AN INTEGRATED APPROACH TO RESOURCE DEVELOPMENT ANALYSIS: A STUDY OF THE FUEL PEAT RESOURCES OF SOUTHEASTERN NEWFOUNDLAND

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AN INTEGRATED APPROACH TO RESOURCE DEVELOPMENT ANALYSIS: A STUDY OF THE FUEL PEAT RESOURCES OF SOUTHEASTERN NEWFOUNDLAND

by

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"The manufacture of peat-fuel is now placed beyond the experimental stage. In a country like [Newfoundland], possessing so much peat at excellent quality, with coal at almost prohibitive prices, and firewood becoming more and more difficult to procure each year, there should certainly be an opening for such an industry."

J. P. Howley, Report on the Mineral Resources of the Island, Geological Survey of Newfoundland, St. John's, 1982, pp. 30-31.

Chapter 1

INTRODUCTION: THE NATURE OF THE RESOURCE ANALYSIS PROBLEM

1.1 BACKGROUND TO THE RESOURCE ANALYSIS PROBLEM

The formulation of resource management policies and development programs traditionally has not been based on the integrated analysis[1] of resource supply and demand. Prior to the 1960s, resource managers were interested primarily in resource inventory and the measurement of potential resource capacity.[2] Proponents of resource developments were also interested in the prior examination of the profitability and technical feasibility of each resource development option.

Since 1960, however, there has been increased awareness in the resource management field of the need to identify and examine the linkages between resource supply and demand,

[1] The decision-oriented terms "analysis", "evaluation", and "assessment" are used interchangeably in this thesis. See S.B. Anderson and S. Ball, The Profession and Practice of Program Evaluation (San Francisco: Jossey-Bass Publishers, 1978), pp. 3-13, and B. Mitchell, Geography and Resource Analysis (London, Longman, 1979).

[2] See, for example, B. Mitchell, op. cit..

plus the impact of resource developments on the human and physical environment. Most resource analysis is performed prior to the resource management or development initiative.[3] The large number of integrated resource analysis studies now being initiated or required by governments before projects are approved (and funded) is evidence of the increased recognition of the value of predictive or front-end analysis[4] in the resource policy-making and management process. Also, the monitoring and hindsight review of resource developments after they are completed is receiving increased attention.

Geographers have been actively involved in the analysis of resource supply and demand, and the examination of factors which link supply and demand. This effort has included the examination of a wide range of variables which influence resource development, plus studies of the social,

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[3] See, for example, D.L. Draper, "Resource Management, Socio-Economic Development and the Pacific North Coast Native Cooperative: A Case Study" (Unpublished Ph.D. dissertation, University of Waterloo, 1977); B. Mitchell, op. cit.; and W.R.D. Sewell, "Broadening the Approach to Evaluation in Resource Management Decision-Making," Journal of Environment Management, Vol. 1, (1973), pp. 33-60.

[4] In this thesis, the terms "predictive" and "front-end" analysis, which refer to the projection of events, distributions or behaviours, given certain conditions or assumptions, are used interchangeably. See, for example, B. Mitchell, op. cit., p.3; and S.B. Anderson and S. Ball, op. cit., pp. 3-13.

economic and environmental effects of such developments.[5]

As was the case in the rest of the resource management field, geographers involved in resource analysis traditionally focused most of their attention upon the measurement of actual and potential resource supply. The efforts of geographers such as Stamp, White, Burton, and O'Riordan, with respect to the determination of the location, distribution and significance of natural resources, have resulted in important contributions being made to resource analysis and management.[6] Most resource supply studies by geographers have been focused on land, water and more recently atmospheric resource problems, however, similar issues and problems are experienced by resource analysts when examining energy, forest, mineral and

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[5] See, for example, B. Mitchell, op. cit. This text contains a detailed documentation of the contribution geographers have made with respect to resource analysis. Also discussed are the links between many of the most prominent resource analysis issues and the four major research traditions within geography. These traditions of geography (i.e., (1) spatial, (2) man-land (or ecological), (3) area studies (or regional) and (4) earth science) are described in W.D. Pattison, "The Four Traditions of Geography," The Journal of Geography, Vol. 63, (1964), pp. 211-216.

[6] L.D. Stamp, The Land of Britain: Its Use and Misuse (London: Longman, 1948); G.F. White, Strategies of American Water Management (Ann Arbor: University of Michigan Press, 1970); I. Burton and R.W. Kates, eds., Readings in Resource Management and Conservation (Chicago : University of Chicago Press, 1965); and T. O'Riordan, Perspectives on Resource Management (London: Pion Press, 1971).

other natural resources.[7] Research and analysis methods used by geographers in resource supply analysis range from field observations to remote sensing.[8] Geographers have examined a wide range of demand related issues pertaining to resource developments. Sewell, and O'Riordan, for example, concentrated on the more tangible economic costs and benefits of resource developments.[9] The benefit-cost analysis technique, which is used extensively in the economic analysis presented in this thesis, is documented in Chapter 2. Included among the many geographers who have examined the socio-economic and environmental effects of resource developments are White, Mitchell, Priddle, Boyer, Fenton, Foster, Pigram, Bisset, Jackson, Hudman and Fookes.[10]

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[7] J.W. Birch, "Geography and Resource Management," Journal of Environmental Management, Vol. 1 (1973), pp. 3-11; and B. Mitchell, op. cit., p. 57.

[8] B. Mitchell, op. cit., pp. 57-71.

[9] W.R.D. Sewell et al., Guide to Benefit-Cost Analysis (Ottawa: Queen's Printer, 1965); and T. O'Riordan, Perspectives on Resource Management (London: Pion Press, 1971).

[10] See Mitchell, op. cit.; R.R. Noakes and J.J.J. Pigram, "Impact Multipliers and Forest Resource Management," Journal of Environmental Management, Vol. 1, (1973), pp. 277-287; R. Bisset, "Quantification, Decision-Making and Environmental Impact Assessment in the United Kingdom," Journal of Environmental Management, Vol. 7, (1978), pp. 43-58; and R.H. Jackson, L.E. Hudman and J.L. England, "Assessment of the Environmental Impact of High Voltage Transmission Lines," Journal of Environmental Management, Vol. 6, (1978), pp. 153-170.

The systematic examination of the future demand for natural resources, however, usually involves Kuhn's three investigation phases, namely: (1) the identification of variables, (2) measurement of relationships and (3) articulation of theory.[11] This systematic process dictates the need to examine a large number of factors pertaining to the technical and financial feasibility as well as the social, economic, environmental and other implications of resource development and use. Geographers such as Sewell, Burton, Mitchell, Leighton and Foster have systematically examined the demand for water and energy resources using the Delphi technique and multiple regression.[12]

The problem investigated in this thesis flows directly from the need to identify and systematically assess up-front the major variables and inter-relationships influencing resource development prospects, as well as the likely effects of these developments on the population and environment of the impact region. The specific problem

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[11] T.S. Kuhn, The Structure of Scientific Revolutions (Chicago: University of Chicago Press, 1962); and B. Mitchell, op. cit., p. 71.

[12] See, for example, W.R.D. Sewell, and B.T. Bower, eds., Forecasting the Demand for Water (Ottawa: Queen's Printer, 1968); W.R.D. Sewell, and H.D. Foster, Images of Canadian Futures: The Role of Conservative and Renewable Energy (Ottawa: Environment Canada, 1976); and B. Mitchell and P.H. Leighton, " A Comparison of Multivariate and Trend Forecasting Estimates with Actual Water Use," Water Resources Bulletin, No. 13, (1977), pp. 817-824.

pertains directly to the analysis of the fuel peat supply and demand in Southeastern Newfoundland, plus the financial and economic feasibility of fuel peat production and use. The potential implications of this front-end analysis for the formulation of fuel peat policies and development programs are also examined. The study of this practical resource management problem, which involves the development and application of an integrated resource analysis approach, reveals some major difficulties in conducting predictive analysis in a rapidly changing human environment.

The resource analysis problem and objectives are provided in Section 1.2. Section 1.3 contains a discussion of the pertinence of this analysis to resource management, while Section 1.4 highlights the organizational structure of this thesis.

1.2 AN OVERVIEW OF THE RESOURCE ANALYSIS PROBLEM

1.2.1 ANALYSIS FROM A FUEL PEAT RESOURCE MANAGEMENT CONTEXT

Resource managers have been aware of the energy potential of the large peatland resources of Newfoundland since at least 1909.[13] The largest and highest quality fuel peat deposits are located on the Avalon and Burin Peninsulas,[14] which are collectively referred to as Southeastern Newfoundland in this thesis (see Figure 1.1). There is evidence of several attempts by the public and private sectors to develop and utilize these resources between 1865 and 1960, but no sustained commercial scale developments have occurred.[15]

Fuel peat resource management and analysis efforts have intensified since the mid-1970s. These efforts are partially a result of government and private sector initiatives to reduce the dependence of eastern Canada upon expensive imported petroleum products. They are also a reflection of the work of a few individuals interested in the research and analysis of Newfoundland peatland resources.[16]

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[13] J. F. Downey, Report on Uses of Peat to the Minister of Agriculture and Mines (St. John's, Newfoundland: Government of Newfoundland, 1909), Newfoundland Provincial Archives, Ref. No. GN 2/5 (4A).

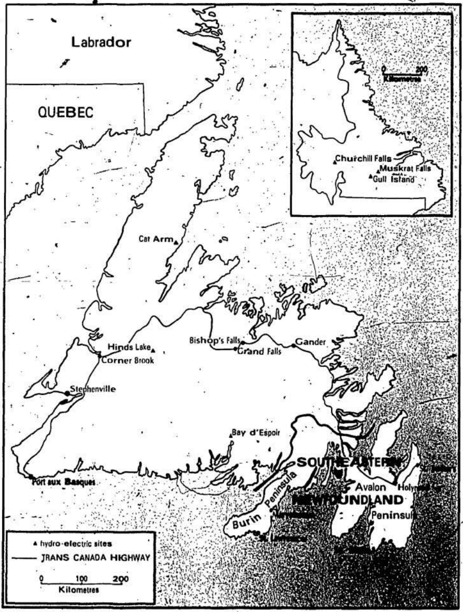
[14] A detailed analysis of regional fuel peat supply is contained in Chapter 4.

[15] These fuel peat development efforts are documented in Section 3.2.

[16] These fuel peat resource management and analysis efforts are documented in Section 3.2.

Figure 1.1

THE STUDY REGION.



The recognition of the need to analyze the energy development potential of peatlands and the resource analysis focus of this thesis originates from an initiative to develop a Newfoundland fuel peat management policy in 1980. The Newfoundland Department of Mines and Energy coordinated this effort, which also involved an advisory committee comprised of representatives from ten Newfoundland and federal government departments and agencies.[17] The intended aim of this policy formulation initiative was the more effective management of Newfoundland fuel peat resources, including (1) the minimization of conflicts with other resource uses, such as agricultural, forestry and the preservation of peatlands in their natural form,[18] and (2) the better coordination of government funded fuel peat projects.[19]

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[17] These departments and agencies were the Newfoundland Departments of Culture, Recreation and Youth; Environment; Forest, Resources and Lands; Mines and Energy; Rural, Agricultural and Northern Development; Newfoundland and Labrador Hydro; Memorial University of Newfoundland; plus Agriculture Canada and the Canadian Forestry Service and Environmental Protection Service, Environment Canada. Post-1980 modifications to the names of Newfoundland departments are reflected. The author was secretary of this inter-departmental and inter-disciplinary advisory committee.

[18] Potential peatland resource use conflicts are highlighted in Section 3.2.

[19] Funding was made available in 1979 for fuel peat development and demonstration projects through the five year, $11.25 million, Canada-Newfoundland Agreement on the Development and Demonstration of Energy Conservation and Renewable Energy Technologies.

This policy formulation effort was unsuccessful, largely as a result of the lack of analysis of the overall potential for commercial scale fuel peat developments in Newfoundland. Discussions among the participants revealed that fuel peat supply and demand, plus the technical, climatic, financial, economic, socio-economic and environmental considerations associated with fuel peat production and use, were factors which needed to be analyzed up-front before a fuel peat management policy could be effectively developed. The participants expressed the viewpoint that it was premature to develop a fuel peat policy since much of the information required would be generated by the many peat related research and demonstration projects planned or ongoing at that time.

Three of the peat related activities initiated during the period 1978 to 1982 are referenced here due to their large influence on the focus of the analysis contained in this thesis. Much of the required technical, socio-economic and environmental information identified in the 1980 fuel peat policy-making exercise has subsequently originated from two fuel peat demonstration projects at Bishop's Falls and St. Shotts, and associated combustion tests.[20] These production projects have also provided valuable data and

[20] T. Tibbetts and A. Winsor, eds., Energy From Peat Symposium '83 (St. John's: Canadian National Committee - International Peat Society, 1984).

insights pertaining to the financial and economic feasibility of fuel peat production and use, which have been incorporated into this thesis. A third peat initiative, the peatland inventory of the Island of Newfoundland, yielded a large amount of raw data pertaining to the location, aerial extent, volume and degree of biological decomposition of peat deposits.[21] This inventory data is the main source of information used in the fuel peat supply analysis contained in this study.

The intensive fuel peat policy research and analysis efforts in Newfoundland during the last decade, highlighted above, have resulted in the identification of four critical factors influencing fuel peat development prospects which need to be evaluated in a systematic manner. These include the ability of fuel peat deposits to support commercial scale fuel peat developments and the likelihood of residential and industrial-commercial energy customers consuming the total output from these production projects. The other two considerations pertain to the technical and economic feasibility of fuel peat production and use.[22] These peat related efforts have also provided many of the

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[21] Northland Associates Limited, Newfoundland Peatland Inventory, St. John's, 1979-1984 (six publications). This inventory is described in Section 4.2.

[22] A fifth critical factor is the suitability of the Newfoundland climate for drying large quantities of fuel peat. The climatic factor is not examined in this thesis.

essential information inputs needed to analyze the above factors in an integrated supply and demand context.

1.2.2 ANALYSIS FROM A REGIONAL ECONOMIC ENERGY CONTEXT

Future fuel peat development activities in Southeastern Newfoundland could make a positive contribution to the Newfoundland economy and would partially alleviate the energy supply-demand imbalance on the Island of Newfoundland, especially on the Avalon Peninsula. Since it is conceivable that such developments would be encouraged by the front-end evaluations of fuel peat development potential, such as presented in this thesis, the influence of fuel peat developments on four important regional economic and energy considerations are referenced below.[11] Such resource development stimulation could also result indirectly via resource management initiatives influenced by the resource analysis. The links between resource management, analysis and developments are discussed in Section 1.3.

The first regional consideration pertains to the weak Newfoundland economy, and the need for increased economic

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[11] These regional economic and regional energy linkages with fuel peat development activities are examined in greater detail in Section 3.3.

activity and employment opportunities. Fuel peat production and combustion are very labour intensive operations, and with the exception of the initial purchase of machinery and equipment there would be a low level of economic leakage from the Newfoundland economy. This compares very favourably with the low provincial value added associated with the displaced petroleum products.[24] A second, and related factor, concerns the high success rate with historical resource development efforts in Newfoundland, relative to attempts to establish secondary processing industries.[25] There is therefore a strong need to analyze the development potential of all natural resources, with the ultimate view of maximizing economic development opportunities.[26]

A third regional consideration is the continued dependence of Newfoundland on imported petroleum products, which in 1984, accounted for 71 percent of its energy requirements.[27] In addition, 43 percent of the electricity

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[24] The economic effects of two fuel peat development scenarios are analyzed in Section 7.2.

[25] Economic Council of Canada, Newfoundland: From Dependency to Self-Reliance (Ottawa: Supply and Services Canada, 1980); and S.J.R. Noel, Politics of Newfoundland (Toronto: University of Toronto Press, 1971).

[26] Government of Newfoundland and Labrador, Managing All Our Resources (St. John's: Government of Newfoundland and Labrador, 1980.)

[27] Statistics Canada, Quarterly Report on Energy Supply-Demand in Canada, 57-003.

generated on the Island of Newfoundland in 1984 originated from oil-fired units at Holyrood.[28] Petroleum is still an expensive source of energy, despite the recent decline in World prices. Also, supply remains susceptible to interruptions, given the volatile political climate in which most of the world's oil production occurs.

The fourth regional consideration stems from the magnitude of residential energy conversions from expensive petroleum products and electricity to wood, along with the fuel wood supply-demand imbalance and large fuel peat reserves in Southeastern Newfoundland. The increase in the number of Newfoundland households relying on wood as the principle heating fuel, from 6,000 in 1978 to 38,000 in 1984,[29] illustrates the extent of efforts on the part of Newfoundlanders to obtain less expensive energy. Fuel wood supply is not a concern in most regions, except on the Avalon Peninsula, where the annual allowable cut on Crown lands is exceeded by 20 percent. It is likely that supply restrictions will have to be imposed in this area, which would negatively impact upon fuel wood use.[30] The

[28] Based on a personal interview with an official of Newfoundland and Labrador Hydro.

[29] Statistics Canada, Electric Power Statistics, 64-202, and Household Facilities and Equipment, 57-202. See Section 3.3 for more detail.

[30] Based on interview with an official of Department Forest, Resources and Lands.

utilization of the fuel peat resources of Southeastern Newfoundland may provide this region with an alternative source of energy, similar to that being provided by wood in other regions.

1.2.3 RESOURCE ANALYSIS OBJECTIVES

A prime objective of the analysis presented in this study is to identify major resource supply, demand, financial and economic variables and relationships influencing commercial fuel peat development prospects in Southeastern Newfoundland. A second major thrust is to adopt, adapt and/or develop an analytical approach and associated methodologies suitable for the evaluation of these considerations. A third objective pertains to the use of this framework and component methodologies to analyze fuel peat supply and demand, as well as the financial and economic feasibility of fuel peat production and use, in Southeastern Newfoundland.[31] A final primary aim is to assess the relevance of this resource analysis, and the approach and techniques employed, to resource management.

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[31] Fuel peat development prospects are assessed during the period 1985-1994. The rationale for the use of a ten year temporal horizon in this thesis is explained in Section 6.1.

1.3 PERTINENCE OF ANALYSIS FROM A RESOURCE MANAGEMENT CONTEXT

1.3.1 INTRODUCTION

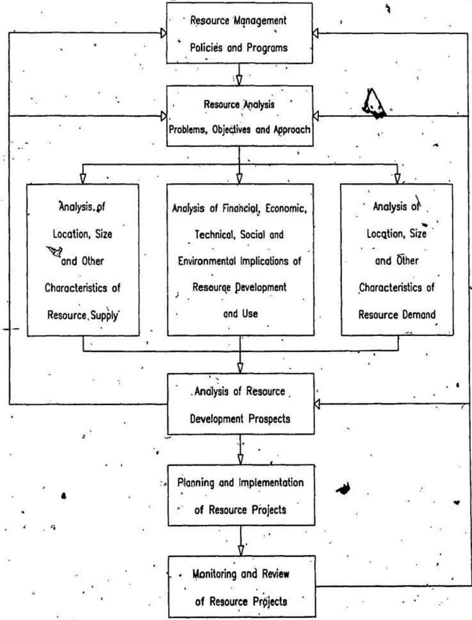
The preceding discussion indicates that resource managers recognize the need for the predictive analysis, as well as hindsight review, of major resource development opportunities. The general process of resource analysis supported in this thesis is shown in Figure 1.2, extending from the identification of the resource analysis problem to the ongoing review of completed projects. The major resource supply and demand factors and inter-relationships affecting the success of, or being affected by, resource developments are identified, as are the main information flows. The in-depth analysis of practical problems, such as the one examined in this study, enables the resource manager to better understand the needs of resource developers and users, as well as the likely implications of government policies and program initiatives. A major objective of the resource-analysis process, outlined below, is more effective resource management.

1.3.2 RESOURCE ANALYSIS PROCESS

The analysis of the development potential of most

Figure 1.2

A GENERAL PROCESS OF RESOURCE ANALYSIS



natural resources involves the examination of resource supply and demand and the major factors influencing resource development and use, as well as the most prominent inter-relationships. In addition to direct supply and demand considerations, Figure 1.2 shows that the dominant factors in the analysis of the development potential of fuel peat in Southeastern Newfoundland are the financial, economic, technical, social and environmental implications of resource development and use. Other factors, such as the legal and political consequences of resource development, are also important for some projects.

Resource supply and demand are the main components of the fuel peat analytical process. Supply and demand are inter-related since demand for fuel peat can be constrained by the availability of supply. In addition, the demand for fuel peat can influence the resource supply parameters. High demands for fuel peat, for example, can result in the development of more marginal resources, or an extension of supply boundaries.[11]

The financial and economic feasibility of fuel peat production and combustion in Southeastern Newfoundland are the main inter-related resource supply and demand factors

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[11] The detailed fuel peat resource supply and demand analysis processes are presented in Chapters 4 and 5, respectively.

examined in this study.[33] The primary research and analysis of these factors, including incorporation of the cost, volume and other quantitative outputs from the fuel peat supply and demand analysis, completes the bridging of resource supply and demand in a systematic resource analysis framework.[34]

The development potential of fuel peat, like that of most natural resources, is influenced by resource supply and resource demand as well as by many inter-related supply and demand considerations affecting fuel peat development and use. The detailed analysis of these influences would provide a much stronger base than presently exists upon which resource management policies and programs could be based. With modifications to reflect variations in degree of emphasis assigned to the major factors influencing fuel peat development prospects, the resource analysis process presented here could be used to examine other small to medium scale energy developments.

In addition to any practical contribution the analysis presented in this thesis may make to the more effective overall management of the fuel peat resources of

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[33] The rationale for focusing on financial and economic considerations is presented in Section 1.2.

[34] The detailed financial and economic analysis methodologies are presented in Chapter 2.

Southeastern Newfoundland, the analysis may contribute also to two more specific needs in resource management. The first pertains to the construction and use of resource development scenarios, as an alternative to project and program analysis. The second involves the development and use of an integrated approach for analyzing the financial and economic feasibility of resource extraction and utilization.

1.3.3 USE OF RESOURCE DEVELOPMENT SCENARIOS

Most integrated resource development analysis studies are associated with large resource developments, such as water management, hydro-electric, petroleum and mining projects.[35] Less emphasis has been placed upon the analysis of smaller resource projects, including development systems involving several resource extraction components and many users.[36] This is a potentially harmful situation, since the direct and induced social, economic and environmental effects of these multiple project developments can be greater than those of one large resource project. The human

[35] See, for example, B. Mitchell, op. cit. Also based on personal interviews with senior resource policy advisors, Government of Newfoundland and Labrador.

[36] An example of a recent exception is the large amount of analysis which preceded the restructuring of the fishing industry of the Atlantic Provinces in 1984.

and physical impacts of the 29,000 residential conversions from conventional fuels to wood in Newfoundland from 1979 to 1984,[37] for example, are likely to have been of a greater magnitude than those of the 75 megawatt Hind's Lake hydro-electric development, completed in 1980. The rapid oil to wood conversion process was stimulated in part by the Canadian Oil Substitution Program, which provided grants of up to $800 for each residential conversion.[38] The hydro-electric project was subjected to thorough resource supply, demand, engineering, financial, socio-economic and environmental analysis and monitoring. But, relative to the Hind's Lake project, the Newfoundland fuel wood component of this National Energy Program initiative was subjected to little front-end analysis.[39]

Resource analysis at the program level has resulted in

[37] Statistics Canada, Electric Power Statistics, 64-202, and Statistics Canada, Household Facilities and Equipment, 57-202.

