise was to pass into U.S. control serving U.S. interest and be detrimental to Canada.

These changes in the financial structure of Trans-Canada have caused the Canadian system to become an integrated part of the larger Tennessee Gas Transportation Corp. network operating in the United States. It was thought that such an arrangement would make it possible for Trans-Canada to complete the Winnipeg section of the line independently. Rising costs and delays, however, proved the company unable to carry out the project alone. On the other hand, Tennessee Gas Transportation Corp. was to export 90 million c/f daily into the Niagara-Toronto line until the northern Ontario section were completed and western gas could supply the east directly.

From a political point of view, this set up could endanger Canadian control over the exploitation and the future of the western natural gas resources.

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Trans-Canada had to face perhaps even more opposition coming from the United States, American railroad and coal interests, fearing to lose their lucrative Ontario market, strongly opposed the project. A group of midwest gas companies also claimed that the Canadian pipeline would invade their present markets and would duplicate already existing transportation facilities inside the United States. The Federal Power Commission itself has rejected the project submitted to it by Tennessee Gas Transportation Corp. It was believed, however, that if Trans-Canada did lay the line, the Commission would accept the "fait accompli" and would grant permission to import at Emerson.

The resolution passed by the Canadian government contains two main parts. First, the act provides federal and provincial help of 83 and 35 million dollars respectively for the construction of the Ontario section of the line and second, to lend up to 80 million dollars to Trans-Canada to build the western section of the line. This loan was made at an interest of 5 per cent and in case the company failed to meet payments, the government was entitled to take over the whole project. In case of default on the part of the company, the pipeline would thus be nationalized.

In mid-1956 concrete and practical objections were opposed to outright government ownership of the line. As western natural gas reserves were rapidly increasing so

did gas wastage, passing from 17 billion c/f in 1953 to 37 billion c/f burnt as wastage in 1955. Moreover, seepages in the natural gas reservoirs now amounted to a loss of 1/6 of the gas on hand. The urgency to find markets was therefore of the essence. A government ownership programme, in which both federal and provincial governments would have taken part, would probably have delayed the project another two years. The preparatory work already done by Trans-Canada including contracts, pipeline orders, purchases of rights of way, etc. would have had to be repeated in a large measure by the new undertaking and the time required to find a solution acceptable to the different governments concerned would have further delayed the whole project. (5) Moreover, the idea of a nationalized project did not appeal to the doctrine of a liberal government. It was therefore decided to give private enterprise (Trans-Canada Ltd.) the chance to build and operate the pipeline. In case of failure and as a last resort measure, the government would take over. The government motion was implemented towards the end of May, 1956.

(5) Ibid., pp. 3936-3938.

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Western Gas Reserves:

By mid-1956 western Canadian gas reserves were estimated to be over 18 trillion c/f or more than Canada's total requirements including growth for the next 25 years and ample exportable volumes to the United States for the same period of time. The very size of these reserves did not prevent further intensified gas exploration and development, but by 1956, the lot of many private enterprises was becoming perilous because of lack of markets and therefore income. Total investment on the part of private enterprise to explore and develop reserves had reached 150 million dollars and market outlets were still limited to the Prairie provinces. The completion of the Westcoast Transmission system by mid-1957 will permit important export movements to British Columbia and the United States particularly for the coming winter months. The Winnipeg section of Trans-Canada is also expected to be completed in time for winter deliveries to the Winnipeg area. After this, permission from the United States Federal Power Commission to export at Emerson will become a most urgent matter. No final decision has been reached from the United States as this is being written and new control policies of the new Canadian federal government are likely to influence the

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the future of Trans-Canada as much as the U.S. Federal Power Commission. (6)

With reserves increasing now at a rate of 2.5 trillion c/f per year, the search for new market outlets is intensified. On the West Coast the most interesting possibility appears to be California where the largest utility concern in the United States, the Pacific Gas and Electric Co. of San Francisco, now intends to draw directly for its supply on Alberta gas. The company plans to build a 1,300-mile pipeline of 36-inch diameter (big inch) to run from Alberta to San Francisco. The total cost of the project would be upward of 330 million dollars. This and similar international projects remain completely dependent, however, on domestic conservation policies both in the United States and Canada where political and other considerations play a very important role. A favorable decision of the Federal Power Commission in connection with imports from Trans-Canada at Emerson would probably cause a precedent and open the way for other international projects. The policy next decided upon by the Federal Power Commission is therefore likely to be of very great influence on

(6) Ibid., p. 3937. W. L. Dack, "Gas: Our Billion Dollar Pot at Rainbow's end", in the Financial Post, Vol. L, No. 48, issue of December 1, 1956, p. 64.

