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Energy Demand and Supply in the Northwest Territories

Martin Adelaar, Energy Probe

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SUMMARY

Energy Demand and Supply in the Northwest Territories

This study examines energy demand and supply patterns in the Northwest Territories (N.W.T.) as a working paper for the Federal Department of Indian Affairs and Northern Development and the N.W.T. Ministry of Energy. Conceptually, the study is similar to the soft path approach employed by David Brooks in Exploring a Soft Energy Path for the Yukon Territory. It focusses on utilizing cost effective technologies to reduce the anticipated growth of energy consumption and also to develop renewable and small-scale supply sources to meet projected demands.

Demand Analysis

The study's demand analysis utilizes an N.W.T. Science Advisory Board study, Energy in the Northwest Territories to delineate regional energy demand, by sector, for the designated base year of 1979. Regional demand is projected to 1989 and 1999 assuming ten years as the maximum time period for economic developments to affect significantly the energy demand patterns.

Regional demand is projected according to optimistic economic and population growth scenarios. The N.W.T. economy is described as currently being in a low growth stage created, for the most part, by the uncertainty in the mineral and oil/gas industries, the fiscal burden of a petroleum based economy, and the possibilities of government spending restraints. On the assumption that the N.W.T. economy will continue to be characterized by a large government sector, and that possibilities exist to return to a medium growth stage, it is projected that the N.W.T. gross territorial economy will, during the period 1979-1999, grow at a real annual rate of

5.3%. Continued government involvement in the territorial economy is forecast to be complemented by revenue from mining expansion, natural gas and oil development, and forest industry expansion.

Projections of a buoyant economy are reflected in the choice of population forecasts. Of projected N.W.T. low and high population growth rates, the latter is used, although only a few N.W.T. communities (Yellowknife, Hay River, Pine Point, Rankin Inlet and Frobisher Bay) are likely to experience significant increases. The population and economic projections are utilized in region specific projection methodologies, all of them described as working papers in the Appendices.

The delineation of 1979 regional demand illustrates that the commercial and transportation sectors dominate territorial energy consumption. Regional breakdowns show that the Fort Smith and Inuvik regions account for 12 thousand terajoules or 52.6% and 22.0% respectively of the N.W.T.'s total demand of 16 thousand terajoules. Conversion and line losses represent at least 10% of total demand.

A variety of conservation strategies and technologies can reduce territorial and regional energy demand significantly. For existing residential buildings typical conservation measures range from no cost thermostat set-back to $2000 (1981 $) retrofit investments, the latter being a cost effective investment with a pay back of less than four years. Desi i and demonstration models for new N.W.T. housing reveal that significant energy savings can be realized. In particular, a super-insulated, air-tight, southerly-facing glazed prototype has, in comparison to existing residences, achieved a heating load saving of 95%.

Energy consumption in existing and new commercial units (most of which are small units) can be reduced by airtight design, superinsulated building shells, and passive solar heat gain. Both conservation measures and technologies can be applied in the transportation sector. For example, cost effective devices such as radial tires and aerodynamic drag reduction devices are readily available for use by road vehicles. In the mining sector, conservation approaches in both the mining and milling stage can reduce consumption. Two important measures are peak load management and residual (waste) heat recovery.

Regional energy demand is projected to 1989 and 1999 assuming both a zero conservation and a conservation approach. Consumption projections yield 1989 and 1999 NWT zero conservation and conservation approach totals of 20.5, 13.7 petajoules and 38.1, 22.3 petajoules respectively. As the region with the most diverse economy and the highest population, Fort Smith represents the greatest challenge to implementing conservation measures. If they were implemented as suggested, the Fort Smith 1999 residential energy demand could be less than in 1979. The commercial demand in 1999 could be kept to a level near that of 1979. It is suggested that a conservation approach in the Fort Smith region could result in $91 million and $164 million annual savings for diesel and heating oil in 1999 (1981$).

Implementation of suggested conservation measures would affect an actual 1979-1999 decrease in the Cambridge Bay, Inuvik, and Keewatin regions' total demand. In these regions, as well as in the Baffin region, reductions in residential and commercial demand are the main reasons for the total demand decrease.

