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CANADA'S CHANGING ENERGY OPTIONS

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E. R. MITCHELL
CANADIAN COMBUSTION RESEARCH LABORATORY

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BY

E. R. MITCHELL[2/]

INTRODUCTION

FOR THIS OCCASION I FELT THAT I SHOULD TRY TO ENTERTAIN YOU WITH SOMETHING LIGHT AND CHEERFUL BUT, TRY AS HARD AS I MIGHT, I COULD FIND NOTHING IN THE ENERGY SUBJECT TO BE CHEERFUL ABOUT EXCEPT THAT WE HAVE AN IMPRESSIVE SHOPPING LIST OF OPTIONS.

I FELT THE SAME WAY IN THE LATE 1940'S, AT THE BEGINNING OF A PERIOD OF ENERGY AFFLUENCE NEVER BEFORE EXPERIENCED, AND POSSIBLY NEVER AGAIN TO BE EXPERIENCED BY MAN, BECAUSE OF THE DEVASTATING EFFECT NEW ENERGY OPTIONS HAD ON THE CANADIAN COAL INDUSTRY.

THAT WAS THE BEGINNING OF WHAT I CALL "THE ERA OF FUEL HIGHGRADING" BECAUSE OIL AND NATURAL GAS WERE SOLD AT PRICES BELOW THEIR TRUE, LONG-TERM VALUE RESULTING IN RATES OF CONSUMPTION TODAY THAT BEAR NO RELATIONSHIP TO RESERVES. UNDER THESE CIRCUMSTANCES WE HAVE WITNESSED THE RAPID DEPLETION OF PREMIUM FUELS AS A CONVENIENCE IN PROTECTING THE ENVIRONMENT AND THROUGH FALSE ECONOMICS.

AS AN EXAMPLE, BASED ON ECONOMIC EVALUATIONS WHICH CONVENIENTLY OVERLOOK THERMODYNAMIC REALITIES, WE HAVE SEEN NATURAL GAS USED FOR GENERATING ELECTRICITY TO HEAT HOMES AND FOR OTHER SERVICES, WHEREAS THE SAME GAS COULD BE USED TO PERFORM THE END SERVICES THREE TO SIX TIMES MORE EFFICIENTLY.

1/ Luncheon address to the North Bay Kiwanis Club, 18 August 1975.

2/ Head, Canadian Combustion Research Laboratory, Energy Research Laboratories, Canada Centre for Mineral & Energy Technology, Department of Energy, Mines and Resources, Ottawa, Canada.

ECONOMIC ANALYSES CONVENIENTLY FORGET THE LARGE AND COMPLEX NETWORK OF NATURAL ENERGY FLOWS. EVERY CHANGE MAN MAKES IN THESE IS AN ACT OF BIOLOGICAL AND SOCIAL SIGNIFICANCE, -- BUT NATURE ADJUSTS AND WE DO NOT WORRY ABOUT OUR LITTLE PART IN THE DRAMA. SO, WE CONTINUE TO MAKE DAY OUT OF NIGHT, SUMMER OUT OF WINTER, WINTER OUT OF SUMMER, AND SHRINK THE WORLD WITH SUPERSONIC FLIGHT.

THE ENERGY CRISIS

THE ENERGY CRISIS WHICH HAS BROUGHT US TOGETHER, IS A SITUATION IN WHICH FUEL IS IN SHORT SUPPLY FOR OUR LAVISH USE-PATTERNS, AND THERE IS NO IMMEDIATE SUBSTITUTE. THIS HAPPENED FIRST IN THE UNITED STATES WHERE THE TOTAL PER CAPITA FUEL RESOURCES ARE GREATER THAN IN CANADA.

		Fossil Fuel Reserves	
	Population	Proven	Potential
U.S.A. / Canada	10 / 1	13 / 1	15 / 1

THE ENERGY CRISIS CAME FIRST TO THE UNITED STATES, AS I SEE IT, BECAUSE 78% OF FUEL CONSUMED IS DRAWN FROM 10% OF FUEL RESERVES. WE ARE NOT MUCH BETTER OFF IN CANADA BECAUSE 80% OF THE FUEL WE CONSUME IS DRAWN FROM 23% OF FUEL RESERVES. THIS IS NOT UNLIKE SUPPLYING THE CITY OF MONTREAL WITH WATER FROM A FEW WELLS WHILE THE GREAT ST. LAWRENCE RIVER FLOWS BY UNTAPPED.

