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Energy – Challenge of Man's Future (Part I)

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"For each age is a dream that is dying
Or one that is coming to birth"
A. W. E. O'Shaughnessy

Fossil Fuel—"A dream that is dying"

A generation ago Harrison Brown (1954), from the vantage point of Ocho Rios in Jamaica, wrote 'The Challenge of Man's Future' which may be the most significant book of the halcyon days of the age of post-war science and technology. Many of his predictions are turning into self evident proofs, subject to computer tests as in Meadows' 'Limits to Growth' (1972). Harrison Brown drew on the pioneer work of M. K. Hubbert (1949, 1956, 1969, 1971, 1973) quantifying the subject of energy resources. Hubbert has lived to see his opinions, taken as wildly radical 25 years ago, vindicated by the award of the Penrose Medal for 1973 by the Geological Society of America, that most traditional and conservative geological group.

The tragedy of the overgrazing of a diminishing commons is brilliantly expounded by Hardin (1972) in his 'Voyage of the Spaceship Beagle' and by Preston Cloud (1971) in a paper exploding the cornucopian fallacy. The oil bearing pastures of the Middle East have been considered limitless grazing grounds and it is the 1001 Arabian knights that rule the petroleum world (Fig. 1). However, Ian MacKay (personal communication, 1971) discerned overgrazing in the oil fields and its inevitable result—a world energy crisis (Fig. 2). As long ago as 1967 an oil hungry world began to consume more oil than the oil geologists found, despite great

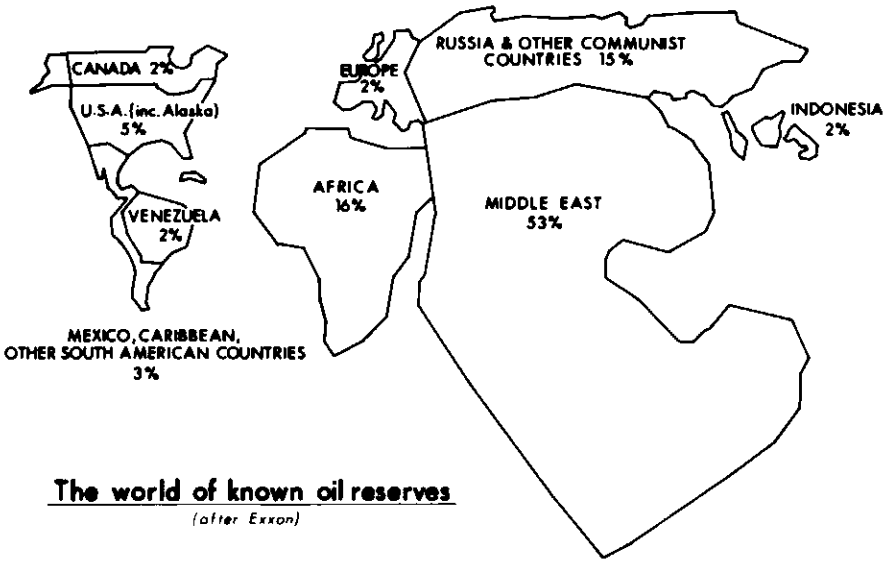

Figure 1
Most of the world's known oil reserves lie in the Middle East (Jamieson, 1973). This area also has the greatest potential for future discoveries (Law, 1957; North, 1971).