Despite the significant demand reductions that can be achieved, total N.W.T. energy consumption is projected to increase by 39% to 1999. This results primarily from optimistic assumptions about growth in the mining and transportation sectors and conservative assumptions for demand reduction possibilities in these sectors. The demand analysis reveals that economic growth does not have to be sacrificed because of conservation strategies.

It is recommended that energy and socio-economic data limitations be addressed as a prerequisite to further evaluation. It is also recommended that the N.W.T. government develop an economic forecasting model(s) and that it assess the various conservation options for their economic feasibility. In this context, it is suggested that real, as opposed to subsidized, energy prices be used in assessing potential conservation savings. In addition, it is suggested that the N.W.T. government take advantage of existing federal energy services and programs to foster the application of conservation measures. Finally, it is recommended that the N.W.T. government integrate the goals of community economic development and employment with housing rehabilitation and construction needs.

Supply Analysis

The study's supply analysis describes both non-renewable and renewable domestic supply sources that might alter supply patterns in a manner reducing petroleum fuels inputs to electricity and space heating requirements. Residual heat energy is selected as a supply source because it represents a fairly constant energy by-product of the N.W.T.'s mining and electricity industries. As much as 978 terajoules of energy has been identified in a Yukon/N.W.T. residual heat stream ranging in quality from radiation to 815°C.

The concept of energy cascading is introduced as a means of utilizing 100% of the residual heat stream. To date, studies and actual demonstrations indicate that "mini" - district heating using heat recovered from N.W.T. diesel-electric generating units is an achievable near term option. Combined jacket and exhaust gas heat recovery results in overall plant efficiencies of 75% and distribution temperatures appropriate to community infrastructure.

Various perspectives of actual residual heat potential are examined. At least 52% of the heating requirements for communities selected in one study can be met by district heating. Other work suggests that combined jacket and exhaust recovery is already cost effective with pay back periods of less than five years. Based on the conversion and line losses identified in the demand analysis, it is estimated that 13.4% of the N.W.T. commercial sector's demand can be met by residual heat. Finally, it is evident from mine heat reclamation efforts at Can Tung and Nanisivik that the mining sector as a whole could utilize a significant residual heat source.

Natural gas is described as potentially an assured supply source and a cost competitive alternative to conventional sources. Four factors, reserve capability, marketing, proximity of demand centres to supply, and costs have, in addition to political concerns, a bearing on potential gas utilization. Calculations suggest that less than 1% of the Mackenzie-Beaufort and mainland reserves (as estimated to 1979) would be needed to meet Fort Smith and Inuvik regional space heating demand to 1999. A perusal of natural gas well prospects revealed that some wells are as close as 26 km to existing demand centres.

Natural gas development for domestic use can be realized by utilizing export pipeline laterals or by developing site specific infrastructure. The latter option is explored for the town of Inuvik, resulting in projected delivered gas costs of $6.71/mcf for one location and $8.65/mcf for a second site (1980$). At a delivered cost of about $65,000 per residential customer it seems preferable to explore the pipeline lateral option estimated at $7957 per customer.

Natural gas can be used to meet both electricity and space heating requirements. The development of mini-district heating or total energy systems indicates that natural gas can be consumed to produce electricity and heat at a 90% 1st law conversion efficiency. In the long term, compressed natural gas might be used as a transport truck fuel.

Although coal is currently not mined in the N.W.T., the Fort Smith and Inuvik regions have several identified seams. One recent study concludes that the greatest possibilities for coal utilization are in some of the Arctic coast communities above the tree line. Coal could be used for residential and commercial heating in forced-air furnaces, stoking furnaces, and fluidized-bed combustion units. A number of environmental impacts associated with coal development are identified including the potential carcinogenity of certain types of organic matter emitted by combustion.

Hydro electricity is described as a renewable source appropriate to all N.W.T. regions. It is noted that existing load demand, primarily in the Fort Smith region could increase substantially as a result of mining and forestry development and pipeline electrification needs. Electricity supply to date is identified as 128 MW installed capacity. This is about 3% of the identified potential hydro sources in the territory.

The extent and type of hydropower to be developed is contingent on a number of variables. The technical achievement in realizing the potential of a selected river is often limited by low terrain and site flooding. This in turn increases the costs of development. Despite certain cost advantages of large scale development, it is suggested that only small scale and micro-hydro are suitable to N.W.T. requirements.