Anticipated Life of Fuel Reserves

Under these conditions, how long will our fuel resources last? A simple mathematical exercise reveals that if current trends continue even the maximum potential reserves will be depleted in the brief span of 34 years for conventional oil, and 77 years for coal. Technology does not yet exist whereby most of the reserves in the ground can be recovered. As an example, many of our conventional oil wells do not respond to tertiary recovery techniques.

Therefore, our immediate interest is the probable life of presently remaining proven reserves. A concensus of proven reserves should give us cause to be gravely concerned because oil and natural gas will last a maximum of 22 years theoritically. However, today's reality is that Alberta's proven oil reserves have declined to 14 years supply at 1970 rate of consumption and about 12 years supply at 1970 rate of production.

Today's Energy Options

How we can either supplement or augment these known reserves is the subject of the current great debate. The oil and gas industries keep telling us that higher prices for oil and natural gas will solve the problem by encouraging new exploration. We have seen higher prices, but in return we have no more oil and gas supplies, only more inflation. Indeed, the more exploratory drilling that is done the more we seem to disprove the forecast reserve estimates, at least below latitude 60°N.

ARCTIC EXPLORATION HAS SHOWN THAT THERE MAY BE A SIGNIFICANT AMOUNT OF FRONTIER GAS AND THERE MAY BE SOME OIL, BUT BEFORE THESE SOURCES CAN SUPPLY OUR NEEDS, NEW NORTHERN TECHNOLOGY MUST BE DEVELOPED. FURTHERMORE, IT MAY TAKE 10 YEARS TO PUT NEW ARCTIC SOURCES ON STREAM, AND SHORTAGES ARE CLOSE AT HAND. ACTUALLY, PROSPECTS ARE THAT TEMPORARY SHORTAGES OF GAS WILL BE FELT IN ONTARIO IN 1977, AND CONTINUOUS SHORTAGES WILL OCCUR IN THE 1980'S TO THE EXTENT OF 500 MILLION CU FT/DAY UNLESS, OF COURSE, NEW SOURCES ARE MIRACULOUSLY BROUGHT ON LINE.

THE EXPERTS WARN THAT WE WILL BE A NET IMPORTER OF OIL IN TWO OR THREE YEARS. THIS, OF COURSE, HAS SPURRED DEVELOPMENT OF THE TAR SANDS DEPOSITS WHERE SYNCRUDE AND OTHERS ARE FOLLOWING THE PIONEERING EFFORTS OF GREAT CANADIAN OIL SANDS LIMITED (GCOS).

DEVELOPMENT OF THE TAR SANDS SEEMED TO ME TO BE AN ESSENTIAL COMPONENT OF A CANADIAN ENERGY DEVELOPMENT PROGRAM. BUT, RECENT EVENTS CAST DOUBT ON THE VIABILITY OF SYNCRUDE'S PLANS. WHAT, THEN, ARE THE ALTERNATIVES?

LET US CONSIDER NUCLEAR POWER, BECAUSE ELECTRICITY IS A VIABLE OPTION FOR SPACE HEATING AND MASS TRANSPORTATION. A RECENT AECL REPORT ESTABLISHED THE 1973 COST OF A NUCLEAR STATION TO WHICH I ADDED 30% FOR INFLATION DURING 1974. THE RESULT IS THAT $2 BILLION INVESTMENT PROPOSED BY SYNCRUDE COULD PURCHASE 8 NUCLEAR UNITS OF 514 MW EACH FOR A TOTAL OF 4000 MW. SUCH A PLANT WOULD PRODUCE 13.6×10^9 BTU/HR OF USEFUL ENERGY IN THE FORM OF ELECTRICITY WHICH NOW COSTS THE CONSUMER ABOUT $3.51 PER MILLION BTU.