[38] This federal program provided 10,000 Newfoundland households with grants for petroleum to wood conversions between 1980 and 1984. Information obtained in personal interviews with an official of the Department of Energy, Mines and Resources, Government of Canada.

[39] Based on the direct involvement of the author in resource analysis preceding both the Hind's Lake hydro-electric project in 1978-79 and the wood component of the Canadian Oil Substitution Program in 1980-81.

important contributions to resource management.[40] However, not all resource analysis associated with multiple projects can be linked with a specific program initiative. Fuel peat development, like many other resource developments, has many human and physical facets. This, plus the maze of federal and provincial resource, economic and social programs and policies, would likely result in fuel peat development prospects being affected by several management and development initiatives.[41] Problems associated with the identification of individual program needs and impacts greatly reduces the effectiveness of program level evaluations of resource developments.[42] As an alternative to program and project level analysis, fuel peat resource development scenarios are employed as the analysis base in this thesis.

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[40] See, for example, Jerome Rothenburg, "Cost-Benefit Analysis: A Methodological Exposition," Handbook of Evaluative Research, E.L. Struening and M. Guttentag eds. (Beverly Hills, California: Sage Publications Inc., 1980).

[41] Task Force on Program Review, A Study Team Report, Economic Growth: Services and Subsidies to Business (Ottawa: Government of Canada, 1985); and Government of Canada, Federal-Provincial Programs and Activities 1984-1985: A Descriptive Inventory (Ottawa: Supply and Services Canada, 1985).

[42] Program education has been much more effective in the evaluation of education, health and other social programs, where causal relationships are often more direct and predictive. See, for example, S.B. Anderson and S. Ball, op. cit.; and L. Rutman, Planning Useful Evaluations: Evaluability Assessment (Beverly Hills, California: Sage Publications Inc., 1980).

The value of the in-depth analysis of multiple project resource developments includes, but is not restricted to, an increased knowledge of human and physical effects. An equally important consideration is the fact that the technical, financial and economic feasibility of whole resource development systems is often quite different from that of component projects, due to economy-of-scale considerations. The analysis presented in this thesis is based on the assumption that the components of the fuel peat development scenarios will be able to avail of economy-of-scale benefits, as a result of close cooperation among fuel peat producers and major users. It is conceivable that a Newfoundland fuel peat industry would be controlled to a large extent by a Crown corporation, perhaps similar to the State Fuel Centre of Finland (VAPO).[43]

Common scale impacts in the resource region include lower prices, increased labour productivity, increased inventories of equipment and materials, more specialized service industries and more research aimed at modifying equipment to better suit regional conditions.[44] The

[43] Finnish Foreign Trade Association, Energy from Peat, Proceedings of Seminar, Toronto, 1982.

[44] W. Isard, Introduction to Regional Science (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1975), pp. 67-69; and P.E. Lloyd and P. Dicken, Location in Space: A Theoretical Approach to Economic Geography (New York:

recognition of the total development scenario in the resource analysis would therefore likely result in lower cost and higher efficiency assumptions, and possible modifications to the machinery and equipment mix deemed appropriate. Any economy-of-scale influences should be reflected in the analysis of the technical, financial and economic feasibility of resource developments. Resource managers should be made aware also of economy-of-scale impacts on technological and profitability aspects of resource development when formulating resource development policies and programs, especially when government funding is involved.

1.3.4 USE OF INTEGRATED ANALYTICAL APPROACH

The financial and economic feasibility of fuel peat production and use are indicated in Section 1.2 as critical factors, along with fuel peat supply and demand, which influence fuel peat development prospects in Newfoundland. Resource managers and developers have long been aware of the value of front-end financial and economic analysis of resource programs and projects,[45] however, interest in these

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Harper and Row Publishers, 1972), pp. 110-135.

[45] W.R.D. Sewell, et al., <u>Guide to Benefit-Cost Analysis</u> (Ottawa: Queen's Printer, 1965).

two considerations has heightened during the last decade due to economic conditions. Resource developers now are placing more emphasis on the profitability of different investment options, as a result of the large number of bankruptcies caused by economic recessions. Increased market competition, stemming from structural changes to most industrialized economies and changing world trade patterns, has led also to more prudent business management. In addition, high government deficits and increasing debt burdens are forcing resource managers to look more closely at the broader economic implications of different policy initiatives when allocating financial resources.

Despite the prominence of financial and economic analysis in resource management, and the distinct meaning of the terms "financial analysis" and "economic analysis", they are still often used interchangeably in resource studies. In an effort to reduce confusion in this thesis, the meanings of the two terms are explained here. Financial analysis refers to the examination of revenues and expenditure flows from the perspective of the investor. This analysis is usually carried out in a systematic manner through the application of capital budgeting analysis,[46] or another financial analysis technique. In resource

[46] J.F. Weston and E.F. Brigham, Managerial Finance (Hindsdale, Ill.: The Dryden Press, 1978).

management, financial analysis is performed mainly at the project level. Economic analysis, however, examines the direct and indirect costs and benefits to the regional, and sometimes national, economy (or government) of resource development programs or projects. Benefit-cost analysis is the economic technique used most frequently in resource management studies,[47] but input-output analysis and regional economic multipliers are also utilized.[48] Benefit-cost analysis, in principle, represents little more than the extension of the financial profit-and-loss calculations used in capital budgeting analysis "to reflect social instead of private objectives, criteria and constraints in evaluating investment projects".[49]

Major problems are still evident in financial and economic elements of most resource analysis studies prepared for resource managers,[50] in spite of the increased recognition of the value of these factors and the existence

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[47] Government of Canada, Benefit-Cost Analysis Guide (Ottawa: Treasury Board, 1976); E.J. Mishen, Cost-Benefit Analysis (London: George Alan and Unwin Ltd., 1971); and Mitchell, op. cit.

[48] See, for example, R.J. Chorley and P. Haggett, Models in Geography (London: Methuen & Co. Ltd., 1967).

[49] Government of Canada, Benefit-Cost Analysis Guide (Ottawa: Treasury Board, 1976), p.3.

[50] Based on personal interviews with resource managers in the Government of Newfoundland and Labrador, as well as the review of dozens of economic feasibility and impact studies.

of proven analytical techniques. The financial analysis of resource developments, for example, sometimes does not extend beyond the calculation of simple, or undiscounted, payback periods. Problems resulting from such over-simplistic analysis include the lack of consideration of revenues and expenditures after the initial project investment has been made, plus the lack of recognition of the effects of inflation on resource revenues and expenditures. Economic studies are often tarnished by the use of unjustifiably high regional economic multipliers, double-counting and the misuse of discounting and other aspects of the benefit-cost analysis technique. Finally, the evaluation of the financial and economic feasibility is often performed separately, resulting in no integration, duplication and gaps in analysis, as well as inconsistencies. Caution was taken in this thesis to avoid the problems noted above.

The integrated analytical framework developed to assess fuel peat development prospects in Southeastern Newfoundland, documented in Chapter 2, encompasses four proven financial and economic analysis techniques. These are: capital budgeting analysis, benefit-cost analysis, regression analysis[51] and scenario building. Use of this

[51] M.D. Intriligator, Econometric Models, Techniques & Applications (Englewood Cliffs, N.J.: Prentice-Hall Inc., 1978); J. Johnson, Econometric Methods (New York: McGraw-

analytical framework, plus the overall analysis process outlined in Section 1.3.2, facilitates the analysis of financial and economic considerations, along with fuel peat supply and demand, in an integrated manner. Also, the extensive use of quantitative techniques and computer models forced the identification and analysis of major dependent and independent variables, and their inter-relationships. A valuable end-result of using this type of systematic approach is the relative ease and certainty associated with the detection of data and other deficiencies in the analysis.

As stated in Section 1.1, integrated studies of practical resource analysis problems are recognized for their contribution to resource management. The study of resource supply, demand, financial and economic considerations associated with fuel peat development prospects in Southeastern Newfoundland was undertaken in light of this value. In addition to any practical value of this thesis in the broad fuel peat resource management context, the approach and methodologies employed may be suitable for use in other integrated resource analysis

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Hill Book Company, 1984); P. Kennedy, Guide to Econometrics (Cambridge, Mass.: The MIT Press, 1979); D.G. Moyes, Applications of Econometrics (London: Prentice-Hall International, Inc., 1981); C.H. Springer et al., Advanced Methods and Models (Homewood, Ill.: Richard D. Irwin, Inc., 1985).

applications. This study also presents an alternative solution to two problems often encountered in resource management. The first involves the construction and use of resource development scenarios to alleviate problems sometimes associated with resource analysis at the project and program level. Also, the development and application of an integrated analytical framework may contribute to efforts to reduce the occurrence of some common problems in financial and economic elements of resource studies.

The organizational structure of the resource analysis performed in this thesis, outlined in Section 1.4, reflects the four major objectives presented in Section 1.2.3.

1.4 ORGANIZATIONAL STRUCTURE OF THESIS

The integrated resource analysis approach used is presented and explained in Chapter 2. In addition to the overall analytical framework, the research and resource analysis techniques, and the major information sources utilized, are discussed. Emphasis is placed upon the description of the capital budgeting analysis and benefit-cost analysis methods, and the rationale for their extensive use.

Background considerations influencing fuel peat development prospects in Southeastern Newfoundland are examined in Chapter 3. Fuel peat utilization considerations and regional economic and energy considerations are considered to have a major influence on fuel peat developments during the 1985 to 1994 period, and are analyzed in detail. This analysis places the analysis of supply and demand, as well as the financial and economic feasibility of fuel peat production and use in Southeastern Newfoundland, in a broad resource management and regional development context.

The ability of the fuel peat resources of Southeastern Newfoundland to satisfy the supply requirements of commercial scale fuel peat developments is analyzed in Chapter 4. This resource supply analysis contains an examination of the peat resources in four Newfoundland supply regions, however, attention is focused upon the recoverable fuel peat reserves of Southeastern Newfoundland. The main indicators used in the assessment of the commercial viability of the fuel peat resources are the location, size and energy value of deposits.

The fuel peat demand analysis presented in Chapter 5 is directed at the determination of whether market prospects in Southeastern Newfoundland could warrant commercial scale fuel peat developments. The demand analysis is directed at the residential and industrial-commercial energy sectors, since these sectors offer the best prospects for fuel peat use in the next decade. Potential demand is analyzed under two petroleum price scenarios, because of the major influence of petroleum prices on the profitability of alternative forms of energy, such as fuel peat. Other factors examined in the demand analysis include the results from the analysis of background development considerations, supply, and the financial and economic feasibility of fuel peat production and use.

The financial analysis of fuel peat production and utilization, documented in Chapter 6, attempts to ascertain if fuel peat production and combustion projects in Southeastern Newfoundland would be financially feasible, from the perspective of potential investors. This analysis, which involves an examination of six fuel peat production and four combustion systems, is facilitated through the development and use of a capital budgeting analysis model. The key inputs into this analysis are fuel peat production and combustion cost estimates and petroleum price projections. While the main indicator of the financial feasibility of fuel peat production and use is the internal rate of return, the net present value and discounted payback period associated with each project are also provided.

The economic analysis of fuel peat developments in Chapter 7 examines the economic feasibility of two development scenarios in Southeastern Newfoundland from the perspective of the Government of Newfoundland and Labrador. This analysis, through the facilities of a benefit-cost analysis model, compares the net revenues accruing from fuel peat related economic activities with the amount of government assistance required to stimulate fuel peat production and use, under two development scenarios. The net revenue analysis incorporates the results from the analyses of the macro-economic effects of fuel peat developments and the econometric relationships between revenues and economic activity. The government cost analysis is based on the demand analysis and the financial analysis of production and combustion.

The most salient fuel peat development related findings stemming from the analysis of background development considerations, supply, potential demand and the financial and economic feasibility of fuel peat production and use, are summarized in Chapter 8. In addition, this chapter presents the major conclusions pertaining to fuel peat development prospects in Southeastern Newfoundland and the integrated resource analysis approach developed and employed in this thesis.

Chapter 2

STUDY OF FUEL PEAT RESOURCE DEVELOPMENT POTENTIAL

2.1 INTRODUCTION

The broad nature of the resource management problem encountered in this thesis, and the resulting need to examine a wide range of resource supply, demand, financial and economic factors influencing fuel peat development prospects in Southeastern Newfoundland,[1] highlighted the need to rely upon more than one research or analysis method. As a result, several proven research and analysis methodologies were incorporated within the problem-oriented analytical approach outlined in Section 1.3.

Field studies and literature reviews were the two major research strategies used in this thesis.[2] Specific research methods included under field studies were personal interviews, meetings, field trips, conferences and

[1] See Chapter 1 for details.

[2] A detailed discussion of research strategies is contained in P.J. Runkel and J.E. McGrath, Research on Human Behaviour: A Systematic Guide to Method (New York: Holt, Rinehart and Winston, Inc., 1972), pp. 82-99.

literature reviews, all of which are widely recognized and utilized techniques in geography.[3] The main reasons for using these standard research methods in this study were: (1) to identify and gather background information relevant to the analysis of fuel peat development prospects; and (2) to identify and measure the key variables and relationships influencing fuel peat development prospects in Southeastern Newfoundland. This second category of information yielded the statistical inputs used in the fuel peat resource analysis methodologies.

The integrated analytical framework presented in this thesis represents an alternative approach to resource development analysis. This approach, unlike that used in most resource analysis studies performed by geographers,[4] places a large amount of attention on the financial and economic feasibility of fuel peat production and use. The quantitative analysis was facilitated through the development and use of computer-based capital budgeting analysis and benefit-cost analysis models. The financial and economic analysis bridges the fuel peat supply and

[3] B. Mitchell, Geography and Resource Analysis (London: Longman, 1979).

[4] Exceptions include Sewell, Day and Krutilla, who have utilized benefit-cost analysis extensively in their analyses of the economic feasibility of resource developments. See, for example, W.R.D. Sewell et. al., Guide to Benefit-Cost Analysis (Ottawa: Queen's Printer, 1965).

demand analysis through an iterative process, involving the use of fuel peat demand and development scenarios.

The research process used in this thesis is outlined in Section 2.2, including the identification and assessment of major research techniques and sources of information. Also, the influence upon the research approach of the direct involvement by the writer in resource management efforts is discussed. An overview of the analytical framework and component methodologies is presented in Section 2.3. Because of the prominence of the capital budgeting analysis and benefit-cost analysis techniques in this resource analysis framework, the modifications made to the standard methods are explained, and the mathematical structure of the financial and economic models developed is documented in Sections 2.4 and 2.5.

2.2 FUEL PEAT RESEARCH METHODS

Most of the fuel peat, background and methodological research incorporated in this thesis originated from a broader involvement by the author in resource management and development activities in Newfoundland, between 1980 and 1986. Fuel peat research efforts were most intense during the period 1980 to 1982, however, information was collected and updated up to March, 1986.[5] The six-year research process is summarized in Table 2.1, which includes categories and sources of information, and major research methods. The fuel peat research process is discussed below.

2.2.1 FUEL PEAT RESEARCH PROCESS

Federal and provincial departments involved in fuel peat management, development and research, as well as companies involved in fuel peat production, utilization, research and analysis, were the main sources of information for this thesis. Government departments and agencies in St. John's provided large amounts of peat related information, as well as background information pertaining to regional economic and energy circumstances. Both levels of government, plus faculty members from Memorial University of Newfoundland, provided valuable inputs into the resource analysis methodologies utilized in this thesis.

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[5] During the period 1979 to 1982 the author was employed as a resource analyst by the Newfoundland Department of Mines and Energy, and was actively engaged in fuel peat resource management related activities. Between 1982 and 1986, the writer has been involved in the financial and economic analysis of major Newfoundland resource developments, including offshore oil and gas development prospects, at the Newfoundland Department of Finance.

Table 2.1

LISTING OF CATEGORIES & SOURCES OF INFORMATION AND RESEARCH METHODS

Information Category	Information Source	Research Method
Resource Analysis Methods	- Memorial University of Newfoundland - Newfoundland Department of Finance - Newfoundland Department of Mines and Energy - Newfoundland Executive Council - Government, Industry and Academic Literature	- Literature Review - Personal Interviews
Conventional Energy Supply, Demand and Prices	- Statistics Canada - Newfoundland Department of Mines and Energy - Newfoundland Petroleum Directorate - Newfoundland and Labrador Hydro - National Energy Board - Department of Energy, Mines and Resources, Canada	- Personal Interviews - Literature Review
Economic and Financial Information	- Newfoundland Department of Finance - Newfoundland Executive Council - Newfoundland Department of Mines and Energy - Department of Finance, Canada - Conference Board of Canada - Clarkson-Gordon - Woods-Gordon - Government and Industry Literature	- Personal Interviews - Meetings - Literature Review
Newfoundland Fuel Peat Resources - Peatland Classification Information - Fuel Peat Development Criteria	- Northland Associates Limited - Canadian Forestry Service, Environment Canada - Newfoundland Department of Forest Resources and Lands - Newfoundland Department of Mines and Energy - Turveruukki Oy, Finland	- Personal Interviews - Meetings - Field Trips - Literature Review

Table 2.1 (Continued)

LISTING OF CATEGORIES & SOURCES OF INFORMATION AND RESEARCH METHODS

Information Category	Information Source	Research Method
Fuel Peat Research and Development Projects in Newfoundland - Equipment Requirements - Production Cost Information - Combustion Cost Information - Transportation Cost Information - Economic Effects - Socio-Economic Effects	- Newfoundland Department of Mines and Energy - Department of Energy, Mines and Resources, Canada - Southern Avalon Development Association - NOVA, An Alberta Corporation - Memorial University of Newfoundland - Canadian Forestry Services, Environment Canada - Newfoundland and Labrador Hydro - Newfoundland Departments of - Environment - Forest Resources and Lands - Rural, Agriculture and Northern Development - Department of Employment and Immigration, Canada - Town Councils of - Bishop's Falls - Gander - St. Shotts - Fuel Peat Consultants - Technopeat Inc. - Northland Associates Limited - Montreal Engineering Company - Shawmont Newfoundland Limited - Government of Newfoundland and Labrador, Historical Reports - Newfoundland and Labrador Peat Association - Residents of Southeastern Newfoundland	- Personal Interviews - Field Trips - Meetings - Literature Review

Table 2.1 (Continued)

LISTING OF CATEGORIES & SOURCES OF INFORMATION AND RESEARCH METHODS

Information Category	Information Source	Research Method

Fuel Peat Research and Development in the World
- Type of Activity
- Level of Activity
- Location of Activity
	- State Fuel Centre (VAPO), Finland
	- Technical Research Centre, Finland
	- Trade Commission, Finland
	- Companies Involved in Fuel Peat Production, Conversion and Combustion in Finland
	  - Turveruukki Oy
	  - Ekono Oy
	  - A-Sprinkleri Oy
	  - Suokone Oy
	- Fuel Peat Consultants
	  - Technopeat Inc.
	  - Peat Consultants Oy
	  - Bakmet Limited
	  - Montreal Engineering Company
	- Horticultural Peat Producers, Canada
	  - Tardif et Frere
	  - Western Moss Peat Limited
	- Royal Forestry College, Sweden
	- Royal Institute of Technology, Sweden
	- Bord na Mona, Ireland
	- Institute of Gas Technology, United States
	- Department of Energy, Mines and Resources, Canada
	- Canadian Forestry Service, Environment Canada
	- National Departments of Energy
	  - United States
	  - Ireland
	  - Sweden
	  - Finland
	- Provincial Departments of Energy
	  - Nova Scotia
	  - New Brunswick
	  - Quebec
	  - Ontario
	  - Saskatchewan
	- State Departments of Energy
	  - Maine
	  - Minnesota
		- Personal Interviews
		- Literature Review
		- Meetings
		- Field Trips
		- Conferences

These efforts involved personal interviews with about 30 individuals,[6] and the direct participation of the writer in about ten meetings aimed at improving the efficiency of fuel peat resource management policies, programs and projects. Approximately 15 field trips to fuel peat demonstration projects at St. Shotts and Bishop's ~~Falls~~, and open-ended interviews with about 20 individuals involved with project management, operations and monitoring, revealed a large number of facts concerning fuel peat production and use in Newfoundland.[7] Also, field trips to Southeastern Newfoundland involved personal interviews with about 30 local residents and representatives of industrial-commercial establishments, mainly from the communities of St. Shotts and Trepassey. Emphasis was placed on these two communities since commercial scale fuel peat developments are possible in this region.[8]

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[6] The writer did not anticipate the direct use in this thesis of a listing of the large number of meetings, personal interviews and field trips linked with the six-year fuel peat research effort, and no detailed list was maintained. The estimates presented in this section are intended to represent the minimum research levels; repeat interviews are excluded.

[7] The author was often accompanied on these field trips by the senior energy engineer, Newfoundland Department of Mines and Energy. On two field trips to Southeastern Newfoundland in 1982, the author was also accompanied by a fuel peat consultant from Technopeat Inc.

[8] Based on fuel peat supply and demand analysis in Chapters 4 and 5, as well as fuel peat utilization considerations (Section 3.2).

In addition to the site visits to the fuel peat production and combustion projects and personal interviews with the project personnel, the author was a participant in approximately ten government sponsored fuel peat management meetings. These sessions involved project operators and representatives of several federal and provincial departments involved in fuel peat management, funding and research, as well as representatives of municipal governments in the impact regions. These field trips, personal interviews and meetings yielded information concerning fuel peat development and use in Newfoundland, including machinery requirements, technical problems, employment opportunities, labour problems, intra-community rivalries, climatic concerns, environmental effects of fuel peat production and use, as well as capital, operating and maintenance costs of specific types of fuel peat production and combustion projects.

Valuable information and insights pertaining to fuel peat development prospects in Newfoundland were obtained by the author through his attendance at and participation in six fuel peat conferences between 1980 and 1982.[9] These

[9] The six conferences, including sponsors, location and year, were: (1) Energy From Peat, Finnish Foreign Trade Association, Toronto, 1982; (2) Bio-Energy Research and Development Seminar, National Research Council, Winnipeg, 1982; (3) Solid Fuels Combustion Seminar, Department of Energy, Mines and Resources, Ottawa, 1981; (4) Elmia Bio-Energy Conference, Jonkoping, Sweden, 1980; (5) Peat as an

conferences involved five meetings and about 20 personal interviews with fuel peat consultants, producers, users and equipment manufacturers from Finland, Sweden, Ireland, the United States and Canada.

A three week tour of the bio-energy[10] industries of Finland and Sweden in 1980 involved visits to about 15 fuel peat research projects and commercial developments, including university testing facilities, electricity generating plants, district heating plants, densification plants, residential and industrial-commercial installations, energy plantations, equipment manufacturing plants and fuel peat production sites. This tour also involved approximately ten meetings and 25 personal interviews with government and fuel peat industry officials from Finland and Sweden.

Energy Alternative, Institute of Gas Technology, Arlington, Virginia, 1980; and (6) Bio-Energy '80, Atlanta, Georgia, 1980. The writer co-authored a paper concerning fuel peat development prospects in Newfoundland which was presented at the Institute of Gas Technology Conference. See E. D. Wells and R.B. Vardy, "Peat Resources of Newfoundland with Emphasis on its Use for Fuel", Peat as an Energy Alternative (Chicago: Institute of Gas Technology, 1980). Five of these conferences involved participants from Finland and Ireland, which have commercial scale fuel peat production.

[10] Bio-energy refers to energy derived from living materials or materials which have lived. Fuel wood and fuel peat are the most common forms of bio-energy.

