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Article abstract

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Canada's Oil and Gas Resources

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Summary
Estimates of Canada's future reserves of conventional oil and gas made by the Department of Energy, Mines and Resources and the Canadian Society of Petroleum Geologists are largely estimates of "potential" reserves, i.e., reserves based on expected production from "frontier areas". These estimates are far too optimistic, and are not supported by a comparison of Canada's "frontier areas" with other large sedimentary basins in the world. Canada's capacity to depend upon domestic oil supplies will probably be at an end within 10 years unless the tar sands are exploited, and there are major objections to the very rapid development of the tar sands that would be necessary.

Introduction
Fast-moving events brought energy problems to the forefront of attention in the last three months of 1973. For Canada, these events had been clearly foreshadowed by a chain of little-noticed developments that had their origin in a single event near the end of 1970.

Of the mass of documents spawned by these events, three have been chosen as planks upon which the arguments of this paper will be laid out. The three documents were issued within a period of six months, one each by the National Energy Board's staff, a committee of the Alberta (now the Canadian) Society of Petroleum Geologists, and the Department of Energy, Mines, and Resources. First, however, the events that made inevitable the critical event of late 1970 must be reviewed.

Historical
1. In the late 1950s, two unconnected events combined to give Canada's domestic oil producers an understandable sense of injustice. The "pipeline debate" forced the producers, by restricting their Canadian markets to the region west of the Ottawa Valley, to seek export markets in the United States. The Eisenhower oil policy, enacted at almost the same time, frustrated this search by putting strict quotas on imports of oil into the United States.

2. In the late 1960's, impending oil shortages compelled U.S. reconsideration of import quotas. The 1967 war in the Middle East emphasized the dangers of dependence on supplies from that region, but the Prudhoe Bay discovery encouraged faith in Arctic reserves. The publication by the Canadian Petroleum Association (1969) of very large estimates of "potential" reserves in the Canadian Arctic, and in other Canadian frontier areas, reinforced this faith. The relaxation of import restrictions into the United States was signalled by the arrival in Ottawa, in November of 1970, of a delegation led by then-Interior Secretary Walter Hickel. His request that Canada ignore the import quotas, and send to the United States the maximum volumes of oil that the pipelines could carry, was therefore welcomed by the Canadian oil producers and by the Alberta and Federal governments, as a return to elementary justice.

It was this event that was critical. Through it Canada changed, within a few months, from being a net importer of oil to being a net exporter. That there was no single, standard, acceptable criterion by which Canada could be judged to possess sufficient reserves to maintain this position was not acknowledged by any spokesman for the industry, for Alberta's provincial authorities, or for the Federal government.

Consequences
Canada's conventional oil and gas "resources" are unique among all primary resources of the earth. No other nation habitually expresses its earth resources in the form of "potential" reserves that are largely (or wholly) undiscovered; and Canada does this only for its conventional oil and gas. Most nations with very large territories—the United States, the Soviet Union, Australia, Brazil, India—have published estimates of their "potential" reserves of oil and gas, but Canada is the only nation whose practical policies are based upon "potential" reserves in preference to "proven" reserves.

Since the author's paper of 1971 drew attention to the fallacies of volumetric reserve estimates, more and more of the commentators on the subject have acknowledged that "potential" reserves are not to be relied upon. Both the Canadian Society of Petroleum Geologists (C.S.P.G.) and the Geological Survey (G.S.C.) have abandoned the word "reserves" in this connection, and write only of either the "potential" or the "resources". The caution is repeated in several sections of the 1973 E.M.R. report (see, for example, p. 84).

In effect, these cautions have been taken to mean merely that the actual reserve figures are not to be accepted at literal face value, as representing something accurately known. But it is still taken for granted that the figures, when they finally do become established, will be very large—in fact, within the range of the various estimates set out on pages 87-91 of the E.M.R. report. The forecasts contained within the three documents under consideration here all presuppose very large "potential" reserves (whether they are called "reserves" or not), in that their projections require very high production rates from reserves for the existence of which there is no present evidence.