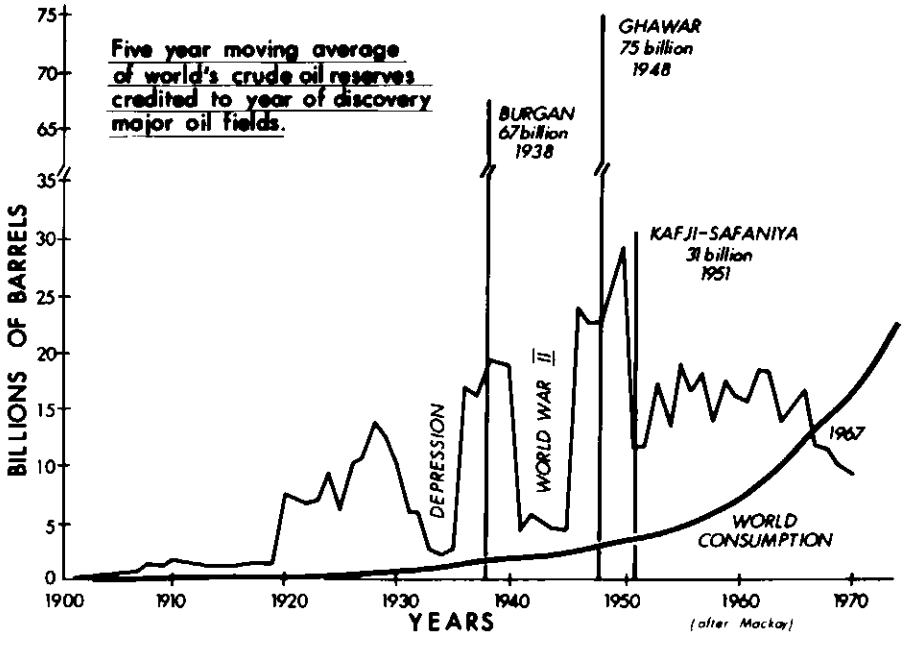

Figure 2
The world's oil reserves are largely attributable to the Mid-East super-giant fields; so far discoveries have managed to keep pace with exponential growth in consumption (MacKay, 1971). The 1970 world published proved reserve of 620.7 billion barrels (84.1 million tons) increased to 672.7 billion barrels (90.9 million tons) at the end of 1972 (British Petroleum, 1972).

exploration efforts in hostile environments. The present exponential growth in world petroleum demand is admittedly unsustainable (Jamieson, 1973).

The North Sea basin, the world's most exciting exploration waters (Folinsbee, 1970) are not a marine replacement for the Mid-East supergiants. Individual pools discovered in the past three years under the North Sea contain recoverable reserves of about a billion barrels each, and the total North Sea basin reserve, 12.6 billion barrels, is a small fraction of the oil consumed by the world since the discovery of Ekofisk in 1970 (British Petroleum, 1972). The newest fields, off the stormy Shetlands, are in 500 feet of water, and the completion and production of development wells under these circumstances poses formidable technological problems. We may look with envy at the Russian bear's rich lair, the West Siberian basin, but the U.S.S.R. is presently having difficulties in supplying oil to its satellites.

Venezuelan oil is currently coming to Montreal from limited reserves (16 bb) which probably should be dedicated to South America as a developing continent. Indonesia has little hope of supplying the petroleum needs of this populous part of the globe, and industrial Japan must either get oil from the Mid-East or transform its economy to a nuclear base. The latter seems most likely. World oil prices have soared in this crisis year of 1973, and a sale of Nigerian crude at $16.40 a barrel was recently topped by an Iranian sale at $17.34, prices which a year ago would have bought a ton of oil. Yet there is growing evidence that the supply of oil from the OPEC nations will remain static in the future, or decline. When you can demand payment for oil in gold and acquire all the gold in the world in a decade, you may well decide that appreciating oil in the sand banks is better than depreciating currency in the Swiss banks.

MacKay (1971) shows (Fig. 3) that under no conceivable circumstances of favourable exploration results will it be possible for North America to continue on its own with an energy system based mainly on oil (60%) and natural gas (30%) beyond the end of this century. The recoverable oil in the tar sands is far from a limitless resource, and frontier potentials are a frozen asset. The sobering facts on costs and expectations of frontier exploration are persuasively presented by McIvor and Lougheed (1974).