Finally, the direct participation by the writer on nine federal-provincial financial and energy committees between 1980 and 1986 has provided a large amount of information concerning economic and fiscal conditions and energy supply, demand and prices:[11] Some of this information was useful in placing the fuel peat analysis in this thesis in a broader context. Two of the committees were directly involved with fuel peat resource management issues and federal-provincial peat related research and development programs.[12]

Valuable information concerning fuel peat development prospects in Southeastern Newfoundland was obtained from all five research methods used in this study. The approximately 125 personal interviews referenced here, however, required the highest level of individual effort on the part of the writer, with respect to both planning and implementation. The distribution of these personal interviews, summarized in Table 2.2, reveals a broad cross-section of government, industry, research and private sector respondents involved in, or likely to be affected by, fuel peat research,

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[11] The nine committees, and the period the writer was a participant, are: (1) Energy Conservation, 1980-1982; (2) Energy Conservation and Alternative Energy R & D, 1980-1982; (3) Alternative Transportation Fuels, 1980-1982; (4) Continuing Committee of Finance Officials, 1982-1986; (5) Fiscal Arrangements, 1982-1986; (6) Equalization, 1982-1986; (7) Established Programs Financing, 1982-1986; (8) Economic Data, 1982-1986, and (9) Financial Data, 1982-1986.

[12] These were the Energy Conservation and the Energy Conservation and Alternative Energy R & D Committees.

Table 2.2

DISTRIBUTION OF PERSONAL INTERVIEWS (1)

Governments(2)	Fuel Peat Industry(3)	Research Organizations(4)	Other(5)	Total
30	40	20	35	125

Notes:

(1) Personal interviews were conducted between 1980 and 1986. Repeat interviews are excluded.

(2) Includes representatives from: (a) the Newfoundland Departments of Mines and Energy; Forest Resources and Lands; Rural, Agricultural and Northern Development; Environment and Finance; plus the Executive Council; (b) the provincial governments of Nova Scotia, New Brunswick, Quebec, Ontario and Saskatchewan; (c) the state governments of Maine, Minnesota, North Carolina and Georgia; and (d) the national governments of Canada, the United States, Ireland, Sweden and Finland.

(3) Includes representatives from six fuel peat consulting companies and seven companies involved in fuel peat production or equipment manufacturing in Canada, the United States, Ireland, Sweden and Finland (see Table 2.1 for listings).

(4) Includes researchers in fuel peat production and combustion at five universities in Canada, the United States, Sweden and Finland (see Table 2.1 for listings).

(5) Includes residents of, and representatives of industrial-commercial establishments in, St. Shotts, Trepassey and other Southeastern Newfoundland communities. Also included are representatives of three economics consulting companies.

development and/or utilization. This broad research base is reflected in the financial and economic analysis, which involves an examination of fuel peat development prospects from the perspective of both the private and public sectors.

2.2.2 INFLUENCE ON RESEARCH OF AUTHOR'S INVOLVEMENT IN RESOURCE MANAGEMENT

As mentioned in the introduction to Section 2.2, all research for this thesis was carried out while the writer was employed by the Government of Newfoundland and Labrador. Most of this research was conducted as part of a broader resource management involvement, which encompassed a wide variety of fuel peat and other energy analysis endeavours.

This direct association with fuel peat resource management efforts has had a major influence upon the choice of research methods. The writer availed of the technical and financial resources of government to a greater extent than could most non-government researchers examining resource management problems. In addition to the fuel peat resource management responsibilities resulting in government sponsorship of field trips and conferences, the writer also had an excellent opportunity to identify and research major factors and inter-relationships influencing fuel peat development prospects in Southeastern Newfoundland, through his direct involvement in many federal-provincial-industry fuel peat policy and development meetings. Other information was obtained from the required analysis of many confidential resource development proposals and technical reports, which could not be provided to researchers outside of government. The direct involvement of the author in fuel peat development programs also resulted in few difficulties in scheduling personal interviews with, and obtaining requested information from, government and industry representatives.[13] The use of personal interviews, meetings, field trips, conferences and literature reviews as the main research methods employed in this thesis was influenced, to a large extent, by the fuel peat resource management responsibilities of the writer.

The association of the writer with fuel peat resource management also influenced the way in which research was conducted. The research efforts were always presented as part of the fuel peat resource management and analysis responsibilities of government. This approach, plus the heterogeneous nature of respondents and information sought, greatly facilitated the research process. The author

[13] The need to obtain certain machinery mix and cost inputs for the financial analysis of fuel peat production and use resulted in a consulting contract with Technopeat Inc. in 1982.

recognizes that if this research had been conducted outside government, a more structured research design with more checks against common threats to reliability and validity, would be needed. Non-government researchers likely would not wish to tackle as broad a problem as encountered in this thesis due to information constraints. It is likely that a narrower research focus would greatly facilitate the use of standard research designs, since the types of respondents and the information sought would be more uniform.[14] As a result, much of the research was carried out in a very direct manner, through previously arranged as well as informal personal interviews with government and industry officials. The informal nature of many of these interviews resulted from the personal relationships developed between the writer and many of the respondents, as a result of joint involvement in fuel peat management, research, and development. Also, the research process involved dozens of repeat interviews with key informants, listed in the acknowledgements, since the formulation of the resource analysis approach and main information base was an iterative process over six years.

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[14] P.J. Runkel and J.E. McGrath, op. cit.; N.L. Gage ed., Handbook of Research Teachings (Chicago: Rand McNally, 1963); E.R. Babbie, The Practice of Social Research (Belmont, California.: Wadsworth Publishing Company, 1975); R.L. Warren, Studying Your Community (New York: The Free Press, New York, 1965); and C.A. Moser and G. Kalton, Survey Methods in Social Investigation (London: Heinemann Educational Books, 1971).

The writer was aware of biases in some of the information presented,[15] but felt that this was not a major problem, since most of the information inputs used were of a quantitative nature, and were cross-checked against several independent sources. Broad, open-ended discussions of fuel peat development prospects with government and industry informants revealed useful insights which were used to place the analysis presented in this thesis in a broader resource management context. The results from this more subjective type of research were omitted from the direct fuel peat supply, demand, financial and economic analysis, eliminating many potential reliability and validity problems.

In summary, the research process was facilitated by the direct involvement of the writer in fuel peat resource management activities, especially during the period 1980 to 1982. This resource management experience resulted in the extensive use of five research methods as well as a more direct and often more informal research approach than is supported in much of the academic literature pertaining to research design. Because of the factual and quantitative nature of most of the desired information outputs, however,

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[15] Many of the individuals interviewed in St. Shotts and Trepassey had high expectations concerning the impact of possible fuel peat developments upon the local economy, and employment opportunities which would result. Some respondents appeared to link the interviews with their own employment opportunities.

this approach was effective in this study.

The fuel peat analysis process documented in Sections 2.3, 2.4 and 2.5 incorporates the information outputs into an integrated analytical framework, which places major emphasis upon financial and economic considerations.

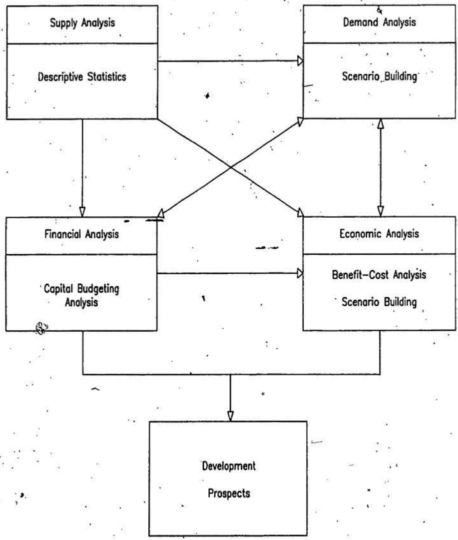
2.3 FUEL PEAT ANALYSIS METHODS

An integrated analytical framework was employed in this thesis to analyze fuel peat development prospects in Southeastern Newfoundland. The analytical process, illustrated in Figure 2.1, combined several proven resource analysis methods to examine the location and size of fuel peat supply and potential demand, as well as the financial and economic feasibility of fuel peat production and use. The major analytical methods used are capital budgeting analysis, benefit-cost analysis and scenario building. An overview of this analytical approach is presented in this section, including the resource analysis methods employed.

The first step in the analytical process was the measurement of fuel peat resources of Newfoundland by region to determine if they were large enough to sustain commercial scale fuel peat developments. This was accomplished by

Figure 2.1

AN INTEGRATED ANALYTICAL APPROACH



applying fuel peat development criteria used in Finland, to the Newfoundland peatland inventory data.[16] This analysis, which confirmed that the Southeastern Newfoundland region had the largest supply of fuel peat in the Province, involved the use of basic descriptive statistics.

Next, fuel peat demand was analyzed in four demand regions of Southeastern Newfoundland for the period 1981 to 1994. This analysis was accomplished through the development of fuel peat demand scenarios. Due to data limitations, it was impossible to use regression analysis or other econometric techniques[17] to systematically develop fuel peat demand scenarios on the basis of historical relationships between fuel peat demand and major influencing exogenous variables. Specifically, fuel peat use as a domestic fuel in Southeastern Newfoundland has been limited to a few communities and has been almost totally non-existent since the 1960s.[18] The use of relationships between fuel peat demand and comparative energy supply and

[16] See Chapter 4 for details.

[17] M.D. Intriligator, Econometric Models, Techniques, & Applications (Englewood Cliffs, N.J. Prentice-Hall, Inc., 1978); J. Johnston, Econometric Methods (New York: McGraw-Hill Book Company, 1984); D.G. Mayes, Applications of Econometrics (Englewood Cliffs, N.J.: Prentice-Hall International, 1981); and C.R. Nelson, Applied Time Series Analysis for Managerial Forecasting (San Francisco: Holden-Day Inc., 1973).

[18] See Section 3.2 for details.

price data from European nations would have been of limited value due to social and economic differences in energy customers, energy mix and energy pricing policies.[19] The demand scenarios initially were based upon the location and size of fuel peat deposits, the distribution and size of potential energy markets, and the results from the research of background fuel peat development considerations. These scenarios later incorporated the results from the financial and economic analysis through the iterative process illustrated in Figure 2.1.

The financial analysis, the third component in the analytical process, examined the feasibility of six fuel peat production systems and four combustion systems, from the perspective of the investor. The choice of the different production and combustion systems was based on the location and size of fuel peat deposits and markets, and types of fuel peat conversions possible. This analysis was facilitated through the development and use of a capital budgeting analysis model, which is described in detail in Section 2.4. This financial analysis calculates the amount of government financial assistance required in order for each type of fuel peat system to be profitable to potential

[19] Canadian petroleum and thermally generated electricity prices in Eastern Canada, for example, had been kept artificially low until the early 1980s due to large petroleum import subsidies paid by the Government of Canada.

investors. The outputs from this analysis were incorporated into the demand scenarios. In addition to the results from the financial analysis, the economic analysis integrated the results from the demand scenarios and the supply analysis. The two fuel peat development scenarios[20] used to assess the overall economic feasibility of fuel peat were based on the outputs from the economic, demand and financial analyses. The two scenarios are based on two petroleum price outlooks, incorporating annual nominal price increases of six and eight percent during the forecast period. The supply analysis identified fuel peat resource size constraints.

The economic analysis compared, in a benefit-cost analysis framework, the revenues accruing to the Government of Newfoundland and Labrador as a result of fuel peat production and consumption, with the costs of subsidizing these developments. This analysis was performed using a benefit-cost analysis model, which incorporated separate government revenue and expenditure models. In addition to the benefit-cost technique, the economic analysis involved the use of regression analysis. This analysis is described in Section 2.5.

[20] The two fuel peat development scenarios are presented in Chapter 7.

Conclusions pertaining to fuel peat development prospects are based upon the fuel peat supply, demand, financial and economic analyses highlighted in this section. Since the outputs from the supply, demand and financial analysis were all integrated within the benefit-cost analysis framework, most conclusions flow directly from the economic analysis.

The capital budgeting analysis model, used extensively in the financial analysis, is described in Section 2.4. This description is necessary because of the technical modifications which were made to the standard capital budgeting analysis methods.

2.4 CAPITAL BUDGETING ANALYSIS MODEL

The analysis of the financial feasibility of most small and medium resource development opportunities has not extended beyond the calculation of simple or undiscounted payback periods. This is cause for concern, given the prominence of financial considerations in the assessment of resource development prospects and the existence of proven financial analysis techniques.[11] These payback methods, which are basic forms of capital budgetary analysis, do not

[11] See Chapter 1 for details.

account for costs and benefits occurring after the initial investment has been recovered. They also completely ignore the effects of inflation on net revenue flows during the construction and operating life of each project.

Net present value and internal rate of return are two additional inter-related capital budgetary methods used in the private and public sectors to analyze the relative merits of major investment alternatives. Since these methods are not constrained by the two limitations identified above, they are used extensively in the financial analysis of fuel peat developments documented in Chapter 6. A description of these two capital budgeting analysis methods, including formulae, are presented below. Section 2.4.1 and 2.4.2 also contain a discussion of the rationale for the structural modifications made to the standard capital budgeting analysis technique and a description of the computer-based capital budgeting analysis model developed and used in this thesis to analyze the financial feasibility of ten small and medium scale fuel peat production and combustion systems.

2.4.1 CAPITAL BUDGETING ANALYSIS METHODS

The two most frequently used capital budgeting analysis methods in resource management studies are the net present value and the internal rate of return.[22] The net present value method involves the discounting of the annual cash flow resulting from an investment. The sum of these discounted cash flows during the expected life of a development, less the initial capital cost, equals the present value of the project. The standard formula for net present value (NPV) is presented below.[23]

$$NPV = \left[\frac{F_1}{(1 + k)^1} + \frac{F_2}{(1 + k)^2} + \ldots + \frac{F_n}{(1 + k)^n}\right] - I$$

$$= \sum_{t=1}^{n} \frac{F_t}{(1 + k)^t} - I$$

Where:

$F_1, F_2 \ldots F_n$ represent net cash flows;
k is the discount rate (often the average cost of capital; sometimes a risk factor is added);
I is the initial capital cost of the project;
n is the expected life of the development; and
t represents time in the shortened equation.

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[22] A.P.H. Van Meurs, Modern Petroleum Economics (Ottawa: Van Meurs and Associates, Limited, 1981).

[23] J.F. Weston and E.F. Brigham, Managerial Finance (Hindsdale, Ill.: The Dryden Press, 1978), p. 295.

Internal rate of return is the discount rate which would cause the sum of the discounted cash flows over the life of the development to equal the investment cost (i.e., net present value to equal zero). Internal rate of return is calculated by solving the following equation for "r".[24]

$$\left[\frac{F_1}{(1+r)^1} + \frac{F_2}{(1+r)^2} + \ldots + \frac{F_n}{(1+r)^n}\right] - I = 0$$

$$\sum_{t=1}^{n} \frac{F_t}{(1+r)^t} - I = 0$$

where:

$F_1, F_2 \ldots F_n$ represent net cash flows;
I is the initial capital cost of the development;
n is the expected life of the development;
r is the calculated internal rate of return; and
t represents time in the shortened equation.

Both the net present value and the internal rate of return methods represent a definite advancement over the undiscounted payback method. Net present values, however, are usually highly correlated, either positively or negatively, with the size of the investment and are therefore not a good indicator of the relative financial feasibility of development options of different financial scales. Since the six fuel peat production systems and the

[24] Ibid., pp. 295-296.

four fuel peat combustion systems examined in Chapter 6 require vastly different levels of investment outlays, the internal rate of return method, which is not affected by the magnitude of project costs, is the main indicator of the financial feasibility of fuel peat developments.

References are made to net present values and discounted payback periods in the financial analysis, however, since these two financial indicators often serve as good complementary measures of project profitability. In fact, the net present value formula is used more extensively than the internal rate of return formula in the capital budgeting analysis model. This stems from the mathematical inter-relationships within the formulae and the nature of the structural modifications to the capital budgeting analysis technique made in this thesis. These modifications to the standard financial analysis technique, as well as the capital budgeting model developed, are described below.

2.4.2 STRUCTURE OF CAPITAL BUDGETING ANALYSIS MODEL

The first step in the financial analysis process modelled and used in this thesis involved the calculation of the internal rate of return to the investors of each resource development option, with no government financial assistance.[25] The second step, involved the segregation of projects into two categories based upon whether or not each met the critical 15 percent internal rate of return profitability criterion.[26] Fuel peat production and combustion projects yielding internal rates of return of 15 percent[27] or larger, were considered by the author to be financially feasible to the investors without government financial assistance and were placed in Category A. The remainder of the projects fell into Category B, since their internal rates of return were less than 15 percent and would require government assistance to become attractive from the perspective of investors.

To calculate the present value of net revenue flows associated with Category A projects, the discount rate in the standard net present value formula was held constant at 15 percent, a rate identical to the internal rate of return. The net present value associated with fuel peat development

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[25] The capital, operating and maintenance costs, plus revenues or ~~savings,~~ and financial, economic and technical assumptions associated with each development are discussed in Chapter 6.

[26] A 20 percent internal rate of return is the critical profitability criterion used in the analysis of the financial feasibility of residential fuel peat combustion systems. The rationale for this higher rate is explained in Chapter 6.

[27] The rationale for this key criterion is presented in Section 6.1.

projects in this category could not be negative, since the discount rate was less than the internal rate of return. The resulting discounted net revenue flows also permitted the identification of discounted payback periods, which were always less than or equal to the ten year economic life of each fuel peat development assumed in this study.[28] The Category A net present value formula is illustrated here.

$$NPV = \left[\frac{F_1}{(1.15)^1} + \frac{F_2}{(1.15)^2} + \ldots + \frac{F_n}{(1.15)^n}\right] - I$$

$$= \sum_{t=1}^{n} \frac{F_t}{(1.15)^t} - I$$

Where:

$F_1, F_2 \ldots F_n$ represent net cash flows;
I is the initial capital cost of the fuel peat project;
n is the expected life of the development (10 years for the purposes of this thesis); and
t represents time in the shortened equation.

Category B fuel peat resource development projects were subjected to more thorough financial analysis within the capital budgeting model, since they required government

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[28] The rationale for this ten year timeframe is presented in Section 6.1.

assistance to meet the minimum profitability criterion. As with Category A projects, the standard net present value formula with a 15 percent discount rate was used to calculate the present value of net revenue flows. The calculated net present values for Category B projects without government financial assistance were all negative, since the discount rate is greater than the internal rate of return.

The model then calculated the amount of government assistance required to make each project in this category financially viable, by taking the absolute value of the negative net present value of the project. The amount of government assistance was next factored into the net present value formula as an offset against the initial investment cost during the construction phase. The resulting net present value and discounted payback period for all projects in this category after the required level of government assistance had been factored into the financial analysis, were zero dollars and ten years, respectively. The discounted payback period corresponded to the ten year economic life assumed for each fuel peat development project in the financial and economic analyses. Economic life is defined as the period over which useful benefits are likely to be derived from a project.[29] The modified net present value formula is illustrated here.

$$NPV = \left[\frac{F_1}{(1.15)^1} + \frac{F_2}{(1.15)^2} + \ldots + \frac{F_n}{(1.15)^n}\right] - (I - G)$$

$$= \sum_{t=1}^{n} \frac{F_t}{(1.15)^t} - (I - G)$$

Where:

$F_1, F_2 \ldots F_n$ represent net cash flows;
I is the initial capital cost of the project;
G is the amount of government assistance needed for the fuel peat project to yield a 15 percent internal rate of return;
n is the expected life of the development; and
t represents time in the shortened equation.

As a final step, the capital budgeting analysis model factored the required amount of government financial assistance into a recalculation of the internal rate of return of each project in Category B. The amount of government assistance calculated for each project was subtracted from the cost of the initial investment, as was done in the net present value analysis, The internal rate of

[29] Sewell et al., op. cit., p. 16.

return, calculated by solving the following equation for "r", was always 15 percent.[30]

$$\left[\frac{F_1}{(1+r)^1} + \frac{F_2}{(1+r)^2} + \ldots + \frac{F_n}{(1+r)^n}\right] - (I - G) = 0$$

$$\sum_{t=1}^{n} \frac{F_t}{(1+r)^t} - (I - G) = 0$$

Where:

F_1, F_2 . . . F_n represent net cash flows;
I is the initial capital cost of the development;
G is the amount of government assistance needed for the fuel peat project to yield a 15 percent internal rate of return;
n is the expected life of the development;
r is the calculated internal rate of return; and
t represents time in the shortened equation.

The capital budgeting analysis model was modelled using FCS, a financial model building package.[31] This modelling was needed to facilitate the analysis of the financial

[30] The internal rate of return was defined above as the discount rate which causes the net present value of a project to equal zero. Also, the required amount of government assistance calculated in the previous net present value formula was based on a 15 percent discount rate and a zero net present value. Therefore the resulting internal rate of return was always 15 percent.

[31] Micro-FCS User Reference Guide (Windham, N.H.: EPS Incorporated, 1984).

sensitivity of the ten fuel peat production and combustion systems to changes in key independent and dependent variables, including fuel peat and petroleum prices, production costs, levels of fuel peat use and discount rates. In addition, the development and use of the capital budgeting analysis model involved the systematic identification and analysis of major factors and relationships influencing the profitability of fuel peat developments in Southeastern Newfoundland, thereby greatly strengthening the quality and consistency of inputs into the economic analysis methodology, documented in Section 2.5.

2.5. BENEFIT-COST ANALYSIS MODEL

Economic analysis was defined,[32] in a resource management context, as the examination of the direct and indirect costs and benefits to the regional economy (or government) of resource development programs or projects. The base of the economic analysis presented in this thesis was the Government of Newfoundland and Labrador, since government revenues and expenditures directly or indirectly associated with the two fuel peat development scenarios in Southeastern Newfoundland were considered to be good indicators of the overall regional economic effects of such

[32] See Section 1.3.

resource developments.[33] The amount of government financial assistance required to subsidize the two development scenarios was compared to the additional government revenues derived in a benefit-cost framework. This economic analysis of fuel peat developments was facilitated through the development and use of an integrated computer model. This model was programmed in Perfect Calc, an electronic spreadsheet package.[34] In addition to the model incorporating the features of the standard benefit-cost analysis technique, the detailed analysis of the benefit and cost components of the economic analysis was facilitated within two subordinate models. A government revenue model was used to examine the economic benefits of fuel peat developments, while the cost analysis was performed using a government expenditure model. The major elements in the benefit-cost analysis process, including the government revenue and expenditure models developed, are described in this section. The discussion of the benefit-cost analysis framework presented below incorporates a comparison of the structural similarities and differences in the financial and

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[33] The Government of Newfoundland and Labrador sponsored this thesis as a joint government-academic exercise. This was an influencing factor in the decision to examine the benefits and costs of fuel peat developments from that government's perspective. Also, the examination of all public and private costs and benefits of fuel peat developments was considered to be too ambitious an undertaking to attempt in this integrated study.

[34] R.B. Wesson, Perfect Calc (Berkley, California, Columbia Data Products, Inc., 1983).

economic models employed in this thesis.