The mental confusion engendered by this habit may be illustrated by two quotations. According to the A.S.P.G. brief of March 1973 (p. 8), "The major hydrocarbon potential of Canada is concentrated in our frontier areas." This sentence is teleological; it means we know that there is no (or almost no) potential in our accessible areas. From the E.M.R. report (p. 12): "Estimates made by the Federal Government in 1972 and 1973, of

potential recoverable conventional oil, are in the range of 83 to 118 billion barrels; *in addition,* there is a remaining proved reserve of about 10 billion barrels" (italics are mine). "Potential resources," in fact, have priority over "proven reserves" in both philosophy and practice.

The first task is to consider how well founded this apparently unquenchable optimism is likely to be. I shall attempt to demonstrate, once and for all, that it has no sound foundation at all; that of the two estimates quoted in the preceding paragraph, and referred to in the E.M.R. report as the "low" and "high" estimates respectively, the "low" one is very high indeed, and the "high" one is absurd.

Volumetric Estimates of "Potential" Reserves

1. It has been established by unchallengeable experience that volumetric estimations of "potential" reserves, made prior to their discovery, are meaningless. Between 1955 and 1962, whilst the concept still held attractions for some exploration companies (especially for those under government control), at least three countries large enough to be compared with Canada (Brazil, India and Australia) were subjected to blanket exploration with volumetric forecasts acknowledged to be the spur. In all three cases, the forecasts were totally demolished by results.

Every large basin, contributing major volumes of sedimentary rock to the calculations, proved to be completely or virtually unpetroliferous —Amazonas, Parana, Maranhao, Indo-Gangetic, Bengal, Eucla, Great Artesian, Fitzroy-Canning. In each country, the only important production accrued from tiny coastal grabens, contributing insignificant volumes of sedimentary rock to the calculations (Bahia Reconcavo, Sergipe-Alagoas, Cambay, Gippsland).

2. The figures of barrels of oil per cubic mile slotted into the calculations are averages taken from U.S. basins of long productive history. To apply this empirical, statistical parameter to an unexplored basin is fallacious even as an exercise in statistics, unless it is accompanied by the application of a second empirical, statistical parameter —that representing the proportion of *explored* sedimentary basins that have proved to be petroliferous; the parameter, in fact, that oilmen called the *risk factor.*

The significance of this second parameter was not fully apparent to Lewis Weeks when he first developed the volumetric estimation method early in World War Two. At that time, the only sedimentary basins in the world which could be described as "explored" were either in the United States or were abundantly supplied with surface manifestations of oil. Furthermore, world petroleum demand at that time (about 6 million barrels daily in 1942, comparable to the present level of United States imports) was such that basins having what would now be utterly trivial productive capacities were important oil producers—in coastal Ecuador, Poland, Assam, Burma, Japan. Hence a clear majority of "explored" basins yielded some oil.

It was precisely because Weeks foresaw the post-war shift in the centre of gravity of world oil production, away from the United States, that he adopted the volumetric estimation technique, in order to make some estimate, for investment purposes, of the total volume of oil that might remain to be found in the then-unexplored regions of the earth (including the continental shelves). He never intended the technique to be used to *forecast* the "reserves" of any one basin or any one region. In fact, he refrained from publishing the figures he himself had derived; they were "pirated" into print in 1948 by Julius Fohs, to Weeks' embarrassment. Their introduction into exploration philosophy in other countries was then the work of Weeks' former colleagues—W. K. Link in Brazil, Fohs in the Soviet Union, and J. C. Sproule in Canada. The manifest inappropriateness of this procedure makes it mildly astonishing that Weeks waited until 1972 before disowning it.

Now that exploratory drilling has been extended to sedimentary basins in virtually all countries, whether they bear surface indications of oil or not, it is clear that there is no "typical" or "average" oil yield per unit volume of sedimentary rock. An "average" yield of 30,000 or 50,000 barrels per cubic mile for all the basins of the world has the same meaning as an average of ten for 999 groups, of which nine contain one thousand each and the other 990 are singletons.

