An Energy Policy for British Columbia

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Canadians, and especially British Columbians, are particularly fortunate because of their endowed wealth of natural resources. In a world threatened by disruptions in the supply of vital commodities such as energy, both Canada and British Columbia are in the nearly unique position of having sufficient *aggregate* energy resources to meet anticipated demand into the twenty-first century. Major B.C. energy resources include hydropower, natural gas, coal, uranium and biomass.[1]

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[1] Current B.C. proven "reserves" are as follows: petroleum — 179 million stock tank barrels (MMSTB), natural gas — 7.5 trillion cubic feet (TCF), coal — 2.8 billion tons, uranium — 6416 tons of elemental uranium, hydropower 24,000 megawatts capacity. [Source: Province of British Columbia, *National Energy Board Inquiry into Supply of Oil, Natural Gas and Other Forms of Energy in Relation to the Domestic Demand for all Forms of Energy*, Submission by Province of B.C., September 1980.] The reserve to annual production (R/P) and reserve to annual domestic consumption (R/C) ratios are as follows:

	R/P	R/C	
petroleum	12.8:1	3:1	
natural gas	23.7:1	48:1	
coal	284:1	~ 2300:1	
uranium	∞ :1	∞ :1	— (no current production)
hydropower capacity	~ 3:1	~ 3:1	

Several qualifications are required to these data:

(i) the R/P ratio for petroleum is significantly higher than the R/C ratio because B.C. must import the bulk of its petroleum requirements. The rate of withdrawals from provincial oil fields is restricted by oil field mechanics and economic recovery considerations.

(ii) the discrepancy between the R/P and R/C ratios for natural gas and coal is accounted for by current exports of these commodities.

(iii) the ratios listed for hydropower are not comparable to those for the other energy sources because of the renewable nature of hydroelectricity. These ratios do provide useful information, however, on potential unexploited capacity.

(iv) these ratios are useful for providing a preliminary assessment of energy supply life and capability. Nevertheless, they must be interpreted very cautiously in light of several factors:

(a) new reserve discoveries and/or recovery technologies, The principal and significant problem associated with the current energy supply situation in Canada and B.C. is a shortfall of domestically produced liquid hydrocarbon fuels. Canada is presently a net importer of petroleum, while British Columbia currently meets only one-quarter of its oil demand from in-province sources. The energy situation has been of concern to the federal government, which instituted a major new energy program in its budget of 28 October 1980.[2] At the provincial level, the government of British Columbia also has recently taken some preliminary steps to formulate and implement an energy policy.[3] However, much more remains to be accomplished. What is required is a comprehensive policy which achieves long-term as well as immediate energy objectives and is successfully integrated with other major governmental goals in the areas of economic and social policy.

Energy, an indispensable commodity in our modern, industrialized society, is desired not for itself but rather as an instrument to facilitate the achievement of economic and social ends. As such, energy policy cannot be divorced from other policies developed to achieve similar goals.

This paper identifies a prospective set of basic principles and instruments which can assist in the development of a comprehensive and integrated energy policy in British Columbia. These principles are used to suggest policy positions on some of the more significant energy issues and challenges facing the province.

(b) changes in end-use associated with price changes and/or efficiency improvements,

(c) major new interfuel substitutions among fuels,

(d) continuing annual increases in fuel use associated with population growth and industrialization, and

(e) new export commitments.

Any one of these factors can have a profound impact on R/P and R/C ratios. By way of example, the following table illustrates the rate of depletion of a hypothetical energy resource under varying assumptions about the annual increase in usage.

Rate of annual increase in use	Expected life of reserves
0%	100 years
2.5%	51 years
5.0%	37 years
10.0%	25 years

[2] Department of Finance Canada, "National Energy Program," *The Budget*, 28 October 1980; Energy, Mines and Resources Canada, *The National Energy Program*, October 1980.

[3] B.C. Ministry of Energy, Mines and Petroleum Resources, *An Energy Secure British Columbia — the Challenge and the Opportunity* (An Energy Policy Statement), February 1980.

GUIDING PRINCIPLES

At least four broad principles can be identified which are essential to energy policy formulation and execution: (i) security of supply, (ii) efficiency, (iii) equity, and (iv) complementarity. Each principle is described briefly in turn.

Security of Supply

British Columbia's problem of energy security has been accentuated by global developments in the last decade. The OPEC oil embargo of 1973 and the subsequent increase in petroleum prices forced a major re-examination of international petroleum reserves and deliverability. There is now a growing agreement that global petroleum production will peak before the end of this century.[4] The prospect of production decreases coupled with continued increases in demand poses one of the most significant threats to international economic and social order.[5]

The central challenge facing all nations is to achieve a successful and relatively tranquil transition from heavy reliance on petroleum to alternative energy sources. The achievement of this goal is confounded by a myriad of issues including: international political and military instability; long lead times inherent in the development and adoption of new energy technology; high levels of risk and uncertainty associated with certain new energy systems; the uneven distribution of energy resources and wealth; and the heavy reliance of certain economic sectors on individual fuel types. The most noteworthy example of the last problem is provided by the transportation sector, which relies on liquid hydrocarbons for approximately 99 percent of its energy demand.[6] This is of particular consequence for Canada, where transportation is an exceptionally important factor in the distribution of products to both domestic and international markets.

The guaranteeing of energy supply security for British Columbia requires the development of broad and imaginative policy options, including contingency planning for most, if not all, credible scenarios. At the

[4] See, for example: Andrew R. Flower, "World Oil Production," *Scientific American*, March 1978, pp. 42-49; United States Central Intelligence Agency, *The International Energy Situation: Outlook to 1985*, 1977; U.S. C.I.A., *The World Oil Market in the Years Ahead*, 1979; and Workshop on Alternative Energy Strategies, *Energy: Global Prospects 1985-2000* (Cambridge, Mass.: MIT Press, 1977).

[5] See United States Senate, Committee on Energy and Natural Resources, *The Geopolitics of Oil*, Staff Report, November 1980; and David A. Deese and Joseph S. Nye (eds.), *Energy and Security* (Cambridge, Mass.: Ballinger, 1981).

[6] Science Council of Canada, *Canada's Energy Opportunities*, March 1975.

extreme, this implies planning for the reduction and potential elimination of extraprovincial supplies of conventional petroleum and its products. Two major policy instruments are available for the achievement of energy security: fuel demand and fuel supply modification, including a reduction in current growth rates in demand for petroleum products, and the creation of an environment which facilitates the replacement of petroleum by alternative energy supplies.

In addition to the uncertainty of external supplies of petroleum, there is an important element of risk associated with the availability and deliverability of all domestic energy supplies. Supply-side energy risk will tend to decrease as the number and diversity of energy production sources increases. This suggests that, despite higher *direct* costs, there may be significant benefits associated with adopting a conscious policy of diversification and size reduction in facilities for both energy production and distribution. This approach would minimize the risk of major systemwide disruptions associated with environmental, social and political variables such as (i) extended periods of low rain and snowfall which can have a profound effect on hydro-electric systems,[7] (ii) acts of God such as floods, storms and earthquakes which can interrupt the transmission of electricity, petroleum or natural gas, and (iii) intentional and unintentional disruptive acts of man.[8]

[7] Of B.C.'s current installed 9362 MW of electricity production capacity, fully 7590 MW are provided by hydropower. Source: Statistics Canada databank information, 1981.