2.5.1 BENEFIT-COST ANALYSIS FRAMEWORK

Benefit-cost analysis has been used extensively in resource management as a method of evaluating the relative merits of alternative public investment projects.[35] As indicated in Chapter 1, benefit-cost analysis entails little more in principle than adjusting the net revenue flow calculations included in the capital budgeting analysis method to reflect social (i.e., broader economic) rather

[35] See for example, W.R.D. Sewell et al., op. cit., W.R.D. Sewell, "Broadening the Approach to Evaluation in Resource Management Decision Making," in R. Krueger and B. Mitchell eds., Managing Canada's Renewable Resources (Toronto: Methuen, 1977); H.F. Campbell, "A Benefit/Cost Rule for Evaluating Public Projects in Canada," Canadian Public Policy, Vol. 1, No. 2, (1975), pp. 171-175; J.V. Krutilla, "The Use of Economics in Project Evaluation," Transactions of the Fortieth North American Wildlife and Natural Resources Conference (Washington: Wildlife Management Institute, 1975), pp. 374-383; A. Maass, "Benefit-Cost Analysis: Its Relevance to Public Investment Decision," The Quarterly Journal of Economics, Vol. LXXX, No. 2, (1966), pp.208-226; J. Rothenberg, "Cost-Benefit Analysis: A Methological Exposition," E. Struening and M. Guttentag, eds., Handbook of Evaluation Research (Beverly Hills, California: Sage Publication, 1975), pp.55-85; C. Price, "Cost-Benefit Analysis, National Parks and the Pursuit of Geographically Segregated Objectives," Journal of Environmental Management, Vol 5, (1977), pp. 87-97; and G. Schramm, "Accounting for Non-Economic Goals in Benefit-Cost Analysis," Journal of Environmental Management, Vol. 1, (1973), pp. 129-150.

than private (i.e., financial) objectives.[36] As in the capital budgeting analysis model, extensive use is made of discounting to account for the influence of inflation, opportunity costs, risks and the other factors upon the time value of money. The similarity of the benefit-cost analysis and capital budgeting analysis techniques is reflected in the formulae presented below[37] and in Section 2.4.

$$NPVB = \left[\frac{B_0}{(1+k)_0} + \frac{B_1}{(1+k)^1} + \frac{B_2}{(1+k)^2} + \ldots + \frac{B_n}{(1+k)^n}\right]$$

$$= \sum_{t=0}^{n} \frac{B_t}{(1+k)^t}$$

$$NPVC = \left[\frac{C_0}{(1+k)^0} + \frac{C_1}{(1+k)^1} + \frac{C_2}{(1+k)^2} + \ldots + \frac{C_n}{(1+k)^n}\right]$$

$$= \sum_{t=0}^{n} \frac{C_t}{(1+k)^t}$$

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36 Government of Canada, Benefit-Cost Analysis Guide (Ottawa: Treasury Board, 1976), p. 3.

37 After Government of Canada, Benefit-Cost Analysis Guide (Ottawa: Treasury Board, 1976), p.27.

$$NPVP = \left[\frac{(B_0 - C_0)}{(1+k)^0} + \frac{(B_1 - C_1)}{(1+k)^1} + \frac{(B_2 - C_2)}{(1+k)^2} + \ldots + \frac{(B_n - C_n)}{(1+k)^n}\right]$$

$$= \sum_{t=0}^{n} \frac{(B_t - C_t)}{(1+k)^t}$$

Where:

- B is fuel peat development benefits in years 0, 1, 2 . . . n;
- C is fuel peat development costs in years 0, 1, 2 . . . n;
- k is the discount rate;
- NPVB is the net present value of benefits associated with fuel peat development scenarios;
- NPVC is the net present value of costs associated with fuel peat development scenarios;
- NPVP is the net present value of fuel peat development scenarios; and
- t represents time in the shortened equation.

In addition to the change in perspective from the investor in capital budgeting analysis to the regional economy in benefit-cost analysis, only minor variations exist between the two techniques, as modelled in this thesis. Three of these differences are outlined here. The benefit-cost analysis model placed more emphasis upon the distinction between fuel peat development benefits and costs than the capital budgeting model placed on project revenues and expenditures. The main reason for this greater segregation was that the economic benefits and costs were calculated and discounted in subordinate government revenue and expenditure models. The results of this revenue and expenditure analysis were incorporated as benefits and expenditure analysis were incorporated as benefits and costs, respectively, into the conventional benefit-cost analysis framework to facilitate the assessment of the economic feasibility of the two fuel peat development scenarios. In the capital budgeting analysis, both revenue and expenditure related information pertaining to each fuel peat project was directly input into the financial model. Also, discounted net revenue flows, internal rates of return and net present values were generated within the capital budgeting model.

A second structural difference between the two models pertains to the treatment of project and government revenue flows during the year of construction (i.e., year zero in the formulae). The benefit-cost analysis model made no distinction between the capital and operating phases of fuel peat resource developments, since benefits would be derived to and costs borne by the Newfoundland economy and government from the start of construction. In the capital budgeting analysis model, only investment expenditures were factored into the analysis during year zero, because project revenues or savings would result only after the resource development project becomes operational.[38]

[38] For fuel peat production projects, the lead time from the start of bog preparation to the first production is often three years. The construction period for industrial or commercial fuel peat combustion systems is about six months. Most financial and economic problems associated

A third deviation in the capital budgeting analysis and benefit-cost analysis models relates to the reliance on different main indicators of financial and economic feasibility. The prime indicator of the profitability of the ten fuel peat production systems examined in Chapter 6 is the project internal rate of return. Extensive use has also been made of internal rate of return in benefit-cost studies of resource developments,[39] using formulae such as that presented below. This formula is structurally the same as the one used in the capital budgeting analysis model, except for the disaggregation of benefits and costs and the inclusion of benefits in year zero. The internal rate of return of each fuel peat development scenario would be the discount rate which would cause the net present value of benefits and costs to equal zero, and would be calculated by solving the following equation for "r".[40]

$$\left[\frac{(B_0 - C_0)}{(1 + r)^0} + \frac{(B_1 - C_1)}{(1 + r)^1} + \frac{(B_2 - C_2)}{(1 + r)^2} + \ldots + \frac{(B_n - C_n)}{(1 + r)^n}\right] = 0$$

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[39] Sewell et al., op. cit.

[40] After Government of Canada, Benefit-Cost Analysis Guide, p.28.

$$\sum_{t=0}^{n} \frac{(B_t - C_t)}{(1 + r)^t} = 0$$

Where:

B is fuel peat development benefits in years 0,1,2 . . . n;
C is fuel peat development costs in years 0,1,2 . . . n;
r is the internal rate of return associated with each fuel peat development scenario; and
t represents time in the shortened equation.

The reliance upon internal rate of return as a main indicator of the economic feasibility of resource developments is conceptually sound. Practical difficulties relating to the specification of the timing of the many fuel peat production and combustion systems in the two development scenarios and associated government revenues and expenditures, however, prevented the effective use of internal rate of return in the economic analysis presented in Chapter 7. The use of discounted government revenues and expenditures in the economic analysis, reduced the need for annual data.[41] Because of this reduced need for annual data and the inherent difficulties of forecasting the level of fuel peat production and use on a yearly basis, the assumption was made that all production and combustion systems in the two fuel peat development scenarios are

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[41] The use of discounted revenue and expenditure flows removes distortions in the analysis caused by inflation and opportunity costs over time.

started in year zero, and have an economic life of ten years.

Benefit-cost ratios are not as restrained by the lack of information pertaining to the annual flows of government revenues and expenditures as ~~is~~ the internal rate of return method. As a result, benefit-cost ratios have been utilized in this thesis as the main indicator of the financial feasibility of each development scenario. This widely used measure of the relative merits of various development alternatives,[42] is based on the ratio of the net present value of benefits (government revenues) to the net present value of costs (government expenditures). The social discount rate used in the economic analysis was 15 percent, the same percentage as the private discount rate used in the financial analysis.[43] Both the standard benefit-cost ratio formula and the slightly modified version used in this thesis are presented here.

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[42] Sewell et al., op. cit., p. 12.

[43] The rationale for this 15 percent social discount rate is presented in Chapter 7. See, for example, E. J. Mishan, Cost-Benefit Analysis (London: George Alan and Irwin Ltd., 1971).

Standard Benefit-Cost Ratio[44]

$$BCR = \frac{NPVB}{NPVC} = \frac{\sum_{t=0}^{n} \frac{B_t}{(1+k)^t}}{\sum_{t=0}^{n} \frac{C_t}{(1+k)^t}}$$

Where:

BCR is the benefit-cost ratio associated with fuel peat development scenarios;
NPVB is the net present value of benefits associated with fuel peat development scenarios;
NPVC is the net present value of costs associated with fuel peat development scenarios;
B is fuel peat development benefits in years 0,1,2 . . . n;
C is fuel peat development costs in years 0,1,2 . . . n;
k is the discount rate; and.
t represents time.

Modified Benefit-Cost Ratio

$$BCR = \frac{NPVB}{NPVC} = \frac{TNIR}{TRGA}$$

Where:

BCR is the benefit-cost ratio associated with fuel peat development scenarios;
NPVB is the net present value of benefits;
NPVC is the net present value of costs;

[44] After Government of Canada, Benefit-Cost Analysis Guide, p.27.

TNIR is the net present value of government revenues from fuel peat development scenarios (from government revenue model); and

TRGA is the net present value of required government financial assistance associated with fuel peat development scenarios (from government expenditure model).

The modified benefit-cost ratio formula reflects the use of the net present values of Government of Newfoundland and Labrador revenues and expenditures associated with fuel peat developments as proxies for the regional economic benefits and costs of fuel peat developments in Southeastern Newfoundland. The analysis and discounting of monetary flows occurred within subsidiary government revenue and expenditure models. The revenue model is structurally more complex than the expenditure model. Most of the analysis needed to generate discounted government revenues from fuel peat development activities had to be performed within the revenue model. As a result, the revenue model is comprised of three sub-models, including an econometric revenue forecasting sub-model. In contrast, the government expenditure analysis relied almost totally on the outputs from the capital budgeting model and the fuel peat development scenario building effort, resulting in the need for only a three equation model. These models, which were integrated within the overall benefit-cost analysis model framework, are documented below.

2.5.2 GOVERNMENT REVENUE MODEL

The benefits component of the benefit-cost analysis framework used in the economic analysis of fuel peat development prospects in Southeastern Newfoundland is a separate government revenue model, which is comprised of three sub-models. These are: (1) an economy sub-model, (2) a revenue forecasting sub-model, and (3) an equalization sub-model. The economy sub-model computed the incremental effects of fuel peat developments on Newfoundland gross domestic product. These gross domestic product projections were the independent variables which drove the econometric equations in the revenue forecasting sub-model. The equalization sub-model calculated the equalization losses resulting from the additional government revenues, and produced forecasts of net revenue flows to the Government of Newfoundland and Labrador from fuel peat developments. Each revenue sub-model is described below.

2.5.2.1 Economy Sub-model

An economy sub-model was developed and used to compute the direct and indirect incremental effects of the two fuel peat development scenarios on the Newfoundland gross domestic product. The sub-model combined fuel peat investment information presented on a project basis in Chapter 6, with the fuel peat production and combustion project mix scenarios developed in Chapter 7, to derive fuel peat investment projections on a resource development scenario level. The investment information was disaggregated into two categories: (1) machinery and equipment, and (2) construction. This information, along with gross domestic product multipliers from Statistics Canada Input-Output Model of Provincial Economies,[45] and projections of the retail values of fuel peat utilized and petroleum products displaced, were the three inputs into the economy sub-model. The formulae for computing incremental gross domestic product resulting from fuel peat developments are presented here.

(1) $GDPI_t = (M\&E_t * 0.092) + (CON_t * 0.826)$

(2) $GDPU_t = (FPS_t * 0.9) - (DPPS_t * 0.2)$

(3) $GDP_t = GDPI_t + GDPU_t$

Where:

$GDPI_t$ is the annual incremental Newfoundland gross domestic product from fuel peat capital investment;

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[45] Statistics Canada, Input-Output Model of Provincial Economies (Ottawa, 1979).

$M\&E_t$ is the annual cost of machinery and equipment associated with fuel peat production and combustion;

CON_t is the annual cost of construction activities associated with fuel peat production and combustion;

$GDPU_t$ is the annual incremental Newfoundland gross domestic product from fuel peat utilization;

FPS_t is the annual retail value of fuel peat sales from production projects in Southeastern Newfoundland;

$DPPS_t$ is the annual retail value of petroleum products displaced as a result of fuel peat consumption;

GDP_t is the annual incremental Newfoundland gross domestic product from fuel peat capital investment and fuel peat utilization; and

t represents time.

The gross domestic product multipliers of 0.092 for machinery and equipment and 0.826 for construction were derived directly from the Input-Output Model of Provincial Economies.[46] The multipliers 0.9 and 0.2 used for fuel peat and petroleum sales, respectively, were based upon input-output multipliers computed for similar categories of economic activity by Statistics Canada.[47] The economy sub-model was programmed in Perfect Calc.[48]

The computed annual incremental effects of the two fuel peat development scenarios on Newfoundland gross domestic product were important independent variables used in the

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[46] Ibid.

[47] Ibid. Examples of industry categories examined are non-metal mines and quarries, plus petroleum and coal products. Also based on interview with official of Newfoundland Executive Council.

[48] R.B. Wesson, op. cit.

revenue forecasting sub-model to forecast fuel peat induced revenues to the Government of Newfoundland and Labrador.

2.5.2.2 Revenue Forecasting Sub-model

Three of the five major components of the revenue forecasting sub-model were based on the historical relationship between Government of Newfoundland and Labrador revenue yields and provincial gross domestic product. These three revenue categories were retail sales tax, personal income tax and corporate income tax. The historic relationships between revenue and gross domestic product were based on 15 years of data covering the period 1971 to 1985, adjusted for tax base and rate changes.[49] The econometric relationships were obtained by using the simple linear regression technique, with the three revenue classes as the independent variable and gross domestic product as the dependent variable. The simple linear regression formula used in this thesis is presented here.[50]

$$REV_{p} = (B * GDP_{t}) + A$$

[49] Data pertaining to revenues, tax rate and base changes were obtained from the Newfoundland Department of Finance.

[50] After G.B. Norcliffe, op. cit., p. 220.

Where:

REV$_t$ is the annual incremental revenue (retail sales tax, personal income tax or corporate income tax) from fuel peat developments;
GDP$_t$ is the annual incremental Newfoundland gross domestic product from fuel peat developments;
A represents the constant equation coefficient; and
B represents the slope equation coefficient.

Both the constant (A) and slope (B) coefficients[51] were based on the historical linear relationships between gross domestic product and the three dependent revenue variables. The formulae used for calculating the values of the two equation coefficients are presented below.[52]

$$A = \frac{(\Sigma\ REV_t)(\Sigma\ GDP_t^2) - (\Sigma\ GDP_t)(\Sigma\ GDP_t\ REV_t)}{N\ \Sigma\ GDP_t^2 - (\Sigma\ GDP_t)^2}$$

$$B = \frac{N\ \Sigma\ GDP_t\ REV_t - (\Sigma\ GDP_t)(\Sigma\ REV_t)}{N\ \Sigma\ GDP_t^2 - (\Sigma\ GDP_t)^2}$$

Where:

REV$_t$ is the annual government revenue (retail sales tax, personal income tax or corporate income tax) from fuel peat developments;
GDP$_t$ is the annual incremental Newfoundland gross domestic product from fuel peat developments;

[51] The constant equation is often referred to as the y intercept.

[52] After G.B. Norcliffe, op. cit., p. 221.

t   represents time; and
N   represents the number of observations (15 in this thesis).

The basic measures of statistical fit, including coefficients of correlation and determination, as well as standard errors of measurement, were judged acceptable[53] for all three linear regression equations. Revenue forecasting models used to forecast short term government revenues often incorporate multiple regression and other more sophisticated time-series methods.[54] The effectiveness of these techniques for medium and long term predictive analysis is usually restrained by the absence of forecasts of desired economic and demographic independent variables. Sometimes gross domestic product projections are used to generate other economic indicators. This would result in high levels

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[53] Based on interviews with representatives of the Newfoundland Department of Mines and Energy and the Department of Economics, Memorial University of Newfoundland. Additional regressions were run using logarithmic transformations of both the dependent and independent variables. However, the results were not used in this thesis since the improvement in statistical fit for two equations was not considered large enough to warrant the addition of the extra complexity in the revenue forecasting sub-model.

[54] M.D. Intriligator, Econometric Models, Techniques, & Applications (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1978); J. Johnston, Econometric Methods (New York: McGraw-Hill Book Company, 1984); D.G. Mayes, Applications of Econometrics (Englewood Cliffs, N.J: Prentice-Hall International, 1981); C.R. Nelson, Applied Time Series Analysis for Managerial Forecasting (San Francisco: Holden Day Inc., 1973).

of autocorrelation[55] if these linked variables were used in econometric revenue forecasting models. As a result, these economic indicators are not used in this study. The regressions were performed using the Statistical Processing System (SPS) computer analysis package.[56]

Fuel peat royalties comprised the fourth category in the revenue forecasting sub-model. These royalties were calculated separately, based on fuel peat production volume and area estimates, plus existing royalty rates. A final classification included other revenues likely to be impacted either directly or indirectly from fuel peat developments in Southeastern Newfoundland. Mining tax revenues were excluded from this analysis, since they are not likely to be impacted upon by fuel peat developments. This other incremental revenue class was projected using a revenue yield elasticity of 0.8 relative to growth in gross domestic product.[57] This is a slightly more conservative assumption

[55] Autocorrelation refers to the correlation of disturbance terms between different sets of observations or independent variables, as measured by the Durban-Watson test. See, for example, P. Kennedy, op. cit., pp. 73-85; and G.B. Norcliffe, op. cit., pp. 215-243.

[56] G.J. Buhyoff et al., Statistical Processing System (SPS), Version PC4.0, Southeastern Technical Associates, 1982.

[57] Revenue elasticity in this paper refers to the sensitivity of relative growth in Government of Newfoundland and Labrador revenues compared to growth in Newfoundland gross domestic product.

than the elasticities resulting from the three regression linear equations associated with the first three incremental revenue categories, since many small components of this other revenue class would not be influenced by fuel peat developments. The revenue elasticities associated with retail sales, personal income and corporate income tax revenues are 0.8512, 0.9681 and 0.8439, respectively, based on the regression analysis performed. It was not possible to develop a regression equation for other revenues due to the inability of the writer to adjust historical revenue data to account for the maze of tax rate and base changes which have occurred over the last decade. The five revenue forecasting equations, plus a summary equation, are presented here. The constant coefficients in the three linear regression equations are omitted, since incremental fuel peat related revenues, rather than total government revenues, were projected in the revenue forecasting sub-model.[58]

(1) $RST_t = GDP_t * 0.056$

(2) $PIT_t = GDP_t * 0.048$

(3) $CIT_t = GDP_t * 0.007$

(4) $FPR_t = (FPPV_t * \$0.15) + (FPPA_t * \$15.00)$

[58] The computed constant, or y intercept, coefficients for the retail sales, personal income and corporate income tax revenue equations are $56 million, $9.1 million and $7.7 million, respectively.

$$(5) \quad OGR_t = [(BOGR_t * \frac{GDP_t}{BGDP_t}) - BORG_t] * 0.8$$

$$(6) \quad TGR_t = RST_t + PIT_t + CIT_t + FPR_t + OGR_t$$

Where:

GDP_t	is the annual incremental Newfoundland gross domestic product from fuel peat developments (computed in the economy sub-model);
RST_t	is the annual retail sales tax revenue from fuel peat developments;
PIT_t	is the annual personal income tax revenue from fuel peat developments;
CIT_t	is the annual corporate income tax revenue from fuel peat developments;
OGR_t	is the annual other government revenue from fuel peat developments;
FPR_t	is the annual fuel peat royalties from production projects in Southeastern Newfoundland;
$FPPV_t$	is the annual fuel peat production volume in Southeastern Newfoundland (in cubic metres);
$FPPA_t$	is the annual fuel peat production area in Southeastern Newfoundland (in hectares);
$BOGR_t$	is the annual other government revenue without fuel peat developments;
$BGDP_t$	is the annual Newfoundland gross domestic product without fuel peat developments;
TGR_t	is the total annual revenue to the Government of Newfoundland and Labrador from the two fuel peat developments scenarios; and
t	represents time (year).

The computed annual value of revenue flows to the Government of Newfoundland and Labrador from each of the five revenue categories examined in the revenue forecasting sub-model, were incorporated into the equalization sub-model presented below. These outputs were critically important independent variables in the calculation of government equalization losses and net revenues from fuel peat developments.

2.5.2.3 Equalization Sub-model

Newfoundland is one of six provinces that qualify for equalization payments from the Government of Canada.[59] Since equalization payments are based on each province's relative fiscal capacity,[60] any additional government revenue from resource developments in Newfoundland are offset, at least partially, by equalization losses. As a result, the economic analysis of resource developments, such as fuel peat developments in Southeastern Newfoundland, should include an examination of effects on the equalization entitlement.

The equalization sub-model developed and used in this thesis to assess the Newfoundland equalization implications of fuel peat resource developments, incorporated the results of sensitivity analyses performed on much larger and more

[59] The other five equalization recipient provinces are Prince Edward Island, Nova Scotia, New Brunswick, Quebec and Manitoba.

[60] Fiscal capacity is a relative measure of the ability of a provincial government to generate revenues from its economy, given national average tax rates and definition of base.

complex models of the Fiscal Equalization Program.[61] This sensitivity analyses showed that the equalization loss associated with an additional dollar of government revenue averages $0.68, with losses on specific revenue sources ranging from $0.50 for corporate income tax to $1.00 for revenue categories where no other province has a revenue generating capacity. Direct fuel peat fees and royalties would fall into this dollar-for-dollar loss category.

The five components of the equalization sub-model are retail sales tax, personal income tax, corporate income tax, fuel peat royalties and other incremental revenues. This use of the same revenue categories as employed in the revenue forecasting sub-model facilitated the equalization analysis,[62] and allowed for the direct calculation of net government revenue flows. Net government revenue flows refer to incremental revenues to the Government of Newfoundland and Labrador, less associated losses in equalization entitlement. Like the government revenue model and the Newfoundland economy sub-model, the equalization

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[61] These models include the equalization model used by the Government of Canada, which includes detailed calculations of each component of the 39 equalization tax bases for each of the ten Canadian provinces, as well as an equalization forecasting model developed by the Newfoundland Department of Finance.

[62] The outputs from the revenue analysis are a major input into the equalization analysis.

analysis process was programmed in Perfect Calc.[63] The five equalization equations, with net government revenue front-end additions, are presented here. Also provided are the summary equations used to compute annual net government revenues and the net present value of revenue flows to the Government of Newfoundland and Labrador during the economic life of each fuel peat development scenario. The net present value formula was based on the standard discounting technique used in benefit-cost analysis, which is detailed in Section 2.4.[64]

(1) $NRST_t = RST_t - (RST_t * 0.61)$

(2) $NPIT_t = PIT_t - (PIT_t * 0.85)$

(3) $NCIT_t = CIT_t - (CIT_t * 0.50)$

(4) $NFPR_t = FPR_t - (FPR_t * 1.00)$

(5) $NOGR_t = OGR_t - (OGR_t * 0.70)$

(6) $NGR_t = NRST_t + NPIT_t + NCIT_t + NFPR_t + NOGR_t$

(7) $$TNGR = \sum_{t=0}^{n} \frac{NGR_t}{(1 + k)^t}$$

Where:

RST_t is the annual incremental retail sales tax revenue from fuel peat developments (computed in the revenue forecasting sub-model);

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[63] R.B. Wesson, op. cit.

[64] After Government of Canada, Benefit-Cost Analysis Guide, p. 27.