3. Fewer than half the sedimentary basins explored yield evidence of ever having been petroliferous. Only one explored basin out of three yields commercial production. Recent studies of *large* fields (notably that by Halbouty *et al,* 1970) show that only one explored sedimentary basin out of *six,* on a world-wide basis, yields even a single large field (defined as one having ultimate recoverable reserves of 500 million barrels or more—the size of Leduc).

If, therefore, we deal with a large territory, possessing a number of discrete sedimentary basins; if furthermore we apply the volumetric calculations to every basin individually, and then sum the results algebraically to reach a total of "potential reserves" for the entire country; then we are *a priori* likely to overstate actuality by a factor of three —even for a country (like India) in which every basin is populated and readily accessible. If a majority of the basins in our territory is geographically or otherwise such that only large fields are operable—a condition that applies in the highest degree to all of Canada's "frontier" regions—then the process I have described is *a priori* likely to result in overstatement *by a factor of six.*

4. This is precisely what happened in Brazil, India and Australia. It is almost certainly what has happened in Canada also. Let us take the C.P.A. forecast of April 1969 as one example from among those listed in the E.M.R. report (p. 91); it is chronologically the prototype, and it accords an intermediate value to its results. The *correct* conclusion from the C.P.A. committee's study, starting from their own data and proceeding along their own calculation paths, is *not* that Canada's potential reserves of oil are about 120 billion barrels, but that they are somewhere between 20 and 40

billion barrels, and probably (because of the requirement for large fields) much closer to the former figure.

5. There are several other lines of reasoning that reinforce this conclusion. In my 1971 paper I pointed out that about as much Canadian sedimentary territory was very well explored (in the western and Williston basins, southwestern Ontario, onshore Maritimes, and the middle Mackenzie valley) as was "inadequately" explored (in the "frontier" and offshore regions); except for the outer shelf off Labrador, and the Beaufort Sea, it is sheer sophistry to continue to call any areas of Canada *unexplored.* As there was no more reason to anticipate much greater productivity than much lower productivity for the frontier regions than for the provinces, a reasonable expectation was that about as much oil might remain to be found in Canada as had already been found. The implication is an ultimate recoverable reserve of about 25 billion barrels.

6. Weeks calculated that the figure of 30,000 bbls per cubic mile was an average ultimate yield for the sedimentary basins of the "lower 48" United States *as a whole*—including unproductive basins. Whereas we have now demonstrated, and Weeks himself has acknowledged, that such a figure has no relevance elsewhere, the figure itself is an accurate one for the lower 48 states (naturally enough, as it was computed when the greater part of the oil had been found). As Canada is part of the same landmass, it is of interest to consider what figure would result *from a logical application of it* to Canada.

Approximately 55 per cent of all the oil so far found in the lower 48 states is in two regions—southern California and the Gulf Coast basin—which both lie *outside* the orogenic belts which flank the North American continent (that is, they lie between the orogenic belts and the ocean basins, not between the orogenic belts and the shield). They therefore have no known counterparts in Canada. The only areas of Canada in which counterparts could possibly exist are below the Grand Banks of Newfoundland, in the Pacific Ocean west of Vancouver Island and the Queen Charlottes, and in the Arctic Ocean northwest of the Queen Elizabeth Islands. None of these regions is known to be *basinal,* in the structural-geological sense, and only the first is imaginably accessible to present technology and present economics.

If the Californian and Gulf Coast basins were excluded from Weeks' calculations (that is, if the continent is given the outline which would permit Canada to be representative of it), the "average" figure for all U.S. sedimentary basins would become about 18,000 barrels per cubic mile (and would be so high principally because of the Mid-Continent basin, which again has no direct age or structural counterpart in Canada). If that figure is applied to the 2.64 million cubic miles of accessible sedimentary rock in Canada (C.P.A., 1969), the "potential" reserves would be 48 billion barrels.

This figure is much higher than any I am prepared to countenance, but it is only a half to a third of those tabled by C.S.P.G. and E.M.R.

7. Estimates of undiscovered reserves are quantifications of the unknowable. However, an ancillary calculation that can lead to important conclusions is quite simple. How large do recoverable reserves of a new region have to be to become commercially exploitable, given existing geographic and environmental constraints and reasonably foreseeable political and economic conditions? And what is the empirical likelihood of those reserves being present?