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future developments. For the time being, a total export volume of 500 million c/f daily has been authorized by the government of Alberta, four fifths of which are either being transported by the Westcoast Transmission Co. or are still pending U.S. approval. It is of interest to note that Alberta gas has already been supplied to the United States as an emergency measure during the Korean war. A pipeline was built from southern Alberta to Montana to supply a copper mine.

Some of Alberta's largest gas reserves are located in central Alberta and are not involved in gas export as they can only be drawn upon to a limited extent. For instance, the Bonnie-Glen and Leduc-Woodbend oil fields have huge gas reserves which, however, must be primarily kept as the most effective means to lift the oil. Where oil deposits are important, large amounts of gas must be kept to be pressured into the wells and assure a steady flow of oil. In these two fields the bulk of the gas reserves will not be available for commercial purposes until late in their production life. (7)

Gas fields which at present lie outside the designated export areas will benefit from the developments of

(7) Oil in Canada, issue of July 15, 1957, pp. 24-25.

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Trans-Canada which will be an important incentive to enlarge existing gathering facilities. In Alberta, plans for a privately owned gathering system of over 1,000 miles, linking all important producing and potential areas, are underway. Saskatchewan has already completed a government programme of 650 miles of gathering lines servicing 26 communities and 5 cities. Provincial demand for 1956 reached 6.5 billion c/f with a winter peak of 50 million c/f daily. It is further planned that the Saskatchewan gathering system will supplement Alberta deliveries to the Trans-Canada pipeline.

When Alberta gave permission for Trans-Canada export, a tentative allotment of reserves by fields was made to supply the pipeline. Roughly a third of Trans-Canada requirements are expected to be drawn from Pincher Creek in southern Alberta. The greatest distance between export fields are the 260 miles from Pincher Creek to Provost in central Alberta near the Saskatchewan border. The designation of specific export areas for Trans-Canada has stimulated gas exploration in southern Alberta and relaxed activities somewhat in the Peace River valley.

The provincial agreement of 1954 covered a period of 27 years, with two years allowed for pipeline construction. Some 4.350 billion c/f of gas were to be delivered over a 25-year period on a pro rata basis according to field allotments.

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(From Table VIII) Cessford was found by Canadian Delhi Oil in August, 1950. Canadian Delhi, sponsor of Trans-Canada Pipeline, is a subsidiary of Delhi Oil Corp. in the United States and has one of the largest gas interests in the area.

Homeglan-Rimbey, 25 miles southwest of Bonnie Glen, has wet gas associated with crude oil. The discovery well was drilled by Calmont Oils and later taken over by Anglo-Canadian Oil Co.

Nevis, 10 miles northwest of Stettler, was discovered by Canadian Gulf Oil in April, 1952. Expansion was carried out by United Oils and Federated Petroleum.

Provost, 65 miles southwest of Lloydminster, was discovered by Imperial Oil in August, 1946.

Princess, 140 miles southeast of Calgary, was discovered by Anglo-Canadian Steveville in January, 1939.

Kessler, is a new and large area located 145 miles northeast of Calgary. The discovery well was the product of joint efforts.

Hamilton Lake, 75 miles southeast of Stettler, was established as a gas producer in 1952.

Duchess, 115 miles southeast of Calgary, was discovered in 1951.

Countess, five miles northwest of Duchess, was discovered by Canadian Delhi Oil and Socony-Vacuum in 1951.

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Table VIII

ALLOTMENT OF GAS RESERVES BY FIELDS TENTATIVELY
MADE AT THE TIME OF THE ALBERTA GOVERNMENT'S
EXPORT AGREEMENT (1954) (8)

	Billion c/f
Pincher Creek	1,374.4
Cessford	823.9
Homeglen-Rimbey	518.3
Provost	417.4
Nevis	323.3
Medicine Hat	242.5
Princess	170.1
Countess	52.4
Hamilton Lake	34.9
Kessler	26.1
Sibbald	26.1
Oyen	15.6
Duchess	11.4

Other smaller fields were scheduled to provide 191.8 billion c/f and 118 billion c/f were not designated at the time of the agreement.

(8) "How Gas 'Reservoir' Growing", in the Financial Post, Vol. XLVIII, No. 49, issue of December 4, 1954, p. 55.