$NRST_t$	is the annual net incremental retail sales tax revenue from fuel peat developments;
PIT_t	is the annual incremental personal income tax revenue from fuel peat developments (computed in the revenue forecasting sub-model);
$NPIT_t$	is the annual net incremental personal income tax revenue from fuel peat developments;
CIT_t	is the annual corporate income tax revenue from fuel peat developments (computed in the revenue forecasting sub-model);
$NCIT_t$	is the annual net corporate income tax revenue from fuel peat developments;
OGR_t	is the annual other government revenue from fuel peat developments (computed in the revenue forecasting sub-model);
$NOGR_t$	is the annual net other government revenue from fuel peat developments;
FPR_t	is the annual fuel peat royalties (computed in the revenue forecasting sub-model);
$NFPR_t$	is the annual net fuel peat royalties from production in Southeastern Newfoundland;
NGR_t	is the annual total net revenue to the Government of Newfoundland and Labrador from fuel peat developments;
$TNGR_t$	is the net present value of total revenues to the Government of Newfoundland and Labrador from fuel peat developments;
t	represents time (year);
n	represents economic life of fuel peat projects; and
k	represents the social discount rate (15 percent).

The net present value of total revenues to the Government of Newfoundland and Labrador from the two fuel peat development scenarios examined in this thesis was the major output from the government revenue model. This information, along with the net present value of the total amount of government financial assistance required to subsidize these resource development scenarios, was incorporated into the benefit-cost analysis framework used in the economic analysis of fuel peat development prospects.

The required amount of government financial assistance was determined in the government expenditure model, described in the next sub-section.

2.5.3 GOVERNMENT EXPENDITURE MODEL

The cost component of the benefit-cost analysis framework used in the economic analysis is a separate government expenditure model. This model is less complex than the government revenue model developed to analyze economic costs, since most of the required expenditure related information was analyzed in the capital budgeting analysis model, detailed in Section 2.4, or resulted from the fuel peat scenario building effort, highlighted in Section 2.2.

In the financial analysis contained in Chapter 6, the capital budgeting analysis model was used to calculate the amounts of government assistance required by each of six different types of fuel peat production systems and four different types of fuel peat combustion systems, in order for each system to satisfy a minimum profitability criterion. This information is a critically important input into the government expenditure analysis. The only other information factored directly into the government expenditure analysis was the number of each category of fuel peat production and combustion systems included in the two development scenarios. These scenarios, which were based on the fuel peat supply and demand analysis, as well as the financial and economic analysis, are presented in Chapter 7. The three equation government expenditure model is illustrated here.

$$RGAP = (P_1 * G_1) + (P_2 * G_2) + . . . + (P_6 * G_6)$$

$$RGAC = (C_1 * G_1) + (C_2 * G_2) + . . . + (C_4 * G_4)$$

$$TRGA = RGAP + RGAC$$

Where:

RGAP is the net present value of required government assistance associated with fuel peat production systems;

RGAC is the net present value of required government assistance associated with fuel peat combustion systems;

TRGA is the net present value of required government assistance associated with fuel peat production and combustion systems;

P represents the number of fuel peat projects in each of the six production categories (from fuel peat development scenarios);

C represents the number of fuel peat projects in each of the six production categories (from fuel peat development scenarios); and

G represents the amount of government financial assistance required by each type of fuel peat production and combustion system (from capital budgeting analysis).

The government expenditure model automatically calculated the net present value of the amount of government financial assistance required to subsidize the two fuel peat development scenarios. The fact that one of the independent variables used in the model had previously been discounted in the capital budgeting analysis model, and that the other information input was a non-monetary value, eliminated the need for built-in discounting formulae. The expenditure model did not take into account any demographic or socio-economic impacts of fuel peat developments in Southeastern Newfoundland, which might indirectly impact upon government expenditure programs. Given the relatively modest size of the two fuel peat development scenarios and the large impact region, it was assumed that the expenditure effects would be small. It is also likely that any additional expenditures would at least be partially offset by the reductions in the need for direct transfers to individuals and businesses. Fuel peat developments could, for example, result in lower social assistance payments and lower subsidies to the private sector, due to increased employment and economic activity, as well as the availability of a less expensive source of energy.

The net present value of government assistance required to finance the two fuel peat development scenarios examined in this thesis was the major output from the government expenditure model. Like the net present value of government revenue flows, computed in the revenue subsidiary model, this information was incorporated into a benefit-cost ratio. As indicated in the introduction to this section, the use of this benefit-cost framework facilitated the systematic economic analysis of fuel peat development prospects in Southeastern Newfoundland.

An analysis of background considerations likely to have a major influence on fuel peat development prospects in Southeastern Newfoundland is presented in Chapter 3.

Chapter 3

ANALYSIS OF BACKGROUND FUEL PEAT DEVELOPMENT CONSIDERATIONS

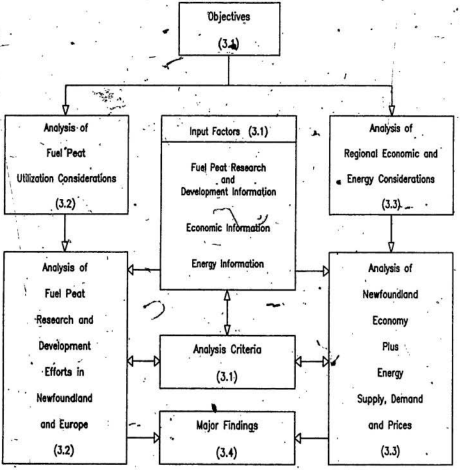
3.1 INTRODUCTION

The analysis of background considerations which affect the development potential of natural resources is an important element in resource analysis. This background analysis also provides the broader context within which the remainder of the resource analysis can be presented. Two categories of background considerations are likely to have major influences on the development of the fuel peat resources of Southeastern Newfoundland. These categories are: (1) fuel peat utilization considerations, and (2) regional economic and energy considerations. The process used to analyze these background considerations is illustrated in Figure 3.1.

An analysis of fuel peat utilization considerations is contained in Section 3.2. The focus is on peatland utilization options, fuel peat research and development efforts and fuel peat utilization in Newfoundland and Europe. The analysis of regional economic considerations,

Figure 3.1

THE PROCESS USED TO ANALYZE BACKGROUND FUEL PEAT DEVELOPMENT CONSIDERATIONS (1)



Note:

(1) Sections are indicated in parentheses.

which involves an examination of the strengths and structure of the Newfoundland economy relative to that of other Canadian provinces, is presented in Section 3.2. Key inputs in this analysis are inter-provincial and sectoral economic statistics, as well as information pertaining to historical and recent economic development efforts in Newfoundland.

Major energy considerations influencing fuel peat development prospects in Southeastern Newfoundland are also examined in Section 3.3. The factors analyzed are the demand, supply and price of petroleum products, electricity and wood. In addition to current and forecasted energy statistics, this analysis incorporates background information pertaining to potential oil and gas and Labrador hydro-electric developments.

Major findings pertaining to the analysis of the two categories of background fuel peat development considerations examined in this study are presented in Section 3.4.

3.2 FUEL PEAT UTILIZATION CONSIDERATIONS

3.2.1 PEAT RESOURCE UTILIZATION OPTIONS

Peat is a heterogeneous substance which occurs throughout the world. It is made up of partially decomposed plant matter and inorganic minerals that have accumulated in wetlands over thousands of years.[1] Peat consists primarily of sphagnum moss, however, sedges and other aquatic plants are prominent in localized areas. Peat varies in colour from yellow to dark brown depending upon the degree of biological decay or humification. The darker, more humified peat is best suited for energy purposes and is referred to as fuel peat in this study. The lighter, less biologically decayed peat, is used primarily for horticultural purposes. When mixed with mineral soil the porous nature of this horticultural peat, which is often referred to as peat moss, enables nitrogen to flow more freely to the roots of planted vegetation. This, plus the ability of horticultural peat to retain up to 27 times its own weight in water, makes this substance a valuable soil conditioner.

In Newfoundland, as elsewhere in the world, the largest potential for peat resource developments are for energy and

[1] D. V. Punwani, "Peat as an Energy Alternative: An Overview," Peat as an Energy Alternative (Chicago: Institute of Gas Technology, 1982), p.2.

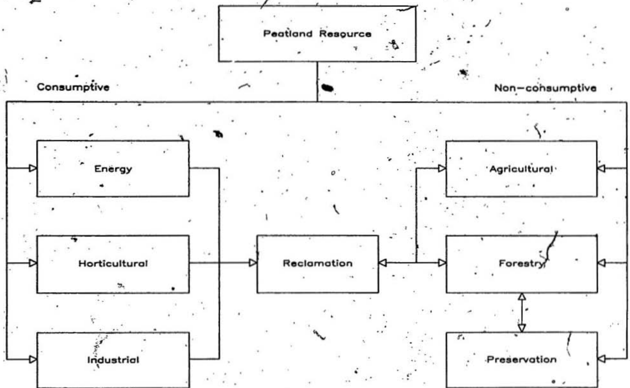
horticultural purposes. Peat resources can also be used for industrial, agricultural and forestry purposes, or can be preserved in their natural condition. In the industrial field, uses for peat include: (1) a filtering agent for removing mercury, pigments and dyes from recycled waste water; (2) an absorbing agent utilized during oil spill cleanups; (3) a raw material in the production of building thermal insulation products, for example, peatboard and peatcrete; (4) a binder for pelletizing iron ore concentrates; (5) an additive in waxes; (6) a waterproofing agent in paints; and (7) an antiseptic for skin and eye disorders. In a non-consumptive mode, peatlands are used for the production of food, feed and fiber crops, including trees. In their natural state, peatlands are the habitat for many species of flora and fauna and are of considerable aesthetic, recreational, scientific and hydrological value.

The six fuel peat resource utilization options are presented in Figure 3.2. Each of the three consumptive resource use alternatives (i.e., energy, horticultural and industrial), will eventually result in the reclamation of the developed site.[2] A fuel peat development site, for example, could later be used for forestry or agricultural purposes, or could be developed into a water reservoir for

[2] Proposals for site reclamation must be approved by the Department of Environment, Government of Newfoundland and Labrador before peatland developments can take place.

Figure 3.2

NEWFOUNDLAND PEATLAND RESOURCE USE OPTIONS



wildlife or recreational purposes. A fuel peat project on a former horticultural peat development site would extend these multiple resource utilization scenarios another step.

The results of a cross-impact analysis of potential peat resource uses are illustrated in Figure 3.3. No two peatland resource utilization options can be classified as being completely compatible. The potential for resource use conflict is extreme when peatland preservation is involved. The only utilization option compatible with preservation under any known scenario is forestry. The size of Newfoundland's peat resource, coupled with the existence of different resource related location determinants for most peatland development alternatives, greatly reduces the probability of non-preservation peatland use conflicts.[3]

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[3] D. Asmussen, "The Minnesota Peat Program," Peat as an Energy Alternative (Chicago: Institute of Gas Technology, 1982), pp. 647-655; A. B. Walters, R.J. King, and S.I. Richardson, "Environmental Issues and Strategies for Peat Energy Developments in the U.S.," Peat as an Energy Alternative (Chicago: Institute of Gas Technology, 1982), pp. 581-593; R.S. Farnham, "Peatland Reclamation," Management Assessment of Peat as an Energy Resource (Chicago: Institute of Gas-Technology, 1980), pp. 189-199; and S. M. Lofton, "Peat: Ecologically Sound Resource Development," Management Assessment of Peat as an Energy Resource (Chicago: Institute of Gas Technology, 1980).

Figure 3.3

POTENTIAL PEAT RESOURCE USE CONFLICTS (1)

Conflict (2)	Energy	Horticultural	Industrial	Agricultural	Forestry	Preservation
Energy	-	P	P	L	L	L
Horticultural	L	-	P	L	L	L
Industrial	L	P	-	L	L	L
Agricultural	P	P	P	-	L	L
Forestry	P	P	P	L	-	P
Preservation	L	L	L	L	P	-

Notes:

(1) Concept based on D. Asmussen, "The Minnesota Peat Program", Peat as an Energy Alternative (Chicago: Institute of Gas Technology, 1982), p. 653.

(2) Likely and possible resource use conflicts denoted by an "L" and a "P", respectively.

3.2.2 FUEL PEAT PRODUCTION AND COMBUSTION

Peat has been used as a residential fuel in Europe throughout recorded history. Since the early twentieth century peat has been an important industrial fuel in the Soviet Union.[4] Between 1950 and 1980, world fuel peat production increased by 91 percent. The largest absolute increase in production occurred in the Soviet Union where production increased from 45 to 80 million tonnes. In Ireland, production increased from 300,000 tonnes in 1950 to 5.6 million tonnes in 1980, for a ten percent compounded average annual increase. Fuel peat production increased by eight percent annually in Finland during that 30 year period. The average annual increase in world fuel peat production between 1975 and 1980 was four percent, compared to 1.8 percent between 1950 and 1975,[5] which was a period of declining real petroleum prices.

Current energy applications of peat are almost exclusively limited to the direct combustion of air-dried milled and sod peat to provide heat, steam and electricity. Milled peat is a loose mixture of three to eight millimetre

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[4] A. M. Radar, "Peat as a Source of Energy - An Overview," Management Assessment of Peat as an Energy Resource (Chicago: Institute of Gas Technology, 1980), p.19.

[5] The Ministry of Trade and Industry of Finland, Report on the Energy Use of Peat (Helsinki, Finland, 1980).

particles mechanically cut from a bog surface. Mechanically produced milled peat, which accounts for an estimated ninety percent of world fuel peat production, is consumed in large industrial boilers and in district heating and electricity plants. Sod peat is mechanically cut and extruded in a cylinder shape from the peat deposits. Sod peat is used for home cooking and space heating, as well as in small to medium size commercial and institutional energy applications.

Even though most of the milled and sod peat produced is consumed in direct combustion heating systems, increasing amounts of dried milled and sod peat are compressed into briquettes and pellets in factories. This densified peat is consumed in the residential energy sector, as is hand cut peat. Considerable peat research and development effort is also being directed towards hydraulic harvesting, chemical dewatering, gasification and production of synthetic fuels.[6] Most of this research is taking place in the United States, Canada, Sweden and Finland.[7]

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[6] Ibid.

[7] Institute of Gas Technology, Peat as an Energy Alternative (Chicago: Institute of Gas Technology, 1982); Institute of Gas Technology, Management Assessment of Peat as an Energy Resource (Chicago, Institute of Gas Technology, 1980), and United States Department of Energy, Peat Prospects (Washington: Department of Energy, 1979).

A geographic breakdown of world fuel peat production is presented in Table 3.1. In 1980 the Soviet Union accounted for 89 percent of the total fuel peat production, followed by Ireland and Finland with six and three percent, respectively. Ninety-five percent of the fuel peat production of the Soviet Union in 1980 was milled peat, which was used mainly for electrical generation. Six million tonnes of briquettes, produced from milled peat, were consumed in the residential energy sector, as were four million tonnes of sod peat.[8] In 1977, peat-fired electricity generation capacity was five gigawatts, which was about two percent of the total electrical energy capacity of the Soviet Union.[9] In Ireland, milled peat used in electrical generation accounts for most of the fuel peat production. In addition, 300,000 tonnes of sod peat are produced annually for consumption in the industrial-commercial and residential energy sectors. Some peat is still manually cut as a residential fuel. About 90 percent of Finland's fuel peat production is milled peat. Fifty percent of this production is consumed in plants producing both electricity and district heat and 30 percent is used in

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[8] The Ministry of Trade and Industry of Finland, op. cit., p.7.

[9] K. Leppa, "Direct Combustion of Peat for Electric Power Generation," Management Assessment of Peat as an Energy Resource (Chicago: Institute of Gas Technology, 1980), p. 28.

Table 3.1

World Fuel Peat Production - 1980 (1)

(thousands of tonnes)

Country	Fuel Peat	Percent
Soviet Union	80,000	88.9
Ireland	5,600	6.2
Finland	3,100	3.4
China	800	0.9
East Germany	250	0.3
Others	250	0.3
Total	90,000	100.0

Note:

(1) Based upon 40 percent moisture content.

Source: The Ministry of Trade and Industry of Finland, Report on the Energy Use of Peat, Helsinki, Finland, p.8.

wood processing industries.[10] The remaining production is sod peat, used in the industrial-commercial and residential energy sectors, or as a raw material in the production of briquettes, pellets and coke.[11]

The use of peat for energy purposes has been heavily concentrated in northern Europe, primarily in the Soviet Union, Ireland and Finland. There have been small scale fuel peat developments in other regions of the world, however, including in Newfoundland.

3.2.3 FUEL PEAT RESEARCH AND DEVELOPMENT IN NEWFOUNDLAND

Interest in the energy potential of Newfoundland's peat resources date back to at least 1865 with the establishment of a plant near Torbay Road which supplied fuel peat to several public institutions in St. John's. According to J. F. Downey, operations closed after two years because the machinery used was not efficient enough to return an adequate profit.[12] Efforts were also made around the turn

[10] K. Sahrman, "Peat Industry in Finland," Energy from Peat, 1982, p.1.

[11] The Ministry of Trade and Industry of Finland, op. cit., p.7

[12] J.F. Downey, Reports on the Uses of Peat to the Minister of Agriculture and Mines (St. John's: Government of Newfoundland, 1909), Newfoundland Provincial Archives:

of the century to stimulate the interest of local businesses in setting up a fuel peat production plant, based on a plant operating in Ontario.[13]

A 1909 Newfoundland Government report by J.F. Downey, for example, documented fuel peat consumption in Newfoundland and the development potential of several peatland areas. According to this report, fuel peat was in fairly common use in the Lamaline area and residents were pleased with both the energy value of this fuel as well as its aesthetic effects. In St. Lawrence, fuel peat supplied the energy needs of the presbytery, the convent and several local residences.[14]

Fuel peat was used in other regions of the province in 1909, including Carbonear and Brigus. Downey concluded that even though the peat deposits in the Conception Bay area were neither large enough, nor of high enough quality, to warrant a mechanized production facility, they could fill the needs of individual residents if they were taught the

Ref. No. GN 2/5 (4A).

[13] J. P. Howley, Report on Mineral Statistics and Mines of Newfoundland (St. John's: Geological Survey of Newfoundland, 1901), and J.P. Howley, Report on the Mineral Resources of Newfoundland (St. John's: Newfoundland Government Report, 1902).

[14] J. F. Downey, op. cit.

necessary harvesting skills.[15] In 1910, four peat cutters from Ireland taught peat harvesting techniques in 39 Newfoundland communities.[16]

Many speculators had applied for Newfoundland Government grants for large areas of peatlands, however, Downey recommended that the Government exercise caution in conceding these grants to ensure an adequate fuel peat supply at low cost for all communities.[17] From 1910 to 1914 the Newfoundland Government was actively engaged in negotiations with several companies regarding potential fuel peat developments,[18] however, no major projects materialized from these efforts.

Interest in the energy potential of Newfoundland peatlands surfaced again in the late 1930s. A 1939 Newfoundland Government report by F. Viquers indicated that hand cutting techniques were employed in Bay de Verde, Bonavista and along the Southern Shore. Residents of these areas cut a large quantity of peat, but adverse weather

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[15] Ibid.

[16] E. Bourte, D. Carr, J. Ryan, and J. Hughes, Peat as a Fuel, Unpublished Government of Newfoundland Report, St. John's, Archive Ref. 004922, 1910.

[17] J. F. Downey, op. cit.

[18] Letters in Newfoundland Archives, GN 215-16A, B, 76 B.D.

conditions prevented it from drying properly. Viquers also stated that the residents of St. John's expressed a great deal of interest in acquiring fuel peat, and suggested that a fuel peat production plant be established. He also claimed that peat would burn in any kind of stove, provide an even controlled heat, and in no way pose a safety hazard.[19] Another 1939 report to the Newfoundland Government, by P. B. Wallheimer,[20] recommended that a Newfoundland Peat Development Board be established. There is no evidence of any official follow up to this recommendation.[21]

Dr. A.A. Loddersol, a Norwegian scientist who visited Newfoundland in 1955 to make recommendations on how the bogland reserves could be best utilized, made reference to fuel peat use on the Burin Peninsula.[22] He stated that the population in the Lamaline area had used large amounts of

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[19] F. Viquers, Peat Bogs in Newfoundland, Unpublished Government of Newfoundland Report, St John's, 1939.

[20] P.B. Wallheimer, Report on Peat, Avalon Peninsula, Newfoundland, Unpublished Government of Newfoundland Report, St. John's, Archive Ref. Nfld. 327, 1939.

[21] R. F. Gosine, "Peat Fuel Data Base for Newfoundland," The Diversity of Peat F.C. Pollett, A.F. Rayment, and A. Robertson eds. (St. John's: Newfoundland and Labrador Peat Association, 1980), p. 74.

[22] A. A. Loddersol, Report on the Investigation and Utilization of the Bogs of Newfoundland, Unpublished Government of Newfoundland and Labrador Report, St John's, 1955.

fuel peat for many years and considered it to be a very satisfactory energy source. Loddersol claimed that the peat on the Burin Peninsula was of excellent fuel quality. In the late 1950s, an attempt was made to start a larger scale fuel peat operation at Lamaline which would include a peat-fired furnace at the local school. Expected financial support for this operation never materialized, and the project never got beyond the initial stages. E. Lear reported that some peat was being used as a domestic fuel on the Burin Peninsula when he did his peatland survey work on the Burin Peninsula in 1960.[23]

Interest in fuel peat was strongest between 1900 and 1914, around 1939 and during the period 1954 to 1960. In between, there is little documented evidence of concerted efforts by either the public or private sector to develop the Newfoundland peat resource for energy purposes. Lamaline and St. Shotts appear to be the only communities where fuel peat has been utilized extensively for extended periods. C.R. Gillespie, in a 1954 report, postulated that the main reason that the use of fuel peat was not more widespread was that the peat harvesting season conflicted with the fishing season, leaving insufficient time for peat

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[23] F. C. Pollett, Peat Resources of Newfoundland (St. John's: Newfoundland Department of Mines and Resources, 1968), p.3.

harvesting.[24] With the advent of rural electrification and the presence of readily available supplies of inexpensive petroleum products, the use of peat as a fuel had become almost totally non-existent by the late 1960s. During the 1960s, a considerable amount of peat research was conducted in Newfoundland, especially by the then Newfoundland Department of Mines, Agriculture and Resources. A 1968 study, for example, examined the location, area, quantity, and biological and geological characteristics of peat deposits in six regions of Newfoundland, including the Avalon Peninsula.[25] In addition to peatland resource analysis, several research and development projects aimed at utilization of peatlands for crops and as pastureland, were initiated by the Canadian and Newfoundland agricultural departments. Many of the key actors involved in this research were driving forces in the organization of a successful peat conference at Memorial University of Newfoundland in 1977,[26] and the subsequent formation of the Newfoundland and Labrador Peat Association.[27]

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[24] C. R. Gillespie, <u>Preliminary Report on Peat Investigations in Newfoundland</u>, Unpublished Government of Newfoundland Report, St. John's, 1954, p. 5.

[25] F.C. Pollett, <u>op. cit</u>.

[26] F. C. Pollett, A.F. Rayment and A. Robertson, eds., <u>The Diversity of Peat</u> (St. John's: Newfoundland Labrador Peat Association, 1979).

[27] In 1985, the Newfoundland and Labrador Peat Association was the largest provincial peat association in Canada. This information was obtained during an interview

Since 1978, several research and development projects aimed at peat resource analysis and fuel peat production and combustion have been completed, or are currently ongoing. On the supply side, a six phase peatland inventory for the Island of Newfoundland was carried out between 1978 and 1984. This inventory involved the mapping of all peatlands greater than five hectares and the compiling of information on the extent of peat deposits as well as the type and volume of peat.[28] In addition to this resource inventory program, which is described in more detail in Chapter 4, two mechanized fuel peat demonstration projects have provided valuable insight into sod and milled fuel peat production systems as well as fuel peat combustion in the residential and large industrial energy sectors.