By the time a pipeline, or a fleet of ice-breaking supertankers, could be made available for oil from any part of the high Arctic, or the Labrador shelf—say by 1980—Canada's requirements for oil from sources not at present available will be about 800,000 b/d (Fig. 1, from the National Energy Board, 1972). The N.E.B. staff report

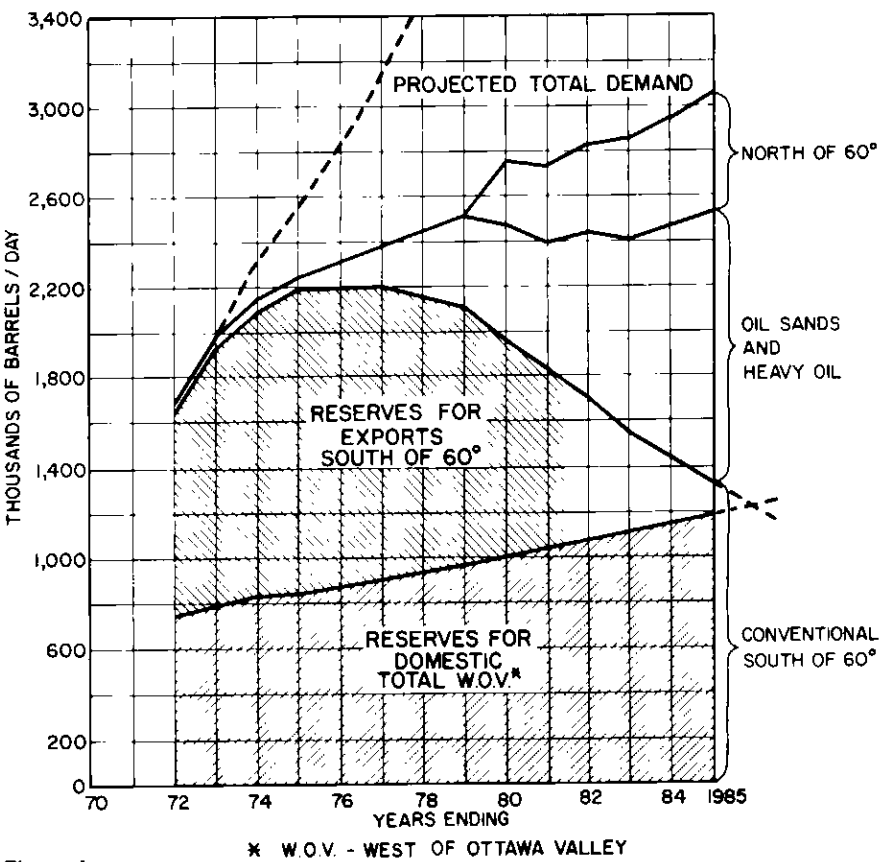

Figure 1
Canadian Petroleum—Supply and Demand
Reproduced from report of National Energy Board (Oil and Gas, Engineering Branch) December, 1972.

forecast a production of 526,000 b/d by 1985 from the Mackenzie delta alone, and this offtake is presumably envisaged as increasing in subsequent years.

No pipeline to transport oil at 140° F over permafrost, taking perhaps four years or even longer to construct, and acknowledged to risk almost incalculable social, political, economic, and environmental consequences, can be planned for a service life of less than 20 years. Consider an annual throughput of only 250 million barrels (less than 700,000 b/d), remembering that the Alyeska line from Prudhoe Bay will carry 550 million b/y or more. The implied recoverable reserves from a Canadian frontier basin are a minimum of five billion barrels. This quantity of oil would extend the North American continent's reserve life for oil by less than one year.

Of all the *productive* basins of the world, fewer than one out of four is known to have recoverable ultimate reserves of this magnitude; of all *explored* basins, only about one out of 14. The chance that the Mackenzie delta, the Arctic islands, and the Atlantic continental shelf will each individually contain this volume of reserves (and *all* official estimates of "potential"—by the C.P.A., the A.S.P.G., and the G.S.C.—presuppose very much larger reserves in all three) is one in 14^3 or about one chance in 2,750. These would be the purely empirical odds *before* extensive exploration (nearly 200 wells have already been drilled in the three basins) demonstrated that all three basins are probably gas-bearing rather than oil-bearing.