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Table IX
RESERVES ESTIMATES (1954) (9)

Fields	Billion c/f
Pincher Creek	2,320
Cessford	489
Homeglen-Rimbey	1,226
Nevis	613
Provost	417
Princess	170
Duchess	53
Hamilton Lake	50
Countess	31
Oyen	16

(9) Ibid., p. 55.

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Oyen, a small field, is located 100 miles north of Medicine Hat and was discovered in 1949.

The Price of Alberta Natural Gas:

All contracts made between Trans-Canada and the gas distributors are for a period of 25 years with prices constant throughout the length of the contract without escalation. Export prices to Tennessee at Emerson increase 1c. per thousand cubic feet every five years. In each of the six zones set up by Trans-Canada along the pipeline, producers may choose between four different price schedules depending on the load factor they can market. Year-round movements will permit^a fairly regular load factor (despite increased loads in winter) and therefore lower and steadier costs of transportation. Transportation rates will thus be lower in large industrial and heavily populated centres. This means that rates may vary considerably between large cities and smaller outlets within the same province. The rates in terms of load factor are identical in the six different zones.

The rate in Saskatchewan at a 100 per cent load factor (same amount every day of the year) is 21.3c. per thousand cubic feet. In Manitoba, the 100 per cent load factor rate anywhere along the pipeline is 26.2c. In western Ontario, the 100 per cent load factor price is

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34.5c. In central Ontario (from Cobalt to Whitby, including Toronto) the full load rate is 44.5c. In the last zone, from Whitby to Montreal, the full load price is 46.6c. Smaller markets consuming at 75 per cent of load factor have the following prices: Saskatchewan, 22.4; Manitoba, 28.3; Western Ontario, 37.7; Northern Ontario, 47.5; Central Ontario, 49.3; and the Eastern zone to Montreal, 52.1.

At a 50 per cent load factor, prices increase 25 to 30 per cent over the 75 per cent load factor rates. (10)

As the pipeline operates on a full-time basis and as carrying charges and other costs are fixed, surplus gas resulting from the failure to maintain a 100 per cent load factor at all times, will be sold for industrial purposes at lower prices. This is particularly relevant to summer months. For instance, summer surplus gas will be available in Saskatchewan for 22c. per thousand cubic feet. In Manitoba, for 24c. In Western Ontario, for 29c. In Northern Ontario, for 32c. In Central Ontario, for 34c. and in Montreal, for 34c. also.

Winnipeg has contracted for 60 per cent of the load factor (as of mid-1956) or at a price of 32.9c. per thousand cubic feet. At a 100 per cent load factor, the price would

(10) "House of Commons Debates" (Hansard), Vol. 98, No. 87, 3rd Session, 22nd Parliament, issue of May 18, 1956, pp. 4085-4086.

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decrease to 26.2c. Both Montreal and Toronto have contracted for a 75 per cent load factor or a price of 52.1c and 49.3c per thousand c/f respectively. Export prices involved in the contract between Trans-Canada and Midwestern Gas and Transmission (subsidiary of Tennessee Gas and Transmission) differ for two parts of the agreement.

For the first three years gas will be exported at a 75 per cent load factor at a price of 27.27c per thousand c/f (Emerson). The contract entails movement of 200 million c/f per day, and for the first three years the minimum movable will therefore be 150 million c/f daily. For the following 22 years, the load factor will be 95 or 100 per cent. A heavy price penalty will have to be borne by Midwestern should it not be able to meet its commitments. The price for the 100 per cent load factor will be 25.08c per thousand c/f and for a 95 per cent load factor, 25.42c. These prices apply for the first five years, thereafter, an increase of 1c per thousand c/f will be imposed. (11)

In case the governments of Canada and of the United States agree to permit additional gas import into the United States, a second contract with Tennessee Gas Transmission would become applicable. The initial price for the

(11) W. L. Dack, "Trans Canada Gas Line Plans Move Rapidly Forward", in World Petroleum, Vol. 25, No. 5, issue of May, 1954, pp. 90-91.

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second 200 million c/f daily would be increased by 3c at a 100 per cent load factor, or about 30.4c per thousand c/f. Here again, for the first three years Tennessee is committed to take a 75 per cent load factor minimum at a price of 31.05c per thousand c/f. During the first five years at a 100 per cent load factor would be 28.04c. The increase of 1c per thousand c/f each year thereafter is also applicable.