[8] Although not a subject which has received, or should receive, extensive media coverage, threats against energy production and distribution systems have become somewhat more credible in recent times with the increased capability of terrorist and other disaffected groups to disrupt or destroy such facilities. See United States, Comptroller General, *Improvements Needed in the Program for the Protection of Special Nuclear Material,* Report to the Congress, 7 November 1973; Robert Gillett, "Nuclear Safeguards: Holes in the Fence," *Science,* 14 December 1973, pp. 1112-14; John McPhee, *The Curve of Binding Energy* (New York: Farrar, Strauss and Giroux, 1974); Mason Willrich and Theodore B. Taylor, *Nuclear Theft: Risks and Safeguards,* Report to the Energy Policy Project of the Ford Foundation (Cambridge, Mass.: Ballinger, 1974); and United States General Accounting Office, *Federal Electrical Emergency Preparedness is Inadequate,* Report to the Congress of the United States by the Comptroller General, EMD-81-50, 12 May 1981. For obvious reasons, much of the literature which does address the issue of the security of energy systems is concerned with nuclear power. Damage to or destruction of a nuclear facility has the capacity to produce very serious health and environmental effects in addition to the loss of electricity output. [See, U.S. Nuclear Regulatory Commission, *Reactor Safety Study, An Assessment of Accidental Risks in U.S. Commercial Nuclear Power Plants,* (WASH-1400), October 1975; and H. W. Lewis, et al. (Ad Hoc Risk Assessment Review Group), *Risk Assessment Review Group Report to the U.S. Nuclear Regulatory Commission,* September 1978.] While the destruction of non-nuclear facilities (such as pipelines, refineries, transmission

Efficiency

The recent history of world energy use has been distinguished by profound inefficiencies and a concomitant waste of resources of massive proportions. In the face of depleting supplies of finite resources, real energy prices have fallen, inducing the construction of an economic and social system which is highly energy intensive and energy dependent. In view of current technology and the state of knowledge concerning our energy resource base, it appears that this structure cannot be sustained.

Government should adopt policies which not only increase the efficiency of energy use but also induce a profound shift in current patterns of utilization. While both economic and non-economic instruments can be employed to achieve this goal, the most effective and efficient mechanism of adjustment is price.

Efficient utilization of energy implies that both corporations and individuals who produce or consume energy must incorporate in their decisions all the direct and indirect costs entailed in the processes of production and consumption. Prices and non-market incentives are instrumental in realizing this goal. Nevertheless, in the presence of externalities, the minimization of the private costs of energy production and consumption is insufficient. Government must be concerned with the minimization of the total or social costs of energy. What makes the determination of social costs potentially complex is the problem of both identifying and quantifying the diverse range of impacts associated with the production and consumption of such a critical and universally required commodity as energy.

Equity

A central tenet in the development of energy policy is guaranteeing its consistency with other broad economic and social goals. One of these goals, equity in the distribution of income, whether regional or individual, is particularly important and worthy of separate consideration. A foremost objective of a democratic society is to guarantee its citizens freedom from poverty and destitution. As such, no policy should be adopted which has a significantly detrimental effect on those members of society who are least well-to-do. While there are strong theoretical arguments in economics for the separation of considerations of efficiency and equity in the decision-making process, it is not always possible to effect

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lines and dams) may entail markedly less damage, the loss of energy supply for any significant length of time poses a potentially serious problem.

an ex post compensatory redistribution of income. Under these circumstances, it is socially desirable to modify pure efficiency criteria with the introduction of specific income distributional constraints.

In the last decade, increasing research has been conducted in the United States on the income distributional consequences of energy price increases directed at curtailing demand and improving end-use efficiency. It is particularly heartening to note that specific policies can be adopted which achieve significant aggregate energy savings while protecting lower income groups from undue hardship.[9] Mechanisms such as lifeline electricity rates have already been adopted in several states.[10]

Complementarity

While issues of equity and the distribution of income loom large in the discussion of energy policy, there is a series of other related political, economic and social goals which government must explicitly consider in the process of policy formation. These include, but are not restricted to: (i) high levels of employment, (ii) a low rate of inflation, (iii) the preservation of specific social and cultural values, and (iv) environmental protection, broadly defined to include the protection of human health as well as the integrity of ecosystems.

SOME MAJOR POLICY INSTRUMENTS

Several energy policy instruments can be identified for use in British Columbia. The instruments described are not exhaustive, mutually exclusive, or confined to this province, but they do represent mechanisms which the provincial government must carefully consider in the near future if it is to respond intelligently to the energy challenge. These mechanisms include (i) pricing, (ii) control of energy exports, (iii) gov-

9 See M. B. Berman, et al., *The Impact of Electricity Price Increases on Income Groups: Western United States and California,* RAND Corporation, November 1972; R. D. Doctor, et al., *California's Electricity Quandary: III Slowing the Growth Rate,* RAND Corporation, September 1972; Gerard M. Brannon, *Energy Taxes and Subsidies,* Energy Policy Project of the Ford Foundation (Cambridge, Mass.: Ballinger, 1974); Gerard M. Brannon (ed.), *Studies in Energy Tax Policy,* Energy Policy Project of the Ford Foundation (Cambridge, Mass., 1975), (esp. chapters 9 and 10); and Jan Paul Acton, "Electricity Prices and the Poor: What are the Effects and What Can We Do?", RAND/P-6456, March 1980.

10 See Edison Electric Institute, "Status of Rate Structure Innovations, by State," Washington, D.C., July 1978, mimeo; Dennis Ray and Rodney Stevenson, "Measuring the Potential Impacts from Lifeline Pricing of Electricity and Natural Gas Services," in Michael A. Crew (ed.) *Issues in Public Utility Pricing and Regulation* (Lexington Books, 1980); and Timothy J. Sullivan, *The Los Angeles Senior Citizen Lifeline Electricity Rate,* RAND Corporation, January 1979.

ernment ownership, (iv) interfuel substitution, (v) the integration and review of public and private energy initiatives, and (vi) education and public participation.

Pricing

Economic logic mandates that the prices of finite and depleting resources should reflect their scarcity value. It is generally agreed that energy, and especially petroleum and related products, has been underpriced in Canada. This price should rise to effect a transition to alternative fuels. Sole reliance on the market cannot solve our energy crisis, yet it would be unwise not to avail ourselves of the effective instruments which a market system can provide.

Increasing the market price for energy, and petroleum in particular, achieves a number of important and complementary goals: reduced demand for oil, more extensive development of remaining petroleum reserves, the employment of alternative fuels and energy technologies, and the more efficient use of limited energy resources.