THE SAME INVESTMENT IN CRUDE OIL PRODUCTION FROM THE TAR SANDS WOULD PROVIDE 125,000 BBL/DAY, ROUGHLY EQUIVALENT TO 31×10^9 BTU/HR OF POTENTIAL ENERGY IN THE FORM OF LIQUID FUEL. REFINING THE CRUDE TO FINISHED PRODUCTS REPRESENTS A 10% ENERGY LOSS AND, ASSUMING AN AVERAGE 50% CONVERSION EFFICIENCY TO USEFUL WORK, THE $2 BILLION INVESTMENT WOULD PROVIDE US WITH 14×10^9 BTU/HR OF USEFUL ENERGY, ABOUT EQUAL TO THAT FROM NUCLEAR PLANTS OF THE SAME COST. AN AVERAGE COST TO THE CONSUMER OF THE PETROLEUM PRODUCTS FROM TAR SANDS CRUDE IS ABOUT $3.31 PER MILLION BUT BASED ON CRUDE ENTERING THE REFINERY AT ABOUT $6.50 PER BBL, COMPARED TO $3.51 FOR NUCLEAR ENERGY.

SIMILARLY, A 2.5 TRILLION CU FT PER YEAR CAPACITY PIPELINE DOWN THE MACKENZIE VALLEY AT A COST OF $7 BILLION WILL PROVIDE 81.5×10^9 BTU/HR PER 2 BILLION INVESTMENT. THIS IS 6 TIMES THE POTENTIAL ENERGY IN BTU FOR THE SAME INVESTMENT IN EITHER NUCLEAR POWER STATIONS OR TAR SANDS PROCESSES.

NATURAL GAS PROCESSING AND TRANSPORTATION COSTS ARE WELL ESTABLISHED. IT IS ONLY THE COST OF MAINTAINING AN ARCTIC PIPELINE THAT IS UNKNOWN. NONETHELESS, OF THE THREE ALTERNATIVES, THIS APPEARS TO PROVIDE THE BEST DOLLAR VALUE IN ENERGY SUPPLY, BUT NOT NECESSARILY THE MOST PRACTICAL NOR THE MOST ACCEPTABLE.

MUCH PUBLICITY HAS BEEN GIVEN TO METHANATION OF COAL GAS, BUT IN MY OPINION THIS ARISES EITHER FROM DESPERATION OR OPTIMISM THAT IS DIFFICULT TO SUBSTANTIATE.

AS AN EXAMPLE, 50% OF THE COST OF UPGRADING A LOW QUALITY FUEL BY HYDROGENATION CAN BE DIRECTLY ATTRIBUTED TO HYDROGEN INPUT. IT REQUIRES SIGNIFICANTLY MORE HYDROGEN TO PRODUCE METHANE FROM EITHER COAL OR BITUMEN THAN TO PRODUCE ANY OF THE CONVENTIONAL LIQUID FUELS. THUS, FROM THE VIEWPOINTS OF CAPITAL COST, ENERGY CONSUMPTION, AND STORABILITY/TRANSPORTABILITY OF PRODUCT, COAL LIQUEFACTION SEEMS TO HAVE ADVANTAGES OVER GASIFICATION. HOWEVER, THE LATTER PROCESSES ARE CLOSER TO COMMERCIAL REALIZATION. INDEED, PROCESSES FOR MAKING LOW-CALORIFIC, AND THEREFORE NON-PIPELINEABLE, GAS HAVE BEEN AVAILABLE FOR 30 YEARS.

COAL IN THE ENERGY FORECAST

WHEN WE EXAMINE AND RE-EXAMINE OUR ENERGY OPTIONS WE COME BACK INEVITABLY TO NUCLEAR IN THE LONG TERM AND COAL IN THE SHORT TERM WHILE DOING THE BEST WE CAN TO EXPLOIT NATURAL GAS AND OIL RESOURCES BY WHATEVER TECHNIQUES APPLY, SUCH AS PIPELINE CONSTRUCTION, TERTIARY RECOVERY OF CONVENTIONAL OIL AND OTHERS. AT THE SAME TIME, IT IS ONLY NATURAL THAT WE SHOULD LOOK TO COAL AS AN ASSURED SOURCE OF FUEL;ONE FUEL THAT COULD PROVIDE STABILITY AT A TIME OF RAPIDLY CHANGING OPTIONS.