One of the most important contracts in Canada involves the Union Gas Company which serves the Hamilton-Toronto-Sarnia area. Union Gas is going to take its supply from Trans-Canada mostly during the summer months when it is available at the surplus gas price. The company has large storage facilities in the market area it serves and its situation from that point of view is exceptional. The average price paid by Union Gas Co. for the length of the 25-year contract will be 39c per thousand c/f.

In Western Canada, Trans-Canada purchases gas from numerous suppliers. (12) In 1955, the Alberta Petroleum and Natural Gas Conservation Board established its charges at 3.14c for good, clean gas. Trans-Canada, on the other hand, will pay 14c per thousand c/f for the same quality of gas. This gives a well-head price of 10.86c per mcf. The

(12) James Richardson and Sons, Western Canadian Oils, Ed. No. 9, 1955, pp. 70-73.

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producer must clean his gas (if sour or heavy with liquid hydrocarbons: "wet" gas) and gather it for delivery into the trunk system. It is believed that producers will accept, as they have done up to now, the price paid by Trans-Canada if they are convinced the company cannot offer more. Negotiations between Trans-Canada and producers have so far demonstrated that tendency. Under present agreements, however, the price paid to suppliers is subject to an escalator clause of 1/4c per year for 20 years. Trans-Canada will continue to pay trunk line operators for moving the gas from the fields to its own pipeline. Such rates vary according to distance but on the average they fluctuate around 6c per mcf. For the next 20 years or so the price Trans-Canada will pay for gas at the Saskatchewan-Alberta border will average roughly 19c per mcf. Using the contract with Union Gas as a basis, Trans-Canada would make about 20c per mcf. The next 20 years with a total movement of 4.35 trillion c/f would thus produce a total revenue upward of 700 million dollars. Compared with the cost of building and laying the pipeline (about 375 million dollars) and operating costs, approximately 17 million dollars, the project should appear to be self-liquidating.

CONCLUSION

FUTURE DEVELOPMENT OF THE PETROLEUM
AND NATURAL GAS INDUSTRY

The forecasts concerning future development in the oil and natural gas industry depend primarily on two assumed conditions. First, that the rate of discovery and reserve increase will be the same or slightly lower than that recorded since 1947. Second, that the development of markets will take place where and when economically feasible without interference from other factors, e.g. politics.

Using the 1930-1955 period as a basis for growth within the following 25 years (until 1980), we see that Canada's gross national income increased 2.5 times and that oil product consumption rose 5.5 times within the first 25 years. Total energy consumption in Canada increased from 1,200 trillion B.T.U. (1) in 1930, of which 19 per cent were supplied by petroleum to 2,640 trillion B.T.U. in 1955 of which 49 per cent were made up by petroleum. Natural gas made up 3 per cent in 1930 and 6 per cent in 1955 of total energy requirements. (2)

(1) British Terminal Unit: heat required for one lb. of water to increase one degree F°.

(2) "Royal Commission on Canada's Economic Prospects", Hearings held at Toronto, January, 1956, Vol. 23, pp. 4754-4756.

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It is expected, barring war and an economic crisis, that the population will increase from 16 million in 1955 to roughly 28 million by 1980. This increase in population constitutes the main growth element on which will depend the general growth pattern of the economy. On that basis, it is expected that the number of occupied dwellings will reach 7 million, or twice the 1955 figure. The number of motor vehicles will increase by 200 per cent to 12 million by 1980. Gross national product will more than double to 70 billion dollars and energy requirements should reach 6,800 trillion B.T.U. by 1980 and will be made up to the extent of 71 per cent by petroleum and natural gas.

Total demand for Canadian natural gas is expected to reach 425 billion c/f per annum and that for petroleum roughly 760 million bbls. by 1980. These figures presuppose an average rate of growth of 4 to 5 per cent. On the other hand, expansion of the petrochemical industry is expected to occur at a rate of 15 per cent. This industry will be particularly favoured by increased petroleum and natural gas productibility and by the growth of domestic and export markets. The last few years have shown a tendency for petrochemicals to concentrate at the sources of supply of raw materials (natural gas, sulphur and hydrocarbons). It is expected that the industry will contribute greatly to the industrial development of Western Canada.

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From 1946 to 1954, the following bulk investments have been made in the different stages of the industry: 1.5 billion dollars in exploration, 1 billion dollars in transportation, refining and marketing, and 1 billion dollars in petrochemical plants and allied products.

In view of the foreseen increase in demand, total investment of upward of 10 billion dollars is suggested for all branches of the industry within the 1955-1980 period. Over a third of this total will be directed to exploration while the rest will be used mainly to expand and improve processing and transportation facilities.