Despite the advantages inherent in the adjustment of petroleum prices, our industrial system cannot respond effectively to rapid price increases in the short run. This is a major reason why a gradual but consistent policy of upward adjustment has been adopted in order to avoid exacerbating current industrial problems in Canada.

The federal National Energy Program of 1980 came under widespread criticism for failing to increase the price of oil at a sufficiently fast rate. Subsequent upward revisions in these price schedules were undertaken in 1981 with the successful conclusion of agreements between Ottawa and the principal petroleum producing provinces.[11] It seems likely, however, that these schedules will require continued reassessment in the years ahead in view of possible external developments.

There are incontrovertible economic arguments for moving energy prices to or near world levels. What has been generally lost in the current and heated debate over pricing policy is an understanding of federal reluctance to adopt too rapid an increase in these prices. The determination of federal pricing policy has not been a casual and arbitrary process.

[11] See, for example, Canada/Alberta, "Memorandum of Agreement between the Government of Canada and the Government of Alberta relating to Energy Pricing and Taxation," 1 September 1981; Canada/B.C., "Joint Statement by the Prime Minister of Canada and the Premier of British Columbia," and letter from the Hon. Marc Lalonde, Minister of Energy, Mines and Resources Canada to the Hon. Robert H. McClelland, Minister of Energy, Mines and Petroleum Resources, British Columbia, 24 September 1981.

It is based on the realization that Canada's industrial structure is fundamentally fragile and subjected to current stresses from deindustrialization. The appropriate policy toward Canadian secondary and tertiary industry is a contentious subject, but the federal government appears motivated by justifiable social and political considerations which transcend issues of a purely economic nature. The policy is not riskless, as admitted in the National Energy Program itself:

> The Government of Canada expects the full benefit of lower energy costs to be reflected in the well-being of every worker, every citizen, through economic growth and new employment opportunities. These low costs should not be used as an excuse for inadequate attention to increasing productivity or improving energy efficiency. A made-in-Canada oil price is not a license to waste oil. It would be unfortunate — indeed, unacceptable — if the benefits of our resource endowment were squandered in this way. . . . We cannot expect to compete in tomorrow's world unless we use the respite and the certainty afforded by the price schedule in the Program to put in place energy-efficient processes, and to develop energy-efficient products.[12]

No less important than the rational pricing of finite energy resources is the determination of the appropriate price for renewable resources such as hydroelectricity. The development of the economic base of British Columbia has been generally well served by the utilization of waterpower. The province is not well served, however, by the continuation of rate structures which promote the excessive use of electricity.

It is recommended that B.C. Hydro alter its pricing structure to eliminate cross subsidies among rate classes and de facto promotional rates — both causes of economic inefficiency and resource waste.[13] It is here, however, that special attention must be paid to broader social and economic considerations. It would be both unfair and unwise to penalize industry which has adjusted to historical energy prices. For this reason, it may be inappropriate in the short run to institute rate schedules which fully reflect the true marginal cost of electricity provision. One suggested short term strategy is the replacement of declining block rate schedules by flat rates at levels which do not significantly increase the total energy bills of commercial and industrial users. This interim strategy achieves two goals: (i) it removes the incentive to increase the use of energy at prices which

[12] Energy, Mines and Resources Canada, *The National Energy Program,* October 1980, pp. 114-15.

[13] For a further discussion of these issues specifically addressed to the B.C. Hydro system, see Sanford L. Osler, "An Application of Marginal Cost Pricing Principles to B.C. Hydro," U.B.C. Department of Economics, Programme in Natural Resource Economics, Paper No. 12, July 1977.

are inappropriately low, and (ii) it provides a period of adjustment. Such a rate structure has already been adopted by B.C. Hydro for its largest industrial customers over 5000 KW. The direction and potential magnitude of future rate structure changes should be signalled to domestic industries to enable them to engage in forward planning for the adoption of alternative fuels and production technologies.

There is room for considerably more rate experimentation than currently demonstrated by B.C. Hydro. Although the provincial electrical system does not suffer from a *capacity* constraint which influences the pricing policies of American utilities, there is a wealth of innovative rate experience in the United States which could be of potential use to British Columbia and Canada.[14]

One additional subject worthy of brief comment is B.C. Hydro's debt. As of 1980, the crown corporation had long-term liabilities of $5.2 billion and an interest service to gross revenue ratio of 34 percent.[15] There are two interrelated issues raised by this situation: (i) the cost of capital to the corporation, and (ii) the direct and indirect impact of this debt on the provincial economy. Neither issue lends itself to simple interpretation.

Depending on the future pricing structure adopted by Hydro, there is the possibility that new capital requirements combined with rollovers of current debt could lead to interest payments substantially higher than the present. B.C. Hydro has recently announced its intention to increase its debt in the next decade.[16] Hydro already accounts for 70 percent of the provincial government's total guaranteed indebtedness.[17]

It can be argued that a large corporation like B.C. Hydro need not be overly concerned with levels of debt if domestic demand is maintained and inflation remains a semi-permanent characteristic of the economic environment. The corporation's weighted average cost of capital in 1980 was 8.6 percent, reflecting not only a lengthy period of relatively low

[14] For a discussion of some of this activity, see J. Robert Malko, Dennis J. Ray and Nancy L. Hassig, "Time-of-Day Pricing of Electricity Activities in Some Midwestern States," *Journal of Business Administration* 12 (2): 143-70 (also available as Peter N. Nemetz [ed.], *Energy Crisis — Policy Response* [Montreal: Institute for Research on Public Policy, 1981]).

[15] British Columbia Hydro and Power Authority, *Annual Report 1979/80*, 1980.

[16] According to documents filed by the B.C. government with the U.S. Securities and Exchange Commission, B.C. Hydro intends to borrow an additional $6.4 billion over the next five years. (See *Vancouver Province*, "B.C. will double its debt to $15 billion," 11 December 1981, p. A1.) B.C. Hydro's own publication *Energy Blueprint 1981* (1981) states that $18.2 billion will be borrowed by the crown corporation over the next ten years.

[17] B.C. Ministry of Finance, *Budget*, March 1980, table A5, p. 54.

interest rates but also the provincial government's unconditional guarantee of Hydro's indebtedness. This government guarantee, in itself, creates a de facto subsidy to electricity consumers and a potential distortion of investment patterns in the province. The extent and cost of Hydro's future debt cannot be viewed independently from other provincial capital requirements. At the very least, an explicit public assessment is required of both the opportunities afforded and foreclosed by Hydro's future capital needs.

Energy Exports

British Columbia is currently engaged in the export of several major energy commodities: coal, natural gas and electricity. This export has occurred in the absence of a comprehensive energy policy which ties such sales to anticipated medium- to long-term domestic requirements. An examination of these issues is needed immediately. There are two principal rationales for energy exports: (i) the generation of revenues to finance domestic social and economic programs, and (ii) altruistic motives to aid nations in need. Each rationale is complex, as there are no unambiguous gains — difficult trade-offs must be undertaken. The most critical of these trade-offs is that between certain short term benefits and uncertain future costs. Several comments are warranted concerning each of the three major energy exports.