Effect on Projections of Supply and Demand

All official projections of oil supply and demand for Canada (that is, all projections made by organizations charged with the responsibility for making them) are based on the apparently unquestioned assumption that the inevitably increasing demand will be matched by similarly increasing supply *from domestic sources.*

This assumption is stated in a variety of ways, at least two of which have achieved the status of *idées reçues.* The assertion that Canada has found only about 10 per cent of its oil reserves stems from the potential estimates (1969) of the Canadian Petroleum Association, and was first popularized by former Energy Minister Greene. The assertion that Canada's resource base in all energy sources (including conventional oil and gas) is "very large" has been repeated during 1973 in both the A.S.P.G. brief to the Science Council and the E.M.R. report.

Canada has almost certainly found more than a third of its oil reserves, and very probably more than two-thirds.

It may very well have found 90% of the conventional oil it is ever going to be able to exploit. In terms of present demand, Canada's proven resource base for natural gas is not "very large", but quite modest. Her known resource base for conventional oil is very small. All projections based on conventional thinking are therefore likely to be invalid.

Principles of Projection

In the introductory sections of the E.M.R. report, the "resource base" for each of Canada's energy resources is stated in turn. The reserves of coal, uranium, and heavy (tar-sand) oil are stated as *proven* reserves, with the acknowledgement that these are not necessarily *recoverable* reserves. Geologists can accompany skeptics into the field and actually show them these reserves.

Conventional oil and gas, on the other hand, are stated as "potential" or "potential resources." Their incidental statement as proven reserves (see above) is essentially irrelevant, because the projections into the future assume that the much larger "potential" resources (or reserves) will in fact be available.

Greatly increased production of coal and uranium is forecast for future decades. This increased production is readily capable of realization provided the right decisions are made in time—decisions concerning investment, recruitment of manpower, construction, and so on. Where the increased production will take place, and by whom, is already more or less established.

This cannot be said for conventional oil or natural gas, because the necessary reserves are not known to exist. For conventional oil and gas, forward projections are bound to be composite; the sources contributing past production will shortly be exhausted and totally new sources, not now available to us, must take over the growing forward projection. This is recognized by all forecasts (see, for examples, Chart III of the A.S.P.G. brief, for a long-term forecast to the year 2050; and Figures 1 and 2 of the N.E.B. staff report, for short-term forecasts to the year 1985; Fig. 1 of the N.E.B. staff report is reproduced as Fig. 1 in this paper.

In each case, sources of oil not at present available to us must begin to contribute significant production in the second half of this decade, and in each case the two sources called upon are the same: conventional oil from "frontier" areas (specifically, for the Board's staff, the area north of the 60th parallel), and heavy oil from the tar sands.

On page eight of the N.E.B. report, some of the obstacles to the achievement of Mackenzie delta oil production are touched upon. The obstacles are sufficiently daunting, but they are trifling beside the obstacle we shall face if the reserves turn out not to exist. The production level of 526,000 b/d in 1985, required by the N.E.B. projection (Fig. 1), presupposes recoverable reserves of at least four billion barrels. Even with these reserves a full-sized pipeline would be doubtfully economic. Exploration in the delta has not so far yielded one percent of this reserve; I doubt if any of the operators there any longer expect to find as much as ten percent of it.

Halbouty *et al* (1970) listed all the largest known oilfields of the world—those the size of Leduc and larger. Of 187 such fields, only seven are in the sandstone reservoirs of young deltas (four in Nigeria, three in Louisiana). Young fossil deltas are gas-prone, not oil-prone, on a world-wide basis (consider the post-drift deltas of the Mississippi, Sacramento, Orinoco, Po, and Nile Rivers; only the Niger delta is an exception, and it is characterized by gas-oil ratios much

higher than the average for Tertiary basins).