By 1980, Canada will produce more than its total requirements and will either supply all domestic demand or export in the west what it will import in the east. The tapping of the Quebec market appears to be feasible on the long run but such a development will depend on the changing supply situation from present sources and on shipping conditions. It is very doubtful on the other hand that the Halifax market will be supplied with western crude before 1980.

The domestic market, it is believed, will absorb roughly one million b/d by 1980 (including Quebec) and crude export will vary between 600,000 b/d and one million b/d if foreseen U.S. deficiencies occur. The total demand for

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Canadian crude is thus expected to be in the vicinity of 2-3 million b/d by 1980.

Total reserves, on the other hand, are expected to reach 23-30 billion bbls and, deducting production for the period in question, net reserves should be about 13-17 billion bbls by 1980.

Canadian exports of crude to the United States are still penalized by a 10.5c tax per bbl. There is no such tax on imports into Canada and the present situation adds to the difficulties of transport borne by Canadian crude in competing in the United States. It is hoped that the Canadian argument based on continental and strategic considerations will soon lead to the revoking of this tax.

Most of the briefs presented to the Gordon Commission on Canada's economic future by petroleum and natural gas concerns have suggested misgivings in the Canadian income tax law which place Canadian companies at a disadvantage vis-à-vis U.S. concerns. The present depletion clause involves only oil already discovered and not exploration expenses which remained unsuccessful. U.S. companies, on the other hand, are permitted to deduct Canadian exploration expenses and depletion from revenues earned in the United States as well as in Canada. (3)

(3) Depletion is only granted after a company has charged off all costs of explorations, including ventures

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This situation explains to no small degree the fact that Canadian finance has not been overanxious to invest risk capital in exploration ventures. A revision of Canadian tax laws in this direction would place the petroleum industry in a favourable position vis-a-vis other Canadian industries and this is still the reasoning behind official policy today. However, as the petroleum industry requires large amounts of capital for exploration purposes and since it is desired that Canadians participate as much as possible, changes to put domestic concerns on an equal footing with U.S. companies are foreseeable in the near future.

All these facts as well as the low well-price which provides a correspondingly low return on investment have to a great degree impaired possibilities of full Canadian participation in the development of the industry.

The tendency for large, integrated companies to be more successful in the past few years has become noticeable and is believed to develop further as more difficult areas are explored and costs increase. The capital invested in risk ventures by large companies is usually distributed throughout many areas thus reducing the total risk element. This is not the case for smaller concerns which may have

anywhere in Canada. The company may produce from a lease in one part of Canada and explore in another part. It may recover all the oil from the lease and never be able to claim depletion for income tax purposes on wasting assets (exploration."Royal Commission on Canada's Economic Prospects", Hearings held at Edmonton, Alberta, Nov. 21, 1955, Vol.9, p. 1764.

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to invest all available capital in one venture. The life or death of the company in such cases depends entirely on the success of the enterprise. (4)

It is expected that by 1960, both Manitoba and Saskatchewan will be more than self-sufficient in petroleum and natural gas and thereafter will compete with Alberta crude in export markets.

In 1956, operations involved only 54 per cent of producibility which is expected to reach 2.8 billion barrels by 1980, and production should be about 90 to 95 per cent of producibility. Furthermore, as the production ratio to reserves is 1/12.5 in the United States and 1/25 in Canada, reserves can be produced twice as fast in Canada as in the United States.

It is of interest to note that Canada made two export shipments during 1956 that were sent to other foreign countries besides the United States. 240,000 barrels were exported to Japan and 75,000 barrels to France. Though the shipments were small, they open the possibility of other foreign markets for Canadian crude, particularly in the Pacific area where the land transport cost penalty is lower. Exports of petroleum in product form have already been made

(4) Ibid., Nov. 1955, Vol. 13, pp. 2528-2532.

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to the United Kingdom, Germany, Italy, Portugal, Switzerland, India, Union of South Africa, New Zealand, Brazil, Peru, Mexico, Venezuela. The United States import tax on Canadian gasoline is 52.5c per barrel and 80c on lubricating oils. It is not expected that large exports in petroleum products to the United States will take place except in emergencies. Development in other areas is heavily dependent on the international situation of petroleum supply.