Electricity

British Columbia is currently interconnected by electric grids on its southern and eastern borders. The two-way transfer of electricity is an essential element in a policy of risk reduction and efficient utilization of installed capacity. In undertaking the export of electricity, however, it is important to recognize significant difficulties with (i) the use of firm contracts which reduce the medium to long-term flexibility of a domestic utility to meet provincial requirements, and (ii) building generating capacity specifically or primarily for export in the presence of major domestic resource conflicts which entail high opportunity costs.

There are at least two issues in particular which concern the nature of American demand for electricity exports from British Columbia. The first is the apparent uncertainty whether such demand will in fact materialize in the Pacific Northwest before the mid-1990s. It does appear, however, that a potential California market for this electricity would be available if significant additions to transmission facilities were undertaken.[18] If B.C. were to serve the California market, the second major issue is the possible political and ethical problems accompanying any eventual cutback or elimination of exports to energy deficient areas.

The issue of hydroelectric development is central to the direction of future B.C. energy policy. This is the case not only because of the sizable contribution it makes to provincial energy requirements (14 percent in 1979),[19] but also because it represents, in many respects, a microcosm of the modern conflict about multiple resource use demands on our finite resource base. Conflicts associated with the production of hydroelectricity include damage to fisheries and wildlife, flooding of agricultural, forest, and Indian treaty land, loss of aesthetic and recreational resources for both domestic population and tourists, and foreclosure of potential human settlement opportunities.[20]

Natural Gas

British Columbia is currently exporting significant quantities of natural gas to the United States and is considering proposals for the export of liquefied natural gas (LNG) and natural gas-based products to Pacific Rim markets. Past export commitments have been conditioned on the existence of sufficient reserves to meet domestic requirements. The incentive to continue current and potentially higher levels of export is significant as the associated revenues have made a major contribution to the provincial treasury, thus facilitating the provision of a wide range of economic and social programs.

However, there are three consequential issues related to current natural gas export policy. First, and foremost, export commitments have been undertaken on the basis of inadequate demand and supply projections. Recent provincial studies focus on a planning horizon of no more than two decades in length.[21] This is a potentially serious mistake. Despite the

18 Arlon R. Tussing, Samuel A. Van Vactor and Connie C. Barlow, "Potential Markets in the Pacific Northwest and California for Surplus Electricity from British Columbia," ARTA, Inc., Seattle, Washington, 3 November 1981.

19 B.C. Energy Commission, *B.C. Energy Supply and Requirements Forecast 1978-1992*, September 1978.

20 For an interesting discussion of the direct impact of hydroelectric development on settlement patterns, see Jim Wilson, *People in the Way* (Toronto: University of Toronto Press, 1973).

21 Province of British Columbia, *National Energy Board Inquiry into Supply of Oil, Natural Gas and Other Forms of Energy in Relation to the Domestic Demand for all Forms of Energy*, Submission by Province of B.C., September 1980; and B.C. Ministry of Energy, Mines and Petroleum Resources, *Natural Gas Allocation Process*, July 1981.

non-trivial problems of forecasting both demand and supply in the medium to long run, the current planning horizon is too short in light of the critical importance of natural gas supplies to the long-term health of the provincial economy. There is no such thing as a "surplus" of a depleting and essential resource.[22]

Second, extreme care must be exercised to avoid demand underestimation in light of the anticipated interfuel substitution away from liquid petroleum products. In this regard, recent attempts to disaggregate demand by industry are particularly useful.[23]

Third, reasonable caution must be exercised in the interpretation of projected additions to gas reserves. In a situation where a miscalculation of reserves can have a serious economic impact, only estimates of proven reserves of natural gas should be used in calculations concerning export proposals. A historical justification for the adoption of this risk averse stance is provided by the extraordinary downward revision of estimated Canadian reserves of oil and natural gas which occurred after 1973. Over a period of seven years, a careful and continuing re-examination of data provided to the federal government by the petroleum industry has led to reductions in national reserve estimates for oil from 134.4 to 5.0 billion barrels;[24] and for natural gas from 906.1 to 88.9 trillion cubic feet.[25]

Coal

Significant quantities of metallurgical coal are currently being exported from British Columbia, with the additional prospect of increasing foreign

22 Kenneth North, "Canadian Oil and Gas — Surplus or Shortage?" *Journal of Business Administration* 10 (1 and 2) (also available as Peter N. Nemetz [ed.], *Energy Policy: The Global Challenge,* [Montreal: Institute for Research on Public Policy, 1979], pp. 49-68).

23 B.C. Ministry of Energy, Mines and Petroleum Resources, *British Columbia Energy Supply and Requirements Forecast, 1979-1996, Technical Report,* February 1980; and *British Columbia Energy Supply and Requirements Forecast 1980-1995, Technical Report,* June 1981.

24 Energy, Mines and Resources Canada, *An Energy Policy for Canada — Phase 1, Volume I — Analysis,* 1973; and National Energy Board of Canada, *Canadian Energy Supply and Demand 1980-2000,* June 1981. Note: current annual Canadian production of petroleum is approximately .8 billion bbls per year.

25 EM&R Canada, *An Energy Policy for Canada,* 1973; and National Energy Board of Canada, *Canadian Energy Supply and Demand, 1980-2000,* June 1981. Of this 88.9 TCF, 72.2 TCF is in conventional, as opposed to offshore or frontier, areas. Note: current annual Canadian production of natural gas, including licensed exports of 1.35 TCF, is approximately 3.0 TCF per year. For a further discussion of these significant adjustments in reserve estimates, see: Eric Kierans, "The Energy Crisis: the Day the Cabinet was Misled," *The Canadian Forum,* 1974, 53 (March) pp. 4-8; and F. K. North, "Canada's Oil and Gas Resources," *Geoscience Canada,* 1974, 1 (March) pp. 24-30.

demand for B.C.'s thermal coal reserves. It appears that this province is exceptionally fortunate, being endowed with large domestic coal supplies. With a larger "cushion" of coal than natural gas,[26] continued exports of this commodity appear to be in the provincial interest. This situation does not relieve the government, however, of the necessity of conducting an extensive review of the following factors related to current and future coal development and utilization:

(i) a comprehensive inventory of coal by type and location,

(ii) an initial assessment of direct costs of coal development by region,

(iii) an initial survey of potential social, economic and environmental effects of coal development by deposit, and

(iv) a long range, multiple-use contingency plan for domestic coal utilization. This would include the potential demand for coal for thermoelectricity generation, gasification, liquefaction and chemical feedstocks.[27]

Once this type of assessment has been completed, the province would be able to make reasonable determinations concerning appropriate levels of export, pricing, and regional deposit development priorities.