TO WHAT EXTENT, THEN, CAN WE RELY ON COAL AND HOW EILL IT BE USED WITHOUT IMPACTING ON THE ENVIRONMENT?

TIME DOES NOT PERMIT ME TO REVIEW THE STANDARD ENERGY FORECAST, BUT FROM PREVIOUS INDICATIONS BASED ON ENERGY SELF-SUFFICIENCY, I FORESEE OUR COAL CONSUMPTION INCREASING FROM 10 MILLION TONS IN 1970 TO BETWEEN 60 AND 150 MILLION TONS IN THE 1990'S. I FORESEE IT BEING CONSUMED IN LARGE PULVERIZED-FIRED POWER GENERATORS AND IN A MULTIPLICITY OF SMALLER CAPACITY FLUIDIZED-BED SYSTEMS.

THIS ASSUMES THAT COAL WILL BE MINED AS IT IS REQUIRED. THAT MAY NOT BE THE CASE IN FUTURE BECAUSE THE PRODUCING PROVINCES GAVE NOTICE AT THE 26TH CANADIAN COAL CONFERENCE THAT THEY ARE NOT ABOUT TO SCAR THEIR BEAUTIFUL COUNTRY-SIDE WITH STRIP MINES JUST TO KEEP THE FIRES BURNING IN ONTARIO. MORE BENEFIT MUST ACCRUE THE PRODUCING PROVINCES THAN IN THE PAST; AND SO WE HAVE A NEW DIMENSION IN PURSUING OUR ENERGY OPTIONS.

CONSERVATION

THESE OPTIONS, WHICH ARE BUT A FEW OF THOSE AVAILABLE TO US, HAVE BECOME SO COMPLEX, INTER-DEPENDENT AND COSTLY THAT WE SORELY NEED SOME BACK-UP STABILIZING STRATEGIES. ONE THAT COMES TO MIND IS FOR THE EXPERTS, I.E. TECHNOLOGISTS, ENGINEERS AND SCIENTISTS TO BE OBJECTIVE WHEN ADVISING ADMINISTRATORS AND POLICY MAKERS. TOO OFTEN THE SPECIALISTS FEEL COMPELLED TO PRESS THEIR PERSONAL PROJECTS WHICH CAN ONLY CONFUSE. ANOTHER STABILIZING STRATEGY, IN WHICH WE CAN ALL PARTICIPATE, IS CONSERVATION.

AD HOCERY HAS BEEN SUCCESSFUL IN EXPANDING OUR FUEL AND ENERGY USES TO THE POINT THAT WE DO NOT FULLY UNDERSTAND THE PROPER ROLE OF ENERGY IN SOCIETY. SURELY, WE HAVE GONE BEYOND A REASONABLE LEVEL OF DEPENDENCE ON ENERGY, AND FROM NOW ON WE NEED TO IDENTIFY WHAT WE MUST NOT DO AND THEREBY CONSERVE.

MANY ENERGY PROBLEMS HAVE NO SOLUTION; SOME ARE CONTROVERSIAL WITH THE RESULT THAT NATIONAL AND WORLD ENERGY STRATEGIES ARE EXPLORATORY RATHER THAN DEFINITIVE AND COSMETIC RATHER THAN EXHAUSTIVE. IF WE HAD ENDLESS WEALTH THIS MIGHT NOT CONCERN US TOO MUCH. THE FACT IS THAT FINANCIAL RESOURCES BECOME A LIMITING FACTOR OF INCREASING MAGNITUDE IN THE FACE OF INFLATION AND IMBALANCE OF TRADE.

THE CLASSICAL ECONOMIST, UNTIL NOW, BELIEVED THAT RECESSION IS A NATURAL CHECK ON INFLATION. WITH LESSENING DEMAND, LARGE INVENTORIES AND RISING UNEMPLOYMENT, PRICES SHOULD EITHER REMAIN STEADY OR DECLINE.