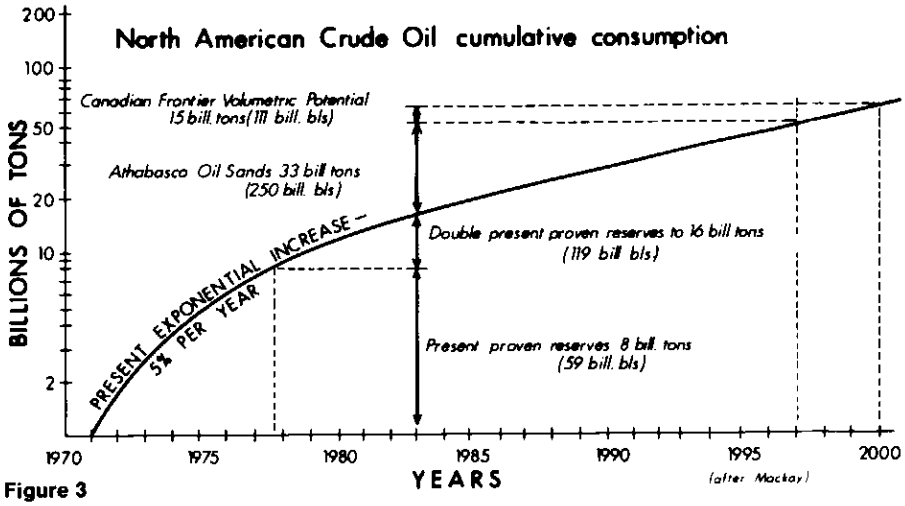

Figure 3
North America, thrown on its own resources, cannot sustain an oil based economy beyond the end of this century without recourse to the technologically difficult oil shales, if exponential growth in demand continues at its present 5% growth rate (MacKay, 1971).

We must make the assumption that the U.S. ultimately will manage energy independence as promised by Richard Nixon for 1980, and that there will be a North American and world transformation within the next decade from domination by conventional petroleum and natural gas produced from wells to an energy transition economy based on a rapidly increasing nuclear component supplemented by methanol and natural gas from coal and petroleum from the tar sands and oil shales (Reed and Lerner, 1973).

The U.S , under the economic incentives of high domestic price for new reserves, will undertake secondary recovery schemes to stretch out its existing reserves and undertake expensive exploration in the deeper parts of the prolific Gulf of Mexico basin, the untested Atlantic shelf, and Alaska with North America's only known super-giant field, the 10 billion barrels at Prudhoe Bay (Abelson, 1973a,b,c,d).

The Eocene oil shales of Colorado, occurring on a critical water-deficient watershed, may not be an answer. Abelson (1973d) says, "Getting oil from shale and coal presents tremendous problems. It is easy to cook hydrocarbons out of shale by using retorts, but the environmental problem of disposing of the residue is dreadful." Though the U.S. is blessed with great coal reserves, these too, pose problems. Eastern coals are high in sulphur. Many of the seams must be mined by labour intensive underground methods, in a country with the highest labour costs in the world. The Western coals, though strippable and low in sulphur, occur in water deficient areas, and pose the same environmental problems as for the oil shales.

We Canadians have garnered the oil and gas riches from a virgin sedimentary basin in Western Canada over the past quarter century (though some would hold that there has been undue American exploitation, on balance we have consumed much more of the world's oil than we have produced). We are now proposing under the common law to two new brides, one from the frigid Arctic, the other from the cold Atlantic (Shell's arrangement with a Pacific maiden, Hecate, proved barren). Courting costs

have run to the hundreds of millions of dollars, and the dowry is uncertain.

Where does Canada stand in 1973? Guarding a dwindling 7.7 billion barrels conventional crude reserves, mostly in Alberta (Fig. 4,5). Jerry McAfee, President of Gulf Oil Canada is reported to have predicted (1973) that western Canadian conventional crude production will peak at 1.9 million barrels a day in 1975. However, over the first six months of 1973, Canadian oil production averaged 2,000,000 barrels a day, a rate that is clearly unsustainable with our limited conventional reserves. By the early 1980s conventional production will scarcely supply Canada west of the Ottawa Valley, and a Sarnia to Montreal pipeline will be economically useful only as a means of transporting oil *from* Montreal to Sarnia (Pollution Probe, 1973; National Energy Board, 1973). It is delusive to believe that tar sand oil will easily and profitably replace conventional crude. John Bookout, President of Shell Canada (Edmonton Journal, Dec. 14, 1973) holds that tar sand oil in 1980 must sell at $10 a barrel for profitability.

It is interesting in retrospect and prospect to quote from an Equitable Securities letter of April 14, 1965, dealing with a secondary offering to the Canadian public of Great Canadian Oil Sands shares at $16.75 (present price $9.25; price to Sun Oil (Great Canadian's parent) for the controlling interest, $5.00 per share).

"The Company has firm sales contracts to sell the 45,000 barrels per day output to two refiners at a fixed price of $2.75 per barrel for 20 years. This imparts a degree of stability to the operation which is unusual in the industry."