Ownership

The continued presence of the government in certain energy markets is an indisputable necessity. The extent of this presence will clearly vary among energy industries depending on their market structure, conduct, performance, and perceived role in total energy provision. Arguments for government ownership include (i) control of industries which are natural monopolies, (ii) influence over policy making in a critical economic sector, and (iii) access to important data through a "window on the industry." A strong case can be made that direct or indirect government funding is required where energy projects are characterized by major risk, long lead times and high capital intensity.

Virtual government dominance of an industry through ownership of a major utility such as B.C. Hydro is not the only option. Other alternatives include: minority equity holdings, as illustrated by the Alberta and On-

[26] See footnote 1.

[27] Some preliminary and useful research has already been conducted on this subject by both the provincial and federal governments. See B.C. Hydro, *Hat Creek Coal Utilization Study*, 1977; and B.C. Hydro and EM&R Canada, *Studies of Advanced Electric Power Generation*, 1976.

tario participation in Syncrude, and Ontario's recent purchase of 25 percent of Suncor Inc.; complete ownership of one corporate entity (such as Petro Canada) in a mixed economy;[28] monopsony arrangements, such as those of the B.C. Petroleum Corporation; public participation through a mechanism such as BCRIC's ownership of B.C. Coal Ltd.; and general tax and regulatory provisions.

Interfuel Substitution

The conscious promotion of interfuel substitution is an important component of a comprehensive energy program. While changes in relative fuel prices will gradually increase the incentives for substitution, government can play an active role in reducing the institutional barriers to this transformation in energy use. Numerous constructive initiatives have been undertaken in both Canada and the United States to promote interfuel substitution in the residential, commercial and industrial sectors. Several of these programs worthy of consideration in British Columbia include:[29]

(a) changes in building codes to facilitate the adoption of alternative energy technologies,

(b) grants, low-interest loans or tax incentives to ease the burden of initial capital expenditures, and

(c) mandated changes in utility buy-back rates to promote the adoption of new energy systems, such as hog fuel based cogeneration, with a net contribution to utility grids.[30]

28 For a recent assessment of Petro Canada and the principal arguments for a direct government presence in the energy industry, see United States General Accounting Office, *Petro-Canada: The National Oil Company as a tool of Canadian Energy Policy*, study by the Staff of the U.S. G.A.O., EMD-82-5, 15 October 1981.

29 Peter N. Nemetz, "Economic Incentives for Energy Conservation at the Consumer Level — An Overview and Preliminary Synthesis," Report prepared for Consumer and Corporate Affairs Canada (Ottawa, 1979); and P. Nemetz, M. Hankey and B. Zethof, "Economic Incentives for Energy Conservation," Second report to Consumer and Corporate Affairs Canada (Ottawa, 1980).

30 A marked increase in industrial cogeneration facilities in the United States has been prompted by recent innovative federal legislation. In particular, the Public Utility Regulatory Policy Act of 1978 (PURPA) provides several critical incentives for this activity. Foremost among the Act's provisions is the requirement that surplus electricity generated by private industry must be purchased by local utilities at "avoided cost," i.e., the cost to the utility of producing the electricity itself or purchasing it from another utility. See Mary Wayne, "Plugging Cogenerators into the Grid," *EPRI Journal*, Electric Power Research Institute, July/August 1981, pp. 6-14; and Colin Norman, "Renewable Power Sparks Financial Interest," *Science*, 26 June 1981, 212:1479-81.

Of particular promise in British Columbia is the increased use of natural gas, biomass (in the form of hog fuel),[31] and coal.

An important corollary to the process of interfuel substitution is the conscious matching of energy type to end uses.[32] This entails the avoidance of potentially expensive mismatching of high-quality fuel with low-quality uses.

There is one type of interfuel substitution which is unique. The "fuel" employed is conservation. While not an answer per se to the energy problem, conservation is an inexpensive method of buying time for the design and implementation of longer term, integrative energy policies. Several utilities in the United States have found it more profitable to "invest" in customer conservation than in the production of more energy.[33] This provides another excellent area for government participation to remove institutional barriers to interfuel substitution, particularly in the residential sector. Several provinces as well as the federal government are already actively involved in promoting conservation in the two areas of consumer activity which are the most energy-intensive: personal transportation and space heating. The governments have employed a mix of mandatory standards and economic incentives such as grants to effect significant fuel savings.

Integration and Review

In sum, a rational energy policy entails an inescapable responsibility for government to formulate an integrative and long-term energy program for British Columbia. While such a policy leaves ample room for the successful operation of quasi and non-governmental entities, it is incumbent upon government to ensure that the activities of such entities

[31] Hog fuel currently contributes 17 percent of total energy used in British Columbia. This is an outstanding example of the advanced use of renewable energy, and significant opportunities exist for even more widespread use. See John F. Helliwell and Alan Cox, "Wood Wastes as an Energy Source for the B.C. Pulp and Paper Industry: Economic Implications and Institutional Barriers," in *Journal of Business Administration,* 1979, 10 (1 and 2):245-63.

[32] Amory B. Lovins, *Soft Energy Paths* (Ballinger Publishing, 1977); Barry Commoner, *The Poverty of Power* (Alfred A. Knopf, 1976).

[33] As Lovins has demonstrated, investments in fuel-saving alternatives by consumers require several times less capital than new conventional energy producing installations. Lovins goes even further by suggesting that if debt-plagued American utilities were permitted to loan money to consumers at appropriate interest rates, these corporations could "remove the instability inherent in their cash flow and hence avoid overbuilding and eventual bankruptcy." Source: Amory Lovins, "Electric Utility Investment: Excelsior or Confetti?" in *Journal of Business Administration* 1982, 12(2):91-114.

are consistent with the broader goals of provincial energy policy. In particular, it is essential that there exist a special agency of government which has the power to assess and delimit the activities of such organizations as B.C. Hydro. An appropriate mandate would include the power to review rate structures, demand forecasts,[34] generation planning and construction. Much of the regulatory structure required to fulfil this role has been provided by the Utilities Commission Act, which was passed in the fall of 1980. It is somewhat early, however, to determine the effectiveness of the Act as an instrument of provincial energy policy. Some concern has been expressed, for example, about the latitude of cabinet discretion afforded by sections 19, 21 and 24 of the Act. A controversial exercise of this discretion was demonstrated recently by a preliminary, and subsequently reversed, provincial government decision, without the benefit of public hearings, to permit B.C. Hydro to construct a natural gas pipeline to Vancouver Island.

Two pathbreaking hearings have been undertaken by the Utilities Commission in late 1981 and early 1982. The first concerns B.C. Hydro's application to construct a hydroelectric facility at Site C on the Peace River, and the second hearing focuses on B.C. Hydro's rate structures. The outcome of these hearings will, in all likelihood, delineate the effective role that the Commission will play in the development of future energy policy in British Columbia.