THIS IS NOT HAPPENING BECAUSE WE HAVE A COST-PUSH INFLATION BROUGHT ABOUT BY GOVERNMENTS FIXING PRICES, AS OPEC COUNTRIES HAVE DONE FOR OIL, BY WAGES GETTING AHEAD OF INFLATION THROUGH ORGANIZED NEGOTIATIONS, BY WHOLESALERS AND RETAILERS RAISING PRICES IN ANTICIPATION OF RISING COSTS FOR NEW STOCK, AND BY REDUCED PRODUCTIVITY PER MAN YEAR. THE CURRENT RECESSION SEEMS TO BE ADDING TO THE INFLATIONARY PRESSURES BUT, IN BALANCE, MANY FEEL THAT IT IS MOST URGENT TO STEM A DEEP RECESSION.

AS THINGS STAND, WE CAN EXPECT A PERIOD OF CONTROLLED INFLATION MAYBE AT THE RATE OF 6 TO 7% PER ANNUM IF WE ARE LUCKY. THIS, TOGETHER WITH SHORTAGES OF FUEL SUPPLY AND SUBSTITUTION OF HIGHER COST, LOWER QUALITY FUEL, LEAVES US NO CHOICE BUT TO CONSERVE, AND IN DOING SO, TO CHANGE OUR ENERGY-USE PATTERNS.

WE COULD CHOOSE MANY CONSERVATION EXAMPLES, BUT LET US LOOK AT THE AUTOMOBILE. IT HAS NO EQUAL AS A TOTAL ENERGY USER BECAUSE OF ITS POPULARITY; AND YET, TRANSPORTING FIVE PEOPLE TO THE GRANDPARENTS, 150 MILES AWAY, IT IS PROBABLY THE MOST EFFICIENT OF ALL MODES. A COMPARISON OF THE VARIOUS TRANSPORTATION MODES ARE GIVEN IN THE FOLLOWING TABLE.

	BTU/MILE		
	PER PASSENGER		PER TON OF FREIGHT
	INTER-CITY	URBAN	INTER-CITY
BUS	1,090 (25% of CAR)	1,240 (25% of CAR)	
STREET CAR	-	1,250 (25% of CAR)	
TRAIN	1,700 (40% of CAR)	-	680 (29% of TRUCK)
CAR	4,250	5,060	
ELECTRIC CAR	-	600 (12% of CAR)	
AIRCRAFT	9,700 (228% of CAR)	-	37,000 (1581% of TRUCK)
PIPELINE			450 (19% of TRUCK)
WATERWAY			540 (23% of TRUCK)
TRUCK			2,340
BICYCLE	-	200 (4% of CAR)	
WALKING	-	300 (6% of CAR)	

FOR URBAN USE, THE CAR IS THE HIGHEST ENERGY CONSUMER PER PASSENGER MILE OF ALL MODES OF TRANSPORT. IT IS EXCEEDED IN INTER-CITY PASSENGER TRANSPORT ONLY BY THE AIRCRAFT WHICH USES MORE THAN TWICE AS MUCH ENERGY AS THE CAR.

IF WE ARE SERIOUS ABOUT CONSERVATION, WE WILL TRAVEL BY BUS OR STREETCAR IN THE CITY AND BY RAIL COMMUTER FROM THE SUBURBS. IF WE MUST DRIVE OUR CARS ON THE HIGHWAY WE SHOULD, AT LEAST, CHOOSE AN EFFICIENT SPEED. IN OUR EVALUATION OF CAR PERFORMANCE ON THE ROAD WE HAVE FOUND THAT REDUCING SPEED FROM 70 TO 55 MPH, AS ONE EXAMPLE, WILL REDUCE FUEL CONSUMPTION BY 18 TO 28%. MORE DETAILS ARE GIVEN IN THE TABLE BELOW.

	% REDUCTION OF FUEL CONSUMPTION			
ENGINE GROUP	70 → 55 MPH	→ 50 MPH	60 → 55 MPH	→ 50 MPH
V8	17.9	24.0	5.3	10
6	23.3	30.3	6.9	13
4	28.3	37.6	7.4	15

MANY OTHER INTERESTING THINGS HAVE BEEN LEARNED FROM OUR CAR TESTING; CITY DRIVING USES MORE GASOLINE PER MILE THAN HIGHWAY DRIVING AT 55 MPH, IN WINTER IT IS 28% MORE AND IN SUMMER IT IS 18% MORE.

WINTER WEATHER INCREASES GASOLINE CONSUMPTION; IN THE CITY IT IS 18% MORE AND ON THE HIGHWAY IT IS 9% MORE.