One of the two refiners was Shell Oil. The price was raised $0.20 on January 1, 1971; net loss on operations to December 31, 1972, $50,500,000.

Anyone knowing the physical limitations imposed by the Athabasca Valley as a manoeuvering ground holds that the best we can hope for in the way of tar sand production by 1985 is 500,000 barrels a day, considerably less than the 800,000

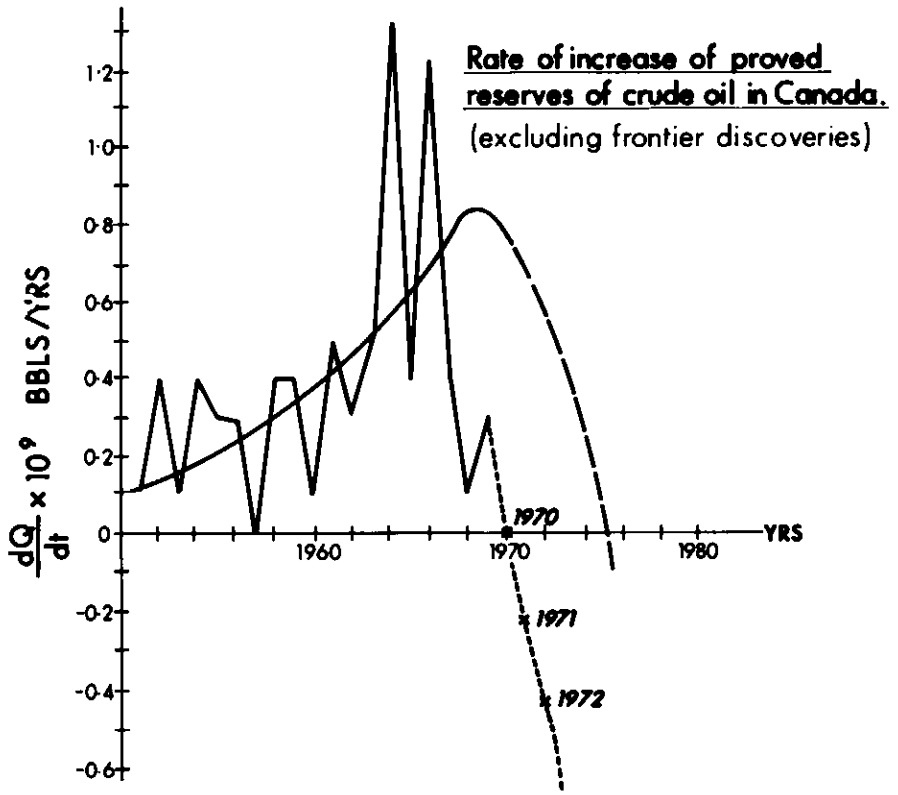

Figure 4
The Western Canada basin is no longer yielding as much oil in new discoveries as is being consumed, and the gloomy predictions of Folinsbee (1970) have been sustained by a dismal discovery rate in the years 1970, '71 and '72. There is no evidence that '73 will show an upward break in the curve, rather heavy consumption suggests that the decline curve will steepen.