In 1979, a milled peat project was started at High Point Bog in Bishop's Falls. Between 1981 and 1983, 5,000 tonnes of fuel peat was produced from this 50 hectare production site.[29] A major result of this project was detailed cost and technical information pertaining to the

with an executive member of the Newfoundland and Labrador Peat Association, 1986.

[28] The peatland inventory program was carried out by Northland Associates Limited for the Newfoundland Departments of Forest Resources and Lands (Phases I to V) and Mines and Energy (Phase VI), between 1978 and 1984.

[29] Information obtained during a personal interview with an official of the Newfoundland Department of Mines and Energy, 1986.

feasibility of harvesting milled peat, its transportation and use as a substitute for heavy fuel oil at the Abitibi-Price Company Limited's pulp and paper mill at Grand Falls. This quantitative information was integrated into the financial analysis of fuel peat developments,[30] but it was not disaggregated due to the confidential nature of the information.[31]

In addition to financial and technical considerations, the environmental and socio-economic impacts of this operation were closely monitored. As a result of visits to European fuel peat production sites, the input of peat consultants, and the review of reports written on peat operations in Canada and Europe, the project developers were aware of most of the potential environmental problems which might be encountered at the Bishop's Falls site, and were able to implement appropriate mitigative measures. Prior to development at the site a team of researchers from the Newfoundland Departments of Mines and Energy, Environment and Culture, Recreation and Youth, plus Newfoundland and Labrador Hydro, the Faculty of Engineering at Memorial University of Newfoundland and Environment Canada, established an environmental monitoring program for the

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[30] See Chapter 6.

[31] Private sector involvement in the Bishop's Falls project restricts the publication of detailed technical and cost information, due to confidentiality requirements.

project.[32] During the project implementation phase, the researchers monitored: (1) water levels and quality (including acidity levels, turbidity, suspended solids and mineral content); (2) dust levels in the air; (3) impact on vegetation; (4) wildlife patterns in and around the fuel peat development site, as well as (5) the socio-economic impact of the project.[33]

Reports prepared by the research team indicated that the acidity levels and mineral content near the drainage entrances to the river were affected by the bog runoff. Tests done on water quality two kilometres downstream from the production site, however, showed that the acidity levels and mineral content had reverted to normal. These reports also indicated that there were no negative effects on the wildlife population in the area.[34] The surface vegetation from the peat bog was removed to provide access to the fuel peat underneath, however, there was no impact on vegetation on fields adjacent to the production site. High Point Bog is sufficiently far from populated areas to avoid concern

[32] The writer was the initial coordinator of this environmental monitoring program.

[33] Particular attention was paid to water quality because drainage ditches from the site flow into the Exploits River, a major river flowing through central Newfoundland.

[34] The sloped field ditches allowed animals to travel across the peat production fields.

about dust created from the dried peat. The dust posed some problems, however, for employees at the production site, resulting in the need to wear dust masks when levels were high.

The 5,000 tonnes of fuel peat produced at Bishop's Falls was burnt in a hog fuel boiler in the Grand Falls paper mill. A problem was experienced with incomplete combustion in the boiler as a result of the lower weight of fuel peat, relative to bark and wood chips. As a result, there was combustion in the smoke stacks and high levels of emissions in 1981.[35]

Overall, the project has been regarded positively by the population of Bishop's Falls because of the employment created and resultant economic spin-offs. Some minor problems were encountered with the Bishop's Falls Town Council during the early stages of development. The Council was of the opinion that the project operator was hiring

[35] This problem would be avoided by technical modifications to the boiler (i.e., installation of a down-draft system) as well as by mixing peat and wood chips. The author visited the Grand Falls mill on three occasions during 1981 and 1982 when peat was being consumed. Personal interviews were held with management and engineering staff at the paper mill.

workers from outside communities when the necessary skills existed in Bishop's Falls.[36]

The Bishop's Falls fuel peat project was funded by the Department of Energy, Mines and Resources, Government of Canada, and the Newfoundland Department of Mines and Energy through the Canada-Newfoundland Agreement on the Development and Demonstration of Renewable Energy and Energy Conservation Technologies. Financial backing was also provided by Noval Technologies Limited, Lundrigans Limited and Memorial University of Newfoundland.

A sod peat demonstration project was started at St. Shotts on the southern end of the Avalon Peninsula in 1982. A ten hectare site was developed, with the aim of annually producing 1,000 tonnes of fuel peat for consumption in households and small commercial and institutional facilities in St. Shotts-Trepassey area. Between 1981 and 1983, approximately 2,500 tonnes of fuel peat was produced at St. Shotts, and was sold in both the immediate market area and St.John's.

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[36] This was mainly a perception problem, since most of the outside workers were technical personnel employed directly by one of the project partners who was working in other projects in the area, and only temporarily loaned to the peat project to perform surveying and other specialized tasks. This was resolved in 1981, partially as a result of the mediation efforts of the writer between the town council and the operator.

The project has tested peat production equipment from Finland and Ireland. The best results have been achieved with the Irish equipment and indicate that the annual production yields would be approximately 100 tonnes per hectare.[37] Product quality, however, has posed problems. The ideal moisture content for sod peat is between 35 and 40 percent,[38] but the sod peat produced at St. Shotts has averaged over 50 percent moisture content. The higher moisture content makes the peat difficult to ignite, causes breakage in storage and increases transportation costs. The project developers have identified several reasons for the higher moisture content, including excessive rainfall during the production seasons, improper ditch design and premature production.[39]

Funding for the demonstration phase of this project was provided through the Canada-Newfoundland Agreement on the Development and Demonstration of Renewable Energy and Energy Conservation Technologies, and by the Department of Employment and Immigration, Government of Canada and the

[37] This compares with production rates of 150 tonnes per hectare in Finland and Ireland.

[38] On a wet basis scale.

[39] In Ireland and Finland it is an accepted practice to wait five years after ditching before production begins. In St. Shotts production started one year after re-ditching. The site had been partially drained in the 1960s for community pastureland purposes.

Newfoundland Department of Rural, Agricultural and Northern Development. The project was managed by the Southern Avalon Development Association.

As a part of the long term development strategy for the project, the Newfoundland Department of Mines and Energy commissioned a study in 1983 to determine the combustion characteristics of sod peat obtained from the St. Shotts project, relative to softwood when burnt in residential wood stoves.[40] In 1984 this department, along with Fishery Products Limited, also engaged fuel peat consultants from Finland to assess the technical and economic feasibility of using sod peat to displace petroleum products burnt for process heat at a large fish processing plant at Trepassey. This study also included a brief evaluation of electricity co-generation and sod peat supply. This study concluded that fuel peat conversion would be financially viable if peat could be supplied at a significantly lower cost than petroleum.

In addition, a fuel peat marketing study was conducted for the St. Shotts project in 1984. This report examined the residential fuel peat demand, and proposed marketing strategies. The St. Shotts fuel peat project, plus the two

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[40] G. M. Trivett, Determination of the Combustion Characteristics of Newfoundland Peat (Halifax, 1983).

related consultants' studies provided a large amount of technical and cost data which is integrated into this study. Also, it provided valuable insights into the overall development potential of fuel peat in Southeastern Newfoundland.

In the residential fuel peat combustion field, Terra Nova Power and Development Limited designed and produced prototypes of a peat burning stove in 1980 and 1981. This appliance, which was certified by the Underwriters Laboratory of Canada Limited as a safe wood and peat burning appliance in 1981, has the distinction of being the first officially certified peat burning stove in Canada.[41]

The analysis of peatland utilization options, fuel peat utilization and fuel peat research and development efforts indicates that commercial fuel peat production and combustion is technically feasible in Newfoundland. The Southeastern Newfoundland climate could cause problems for drying milled peat. However, technological solutions, such as improved ditching and longer drainage periods before production, are possible. Environmental concerns can be minimized through proper site selection and implementation of proper monitoring procedures and mitigative measures.

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[41] The focus of the peat related research of this Newfoundland company was the development of an absorbent for use in marine oil spill clean-ups.

The broad analysis of fuel peat utilization presented in this section reveals no obvious impediments to fuel peat resource developments in Southeastern Newfoundland. In addition, fuel peat research and development activities which have taken place in Newfoundland since the mid-1970s provide most of the information inputs on which a systematic analysis of the development potential of the resource can be based.

3.3 REGIONAL ECONOMIC AND ENERGY CONSIDERATIONS

3.3.1 ANALYSIS OF THE NEWFOUNDLAND ECONOMY

Economic disparities between provinces is a recognized and quantifiable facet of the Canadian economy. The three macro-economic indicators presented in Table 3.2 and Figures 3.4 to 3.6 illustrate the magnitude of these regional disparities, especially between the economies of Newfoundland and the other Canadian provinces. The indicators presented are gross domestic product, personal income and employment dependency factor.

Gross domestic product is a measure of the value of goods and services produced within the boundaries of a geographic area during a defined time period. Gross domestic product values presented in this study are based upon the returns to

Table 3.2

SELECTED ECONOMIC INDICATORS - 1984

	Per Capita Gross Domestic Product (1)	Per Capita Personal Income (2)	Employment Dependency Factor (3)
Canada	$15,631	$14,412	0.71
Newfoundland	9,411	9,702	1.40
Prince Edward Island	9,029	10,310	0.86
Nova Scotia	10,885	11,893	0.97
New Brunswick	10,041	10,734	1.08
Quebec	13,186	13,487	0.82
Ontario	16,447	15,841	0.60
Manitoba	14,221	13,743	0.66
Saskatchewan	16,399	13,006	0.64
Alberta	24,903	15,376	0.55
British Columbia	15,518	14,778	0.81

Notes:

(1) Statistics Canada, System of National Accounts, Provincial Economic Accounts, 13-213.
(2) Statistics Canada, System of National Accounts, National Income and Expenditure Accounts: The Annual Estimates, 13-201.
(3) The average number of persons fifteen years and older supported by each person employed.

Figure 3.4
GROSS DOMESTIC PRODUCT PER CAPITA – 1984

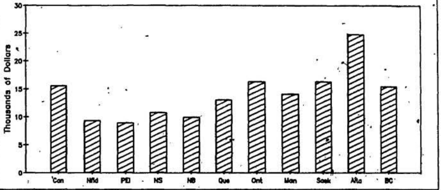


Figure 3.5
PERSONAL INCOME PER CAPITA – 1984

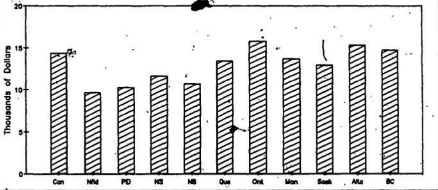
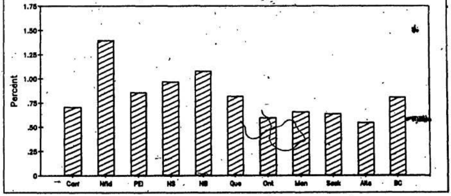


Figure 3.6
EMPLOYMENT DEPENDENCY FACTOR – 1984



the factors of production, including wages, corporate profits and investment income, plus the non-factor cost of capital cost allowances.[42] In 1984, Newfoundland's per capita gross domestic product was only $9,416 which was the second lowest of any Canadian province, and only 60.2 percent of the all-province average. Newfoundland also has the lowest per capita personal income in Canada.

The provincial employment dependency factor[43] reflects high unemployment and low labour force participation rates in Newfoundland. In 1983, the unemployment rate in Newfoundland averaged 18.8 percent, compared to 11.9 percent for Canada. The labour force participation rate during that year was 52.1 percent in Newfoundland, and 64.4 percent nationally.[44] The Newfoundland employment dependency factor in 1984 was 1.40, compared to 1.08 for New Brunswick, the province having the second highest dependency factor. The dependency factor for Canada was 0.71. Despite social and cultural differences between Newfoundland and the more urbanized and industrialized provinces, most of the variances in employment dependency factors are attributed to

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[42] Statistics Canada, Gross Domestic Product at Factor Cost, By Industry, Newfoundland, 1963-1983, 64-202.

[43] Employment dependency factor is the mean number of persons fifteen years and older supported by each person employed.

[44] Statistics Canada, Labour Force Annual Averages, 71-529.

economic factors. This is supported by the high negative correlation between provincial employment dependency factors and gross domestic product, evident in Table 3.2.

The poor performance of Newfoundland on all three macro-economic indicators, shows the high level of regional economic disparity and the tremendous need for increased levels of economic activity and employment in the province. Post 1900 economic development efforts are briefly examined below. This analysis highlights the negative influences of locational, demographic and other geographic factors upon the economy of Newfoundland.

3.3.1.1 ECONOMIC DEVELOPMENT EFFORTS

The development of the mining,[45] fishing, forestry and hydroelectric resources, plus associated processing industries, has been the primary focus of the Government of Newfoundland and Labrador development policies since 1900.[46] A major aberration from this resource orientation occurred during the period 1934 to 1955. The Commission of

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[45] Including offshore oil and gas resources.

[46] The Grand Falls pulp and paper mill was started in 1905 and an industrial development policy aimed at keeping workers in Newfoundland was announced in 1908. S.J.R. Noel, Politics of Newfoundland (Toronto: University of Toronto Press, 1971), pp. 58 and 104.

Government, which governed Newfoundland from 1934 to 1949, directed most of its energies towards social programs and placed little emphasis upon industrialization.[47] Between 1949 and 1955, the Government of Newfoundland and Labrador funded a major economic development program aimed mainly at the development of labour intensive manufacturing industries catering to the large North American market, as well as to the Newfoundland market.[48]

Most of the industries started under this economic development program were unsuccessful. Factors which contributed to the failure of specific industries included poor management, obsolete equipment, unskilled labour and high labour costs. High handling and transportation costs, coupled with the long distances to mainland markets and the need to import most of the required raw materials, spelled the doom of most of the exogenous market-oriented operations.[49]

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[47] The establishment of American and Canadian military bases resulted from Newfoundland's strategic location in the North Atlantic in the 1930s and 1940s. The Commission of Government was not actively involved in negotiations leading up to the development of these military bases. See, for example, Economic Council of Canada, Newfoundland: From Dependency to Self-Reliance (Ottawa: Supply and Services Canada, 1980).

[48] S.J.R. Noel, op. cit., p. 276.

[49] See, for example, Economic Council of Canada, op. cit., p.7.

The opportunities for market-oriented industries in Newfoundland are limited because of the small provincial market[50] and the physical isolation from major North American markets.[51] The recent history of economic development in Newfoundland is reflected in the structure of it's economy, which is examined in the next sub-section. This analysis highlights the relatively heavy dependence of the Newfoundland economy upon natural resources.

3.3.1.2 STRUCTURE OF THE NEWFOUNDLAND ECONOMY

The Newfoundland economy, like the economies of most Canadian provinces, is dominated by the service sector (Table 3.3). This sector accounted for 64 percent of the Newfoundland 1983 gross domestic product (Table 3.4) and 69.5 percent of the 1983 employment (Table 3.5).

The primary resource sector contributed 934 dollars per capita to the Newfoundland economy in 1983, which was 12.2

[50] The population of Newfoundland in 1981 was 567,681, which was dispersed over 404,517 square kilometres. Statistics Canada, Estimate of Population Projection for Canada and the Provinces, 91-201.

[51] Despite the small size of the local market, there are several endogenous market-oriented manufacturing industries operating in Newfoundland, primarily food and beverage industries. Other market-oriented manufacturing operations include wood processing, cement, and concrete products and shipyard industries.

Table 3.3

PROVINCIAL PER CAPITA GROSS DOMESTIC PRODUCT BY INDUSTRY - 1982 (1)

Province	Resource Industries	Manufacturing Industries	Other Goods Producing Industries (2)	Service Industries	Total
Canada	$ 1,217	$ 2,388	$ 1,150	$ 8,595	$ 13,387
Newfoundland	935	850	969	4,912	7,931
Prince Edward Island	872	513	556	5,739	7,832
Nova Scotia	559	1,184	791	6,492	9,122
New Brunswick	526	1,217	866	6,122	8,625
Quebec	393	2,407	1,027	7,459	11,383
Ontario	460	3,491	946	8,854	13,719
Manitoba	1,168	1,524	889	8,637	12,148
Saskatchewan	4,033	658	1,051	8,837	14,424
Alberta	5,966	1,348	2,319	11,508	21,550
British Columbia	989	1,808	1,356	10,059	14,013

Notes:

(1) Gross Domestic Product at factor cost.
(2) Includes construction plus electric power, gas and water utilities.

Source: Statistics Canada, System of National Accounts, Gross Domestic Product by Industry, 61-202 and System of National Accounts, Provincial Economic Accounts: Experimental Data, 13-213.

Table 3.4

NEWFOUNDLAND GROSS DOMESTIC PRODUCT BY INDUSTRY - 1982 (1)

(millions of dollars)

Industry	Gross Domestic Product	Percent
Resource:		
Mining	334.2	7.5
Fishing	122.6	2.7
Forestry	55.4	1.2
Agriculture	19.3	0.4
Sub-Total	531.5	11.9
Manufacturing:		
Fish Processing	174.1	3.9
Pulp and Paper	147.5	3.3
Other Manufacturing (2)	161.9	3.6
Sub-Total	483.5	10.8
Other Goods Producing (3)	551.1	12.3
Service (4)	2,905.0	65.0
Total	4,471.1	100.0

Notes:

(1) Gross domestic product at factor cost.
(2) Food and beverage industries represent the largest component of this industrial classification.
(3) Includes construction plus electric power and water utilities.
(4) Includes transportation, trade, services and public administration.

Source: Statistics Canada, System of National Accounts Gross Domestic Product by Industry, 61-202.

Table 3.5

NEWFOUNDLAND EMPLOYMENT BY INDUSTRY - 1983

Industry	Employment (man-years)	Percent
Resource:		
Mining	4,000	2.3
Fishing	10,000	5.8
Forestry	2,000	1.1
Agriculture	1,000	0.6
Sub-Total	17,000	9.8
Manufacturing:		
Fish Processing	9,000	5.2
Pulp and Paper	2,000	1.1
Other Manufacturing (1)	12,000	6.9
Sub-Total	23,000	13.2
Other Goods Producing (2)	13,000	7.5
Service (3)	121,000	69.5
Total	174,000	100.0

Notes:

(1) Food and beverage industries represent the largest component of this industrial classification.
(2) Includes construction plus electric power and water utilization.
(3) Includes transportation, trade, services and public administration.

Source: Newfoundland Statistics Agency, Unpublished Data.

percent of the total per capita value of goods and services produced. Newfoundland ranked eighth highest among the ten provinces in terms of resource share of gross domestic product and sixth highest with respect to per capita output value. The rank differential reflects the low per capita gross domestic product of the Province. Output and employment in the resource sector is dominated by the mining, fishing and forestry industries. The labour intensive fishing industry accounted for 59 percent of the 17,000 man-years of employment in the resource sector in 1983. Sixty-three percent of the value of output, however, came from the capital intensive mining industry, mainly from the iron ore mines in western Labrador.[52]

The Newfoundland per capita value of goods produced in the manufacturing sector was only 36 percent of the national average. The resource based fish processing and pulp and paper industries accounted for two-thirds of this production, while the food and beverage industry, which caters almost exclusively to the Newfoundland market, was the third largest component of the manufacturing sector. Fish processing, like the primary harvest of fish, is very labour intensive, yielding 9,000 man-years of employment in

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[52] Eighty-seven percent of the 1983 total value of mineral shipments of 690 million dollars was iron ore mined in western Labrador. Statistics Canada, General Review of the Mineral Industry, 26-201.

1983. The construction and electric power industries comprised 60.2 and 38.6 percent of the value of 1983 output from the other goods producing sector, respectively. In 1982, 97.2 percent of the total electric power produced in the Province was hydro generated.[53]

In summary, primary resource and resource-oriented fish processing, paper manufacturing and hydro-electric generating industries accounted for 67.2 percent of the non-service components of the Newfoundland 1983 gross domestic product. The development potential of all major Newfoundland natural resources should be analyzed, especially given this resource dominance, along with the relatively weak economy, unsuccessful attempts in the past to develop export oriented manufacturing industries, and diseconomies-of-scale and population constraints associated with endogenous market oriented manufacturing. The development of the fuel peat resources of Southeastern Newfoundland would therefore be viewed favourably from a Newfoundland regional economic perspective.

The influence of Newfoundland energy considerations on fuel peat development prospects in Southeastern Newfoundland is analyzed in Section 3. This analysis incorporates the

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[53] Statistics Canada, Household Facilities and Equipment, 57-202.

current and medium term outlook pertaining to the supply, demand and price of petroleum products, electricity and wood.

3.3.2 ANALYSIS OF NEWFOUNDLAND ENERGY CONSIDERATIONS

3.3.2.1 CONVENTIONAL ENERGY SUPPLY, DEMAND AND PRICES

Imported petroleum products accounted for 71 percent of the 1984 Newfoundland conventional energy[54] requirements of 105,744 terajoules (Table 3.6).[55] The two major factors influencing the degree of reliance upon imported petroleum products are: (1) the lack of developed Newfoundland petroleum resources; and (2) the location of hydro-electric capacity relative to energy demand, given the physical separation between the Island of Newfoundland and Labrador.

The development of the oil and gas resources off Newfoundland's north and east coasts could conceivably solve the petroleum supply problem in the Province. A long-term agreement on the joint management of offshore oil and gas

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[54] Conventional energy includes petroleum products, electricity, coal and coke, but excludes wood and fuel peat which are considered alternative energy sources.

[55] Statistics Canada, Quarterly Report on Energy Supply-Demand in Canada, 57-003.

Table 3.6

NEWFOUNDLAND CONVENTIONAL ENERGY DEMAND BY SECTOR - 1984

(terajoules)

	Petroleum Products (1)	Electricity	Other (2)	Total
Residential (3)	8,270	7,768	123	16,161
Mining	10,031	7,393	0	17,424
Pulp and Paper	4,671	7,387	0	12,058
Other Industrial	2,704	3,309	48	6,061
Commercial (4)	20,565	4,859	97	25,521
Transportation	28,498	1	21	28,519
All Sectors	74,738	30,717	289	105,744

Notes:

(1) Includes motor gasoline, kerosene, stove oil, diesel fuel oil, light fuel oil, heavy fuel oil, aviation gasoline and aviation turbo fuel.
(2) Includes coal, coke, propane, butane and ethane.
(3) Includes agriculture.
(4) Includes public administration and other institutional.

Source: Statistics Canada, Quarterly Report on Energy Supply-Demand in Canada, 57-003.

development was signed on February 11, 1985 between the Governments of Canada and Newfoundland and Labrador. This agreement, the Atlantic Accord, removed most of the jurisdictional hindrances to offshore oil and gas development. The average annual 8.5 percent decrease in real world oil prices between 1981 and 1985[56] and the major decline in petroleum consumption in most industrialized nations since 1980,[57] however, have reduced the financial attractiveness of offshore energy developments and have resulted in a large amount of concern with respect to development prospects in the 1980s. There is also uncertainty about whether or not offshore oil will be transported to Newfoundland, either in a crude or refined form, after production begins.

Most of the developed and potential hydro-electric generating capacity of the Province exists on the rivers flowing off the Labrador Plateau, especially on the Churchill River. In 1982 the one major developed site in Labrador, at Churchill Falls, accounted for 80 percent of

[56] The average annual costs of petroleum crude imports at Montreal deflated by Canadian consumer price index. Department of Energy Mines and Resources, Government of Canada, 12S/0508E/1, and Statistics Canada, Consumer Price and Price Indexes, 62-010.