VEHICLE WEIGHT AFFECTS GASOLINE CONSUMPTION. DECREASING WEIGHT BY 10% REDUCES GASOLINE CONSUMPTION BY ABOUT 10% IN THE CITY AND SOMEWHAT LESS ON THE HIGHWAY.

IN OUR EVERYDAY LIVES, THERE ARE MANY WAYS IN WHICH ENERGY CAN BE SAVED. WE HAVE ASSEMBLED 100 OF THEM IN A BOOKLET YOU HAVE RECEIVED. THIS BOOKLET GIVES YOU A NUMBER OF GOOD TIPS RANGING FROM MORE HOME INSULATION TO PLACEMENT OF YOUR REFRIGERATOR AND I AM SURE THAT YOU CAN ADD TO THEM.

AT PRESENT WE ARE PREPARING A COMPANION BOOKLET ON SPACE HEATING BY OIL IN WARM-AIR AND HOT-WATER SYSTEMS. TO GIVE YOU A PREVIEW, IT WILL EXPLAIN HOW TO MEASURE YOUR FURNACE EFFICIENCY AND HOW TO GET THE BEST EFFICIENCY FROM IT. IT WILL EXPLAIN HOW TO MAINTAIN THE BEST EFFICIENCY AND HOW TO CLEAN YOUR FURNACE. IT WILL EXPLAIN WHAT YOU SHOULD GET FROM YOUR ANNUAL SERVICE AND OVERHAUL. IT WILL SHOW YOU THE LEVEL OF OVERALL EFFICIENCY THAT YOU SHOULD EXPECT FROM STANDARD-HEAD BURNERS (75% TO 80%) AND RETENTION-HEAD BURNERS (80% TO 85%). IT WILL ALSO POINT OUT SAFETY FEATURES WHICH ARE AN OVERRIDING PRECAUTION.

IT IS RECOGNIZED THAT THERE IS A LIMIT TO WHICH WE, AS INDIVIDUALS, CAN SAVE IN THE LIFE-STYLE THAT IS THRUST UPON US. THEREFORE, ATTENTION MUST BE GIVEN TO INDUSTRIAL ACTIVITIES WHERE POTENTIAL FOR ENERGY SAVING IS HUGE. AN OBVIOUS EXAMPLE IS POWER GENERATION BY THERMAL AND NUCLEAR MEANS WHERE 50% OF THE FUEL INPUT IS WASTED IN COOLING WATER THAT CONDENSES STEAM. IN OTHER WORDS A 2000 MW (E) STATION WASTES 4000 MW OF HEAT. BY COMBINING THERMAL POWER GENERATION WITH EITHER DISTRICT HEATING OR FOOD PRODUCTION, MUCH OF THIS WASTE CAN BE PUT TO USE TO REPLACE PREMIUM FUELS.

I COULD GO ON AND TALK ABOUT EFFICIENT COMBINED GAS-TURBINE STEAM-TURBINE POWER CYCLES, SOLAR, WIND AND TIDAL ENERGY BUT THEY ARE IDEAS THAT REQUIRE LARGE FINANCIAL INVESTMENTS. NONETHELESS, THEY ADD TO OUR ENERGY OPTIONS IF WE NEED THEM.

WHILE OUR OPTIONS MAY SEEM TO BE CHANGING, NOTHING REALLY HAS CHANGED. THE FINITE LIMITS OF OUR CONVENTIONAL OIL AND NATURAL GAS HAVE NOT CHANGED, WE ARE ONLY FACING UP TO THEIR REALISTIC MANAGEMENT;WE HAVE THE WORLD'S LARGEST SINGLE SOURCE OF OIL IN THE TAR SANDS; WE HAVE A LARGE SOURCE OF HYDRO POWER; WE HAVE ONE OF THE BEST SETTINGS IN THE WORLD FOR DEVELOPING TIDAL POWER;WE HAVE THE WORLD'S BEST FUSION PROCESS IN CANDU;WE HAVE A SIGNIFICANT COAL RESOURCE; AND FINALLY, WE HAVE AN INTELLIGENT HUMAN RESOURCE TO PUT THESE THINGS TOGETHER.