For the Canadian economy, the discovery and development of petroleum and natural gas resources have helped overcome one of the most important energy shortages. Canada possesses little economical coal resources and this fact has constituted a drawback for the industrialization of the country. For this reason, Canadian industries have developed along lines which require mostly hydroelectric and petroleum energy. Until 1947, Canada had to rely heavily on the United States to meet its domestic coal and petroleum requirements. This is still the case and will remain so for some years to come but at a steadily decreasing rate. Moreover, the conversion from the usage of coal to petroleum and natural gas by private and industrial concerns has been greatly accelerated since Leduc.

The small population and the size of the country have led to a high energy consumption on a per capita basis both

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for industrial and household requirements. If the productivity of the whole economy is to be raised and the standard of living improved, even more energy will have to be made available to the Canadian worker. In this respect Canada now comes second only to the United States. The increasing role played by petroleum and natural gas in the total energy structure of the land will contribute no small part in this development. (5)

From a strategical point of view the Canadian reserves represent a continental guarantee of self-sufficiency. The tar sand area in North Alberta with estimated reserves of up to 300 billion barrels have not yet been commercially exploited and efforts in this direction will probably remain of secondary importance as long as oil exploited by more conventional methods is available in sufficient quantity and can be produced cheaply enough. However, the tar sand oil remains an important reserve for any emergency and can be looked upon as capable to assure self-sufficiency of the whole continent for an indefinite period of time.

The near future will see the realization of the Trans-Canada pipeline and with it the completion of Canada's whole network system, at least for the time being. The

(5) Ibid., Nov. 1955, Vol. 12, pp. 2320-2322.

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success of Trans-Canada, so far as the Canadian economy is concerned, depends to a considerable extent on the receptibility of the eastern markets for a new type of fuel. Should full use of natural gas eventually be made in Canada, then it will reduce in the same measure the necessity to import foreign fuels of all types.

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APPENDIX

Short Analysis of the most important
Oil Companies in Canada (1)

1. Imperial Oil Limited. This company is one of the outstanding subsidiaries of Standard Oil Co. of New Jersey. Imperial is and has been for quite some time the unchallenged leader of the petroleum industry in Canada. Directly and indirectly this company participates in all phases of the industry. Imperial's exploration interests extend from the North West Territories to the U.S. boundary and from British Columbia into Southwest Manitoba. In South Western Ontario the company is carrying out a modest exploration programme and from time to time minor investigations are made in Quebec and in the Maritimes. For thirty years prior to Leduc, Imperial undertook a vast exploration programme involving expenditures of upward of 23 million dollars.

Developments: Imperial discovered both Leduc-Woodbend and Redwater. These two fields have total reserves of roughly one billion barrels and a daily production of

(1) James Richardson and Sons, Western Canadian Oils, Ed. No. 9, 1955, pp. 6,7,9,15,17,75,76,79.

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over 100,000 barrels. The company also controls the Golden Spike field.

Production and potential:

Since potential production exceeds the markets available to western Canadian oil, fields are subject to rationing. Imperial's wells at the beginning of 1954 had a potential of 127,000 b/d while production averaged 89,843 b/d.

Transportation: Imperial owns in whole or in part the Winnipeg Pipeline Ltd (75 miles between Gretna and Winnipeg), the Imperial Pipeline Co. Ltd. (gathering lines totalling 217 miles the Leduc-Woodbend and Golden Spike fields, and 94 miles in the Redwater and Excelsior fields), the Portland Pipeline Corp. and the Montreal Pipeline Co. Ltd., Interprovincial Pipeline Co. Ltd (crude line from Redwater to Sarnia, Imperial owns one third interest in this enterprise), Trans Mountain, Oil Pipeline Co. Ltd., and, the Imperial Oil Shipping Co. (ocean going fleet and carrier cargos for other interest which is wholly owned).

Refineries: Imperial owns 9 modern refineries located at Dartmouth, N.S.; Montreal East; Sarnia; Winnipeg; Regina; Calgary and Edmonton; Ioco, B.C.; Norman Wells, North West Territories. The total capacity as of Jan. 1955, was 240,275 b/d.

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Distribution and Marketing:

The company maintains nearly 1,300 bulk plants and distributes products to over 9,400 retailers. In all, some 600 petroleum products are marketed, of which some of the better known brands are "Esso Extra" and "Esso" gasolines, "Marvalube", "Gargoyle Mobiloil", "Essolube Heavy Duty" and "polarine" motor oils. Other products include fuel oils, diesel oils, lubricating oils, greases for industrial uses and propane.