In sum, government should expect that large energy producers will generate energy as efficiently as possible. What government cannot and should not expect, however, is that such producers will be cognizant of, or respond to, broader economic, social and environmental goals outside their narrow scope of operations. It is the role of government to guarantee that the activities of producers are consonant with these broader societal objectives without unduly restricting efficient energy production.

[34] The issue of demand forecasting is particularly critical as it forms the basis for multi-billion dollar investment planning with lead times as long as a decade. Given the magnitude of the capital needs, it seems an indisputable requirement that several forecasts be generated and critically evaluated by independent agencies. The consistently higher estimates produced by B.C. Hydro than by the former B.C. Energy Commission and the provincial Ministry of Energy suggest that outstanding issues of methodology and policy direction still remain unresolved. By way of example, see "Hydro won't try to control demand," *Vancouver Province*, 2 April 1976, p. 17 (Report of a speech by Robert Bonner, chairman of B.C. Hydro); B.C. Energy Commission, *B.C.'s Energy Outlook 1976 to 1991*, 1976; B.C. Hydro, *Energy Blueprint*, 1980; B.C. Ministry of Energy, *National Energy Board Inquiry . . . Submission*, 1980; and Columbia-Pacific Resources Group Ltd., "Assessment of B.C. Hydro Electric Load Forecasts Including Comparisons with B.C. Government Forecasts," prepared for British Columbia Utilities Commission, 5 November 1981.

Education and Public Participation

The last but potentially most important instrument of an intelligent energy policy is education. Governments cannot successfully design and implement major policy initiatives without technical expertise and the understanding and consent of the public. British Columbia lacks expertise in the use of one of its most plentiful energy resources, coal. The B.C. Coal Task Force[35] identified several deficiencies in the supply of trained manpower for coal development. Recent efforts to institute new university teaching programs and research centres for coal-related activity should be supported and enlarged.

The public should have access to continually updated information on energy matters in British Columbia in order to aid the process of informed public decision making. Ideally, the information base provided should be sufficiently broad to include such critical topics as the nature and extent of energy resource supplies, end-use alternatives, the diverse range of social and economic impacts associated with energy production, and the role of price and alternative regulatory mechanisms in achieving the rationalized and efficient utilization of energy. It is the role of democratic government to ensure public access to and input into the decision making processes.[36]

RECENT ENERGY PROJECTS AND PROPOSALS IN B.C.

A brief commentary is provided on several recent energy-related projects and proposals in British Columbia in light of the suggested guiding principles for energy policy.

Uranium Mining and Nuclear Fission

Although the issues of uranium mining and nuclear power generation can be viewed separately, similar considerations apply in the evaluation of their role in an energy policy for British Columbia. On the one hand, the principle of diversity and supply-side risk reduction suggests that these alternatives not be irreversibly rejected. On the other hand, because of the range of energy options available, the government of British Columbia need not proceed at this time with a nuclear fuel cycle while major prob-

35 B.C. Coal Task Force, *Coal in British Columbia: A Technical Appraisal*, February 1976.

36 An incisive blueprint for energy project review in B.C. is provided in Andrew R. Thompson, Nigel Bankes and Joel Sauto-Maior, *Energy Project Approval in British Columbia* (Vancouver: Westwater Research Centre, U.B.C., 1981).

lems remain unresolved in the areas of mine worker safety, uranium tailings control, reactor emergency operations, waste disposal and nuclear-related terrorist activity. The recently imposed seven-year moratorium on uranium exploration in B.C. is a reflection of public concern over issues of safety.

Nuclear Fusion

One potential long-term solution to global energy requirements is the fusion process. Two comments are warranted on this subject. First, the process, if successful, will not be "clean." There are unresolved problems associated with the release of radioactive tritium and disposal of system components with high levels of neutron-induced radioactivity. Large research efforts are currently underway in several nations on inertial and magnetic confinement systems, but much work remains to be done to demonstrate scientific, engineering and commercial feasibility. Except for small-scale university-related work in fusion, the provincial government should refrain from sponsoring or engaging in highly capital-intensive research activities in this field which may unduly strain local resources. It is too early for British Columbia to become deeply involved in a specific area of fusion research which may turn out to be unproductive. Given the current state of technological uncertainty, and major problems which have beset the once promising laser fusion technology,[37] extensive fusion research entails too high a risk for our limited capital resources.[38]

Hydroelectric Development

The era of hydroelectric development with relatively low social costs has passed. Although British Columbia has exploited only one-third of its potential hydropower, many of the remaining sites entail resource conflicts of major proportions.

In some cases, the resolution of these resource conflicts seems clear; for example, fully 20 percent of B.C.'s hydro potential cannot be used at Moran because of a threat to three-quarters of the Fraser River salmon run.[39] In other cases, resolution may be more complex. What is apparent,

[37] William D. Metz, "Ambitious Energy Project Loses Luster," *Science*, 1 May 1981, pp. 517-19.

[38] Peter N. Nemetz, Dean H. Uyeno and Ilan Vertinsky, "National Energy R&D Decision Making — Overview of a Methodology," in *Journal of Business Administration*, 1979, 10 (1 and 2):265-81.

[39] Environment Canada, *Fisheries Problems Related to Moran Dam on the Fraser River*, August 1977; and G. K. Bowden and Peter Pearse, *Evaluation of the Commercial Catch of Fish Dependent Upon Spawning Grounds Upstream from Moran*, 1971.

however, is that in the interest of diversification, risk reduction, and environmental and aesthetic values, B.C. Hydro should broaden the range of alternatives under consideration to include the use of smaller installations.[40] The general tendency of Hydro to engage in "megaprojects" with significant external impacts provides an example of the divergence between private and social costs. What may be least cost for a "private" company may not be least cost for society. The inclusion of broader resource issues in the design of hydroelectric facilities may lead to less expensive solutions at the societal level.

The future of hydroelectric power in British Columbia represents one of the most complex resource policy problems. Superficially, this abundant resource presents the opportunity for extensive energy development with relatively low direct costs. It is free from the more prominent forms of air, water and radiation pollution associated with alternative energy forms. Thermodynamic conversion losses are much less critical in a hydro than a thermal system, and electricity presents a potential opportunity for interfuel substitution to protect us from gradual or even sudden reductions in external petroleum supplies.[41]

Yet, in addition to the multiple resource conflicts enumerated earlier, there remains a fundamental disagreement about the potential capacity of electricity to assume a significantly larger role in modern industrial economies.[42] While a continued commitment to hydropower as part of an integrated provincial energy policy could well be the least cost route from a social point of view, this is not an alternative which should be adopted by default. It is a choice in which British Columbians should participate with full knowledge of the costs, risks and benefits.

Natural Gas Projects

As indicated earlier, the export of liquefied natural gas or methanol from British Columbia without an accounting of long-term provincial energy requirements is inadvisable. If, however, it is deemed appropriate

[40] In fact, B.C. Hydro has just recently adopted such a position with regard to its proposed Murphy Creek Dam on the Columbia River. A revised project study plan now calls for a lower dam and reduction in proposed capacity from 400 to 280 MW. According to Hydro, this revised installation would be "the option most likely to provide a favourable balance between environmental and social impacts and full utilization of the potential river generating capability." B.C. Hydro, News Release, 3 November 1981.