[57] Canadian demand for petroleum products dropped from 4,151 petajoules in 1979 to 3,178 petajoules in 1984, a decline of twenty-three percent. Department of Energy Mines and Resources, Government of Canada, 12S/0508E/1..

the hydroelectricity production of the Province. The Island of Newfoundland, however, has 95 percent of the provincial population[58] and accounts for an estimated 90 percent of total energy consumption.[59]

Despite hydro-electric developments at Bay d'Espoir, Deer Lake, Hinds Lake and Godaleich, 43 percent of the electricity consumed on the Island of Newfoundland in 1983 was produced thermally in petroleum fueled generating units, mainly at Holyrood.[60] The Cat Arm project, which was completed in 1985, occupies the last large economically viable hydro-electric site on the Island of Newfoundland. Small hydro projects offer some potential for development, in regions not connected to the main electricity transmission grid. The capital intensive nature of small hydro developments, combined with diseconomies-of-scale relative to larger electricity generating projects and the need for petroleum fueled back-up systems, reduce the financial attractiveness of small hydro projects.

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[58] Statistics Canada, Estimates of Population Projections for Canada and the Provinces, 91-201.

[59] Personal communication with Newfoundland Department of Mines and Energy, 1986.

[60] Newfoundland and Labrador Hydro has three 150 megawatt petroleum fueled generating units at Holyrood.

The capital cost of the 1,000 kilometre electricity transmission link between St. John's and the most attractive undeveloped hydro-electric sites at Gull Island and Muskrat Falls on the Churchill River is estimated at $1.5 billion. The capital cost of developing the 1,700 megawatt Gull Island project is estimated to be $3.3 billion, while the 800 megawatt Muskrat Falls site is costed at $2 billion.[61] Such high capital costs, as well as uncertainties pertaining to the export of surplus electricity generated and the unstable investment climate thus far in the 1980s, are among the major factors which have prevented the development of these projects.

The most viable medium-term electrical energy option, from the Newfoundland perspective, would be to gain access to an increased percentage of the existing output from the Churchill Falls generating station, thereby restricting capital costs to the transmission component. To date, however, the Government of Newfoundland and Labrador has been unsuccessful in attempts to renegotiate a 65-year contract, between Churchill Falls Labrador Corporation and Hydro-Quebec, which was signed in 1969.[62]

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[61] Information obtained during a personal interview with an official of the Economic Analysis Department, Newfoundland and Labrador Hydro, 1984.

[62] Under the terms of this contract, approximately 85 percent of the electricity produced at Churchill Falls is committed to Quebec at prices which are approximately ten

World petroleum prices increased by an average of 18.9 percent annually in real terms between 1977 and 1981,[63] resulting in high conventional energy prices in most countries. During that period, conventional energy prices in St. John's increased by an average annual real growth rate of 6.6 percent.[64] The 8.5 percent mean annual decline in real world petroleum prices experienced between 1981 and 1985[65] is not expected to be a long-term phenomenon, and most petroleum analysts predict that real prices will rebound to 1985 levels by the early 1990s.[66] The prime factor causing the current decline in real world prices has been a decreased energy demand in most industrialized nations,[67] mainly as a result of price induced energy

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percent of the current market value for electricity in Canada. This contract does not have a price escalation clause, and has a provision for a 50 percent price reduction by the year 2026.

[63] Department Energy, Mines and Resources, Government of Canada, 125/0508E/1 and Statistics Canada, Consumer Price and Price Indexes, 62-010.

[64] Statistics Canada, Consumer Price and Price Indexes, 62-010.

[65] Department of Energy Mines and Resources, Government of Canada, 12S/0508E/1.

[66] Personal communication with Woods-Gordon, Clarkson Gordon, Department of Energy Mines and Resources, Government of Canada and Newfoundland Petroleum Directorate, 1985.

[67] In Canada, total energy demand fell by 5.5 percent between 1980 and 1984. Statistics Canada, Quarterly Report on Energy Supply-Demand in Canada, 57-003.

conservation and structural shifts in economies.[68] Inflation driven increases in energy conversion[69] and distribution costs, plus higher real prices of imported petroleum products, are expected to result in mean annual real conventional energy retail price increases in Newfoundland in the zero to two percent range during the next decade.[70]

In Canada, the federal and provincial governments have sponsored programs aimed at increasing the level of awareness and activity in the energy conservation and alternative energy fields, to reduce the eastern Canadian dependency upon expensive imported petroleum products. The Governments of Canada and Newfoundland and Labrador spent nine million dollars in this effort from 1979 to 1985, through the Energy Conservation and Renewable Energy Demonstration Agreement. The primary focus of the alternative energy components of the Newfoundland programs has been residential and industrial-commercial energy

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[68] Structural shifts refer to shifts in the focus of economic activity from energy intensive heavy industries to service and high technology industries.

[69] Energy conversions refer to petroleum refining and petroleum-fired electricity generation.

[70] Residential real energy costs in St. John's increased by an average of 4.3 percent annually between 1981 and 1984, despite a 10.7 percent decline in real world petroleum prices. Statistics Canada, Consumer Price and Price Indexes, 62-010 and Department of Energy Mines and Resources, Government of Canada, 12S/0508E/1.

conversions from petroleum products to wood, and to a lesser extent, fuel peat. Under the Canadian Oil Substitution Program, a taxable grant of up to 800 dollars was provided to 10,000 Newfoundland homeowners between 1980 and 1985, to assist with the cost of changing from petroleum to wood-fired residential heating systems. This program, which also covered the cost of residential petroleum to fuel peat conversions, ended in March, 1985.

3.3.2.2 FUEL WOOD SUPPLY, DEMAND AND PRICES

Thirty-three thousand more Newfoundland households were using fuel wood as the principle heating fuel in 1984 than in 1976.[71] Most of these households represent conversions from petroleum products and electricity to wood (Table 3.7). The total residential consumption of fuel wood in 1984 was approximately 200,000 tonnes.[72]

There are variations in the delivered price of fuel wood in Newfoundland from 25 up to 165 dollars per tonne, depending upon region and type of wood sold. The highest

[71] Statistics Canada, System of National Accounts: Gross Domestic Product by Industry, Newfoundland, 1963-1983, 64-202 and Electric Power Statistics, 57-202.

[72] Newfoundland Department of Forest Resources and Lands, 1985.

Table 3.7

NEWFOUNDLAND HOUSEHOLDS BY PRINCIPAL HEATING FUEL: 1976-1984

Year	Petroleum Products	Electricity	Wood	Total
1976	91,000	32,000	5,000	131,665
1977	89,000	37,000	6,000	133,000
1978	91,000	38,000	6,000	136,000
1979	87,000	42,000	9,000	138,000
1980	76,000	48,000	17,000	142,000
1981	76,000	50,100	- (1)	148,000
1982	68,000	54,000	26,000	148,000
1983	68,000	55,000	38,000	159,000
1984	66,000	55,000	38,000	159,000

Note:

(1) Not available.

Source: Statistics Canada, Household Facilities and Equipment, 64-202 and Electric Power Statistics, 57-202.

prices are charged for dried birch in the St. John's area. The mean delivered price of fuel wood is approximately 60 percent of the cost of conventional fuels.[73] However, the actual cost of firewood for most households outside the St. John's region is lower since they obtain their own supply from nearby timber stands.

In the industrial sector, the pulp and paper mills at Corner Brook and Grand Falls derive about 20 percent of their total energy requirements from wood. In addition, several other industrial, commercial and institutional facilities have added wood heating systems, including the James Paton Memorial Hospital in Gander and Newfoundland Hardwoods Limited plant in Clarenville. The consumption of fuel wood in the commercial and industrial sectors was approximately 140,000 tonnes in 1984.

Approximately 60 percent of the Island of Newfoundland is wooded, and fuel wood supply is not a major problem in most areas. On the Avalon Peninsula, the annual quantity of fuel wood harvested is estimated to exceed the maximum allowable cut by 40 percent.[74] In 1981, the fuel wood

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[73] Based upon a personal interview with an official of the Newfoundland Department of Mines and Energy.

[74] Based upon personal communications with an official of the Newfoundland Department of Forest Resources and Lands, 1982.

harvest on Crown lands on the Avalon Peninsula was estimated to have exceeded the annual allowable cut of 25,000 cords by 10,000 cords, creating a wood demand-supply imbalance.

In summary, Newfoundland is heavily reliant upon expensive imported petroleum for 73 percent of its conventional energy requirements. Electricity, the second major energy source, is also an expensive commodity in limited supply. Short to medium term prospects for accessing offshore petroleum and hydro-electricity from Labrador are clouded with uncertainty. As a result, thousands of Newfoundland energy customers have converted to wood as an economical alternative to conventional energy sources.

The analysis of the demand, supply and price of petroleum products, electricity and wood places the development potential of the fuel peat resources of Southeastern Newfoundland in a positive light from a total Newfoundland energy perspective. The lowering of Canadian petroleum prices and the elimination of government assistance for residential energy conversions from petroleum to alternative forms of energy, however, is cause for some concern.[75]

[75] The effect of these changes is examined in the financial analysis of fuel peat development prospects, presented in Chapter 6.

3.4 MAJOR FINDINGS

This chapter analyzed two categories of background factors which have a major influence on fuel peat development prospects in Southeastern Newfoundland. The analysis of fuel peat utilization considerations and regional economic and energy considerations were all generally conducive to commercial fuel peat developments in the region.

The analysis of peatland utilization options, fuel peat utilization and fuel peat research and development efforts presented in Section 3.2 does not identify any obvious barriers to fuel peat production and combustion in Southeastern Newfoundland. Fuel peat has been produced and used in the residential and industrial-commercial energy sectors in northern Europe for decades and research and development efforts in Newfoundland indicate that European fuel peat production and combustion technology can be successfully transferred to Newfoundland. In addition, there has been localized, small scale use of fuel peat in Southeastern Newfoundland since at least 1865. While the climate could hamper the drying of milled peat in Southeastern Newfoundland, the reliance on the sod peat method of production, and modified drainage and field preparation techniques are expected to reduce this problem.

Proper site selection and implementation of appropriate monitoring procedures and mitigative measures should eliminate most environmental problems associated with fuel peat production and combustion. Most of the fuel peat related information inputs, used in this study to systematically assess the energy development potential of Newfoundland's peat resources, originate from the many fuel peat research and development projects carried out in Newfoundland since the mid-1970s.

The analysis presented in Section 3.3 shows that the Newfoundland economy is weak relative to that of most Canadian provinces. It is also characterized by low levels of economic output, personal income and employment. The economy is resource based and attempts to diversify the economic base by developing a stronger manufacturing sector have failed due to the small size of the Newfoundland market and long distances and physical separation from major North American markets. The Newfoundland economy presents a very favourable setting for labour intensive small to medium scale resource developments, such as those associated with fuel peat production and use. The indirect financial and macro-economic benefits stemming from the displacement of imported petroleum products with a less expensive indigenous energy source would be an additional bonus for fuel peat resource developments.

The analysis of the demand, supply and price of petroleum products, electricity and wood, also provided in Section 3.3, reveals that the Newfoundland medium-term energy outlook is filled with uncertainty. Despite the large offshore petroleum resources and the hydro-electric potential of Labrador, most Newfoundland energy customers are likely to have to continue to rely upon expensive imported petroleum products for most of their energy requirements for the next decade. Fuel wood will provide a more economical energy alternative to conventional fuels in some regions of Newfoundland, however, supply constraints will prevent this fuel from becoming a viable option in many areas of Southeastern Newfoundland, particularly on the Avalon Peninsula. Newfoundland energy demand, supply and price conditions during the next decade are expected to be generally conducive to an alternative source of energy. Given the high costs and limited supplies of conventional energy, the fuel wood supply-demand imbalance on the Avalon Peninsula and the limited energy options available, the development of the energy potential of the peatland resources of Southeastern Newfoundland would be desirable. The recent lowering of petroleum price forecasts, however, has reduced the financial and economic attractiveness of fuel peat and other alternative forms of energy relative to petroleum products.

The analysis of background factors influencing fuel peat resource development prospects in Southeastern Newfoundland reveals no major barriers to fuel peat production or combustion. This assessment enables fuel peat supply and demand, as well as the financial and economic feasibility of fuel peat production and use, to be examined within broader fuel peat utilization and regional economic and energy contexts in Chapters 4 to 7.

Chapter 4

ANALYSIS OF FUEL PEAT SUPPLY

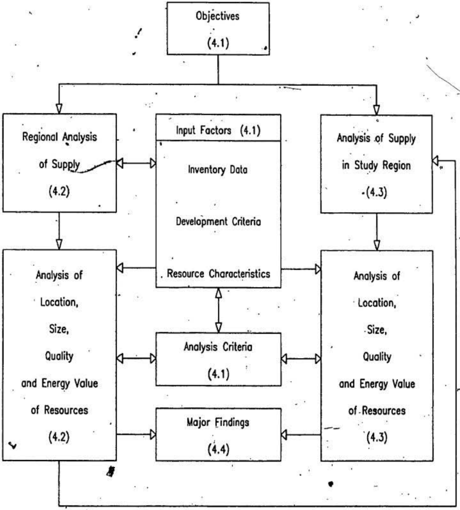
4.1 INTRODUCTION

Resource supply is a critical element in resource analysis since no development can take place without the availability of appropriate resources. The resource supply analysis presented in this chapter encompasses a regional examination of the Newfoundland peat resources, as well as a more extensive assessment of the peat resources of Southeastern Newfoundland. The main objective of this analysis is to ascertain whether or not the fuel peat resources of this region could satisfy the supply requirements of commercial scale fuel peat developments. An overview of the fuel peat supply analysis process, illustrated in Figure 4.1, is provided below.

The regional analysis of peat resources in Newfoundland, in Section 4.2, presents the location, size, quality and energy value of fuel peat resources. The analysis of fuel peat supply in Southeastern Newfoundland, Section 4.3, incorporates these four considerations. In

Figure 4.1

THE FUEL PEAT SUPPLY ANALYSIS PROCESS (1)



Note:

(1) Sections are indicated in parentheses.

addition, the analysis of fuel supply in Southeastern Newfoundland focuses in on more micro geographic areas than are used in the regional comparison of peat resources.

Inventory data, from the Newfoundland peatland inventory program, is the primary data source employed in this analysis. Also incorporated into this analysis is fuel peat supply development criteria used in the peat industry in Finland, the results of energy analysis of Newfoundland European fuel peat, and the results of studies of the morphology of Newfoundland's peatlands.

Major findings stemming from the regional analysis of Newfoundland's peat resources and the more detailed analysis of fuel peat supply in Southeastern Newfoundland are presented in Section 4.4.

4.2 REGIONAL PEAT SUPPLY

4.2.1 PEATLAND TYPES

The peatlands of Newfoundland have been classified into nine morphological types, based on peatland floristics, basin or slope morphology, surface features, peat depth, peat composition, peat humification, and physical and chemical characteristics of the peat.[1] These peatland types are: (1) blanket bogs, (2) Atlantic plateau bogs, (3) slope bogs, (4) domed bogs, (5) basin bogs, (6) string bogs, (7) slope fens, (8) ladder fens and (9) ribbed fens. The three peatland types that offer the greatest potential as an energy alternative are briefly described below in descending order of importance.

Blanket bogs occur mainly on the southern halves of the Avalon and Burin Peninsulas. They vary in depth from one to three metres and often extend over the landscape for eight to ten kilometres. Blanket bogs are usually treeless and have few ponds. The extensive occurrence of this peatland type is due mainly to climatic conditions. Both the highest mean annual rainfall (135 centimetres) and fog frequency (1,145 mean annual hours of visibility 0.8 kilometres or less) for Newfoundland occur in this bog region.[2] From a

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[1] F.C. Pollett, Peat Resources of Newfoundland (St. John's: Newfoundland Department of Mines and Energy, 1968); F.C. Pollett, "Classification of Peatland in Newfoundland," Proceedings of the Fourth International Peat Congress (Finland, 1972); F.C. Pollett, and P.B. Bridgewater, "Phytosociology of Peatlands in Central Newfoundland," Canadian Journal of Forestry Resources, (1973); F.C. Pollett, and E.D. Wells, "Peatlands of Newfoundland," in The Diversity of Peat F.C. Pollett, A.R. Rayment and A. Robertson eds. (St. John's: Newfoundland and Labrador Peat Association, 1980); E.D. Wells and R.B. Vardy, "Peatlands of Newfoundland With Emphasis on its Use as a Fuel," in Peat as an Energy Alternative (Chicago: Institute of Gas Technology, 1980).

[2] E.D. Wells, and R.B. Vardy, op. cit., p. 683.

resource perspective, this peatland type offers the greatest potential for large scale use as a source of energy in Newfoundland. The usually thin upper layer of sphagnum-sedge peat is poorly decomposed (H-1 to H-3)[3] however, below this the peat varies in decomposition from H-4 to H-10. The sod peat demonstration project at St. Shotts is situated in an extensive blanket bog region.

Atlantic plateau bogs occur in western and northwestern Newfoundland. These deposits vary in thickness from two to four metres and have developed on flat to gently undulating terrain. Surface vegetation consists mainly of sphagnum mosses. Slope bogs occur throughout Newfoundland. Usually they are small, shallow and topographically confined to poorly-drained slopes. In areas of high precipitation, however, such as in western Newfoundland and on the Avalon Peninsula, slope bogs are sometimes extensive. Sphagnum mosses dominate the surface vegetation of slope bogs, however, beneath the surface the peat is usually highly decomposed.

The selection of blanket bogs, Atlantic Plateau bogs, and slope bogs as the peatland types having the most

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[3] Based on Von Post peat classification system. This system, which utilizes a ten-grade humification (decomposition) scale called H-values, is described in more detail in Section 4.2.2.

potential as a source of fuel peat is based on four factors: (1) the peat has a degree of humification suitable for energy purposes, (2) the fuel peat strata are close to the surface, (3) the peat deposits are extensive, and (4) the fuel peat contained in these deposits can be harvested with current technology.

Technological advances and higher demands for heating fuel may eventually lead to the utilization of other types of peatlands for energy purposes. High Point Bog, the site of the milled peat demonstration project at Bishop's Falls, is a domed bog. Several smaller peatland types such as slope fens and basin bogs also contain peat suitable for fuel. Although these peatland types occur throughout much of Newfoundland, their one to two metre depth and less than twenty hectare size prevent utilization based on current harvesting methods.[4]

4.2.2 REGIONAL DISTRIBUTION OF FUEL PEAT RESOURCES

This section examines the regional distribution of fuel peat resources on the Island of Newfoundland. Particular attention is placed upon the measurement of recoverable fuel peat reserves.

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[4] E.D. Wells, and R.B. Vardy, op. cit., p. 683.

Peatland inventory tables from the first four regions inventoried[5] are the primary source of data for the regional comparison of peat resources contained in this section. These four inventory regions, Northeastern, Western, Eastern, and Northern, shown in Figure 4.2, account for approximately 80 percent of the landmass of the Island of Newfoundland, and are the four fuel peat regions used in this study.

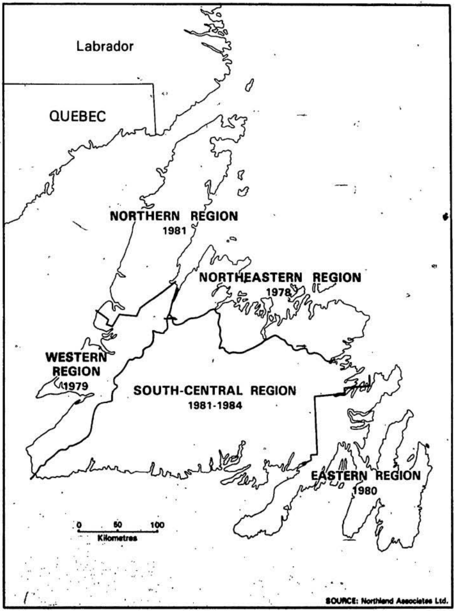
The results from the South-Central Region, which was inventoried in two phases between 1982 and 1984, were not included. Despite the fact that 65 percent of the peat resources of this region are classified as fuel peat,[6] many of the better deposits are located in unpopulated areas of central Newfoundland, currently inaccessible by road. Inaccessibility, combined with the presence of high percentages of shallow deposits and peat ash, are considered major hindrances to large scale fuel peat developments in this region. In addition to the resource barriers, the second phase of the peatland inventory for south-central

[5] Northland Associates Limited, Peatland Inventory Volume Tables, St. John's 1978, 1980, 1981, and 1982. Over 2,000 pages of data pertaining to 53,047 peat deposits are included in these four sets of inventory tables.

[6] Northland Associates Limited, Peatland Inventory of Newfoundland, 1983 and Updating of the Existing Peatland Inventory Data and Completion of the Inventory in South-Central Newfoundland, St. John's, 1984.

Figure 4.2

NEWFOUNDLAND FUEL PEAT SUPPLY REGIONS



Newfoundland was less detailed than the inventories for other resource regions, resulting in little data concerning specific deposits.

The primary aim of analyzing the peat resources of the four regions inventoried between 1978 and 1981 was to place the fuel peat resources of the study region, Southeastern Newfoundland, in a regional context. Some caution should be exercised, however, when interpreting regional fuel and horticultural peat volume and average depth information, because of differences in the peat resource classification systems used during the inventory program.[7] This variation in classification systems used results in relative underestimates of the fuel peat share of the total peat

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[7] The Canadian System of Soil Classification was used for inventories carried out in 1978 and 1979 for the Northeastern and Western Regions, while the Von Post scale of decomposition was utilized for inventories carried out in other resource regions. In Newfoundland peat deposits, some well decomposed strata have high concentrations of fibre and are classified as fibric or horticultural peat under the Canadian System of Soil Classification. This same strata would be classified as fuel peat under the Von Post scale. The Von Post scale of decomposition recognizes ten levels of organic soil decomposition, Level one (H-1) is the least decomposed stratum while level ten (H-10) is highly decomposed. In this study, fuel peat is defined as organic soil strata classified as <u>mesic</u>, and <u>humic</u> under the Canadian System of Soil Classification and from H-5 to H-10 on the Von Post scale. Organic soil strata classified as <u>fibric</u> under the Canadian System of Soil Classification and from H-1 to H-4 on the Von Post scale is referred to as horticultural peat. See Northland Associates Limited, <u>Updating of the Existing Peatland Inventory Data and the Completion of the Inventory in South-Central Newfoundland</u>, St. John's, 1984, p.1.

resource of the Northeastern and Western Regions.[8] However, this methodological inconsistency does not account for a major portion of the regional difference in the distribution of fuel and horticultural peat resources, presented in Table 4.1.

Peatlands account for 12 percent of the total land area of the Northeastern, Western, Eastern and Northern Regions. It is estimated that almost 11 billion cubic metres of peat are contained in the 623,770 hectares of peatland. These figures indicate an average peat depth of 1.75 metres. Fifty-two percent of the peat is classified as fuel peat and 48 percent as horticultural peat. The total fuel peat reserve of the four regions is 5,651 million cubic metres. This is equivalent to 324 million cubic metres of petroleum,[9] or 162 times the total Newfoundland consumption.

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[8] In 1984, Northland Associates Limited was contracted by the Newfoundland Department of Mines and Energy to recompile the peatland inventory tables for the Northeastern and Western Regions using the Von Post scale of decomposition. The results of these conversions were not available at the time of writing.

[9] The conversion factor for cubic metres of peat (in situ) to cubic metres of Petroleum is 0.05736. This is based upon: (1) conversion factor for cubic metres of peat (in situ) to tonnes of peat at 50 percent moisture content (0.19) used in Montreal Engineering Company Ltd., The Mining of Peat A Canadian Energy Resource (Toronto: Montreal Engineering Company Ltd., 1978); and (2) conversion factor for barrels of petroleum to cubic metres of petroleum (0.1589).