But the equivalent of six Leduc oilfields must be found in the Mackenzie delta *by the time this paper is published* if the projection reproduced here as Figure 1 is to be achieved. In the entire history of oil exploration in Canada, only five fields as large as, or larger than, Leduc have been found (Pembina, Swan Hills, Redwater, Rainbow, Leduc itself). Unless oil reserves in either the Arctic or the Atlantic offshore region are *proven*—not suspected, not estimated —to be at least one hundred times as great as they are at present estimated to be, *by the time this paper is published,* the projection reproduced in Figure 1 must be abandoned. The area within the projected curve may be divided into two sub-areas. The shaded area must depend entirely on present proven reserves; the whole of the unshaded wedge must be supplied from the tar sands.

Criteria for Production and Export from Existing Reserves

1. Considering crude oil only, not total liquids, Canada's proven recoverable reserves are now less than eight billion barrels. They have declined for four consecutive years. There is no evidence whatever that the country south of the 64th parallel is capable of reversing this trend. A 50-million-barrel oilfield (only one-tenth the size of a large field in modern terms) is capable of a production rate of about 7,000 b/d, about 0.4 percent of Canada's current production rate). Only three fields as large as this have been found in Canada in the past 15 years (Rainbow, Zama and Mitsue).

2. Canada's present internal demand for crude oil is 1.7 million b/d, or approximately 600 million b/year. The ratio of reserves to *consumption* is therefore 13.3. This ratio is dangerously low on all standard criteria; it provides a margin of only 30 per cent above the "peril point" of ten years' supply.

3. No official proposal known to this writer has recommended protection of Canada's domestic reserves for less than 15 years (which again might be considered too low). On this basis, Canada's current production should be no more than 530 million b/year, or 1.45 million b/d. Furthermore, so long as new discoveries, extensions, and revisions fail to keep up with production (see (1) above), this rate of production should go down each year, instead of up as at present. Our present ratio of reserves to *production* is about 11.5. The only other important oil-exporting country in the world ("important" can be set arbitrarily at 0.5 million b/d of exports, or higher) with such a low R/P ratio is Venezuela. All others maintain R/P ratios of 24 or very much higher.

4. Canada's domestic demand west of the Ottawa valley (WOV) has been computed by extrapolating the Board staff's conservative figures (1972, Tables 1 and 2). The demand for the next twenty years (to the end of 1993) is conservatively estimated to be 8.42 billion barrels—greater than our proven reserves.

5. Allow a lead time of ten years—acknowledged by the industry—for bringing any frontier reserves to market. (Prudhoe Bay, discovered early in 1968, will not deliver at maximum production rates (MPR) of 1.5 million bbls of oil and 2.5 tcf of gas daily to the "lower 48" United States before about 1978). Before any frontier oil discovery could deliver at MPR to, say, Ontario markets, Canadian domestic demand WOV (on the Board staff's own figures) will be 3.5 billion bbls. On this criterion, and if all exports were halted today, the reserves of fields now known to exist in Canada will have been reduced to less than 4.5 billion bbls, by the end of 1983, *by domestic consumption alone.* This reserve would justify, on the Board staff's 15-year criterion, a production rate not exceeding 825,000 b/d in 1983. Domestic WOV demand would then be 1,114,000 b/d on the staff's own projection.

6. On these grounds of general production (engineering) practice, as well as on projections of domestic demand, then, Canada's existing oilfields are being over-produced by an amount that may be set between 300,000 and 500,000 b/d (depending on which criterion is given greatest weight). This is without regard to level of exports, but it is of course this level that will have to be cut if production rates are reduced by 300-500,000 b/d. Such reduction, which should have been imposed the moment U.S. quotas on Canadian oil were modified, would have the effect of bringing Canadian oil exports and imports into approximate balance.