2. The British American Oil Company Limited. Completely integrated as for production, transportation, refining and distribution, B.A. is the largest independent petroleum concern in Canada. It was incorporated under a Canadian charter in 1909. The company has been actively interested in Western Canada since 1935. The main areas of activity are Glen Park, Olive, Virden and Woodnorth (Manitoba). The company's wholly owned subsidiary, British American Oil Producing Co., has been extensively active in the United States.

Reserves: as of January 1954, crude oil reserves in Canada and the United States amounted to approximately 110,000,000 barrels and interests were held over 1,700 oil and gas wells.

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Refineries and plants: The company owns five refineries - at Montreal East, Clarkson, Ontario; Moose Jaw, Saskatchewan; Calgary and Edmonton, Alberta. Crude capacity totalled 91,200 barrels daily in 1953 and operations averaged 96 per cent of capacity. A petrochemical plant jointly owned by B.A. and Shawinigan, operates at Montreal. It manufactures phenol and acetone from raw materials supplied by B.A.'s Montreal refinery (see above, Secondary industry).

Transportation: B.A. Alberta Pipeline Ltd. wholly owned (operates a crude gathering system of 21 miles in the Red-water field), B.A. Saskatchewan Pipeline Ltd. wholly owned (operates 22 miles of line between the company's Moose Jaw refinery and the Interprovincial pipeline), Trans Northern Pipeline Ltd., one third interest (transports finished products from Montreal to Ottawa, Toronto, Hamilton).

Additional interests are held in the Portland Pipeline Corp., the Montreal Pipeline Co. Ltd., Toronto Pipeline Co. (wholly owned, operates an extensive gathering and transportation system in the United States) and the Platte Pipeline in Northwest U.S.

Distribution: products are marketed in all Canadian provinces through over 7,700 branches and retail outlets.

Products: B.A. refineries produce over 250 products, among them B.A. Super 98 and 88 gasolines and Peerless Premium and Heavy Duty motor oils.

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3. McColl-Frontenac Oil Company Limited. This company is owned 58.5 per cent by the Texas Co. of the United States and was incorporated with a Canadian charter in 1927. The company is engaged in the exploration, production and refining of crude oil, and the distribution and sale of products across Canada.

Production: For 11 years prior to 1949, the company's only crude production came from two fields in Trinidad, British West Indies, through its wholly owned subsidiary, Antilles Petroleum Co. (Trinidad) Ltd. In 1954, the company controlled some 126 producing wells in Trinidad fields. The first Canadian production came from Redwater where McColl-Frontenac now holds interests varying from 20 to 50 per cent in nine separate quarter sections on which 34 wells are located. At the end of 1954, the company received production from eight wells at South Leduc, 7 at Calmar, 5 at South Calmar, 51 at Wizard Lake, 91 at Bonnie-Glen-Pigeon Lake and 3 at Glen Park.

Refineries: McColl-Frontenac operates a refinery in Montreal East with a capacity of 45,000 b/d and one at Edmonton with an 11,000 b/d capacity. Each refinery is equipped with fluid catalytic units. In addition, the Edmonton refinery has facilities to produce petroleum coke. Further, two plants to blend lubricating oils are operated at Toronto and Winnipeg.

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Distribution: The company maintains 195 marketing bulk stations for wholesale distribution, owns 525 retail service stations and holds under lease 227 additional stations, all of which are leased to independent operators. Products are marketed under different trade names, including Sky Chief, Fire Chief, Indian Gasolines, Advanced Custom-Made Havoline Motor oil and Texaco Marfak.

4. The Interprovincial Pipeline Company was incorporated by a Special Act of the Parliament of Canada in 1949, to construct the first large, long-distance crude pipeline in Canada. The pipeline extends from Redwater and Edmonton, Alberta, to Gretna, Manitoba, on the U.S.-Canadian border. Thence southeast to Superior, Wisconsin, and from there to the Straits of Mackinac and South to Sarnia, Ontario, a total distance of 1,770 miles. The 959 miles of line in the United States are owned and operated by the Lakehead Pipe Line Co. Inc., a wholly owned subsidiary. There are 13 main pumping stations between Edmonton and Superior and three receiving (from gathering lines) stations in the Redwater area.

Oil is received into the system at Cromer, Manitoba, as well as at Redwater and Edmonton and is delivered at various take-off points in the Prairie Provinces, to refineries in the Superior area and at Sarnia.