[41] See John G. Melvin, "Energy: The Future Has Come," *Journal of Business Administration*, 1981, 12(2):61-81.

[42] See Amory Lovins, "Electric Utility Investment: Excelsior or Confetti," *Journal of Business Administration*, 1981, 12(2):91-114.

at some time in the future to develop a domestic methanol industry to supplement or replace dwindling petroleum stocks, then the export of this fuel should be encouraged to the extent that it facilitates this technological development.

The B.C. government recently requested proposals for the export of "surplus" natural gas and related products. As of the 1 December 1981 deadline for project submissions, the government had received three liquefied natural gas proposals, three for petrochemicals and two for fertilizers.[43]

While the extent of the provincial "surplus" and corresponding exports remain to be determined by future PUC hearings, it is useful to consider the impact of these potential developments. It is clear that only a subset of the proposals has a chance of receiving approval. Yet even one LNG project requires significant quantities of feedstock.

The three proposed installations have requirements of 270, 465 and 520 million cubic feet of natural gas per day. Given the major capital investment in pipeline, plant and transportation facilities, the related sales contracts could be expected to last twenty-five to thirty years. Under these circumstances, the total gas use over the plant lifetime would range from 2.46 TCF to 4.75 TCF, depending on which LNG proposal receives government approval. At 33 and 63 percent respectively of currently proven provincial reserves, these proposals represent truly immense and virtually irreversible commitments of finite domestic natural gas. Clearly, these plants could not rely exclusively on B.C. reserves. At least one project sponsor has already acknowledged the need to supplement B.C. gas with Alberta and Arctic supplies.

There are at least two critical issues which must be addressed in the assessment of these proposals: first, the extent of B.C. natural gas reserves; and second, the availability of external supplementary supplies over the contract life. The second question lies largely outside the scope of this paper, although it is by no means clear that such external supplies can be guaranteed. If and when reserves of natural gas in the Arctic are sufficiently large to justify the immensely complex and expensive process of extraction and transportation, it is possible that such reserves will be utilized primarily for oil substitution in Central and Eastern Canada.

While Alberta reserves of natural gas are more abundant, closer and less expensive, the government of that province has already committed itself to an extensive program of petrochemical development, and has

43 *The Globe and Mail*, "B.C. government gets impressive gas proposals," 2 December 1981, p. B2.

announced its readiness to protect these reserves for provincial use through future restrictions on out-of-province shipments.[44]

The assessment of a natural gas "surplus" and anticipated accretions to B.C. reserves of natural gas is central to the acceptance of any one or more of the export proposals. In anticipation of the PUC hearings to establish specific procedures for determining the quantity of exportable gas, the B.C. Ministry of Energy, Mines and Petroleum Resources published its own speculative estimates in July 1981.[45] The ministry generated these estimates by utilizing the three basic surplus determination procedures of the National Energy Board.[46] The "preliminary and highly tentative" surplus generated by this methodology was estimated at 2.3 TCF, or approximately 30 percent of current provincial proven reserves. The NEB procedure produces a number of contentious results. In particular, the methodology generates this significant B.C. "surplus" despite the fact that

1. the supply of natural gas from established reserves peaks in 1984, just two years hence;
2. there is a projected shortfall in 1987 under the current deliverability test;
3. when the established reserves of natural gas are increased by *estimated* new reserve additions, the peak in supply is postponed to only 1992, just ten years hence; and
4. all of these considerations must be viewed in the context of expected increases in total provincial energy demand, decreasing availability of crude oil, and increasing interfuel substitution by natural gas.

[44] See Alberta Energy Resources Conservation Board, *The Supply and Demand for Alberta Gas*, 1978; and *Alberta's Gas Supply — Protection Procedures and Formulae*, December 1979.

[45] B.C. Ministry of Energy, Mines and Petroleum Resources, "A Preliminary Estimate of the Natural Gas Surplus in British Columbia based on National Energy Board Procedures," in *Natural Gas Allocation Process*, July 1981.

[46] These three procedures, defined as the current deliverability, current reserves and future deliverability tests, are described in National Energy Board Canada, *Canada's Natural Gas: Supply and Requirements*, February 1979. The current deliverability test, based on established reserves, is currently designed to provide a period of "highly assured protection" for a "minimum of five years." The current reserves test determines the "quantities of established reserves which remain after setting aside 25 times the current year's Canadian demand." (See footnote 1 in this paper for an illustration of the effect of a positive growth rate on expected reserve duration.) The future deliverability test, based on established reserves and anticipated future reserve additions, provides a protection of "some ten years." (See pages 95-96 of the NEB report.)

Under these circumstances, it is a moot point whether the ultimate adoption of identical or even similar criteria by the PUC would be in the best interest of British Columbia's energy security.

The federal government has recently embarked on a program to encourage the wide-scale interfuel substitution of natural gas in Canada.[47] Proposals by Ottawa in this area include active financial support of extensions of natural gas pipelines into the Maritimes and from mainland British Columbia to Vancouver Island. The latter proposal must be viewed with some circumspection. The promotion of interfuel substitution on Vancouver Island is an important goal of a provincial energy policy; nevertheless, great care must be taken when implementing such a policy that the provision of natural gas does not foreclose the option of new and innovative hog fuel uses by the Island's pulp mills. This decision is made all the more difficult by recent newspaper reports that a natural gas pipeline to Vancouver Island would be uneconomic without gas purchases by the Island's pulp mills.[48]

Coal Development

British Columbia must find a way to use its coal reserves in the most efficient and productive manner. This decision includes not only the timing and location of development but also the nature of the technology for conversion and utilization. Exclusive of the issue of current domestic revenue requirements, there is little justification for "fire sales" of this resource. There is every reason to believe that demand for B.C. coal reserves will steadily increase over time. Gasification and liquefaction offer promising opportunities for the domestic use of coal reserves. These emerging technologies require extensive and careful study to guarantee that their potential future use does not entail the adoption of inefficient and unproven systems, excessive outlays of scarce domestic capital, or unacceptable environmental degradation.

This last factor is particularly cogent with respect to the development of coal-fired thermal electric generation. There are several promising sites for such activity in British Columbia, but Hat Creek has received much recent attention. Of particular concern is the fact that lakes to the south

47 See Department of Finance Canada, "National Energy Program," *The Budget*, 28 October 1980; and EM&R Canada, *The National Energy Program*, October 1980.