7. It has been suggested by several commentators (myself among them) that oil exports from western Canada to the U.S. should be permitted at least to maintain equality with oil imports into eastern Canada. Otherwise the National Oil Policy decision concerning the Ottawa Valley line could be regarded as unfair to Canada's independent producers (as in a sense it was, so long as U.S. import restrictions kept Canadian production below total Canadian demand). There is force in this argument, and abandonment of it will be resisted. However, it is obvious that imports EOV must increase, and the sheer constraint of field capacities will force exports WOV to decrease within a very short time even on the NEB staff's criteria. Abandonment of this argument will therefore be unavoidable, and its consequences must be considered by the government, and by the industry, now. The abandonment of the Ottawa Valley line, in November of 1973, only makes this matter worse.

The Tar Sands

The foregoing is intended to put in perspective the problem that is possibly the most urgent of all that face this nation. *The odds now are that Canada's capacity to depend upon domestic oil supplies will be at an end within ten years unless the tar sands are exploited.*

It is not, of course, imperative that the tar sands be exploited. Canadians may choose to rely upon imported oil rather than undertake the colossal task of tar sand development, with its almost incalculable social, economic, and environmental risks

What is imperative is that the country decide now, at once, whether

we are going to exploit the tar sands or not. If we are not, they must cease to be included in our resource inventory, and all references to them in future energy projections must be expunged. Canada will then become a major net importer of oil before 1980. *If we are to exploit the sands, however, we must begin immediately, and all other major oil or gas developments must be postponed.*

The projections in the National Energy Board report require the tar sands (assuming failure of delta oil) to reach a production of 0.5 million b/d early in 1979, one million b/d early in 1981, and presumably two million b/d early in 1987 (Fig. 1). These production rates are almost certainly conservative, because it is nearly inconceivable that conventional oil will still be produced at a rate of 1.2 million b/d in 1985 from fields south of 60°.

There is no point in considering exploitation of the tar sands unless it is to be on a scale such as this. A production rate of two million b/d could be maintained until the middle of the 21st century from outcropping and shallow-mined sands alone. What steps are necessary if these rates of production are to be achieved?

1. Only one size and type of plant has so far been constructed and commercially operated. Such a plant is taken as the prototype, with the following characteristics:—
(i) Cost $750 million;
(ii) Construction time three years;
(iii) Testing and preliminary operating time one year;
(iv) Shutdown time five per cent;
(v) Optimum production rate 100,000 b/d.

2. In order to achieve the production schedule indicated above through plants of this type and size, the following timetable of construction will be required:—
(i) Four more plants must be under construction by January 1, 1975;
(ii) Five further plants, in addition to (i), must begin construction between January 1, 1975 and January 1, 1977;
(iii) Two further plants must be started each year from 1978 to 1982 inclusively.

3. The construction costs involved over this eight-year period will be approximately $15 billion. Not only will this effectively saturate Canada's access to capital markets (leading to economic consequences which are outside the scope of this paper); it will also effectively saturate the nation's capacity to produce or import steel, cement, and electrical components, and her access to engineering skills, construction crews, and earth-moving equipment.

It is for these reasons that access to all these people, materials, and money must be completely planned and assured *before they are committed to other energy projects.* If, for example, a Mackenzie valley gas pipeline is approved by the National Energy Board (and by the cabinet) before applications for the first nine new tar sands plants are approved (and access to all the requirements assured), exploitation of the tar sands will have to be abandoned until the pipeline is completed—say by 1979—when Canada will again have become a major net importer of oil.

4. In stark contrast to this schedule, a recent in-house report for the Alberta Legislature, acknowledging the need for development of the tar sands, envisages one new plant every fourth year, beginning with the Syncrude plant in 1974. This schedule, involving little more than one-tenth of the progress likely to be required, is nonetheless considered by the province to approach crash-program status. It would permit the operation of three new plants (perhaps only two) by the beginning of 1985. The end of the Energy Board's forecast period would therefore find Canada's domestic oil production in shortfall by an amount of 1.5 million barrels daily.

Prospects of Tar Sand Development

It is obvious that an ambitious schedule for tar sand development is possible only if all parties involved are united in a determination to begin at once and to co-operate fully. How realistic is this prospect?