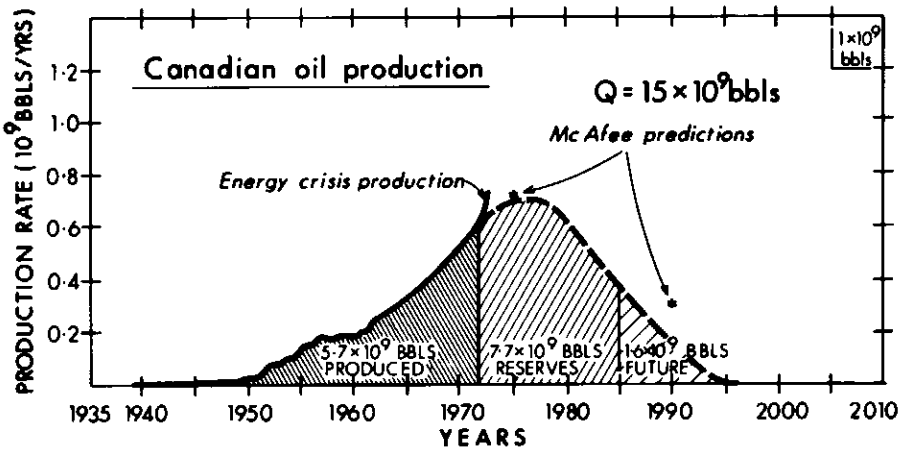

Figure 5
The curve of Canadian oil production developed by Folinsbee (1970) has been brought up to date. Lougheed and McIvor (1973) of Imperial Oil hold that Q, the total quantity of oil to be discovered in the provinces of Western Canada, is only 14 billion barrels, whereas Gulf Oil's (McAfee, 1973) predictions suggest about 16 billion barrels of conventional crude.

barrels a day predictable decline in deliverability from conventional crudes (Fig. 5). There is an even fainter hope that an oil pipeline will be in existence to bring crude that has not yet been discovered from the Arctic. There is a possibility that extensive shallow heavy oil deposits at Cold Lake, Lloydminster and Peace River (over 30 billion barrels) will be recovered by *in situ* methods, though the energy balance considerations are marginal (MacKay, 1973).

There remains little conventional oil to be found in the western Canada basin (Ryan, 1973a and b); though higher prices may offer incentives to produce oil from fields like Twining, with substantial potential reserves marginally economic at present prices (Oilweek, December 3, 1973) and foster secondary recovery schemes.

Canadian gas reserves of 50 trillion cubic feet are believed to be sufficient for Canadian needs and export commitments for 25 years. However, at present, 500 cubic feet of gas are used in the recovery and hydrogenation of each barrel of synthetic crude coming out of the Athabasca tar sands area. We Albertans might prudently reserve *all* our natural gas for this purpose!

MacKay (1973) holds that the economics of a gas pipeline from the Mackenzie Delta are not particularly attractive. At a cost of $3 billion, or ten million dollars for each permanent job, certainly it is one of the most capital intensive projects since the beginning of civilization. Present reserves in the Delta of about 10 trillion feet have not reached the 15 trillion foot threshold which is believed to be the economic minimum required to support the project. Prudhoe Bay associated gas will likely go with a gas pipeline parallel to the Alaska pipeline to Valdez, and liquified, by natural gas tanker to the California market. The first round of major geophysical structures on land and in the shallow waters of the Beaufort Basin (Immerk) have now been drilled, with equivocal economic results. North (1971, 1973) looks at the dark side of northern prospects, Proctor and Evans the bright (1973). Without choosing sides, we hold for an Arctic gas pipeline with its promise of a touch of Northern Comfort in the declining years of the fossil fuel era (Folinsbee, 1972).

Against the gloomy background we have painted, one must mount the determined optimism of the petroleum industry. In the dark days of early 1947, Imperial Oil, after a quarter century of fruitless foothills search, began seriously to contemplate supplying Canada with synthetic gasoline made from heavy Lloydminster oil and Viking-Kinsella natural gas. In exploration downdip from their Kinsella gas field, which had a negligible thickness of oil at its base, they discovered Leduc, the oil field for which G. M. Dawson of the Geological Survey of Canada had drilled in 1894 in his search for the Great Northern Field.

Perhaps the recent untested find in the Labrador trough is the Loch Ness monster of offshore fields, though we Albertans do not envy the Newfoundlanders production from Iceberg Alley. It makes common sense to have the proven technical proficiency of the existing oil companies supported by enough profits from past successes to make this last great search.

The chips are down on the prairies, and the buffalo chips long gone. It is only one hundred years ago that the plains bison made life on the prairies as tolerable as our oil and gas does today. Flourishing in vast numbers, representing a seemingly inexhaustible resource, the buffalo provided the plains Indians with food, fire, clothing and shelter. Our oil and gas powers the agriculture and industry that feeds, warms and transports this nation. Of the buffalo and the Indians there remained within a generation only Pile of Bones and a shifting remnant of a once proud race. Within a generation, the new riders of the plains (Broncos, Colts, Mavericks, Mustangs and Pintos) will be dependent on the shifting sands of the Athabasca; what happens if the men and the sands prove economically shiftless?

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Part II, dealing with nuclear energy, will be published in the next issue of *Geoscience Canada*.