48 See: "Hydro, Victoria Clash over Island Gas Use," *Vancouver Sun*, 14 March 1981, p. C.1; "Vancouver Island Line: Gas Costs 'Unknown'," *Vancouver Sun*, 23 April 1981; and "Island Gas Pipeline Issue Refuses to Die," *Vancouver Sun*, 15 May 1981, p. C.1.

and west of Hat Creek have low levels of buffering capacity. A major environmental impact study conducted by B.C. Hydro predicts that "the long-range transportation of acid-forming pollutants would *primarily* [author's italics] occur to the northeast of the project."[49] Nevertheless, Hydro states that "the ability to predict long range transport or acidic occurrences as a result of meteorological conditions is an imprecise science at this time."[50] It is for this reason that the thermal utilization of Hat Creek coal should be dependent upon high levels of control technology[51] and/or the adoption of low-pollution production technologies currently under development (such as fluidized bed combustion).

Soft Energy Technologies

There is a range of soft, or largely renewable, energy sources that hold some promise for use in British Columbia. These include biomass, wind, geothermal, solar and tidal power. Biomass, in the form of hog fuel, has already found use in B.C.'s forest industry and the potential exists for significantly increased levels of utilization.[52] There are, at present, on-

[49] B.C. Hydro, *Hat Creek Project — Environmental Impact Statement*, April 1981, p. 6-19.

[50] B.C. Hydro, *Hat Creek Project*, p. 12-5. Hydro expects "the heaviest annual deposition . . . to occur within 50 km [to the northeast]. Although long-range deposition could extend beyond 200 km, it would be of small magnitude" (p. 6-19). The report continues by stating that "the rivers and lakes in the short-range area [to the northeast] have either moderate or high buffering capacities against acid deposition due to their relatively high alkaline content. Conditions change in the long-range area, 50 to 200 km distant. This region includes mountainous terrain which causes an increase in precipitation and consequently receives an abundant snowpack. Accumulation of acidic compounds in this snowpack occurring during the winter, would mean a subsequent more concentrated release into river systems during the spring snowmelt. Soils and waters in these mountainous regions, particularly those located 150 to 200 km downwind, have lower alkalinities and hence less capacity to buffer against acid precipitation" (p. 6-20).

[51] One cost-benefit study conducted by B.C. Hydro on the feasibility of removing sulphur from Hat Creek thermal power generation has estimated costs of 50 percent removal at $143 million (1980 dollars) in capital costs with an annual operating expense of $11.5 million; and "100 percent removal" [*sic*] at $234 million capital costs with annual operating expenses of $16.1 million. Source: B.C. Hydro, *Peace Site C Project Benefit/Cost Analysis*, October 1980. The more recent environmental impact statement contains a detailed analysis of the present worth of alternative control options. See Table 24-15, "Present Worth Total Costs for Alternative Configurations of Air Quality Control Systems," pp. 24-23 to 24-25. Hydro has announced its intention to build a 366m stack and use flue gas desulphurization technology to remove approximately 50 percent of the sulphur dioxide.

[52] For some recent studies on hog fuel and potential in British Columbia, see: British Columbia Wood Waste Energy Co-ordinating Committee, *Hog Fuel Availability in British Columbia*, 1978; Reid, Collins and Associates Ltd., *Hog Fuel Availability Study: South Coastal Region of B.C.*, 1978; Paul H. Jones and Associates Ltd.,

going experiments concerning the potential for wind, geothermal and solar power in the province.[53] Of these three, solar energy, as a supplemental power source for space heating and hot water production, is probably the most promising.[54] While none of the soft technologies appears able at this time to provide a major source of energy, the use of each where appropriate in British Columbia is an indispensable part of a diversified and robust energy system.

A Note on Transportation Systems

One of the largest uses of petroleum is for the fueling of the private automobile. Our cities have developed in a fashion which has been dictated largely by underpriced gasoline. The social, economic and physical systems inherent in our urban development are remarkably inflexible in the short run, and yet it is these systems which are most actively threatened by the potential disruption and decline in the supply of liquid hydrocarbon fuels. Elementary prudence suggests that planning must begin immediately for the era when motive power may no longer be derived from gasoline.

It is here especially that short- and medium-term remedies may be counterproductive in the long run. Spurious arguments have been advanced that mass transit cannot compete successfully with technological modifications in the private automobile. These arguments fail to consider the possibility of insufficient liquid fuel, at some future date, to meet domestic transportation requirements. The probability of such an occur-

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Energy from Forest Biomass on Vancouver Island, 1979; H. A. Simons (International) Ltd., *Engineering Feasibility Study of the British Columbia Research Hog Fuel Gasification System*, B.C. Research, May 1978; B. H. Levelton and Associates Ltd., *An Evaluation of Wood-Waste Energy Conversion Systems*, Environment Canada, March 1978; British Columbia Wood Waste Energy Co-ordinating Committee, *Hog Fuel Co-Generation Study, Quesnel, British Columbia*, May 1978; and Michael Margolick and John F. Helliwell, "Electricity Generation from Wood Wastes in British Columbia," *Journal of Business Administration* 13, forthcoming.

53 For some recent research on renewable energy sources in B.C., see: Acres Consulting Services, *Solar Energy Resource Assessment for British Columbia*, May 1980; Nevin, Sadlier-Brown Goodbrand Ltd., *Report on 1978 Field Work: Meager Creek Geothermal Area*, 1978; B.C. Hydro and Power Authority, *Tidal Power in British Columbia*, 1979; Province of British Columbia, *National Energy Board Inquiry . . . Submission*, September 1980; and Energy, Mines and Resources Canada, *Micro-hydro*, vol. 1, October 1980.

54 It has been estimated that in excess of 32 percent of Canadian energy demand is for low temperature heat below 100°C. (Statistics Canada, *Canada Year Book 1978-79*, 1978, p. 556; and Amory Lovins, "Electric Utility Investment: Excelsior or Confetti?", *Journal of Business Administration*, 1981, 12(2). The potential exists for meeting much of this demand with solar power, even in Canada.

rence may be low, but its consequences are so great they cannot be ignored. Therefore it is advisable to begin the planning and construction of a mass transit infrastructure. A recent decision to construct another automobile crossing of the Fraser River should be reconsidered.

While technological innovation and/or the discovery of unanticipated energy sources may solve our current crisis and permit the perpetuation of energy-intensive urban settlement patterns, there is a non-zero probability that these solutions will not materialize. The negative consequences of inadequate preparation are truly monumental. Society is ultimately forced to make decisions based on assessments derived from the current state of knowledge — we cannot assume that remedies will necessarily materialize. In decision situations marked by low probability and high consequence effects, normal decision-making paradigms are insufficient.[55]

CONCLUSION

This paper has attempted to outline a viable and realistic energy policy for British Columbia. The development and application of such a policy is dependent on the acceptance of certain guiding principles which are consistent with the broader context of government social policy. It is important to realize that the development and utilization of energy is not an end in itself, but only one, albeit essential, method of achieving society's goals. It is for this reason that energy policy cannot evolve independently from other central policies concerning industrial development, employment, social welfare, health, environmental control and the provision of the basic necessities of existence.

[55] See John V. Krutilla and Anthony C. Fisher, *The Economics of Natural Environments*, Resources for the Future, Johns Hopkins University Press, 1975 (esp. chapters 10 and 11).