1. It is too often overlooked that heavy oil sands are unlike any other major, primary resource in Canada, except for Saskatchewan potash. They are entirely the property of a single province. The first requirement is a determination by that province to develop the sand in the most expeditious manner. But the actual development will be done by other agencies, and the oil produced will largely be required by other jurisdictions. The industry regards the present provincial regulations as being either far too onerous, or far too vague. The regulations were made so deliberately, at the industry's own behest in better days. Recent moves by the government of Alberta over oil and gas reserves, royalties, etc., do not encourage hope that big plans for tar sands will be quickly settled.

2. The second group involved is the operating companies. The independents have neither the financial nor the technological base for development on the scale required. The majors have evinced minimal interest in the tar sands prior to the present year. They control huge conventional reserves outside North America, and desire access to all markets for those reserves without undertaking the expenses and risks of unconventional production. A number of majors are conducting somewhat perfunctory research, evaluation, or discussion concerning the tar sands, but in comparison with the scale now required most of this represents tinkering.

3. Furthermore, the majors are unlikely to be interested in large-scale tar sand development as long as an excess of conventional productive capacity over *domestic* demand remains in Alberta, and as long as any further conventional reserves can be even tenuously anticipated (in the frontier regions)—unless there is a clear commitment in advance that the additional crude produced will be exported to the United States. There is a persuasive case to be made against the stepping-up of tar sand production for export to the U.S. If Canada can undertake the gigantic economic, engineering, and environmental risks attendant upon large-scale tar sand development, the

Americans should be willing and able to attempt the same with the oil shales. Otherwise Canada would be importing the American environmental damage.

4. Nor, as a result of 1973 export restrictions on oil and oil products, and of the tightening supervision over the oil industry's activities, are the companies likely to be well disposed towards cooperation with the Federal Government. Even if the Federal Government, the provincial governments of Alberta and Ontario, the National Energy Board, the Alberta Conservation Board, and the pipeline companies come to early agreement, therefore, that they will act in concert to expedite development of the sands, who will undertake the task? What would the terms be? How onerous would be the construction and production schedules? What would be the work requirements, the rentals, the royalties, the tax write-off terms, the depletion allowance, the environmental restraints? How would damage claims be adjudicated? Is it imaginable that the terms and controls demanded by the governments, and by nationalist and protectionist groups, would be acceptable to private oil companies?

5. Even if all the terms of operation were agreed upon and the commitment of tar-sand oil to export were allowed, no attempt at large-scale production will be made by the majors until the world price of conventional crude has risen beyond, say, $8.00 per barrel. The lead time of ten (?) years will then be *started*. When it ends, the world price of conventional crude (then produced almost exclusively in the eastern hemisphere) will be whatever the Muslim countries wish to make it. The price of tar-sand oil will automatically rise to this level if tar-sand developments are in the hands of the present oil industry.

6. So much is being written, planned, and argued about the tar sands that it is time more people realized one astonishing fact—that this enormous reserve would be yielding no oil whatever today, at a time of critical oil deficiency, had an elementary political decision gone otherwise fifteen years ago. The National Oil Policy that came out of the "pipeline debate" excluded imported crude oil from the region west of the Ottawa valley. One oil company having no production at all in western Canada operated both a refinery and a marketing organization in Ontario. The refinery was supplied with feedstock from wells in Lake Maracaibo in Venezuela. Ottawa's political decision had put both the refinery and the marketing organization out of business. To prevent this catastrophe, the company bought a piece of the tar sands, and has provided enough production (at great financial loss) to keep its refinery and its service stations going. Had the Ottawa valley line not been erected into a commercial boundary, there would still be no production whatever from the tar sands.

7. Unless we are to permit development of the tar sands to pass into the hands of the Japanese, the Germans, or the Swedes, the only possible vehicle for construction and development on the scale described here is a consortium of international majors, encouraged by economic inducements probably unacceptable to any sovereign government, and necessarily backed by both the Canadian and American governments. A minimum pre-requisite for this would seem to be a re-casting of Canada's constitution, and it might be necessary to see the western provinces secede from Confederation whilst the re-casting was going on.

8. Alternative to the development of the tar sands, on this scale and at this speed, is likely to be renewed dependence upon imported oil. Against that eventuality, deep-water ports capable of handling modern supertankers should be constructed on both Canada's east and west coasts without delay.

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