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Since the construction of the line in 1950, the main expansion programme took place in 1954. It involved 455 miles of 24" loop between Gretna and Superior, and 196 miles of 26" loop between Gretna and Superior. Furthermore, 8 new pumping stations were built between Regina and Superior at existing station sites and one entirely new station erected at Saxon, Wisconsin.

5. Trans Mountain Oil Pipe Line Company was incorporated by a Special Act of the Canadian Parliament in 1951 to construct an oil pipeline from Edmonton, Alberta, to Burnaby (near Vancouver), B.C. During 1952 and 1953 the line was built over the Canadian Rockies, a distance of 718 miles and began operations in October, 1953.

The main route of the pipeline is entirely within Canada. It roughly parallels the C.N. Railway from Edmonton through Jasper Park, over the Yellow Head Pass to Kamloops, B.C. From there, the line proceeds southwesterly to Merritt, and, farther parallel to the C.P. Railway to Hope and down the Fraser River valley to Burnaby.

The 718-mile line from Edmonton to Burnaby consists of 24" pipe with four pumping stations, located at Edmonton and Edson in Alberta, and Kamloops and Black Pool in British Columbia. In 1954, a branch line was constructed from Sumas, B.C. to Ferndale, Washington, 26 miles away to supply a new refinery. An additional line, 27 miles in length,

was built from the branch line in 1955 to serve another refinery at Anacortes, Wash.

There are hundreds of companies taking part in the search for oil, in production, transportation, refining and distribution throughout Canada. We have concentrated our attention in the last few pages on some of the most important concerns operating in Canada. Success in the oil industry, however, does not depend on size alone and many medium and small concerns specializing in one phase of the industry have often proved to be at least as efficient as the larger, integrated companies.

Description of the more important gas transmission concerns:

1. Trans-Canada Pipelines Limited.

This company was incorporated by a special act of Parliament of Canada in 1951 to build the world's longest natural gas pipeline and move natural gas from Alberta eastward. In 1954, the company received permission to export 4.35 trillion c/f of gas from Alberta's Petroleum and Natural Gas Conservation Board. The export quantity permitted is not to exceed 540 million c/f daily. In July, 1954, the Board of Transport Commissioners in Ottawa approved in principle the application to build the pipeline. Final approval, enacted by Parliament and involving financial help was made only in May, 1956. The line will run from the Alberta-Saskatchewan border to Montreal via Regina, Winnipeg, Fort

William, Port Arthur, Kapuskasing and Toronto. A lateral line from Winnipeg to the international boundary at Emerson, Manitoba, will deliver natural gas to the lines of Northern Natural Gas for the Minneapolis-St. Paul Market.

A 80-mile lateral has been built by Trans-Canada to bring natural gas to Toronto from the United States. The purpose of this line was to provide a build up in markets for natural gas. When the main trans-continental line is completed, these markets will be supplied with Alberta gas and at that time the flow through the Toronto lateral may be reversed.

Subsidiaries: Western Pipe Lines Limited, the Toronto lateral line, Alberta Inter-Field Gas Lines.

At the end of 1956, assets of Trans-Canada totalled 361,215,000 dollars. A projection of the financial situation of the company made for 1961 shows common stock of 37 million dollars, earned surplus of 32,765,000 dollars and 13 million available for dividends at that date.

2. Westcoast Transmission Company Limited.

Incorporated by a special act of the Canadian Parliament in 1949, this company proposed the construction of a 932-mile system including a 650-mile main line together with gathering facilities and sales laterals. The system, which was completed by July, 1957, will serve the Pacific Northwest area, including Vancouver, B.C., Spokane, Seattle,

Tacoma and Olympia, in the State of Washington, and Portland, Oregon.

The gas reserves in the Peace River area of Alberta and British Columbia are estimated at over 5 trillion c/f, or in excess of 25 years' requirements for the serviced markets. The company is due to start operation as this is written. Total cost of the pipeline project was about 150 million dollars.

The most important distributors are: British Columbia Power Corporation Limited, Winnipeg and Central Gas Company, Union Gas Company of Canada Ltd., Interprovincial Utilities Ltd. and the Consumers' Gas Company of Toronto.

The most important gas gathering concern is the Alberta Gas Trunk Line Co. Ltd., which was incorporated in 1954. The system, consisting roughly of some 400 miles of varying pipe, was built in three sections at a total cost of some 38 million dollars. Its purpose is to tie in all present gas producers as well as future potential producing areas and forward the collected gas to Trans-Canada. The capacity of the line is roughly 540 million c/f daily relying only on field compressors.