Micro-hydro, i.e. hydro development of $\leq$ 5 MW capacity, can meet most load requirements and can also be used to divert water into existing power sites. Equipment is proven with no expected limitations from winter freeze-up. Site specific capital cost estimates vary from 39 mils to 550 mils per installed kw. It is suggested that the economic feasibility of much micro-hydro is contingent on higher production volumes of North American low and medium head turbines, near-term price escalation of conventional fuel, and accelerated depreciation of equipment. Rapid depreciation for equipment is supported by recent tax incentives from the Federal government.

Wood or forest biomass is an important untapped renewable resource in the N.W.T. To date, wood biomass accounts for about 99% of the Canadian biomass fuel supply. Despite significant information deficiencies that are only now being slowly rectified, it is possible to estimate some of the N.W.T. forest biomass potential. Forest land in the N.W.T. is confined mainly to the Inuvik and Fort Smith regions with the most productive land located on the alluvial plains of the Mackenzie River valley and basin.

To date, an annual maximum of 17.6 million m^3 of lumber and piles have been harvested but new development indicates a potential of 24 million m^3. Fuelwood production has averaged about 7000 m^3 annually with a maximum of 17,833 m^3 or 0.14 petajoules, about 24% of the projected 1989 conservation scenario heating demand for the Inuvik and Fort Smith regions. Calculations using methodologies that encompass total biomass utilization are used to derive the total N.W.T. forest biomass energy potential. A potential of 18.7 petajoules is estimated. Factors such as commercial production and ecological constraints suggest that only a small percentage of 18.7 petajoules is actually harvestable. Nevertheless, 5% of 18.7 PJ or .93 PJ is 1.6 times the projected 1989 space heating demand (conservation) of the Fort Smith and Inuvik regions.

Combustion and gasification to meet space heating and electricity requirements appear to be the conversion technologies most appropriate to the territory. A variety of stoves and furnaces exist that can burn wood, wood wastes, and chips. Chip burning is noted to have several technical and economic advantages but one study suggests that labour costs are still prohibitive.

Gasification is being evaluated as both a space heating and electricity supply by the federal government and a number of provincial governments. The more feasible gasification technology appears to be fluidized-bed systems.

There are a number of factors that can alleviate the development of forest biomass in the N.W.T. They include inter-governmental cost sharing, conventional fuel price increases, and tax incentives, the latter being included in recent Income Tax Act revisions that allow for rapid depreciation of biomass equipment.

Despite a very small agriculture base, the N.W.T. (the Fort Smith region) has a significant area of Class 2 to Class 5 land capable of growing oats, barley and forage crops. Since a livestock industry is likely to be hampered by transportation costs and high incidence of disease, it is suggested that the land be developed for agriculture biomass production, either from the main crop or from waste, suitable to meet limited space heating requirements.

Although fuel peat is recognized by one study as a superior fuel to coal and wood, extensive date on its potential in the N.W.T. is limited. Nevertheless, the identification of peat along the Mackenzie River flood plain warrants follow-up evaluation.

Geothermal reservoirs have been identified in the Fort Smith Inuvik regions. Depending on the heat potential of the reservoirs, geothermal energy may be able to meet limited residential and commercial space heating and electricity requirements.

Continued research and development suggests that large vertical axis wind turbines (e.g., 200 kW) may, in the near-future, provide limited electricity requirements. Life-cycle cost estimates have indicated that despite high $/kw installed costs, diesel-wind systems are currently cost competitive with diesel-diesel. A recent study suggests that the most efficient linking of wind and diesel units would involve wind supplying mechanical power to the diesel generator.

Despite periods of little or no sunshine, solar energy can to some extent, be utilized in the N.W.T. In fact, passive solar design is shown to be an important component in the energy efficient prototypes described in the demand analysis. Active solar systems appear to be suitable for hot water heating. It is noted that an important factor likely to enhance the feasibility of wind and solar supply is the development of seasonal storage mediums.

It is recommended that significant effort be made to develop comprehensive inventories of all potential supply alternatives to be followed up by site specific evaluations. Within such a context, it is recommended that the NWT government continue to utilize existing renewables programs. Given the costs likely to be necessary for such endeavours, it is suggested that continued analysis focus on the question of utilizing potential hydrocrabon revenues.