Table 4.1

PEAT RESOURCES BY SUPPLY REGION

(millions of cubic metres)

Region	Area of Peat Deposits (hectares)	Spatial Share of Region (percent)	Total Peat	Horticultural Peat	Fuel Peat	Fuel Peat(1) (percent)
Northeastern	135,493	12	3,156	2,166	990	31
Western	87,885	9	1,759	962	797	45
Eastern	273,548	14	4,123	1,329	2,794	68
Northern	126,844	10	1,875	805	1,070	57
Totals	623,770	12	10,913	5,262	5,651	52

Note:

(1) Share of total peat resources of each region.

Source: Based upon Northland Associates Limited, Newfoundland Peatland Inventory, 1978, 1979, 1980 and 1981.

of two million cubic metres of petroleum in 1983.[10]

The Eastern Region, which contains the massive blanket bogs of Southeastern Newfoundland, has the largest peat deposits in terms of both areal extent and volume. The average deposit size in this region is 16 hectares, compared to 12 hectares for the four resource regions combined. Thirty-eight percent of the total peat resources identified in the four supply regions is located in the Eastern Region.

In addition to the Eastern Region having the largest volume of fuel peat, it has relatively small amounts of horticultural peat. As a result, the fuel peat deposits could be more economically harvested and utilized for energy, since developers would not have to contend with thick overburdens of horticultural peat. The presence of large quantities of horticultural peat, such as the 'levels' existing in the Northeastern Region, would seriously impede potential fuel peat development.

Two criteria, used by the peat industry in Finland,[11] were applied to peatland inventory data to derive estimates

[10] Statistics Canada, Quarterly Report on Energy Supply and Demand in Canada, 57-003.

[11] Based on interviews with officials of the State Fuel Centre (VAPO) and Turveruukki Oy during a field trip to major fuel peat developments in Finland in September, 1980.

of economically recoverable reserves. Recoverable reserves were defined as the volume of fuel peat contained in: (1) deposits 50 hectares or greater in size; and (2) with average depths of fuel peat of 0.95 metres or greater. Many of the deposits meeting these criteria are inaccessible and steeply sloped. This is compensated for by the fact that smaller deposits may be economically developed, especially for sod peat production, if they are in close proximity to larger deposits. The average fuel peat depth criterion of 0.95 metres takes into consideration the fact that peat H-3 and H-4 on the Von Post scale can also be used for energy purposes, even though it is classified as horticultural peat in this study. This factor raises the effective average depth criterion to more than one metre, the critical mean depth used in Finland.

The recoverable fuel peat reserves of the four inventory regions were calculated by applying the 50 hectare area criterion and the 0.95 average depth criterion to the data compiled for each of the 53,047 deposits in the <u>Peatland Inventory Tables</u>. Since deposit depth data are not contained in the volume tables, the average depth of fuel peat in each deposit meeting the area criterion was obtained by dividing the volume of fuel peat by the surface area of the deposit.

As in the peatland inventory, deposits in close proximity are grouped under geographic place names.[12] A third criterion used in Finland to determine recoverable fuel peat reserves involves the grouping of deposits within fifty kilometre radii.[13] This criterion is used in the analysis of the fuel peat resources of Southeastern Newfoundland in Section 4.3.

Recoverable fuel peat reserves are not evenly distributed throughout the resource regions, although large deposits occur in each region. Figure 4.3 and Table 4.2 show that the Eastern Region has the eight largest, and 20 of the 30 largest recoverable fuel peat reserves. The Northern Region has five reserves and the Western Region has four reserves ranked in the top 30, while the Northern Region has one reserve ranked twenty-fourth on this list.

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[12] Most groupings of deposits, or recoverable reserves, in the first four regions inventoried are identified by the name of a community situated near the major fuel peat deposits. Twenty of the 79 recoverable reserves identified in the four regions, however, bear the name of either a lake, river, bay, inlet, mountain, or island. A listing of recoverable fuel peat reserves by resource region is presented in Appendix A, along with the volume of fuel peat and surface area of grouping of deposits.

[13] The application of this criterion would reduce the number of recoverable fuel peat reserves in the four resource regions from 79 to approximately 40. The mean volume of fuel peat in each recoverable reserve would be inversely affected, since the total quantity of recoverable fuel peat would not change.

Figure 4.3

MAJOR NEWFOUNDLAND FUEL PEAT CONCENTRATIONS

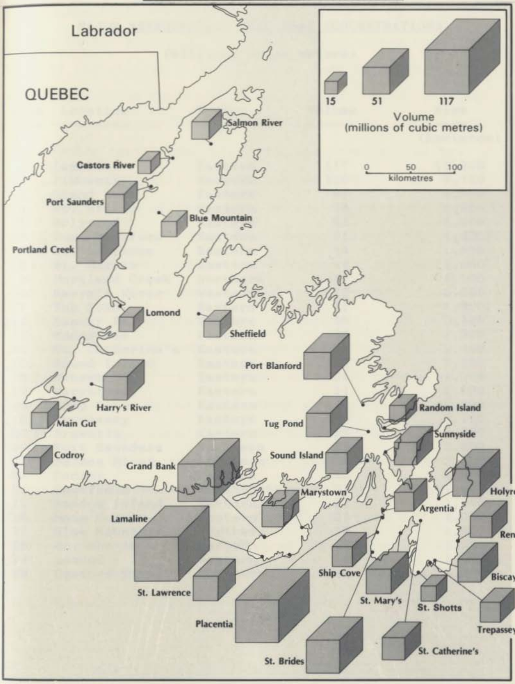

Table 4.2

MAJOR NEWFOUNDLAND FUEL PEAT CONCENTRATIONS

(millions cubic metres)

Rank	Location	Region	Volume	Area (hectares)
1	Lamaline	Eastern	117	12,200
2	Placentia	Eastern	116	9,700
3	Grand Bank	Eastern	85	8,900
4	St. Brides	Eastern	74	6,500
5	Holyrood	Eastern	53	3,300
6	Port Blanford	Eastern	51	4,800
7	St. Lawrence	Eastern	44	1,600
8	St. Mary's	Eastern	44	4,000
9	Portland Creek	Northern	43	4,100
10	Harry's River	Western	42	2,500
11	Tug Pond	Eastern	41	3,900
12	Biscay Bay	Eastern	39	3,400
13	Sunnyside	Eastern	36	3,300
14	St. Catherine's	Eastern	36	2,400
15	Sound Island	Eastern	35	3,100
16	Renews	Eastern	34	1,900
17	Marystown	Eastern	34	3,500
18	Ship Cove	Eastern	31	2,800
19	Trepassey	Eastern	30	3,100
20	Argentia	Eastern	29	2,300
21	Port Saunders	Northern	27	2,600
22	Salmon River	Northern	25	2,500
23	Codroy	Western	22	1,300
24	Sheffield	Northeastern	21	1,200
25	Random Island	Eastern	21	1,900
26	Main Gut	Western	21	1,500
27	Blue Mountain	Northern	19	1,800
28	St. Shotts	Eastern	19	1,900
29	Lomond	Western	18	1,500
30	Castors River	Northern	15	1,300

This Eastern Region has an estimated 1,015 million cubic metres of recoverable fuel peat, which is 72 percent of the total recoverable reserves. Recoverable reserves of 180 and 159 million cubic metres of fuel peat are found in the Northern and Western Regions, respectively, while the Northeastern Region contains only 48 million cubic metres of recoverable fuel peat. The total recoverable fuel peat reserve of 1,402 million cubic metres of fuel peat is equivalent to 80 million cubic metres of petroleum products or 20 times the total petroleum consumption of Newfoundland in 1983. A summary of the total volume of peat and fuel peat, as well as recoverable fuel peat reserves, is presented on a regional basis in Table 4.3. The information presented highlights the regional comparison of the Newfoundland fuel peat resources contained in this section. The Eastern Region has the highest percentage of fuel peat, largest average deposit size and highest average depth of fuel peat. From a resource supply perspective, this region clearly offers the best fuel peat development potential on the Island of Newfoundland. Appendix A reveals that the five largest recoverable fuel peat reserves are located in the Eastern Region[14] and 11 of the next 15 largest reserves, are located in Southeastern Newfoundland. The recoverable

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[14] These five deposits (i.e., Lamaline, Placentia, Grand Bank, St. Bride's and Holyrood) are also the five largest recoverable deposits in the four supply regions.

Table 4.3

RECOVERABLE FUEL PEAT RESERVES BY REGION

(millions cubic metres)

Region	Total Peat Resources(1)	Percent of Total	Fuel Peat(1)	Percent of Total	Recoverable Fuel Peat Reserves(2)	Percent of Total
Northeastern	3,156	29	990	18	48	3
Western	1,759	16	797	14	159	11
Eastern	4,123	38	1,794	49	1,015	72
Northern	1,875	17	1,070	19	180	13
Totals	10,913	100	5,651	100	1,402	100

Notes:

(1) From Table 4.1.
(2) Recoverable fuel peat reserves were derived by applying the fuel peat supply development criteria used by peat industry in Finland to the Newfoundland Peatland Inventory Tables. Information pertaining to recoverable fuel peat deposits for Northeastern, Western, Eastern and Northern Regions is presented in Appendix A.

fuel peat reserves of this region are analyzed from an energy supply perspective in Section 4.3.

4.3 FUEL PEAT SUPPLY IN SOUTHEASTERN NEWFOUNDLAND

The analysis of the fuel peat supply in Southeastern Newfoundland is focused upon the measurement of recoverable reserves and identification and analysis of geographic groupings of deposits, based on the 50 kilometre radius criterion referenced in Section 4.2. The 21 recoverable fuel peat deposits in Southeastern Newfoundland, presented in Figures 4.4 and 4.5 as well as in Table 4.4, have a total area of 69,600 hectares and contain 806 million cubic metres of recoverable fuel peat. This volume figure represents 79 percent of the total recoverable reserves for the Eastern Region and 57 percent of the total identified for the four resource regions analyzed in this study.

The 11 recoverable reserves on the southern half of the Avalon Peninsula contain 38,900 hectares of peatland with recoverable fuel peat reserves of 461 million cubic metres. The average depth of fuel peat in these deposits is 1.2 metres, which is deep enough for fuel peat production.[15]

[15] Technopeat Inc., Feasibility Study: Sod Peat Burning Steam Generation Plant, Montreal, 1984, p. 18.

Figure 4.4

MAJOR AVALON PENINSULA FUEL PEAT CONCENTRATIONS

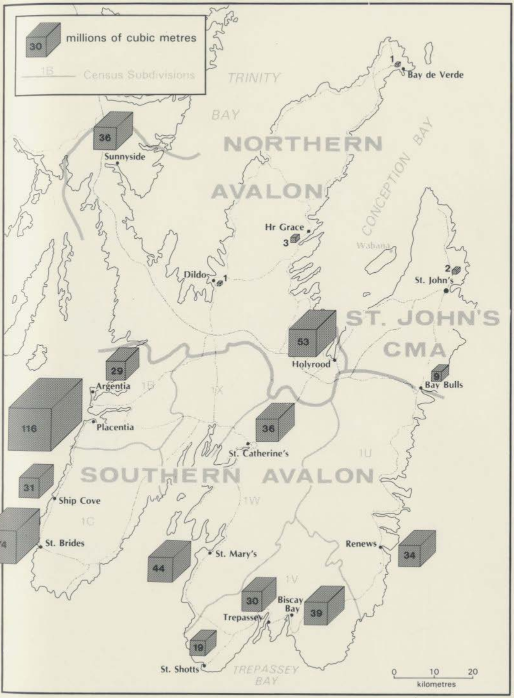

Figure 4.5

MAJOR BURIN PENINSULA FUEL PEAT CONCENTRATIONS

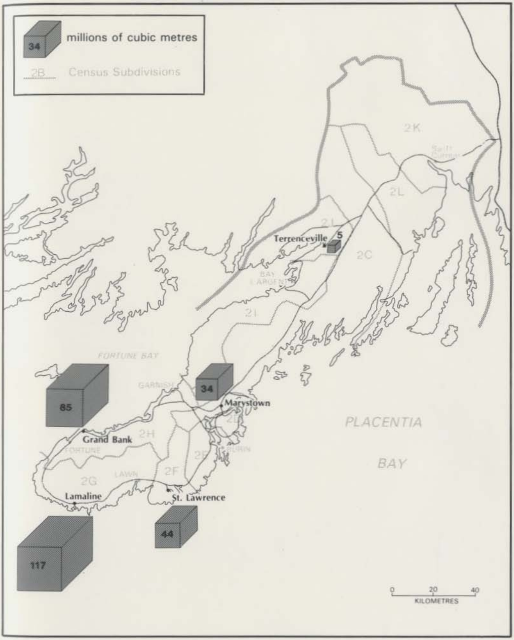

Table 4.4

MAJOR SOUTHEASTERN FUEL PEAT CONCENTRATIONS (1)

(millions cubic metres)

Rank	Location	Volume	Area (hectares)	Mean Depth (metres)
1	Lamaline	117	12,000	1.0
2	Placentia	116	9,700	1.2
3	Grand Bank	85	8,900	1.0
4	St. Bride's	74	6,500	1.1
5	Holyrood	53	3,300	1.6
6	St. Lawrence	44	1,600	2.8
7	St. Mary's	44	4,000	1.1
8	Biscay Bay	39	3,400	1.1
9	St. Catherines	36	2,400	1.5
10	Renews	34	1,900	1.8
11	Marystown	34	3,500	1.0
12	Ship Cove	31	2,800	1.1
13	Trepassey	30	3,100	1.0
14	Argentia	29	2,300	1.3
15	St. Shotts	19	1,900	1.0
16	Bay Bulls	9	900	1.0
17	Terrenceville	5	500	1.0
18	Harbour Grace	3	300	1.0
19	St. John's	2	200	1.0
20	Dildo	1	100	1.0
21	Bay de Verde	1	100	1.0
Totals		806	69,600	1.2

Note:

(1) Recoverable fuel peat reserves derived by applying fuel peat supply development criteria used by peat industry in Finland to <u>Peatland Inventory Tables</u>, Northland Associates Limited, St. John's, 1980.

The volume of fuel peat is 33 percent of the recoverable fuel peat reserves of the four resource regions and represents an energy value 13 times larger than the total consumption of petroleum products in the Province of Newfoundland and Labrador in 1983. There are four recoverable reserves on the southern half of the Burin Peninsula with a total area of 26,200 hectares and volume of 280 million cubic metres of fuel peat. The average depth of fuel peat in these deposits is 1.1 metres. The recoverable fuel peat in this area equates to 20 percent of the total for the four resource regions, and is about eight times the 1983 petroleum consumption of Newfoundland.

The application of the 50 kilometre road radius criterion, to the 50 recoverable reserves located in Southeastern Newfoundland reveals two major spatial groupings of fuel peat on the Avalon Peninsula and one on the Burin Peninsula. The volume of fuel peat in the Argentia-Cape Shore and Southern Shore-St. Mary's concentration is 250 and 202 million cubic metres, respectively, while the Lamaline-St. Lawrence group of deposits has 280 million cubic metres of fuel peat (see Table 4.5).

The energy value of the Southern Shore-St. Mary's spatial concentration of fuel peat reserves is equivalent to

Table 4.5

THREE MAJOR SPATIAL CONCENTRATIONS OF FUEL PEAT

(millions cubic metres)

Spatial Concentration	Recoverable Reserve	Volume	Area (hectares)	Mean Depth (metres)
Argentia-Cape Shore	Placentia	116	9,700	1.2
	St. Bride's	74	6,500	1.1
	Ship Cove	31	2,800	1.1
	Argentia	29	2,300	1.3
	Sub-totals	250	21,300	1.2
Southern Shore-St. Mary's	St. Mary's	44	4,000	1.1
	Biscay Bay	39	3,400	1.1
	St. Catherines	36	2,400	1.5
	Renews	34	1,900	1.8
	Trepassey	30	3,100	1.0
	St. Shotts	19	1,900	1.0
	Sub-totals	202	16,700	1.2
Lamaline-St. Lawrence	Lamaline	117	12,200	1.0
	Grand Bank	85	8,900	1.0
	St. Lawerence	44	1,600	2.8
	Marystown	34	3,500	1.0
	Sub-totals	280	26,200	1.1
	Totals	732	64,200	1.1

11.5 million cubic metres of petroleum products. In perspective, this is enough energy to supply both the total space heating requirements of 35,000 houses[16] and 145 percent of the total energy requirements of 100 large fish plants[17] for 50 years. In terms of electricity generation potential, 202 million cubic metres of fuel peat could yield 565 gigawatt hours of electricity annually for 50 years, from a peat-fired power plant.[18] This annual production is seven percent of the total 1983 consumption of electricity in Newfoundland and Labrador of 7,829 gigawatt hours.[19] Adjustment factors of 1.25 and 1.40 can be applied to the energy value presented above to place the larger Argentia-Cape Shore and Lamaline-St. Lawerence spatial concentrations of recoverable fuel peat reserves in an energy perspective.

The fuel peat contained in the blanket peat deposits of Southeastern Newfoundland is the best quality fuel peat in the Province of Newfoundland, based upon degree of

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[16] Based upon a projected mean annual residential space heating requirement of three cubic metres of petroleum.

[17] The average annual petroleum requirement for a large fish plant (860 cubic metres) was obtained from Technopeat Inc., op. cit., p.8.

[18] The Conversion factor used for millions of cubic metres of fuel peat to gigawatt hours of electricity is 140. This factor was obtained from Wells, and Vardy, op. cit., p. 691.

[19] Statistics Canada, Quarterly Report on Energy Supply and Demand in Canada, 57-003.

humification. Sixty-eight percent of the total peat resources of the Eastern Region is H-5 or higher on the Von Post scale of decomposition, compared to 52 percent for the four resource regions examined in this thesis (see Table 4.1). It is estimated that over 80 percent of the peat in the recoverable reserves of Southeastern Newfoundland fall into this fuel peat category.

The linear relationship between the calorific or heat value of Newfoundland peat and the degree of humification, as expressed by the Von Post scale of decomposition, was computed by Tibbetts in 1976.[20] This analysis revealed a high positive correlation between the calorific values and humification, however, H-10 peat was shown to have only 17 percent more heat value by unit weight than H-1 peat. This gap would be much greater if the comparison was based upon volume rather than weight, because of the higher bulk density of the less humified peat.

A comparison of the calorific value, ash content and volatile matter of peat samples from Southeastern Newfoundland, Terra Nova, Gander, the Buchans Plateau and Stephenville Crossing, with peat from Ireland and Finland shown in Table 4.6, reveals the favourable energy properties

[20] T.E. Tibbetts, Evaluation of Peat Samples as Part of a Peat Fuel Inventory Study in the Province of Newfoundland (Ottawa: Energy, Mines and Resources, 1976).

Table 4.6

COMPARISON OF FUEL PEAT PROPERTIES

Location	Calorific Values (1) (kilojoules/kilogram)	Ash Content (1) (percent weight)
Southeastern Newfoundland (2)	-	3-10
Terra Nova (3)	22,351	2.17
Gander (3)	22,232	3.63
Buchans Plateau (3)	22,843	13.71
Stephenville Crossing (3)	21,983	2.77
Ireland (4)	22,538	2.70
Finland (4)	18,500-21,500	4-7

Notes:

(1) Based upon zero percent moisture content.
(2) From Technopeat Inc., Feasibility Study: Sod Burning Steam Generating Plant, Montreal, 1984.
(3) Average data from Tibbetts, T. E., Evaluation of Peat Samples as Part of a Peat Fuel Inventory in the Province of Newfoundland, Department of Energy, Mines and Resources, ERP/ERL 76-14, Ottawa, 1976.
(4) From E. D. Wells and R. B. Vardy, "Peat Resources of Newfoundland with Emphasis on its use for Fuel", Peat as an Energy Alternative, Institute of Gas Technology, Chicago, 1980, p. 694.

of Newfoundland peat. The 13.71 percent ash content of the Buchans Plateau samples reflect the high ash content that is widespread in this area of the South-Central Region diminishing its value as a fuel source.[21]

4.4 MAJOR FINDINGS

The analysis of the peatland resources of Newfoundland in Section 4.2 revealed that high quality fuel peat resources exist in all four supply regions examined. The largest deposits, however, occur in Southeastern Newfoundland.

The detailed analysis of the fuel peat resources of Southeastern Newfoundland in Section 4.3 showed that most of the fuel peat in this region was spatially concentrated in three areas. Two of these groupings are in the southern part of the Avalon Peninsula and the third concentration is on the Burin Peninsula. The quantity and quality of the Southeastern Newfoundland fuel peat deposits are sufficient to support the total 1994 fuel peat demand levels in Chapter 5 for at least 160 years.

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[21] R.F. Gosine, op. cit., p. 76. This high ash content was a consideration in the decision to exclude the South-Central Region from this study.

Chapter 5

ANALYSIS OF FUEL PEAT DEMAND

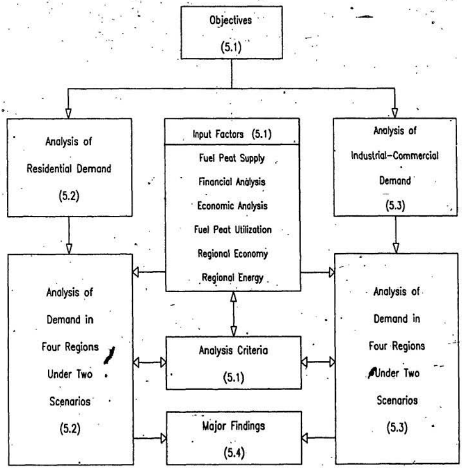
5.1 INTRODUCTION

Resource demand, like supply, is a critical element in resource analysis, since no substantial developments can take place without an available market for the resources produced. This chapter analyzes the demand potential for fuel peat in Southeastern Newfoundland in the residential and industrial-commercial energy sectors. The primary aim of this demand analysis is to determine if fuel peat demand under either of the two demand scenarios could be large enough to support commercial scale fuel peat resource developments in Southeastern Newfoundland. An overview of the fuel peat demand analysis process, illustrated in Figure 5.1, is presented in this section.

The potential demand for fuel peat is perceived to be different in various regions of Southeastern Newfoundland. As a result, four fuel peat demand regions, defined in terms

Figure 5.1

THE FUEL PEAT DEMAND ANALYSIS PROCESS (1)



Note:

(1) Sections are indicated in parentheses.

of Statistics Canada census boundaries,[1] are employed in the analysis in this section. The four demand regions are Southern Avalon, Burin Peninsula, St. John's,[2] and Northern Avalon. The three Avalon Peninsula regions are presented in Figure 5.2, while the Burin Peninsula Demand Region is shown in Figure 5.3. Also, the Remainder of Newfoundland is included as a fifth region[3] to facilitate the regional breakdown of provincial demographic and energy data employed in the demand analysis.

The Southern Avalon and Burin Peninsula[4] fuel peat demand regions contain the best fuel peat deposits in Newfoundland and have been exposed to small-scale fuel peat developments on several occasions during the last century. Because of these factors, and the existing fuel wood demand/supply imbalance, these two regions were judged to offer the best medium-term market potential for fuel peat and are the focus of more intensive research and analysis in

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[1] Statistics Canada's Census Divisions and Census Consolidated Subdivisions were used to spatially define fuel peat demand regions, because their use enabled the regional breakdown of population and household information.

[2] St. John's refers to the St. John's Census Metropolitan Area.

[3] The Remainder of Newfoundland covers Statistics Canada Census Divisions 3 to 10.

[4] The Southern Avalon encompasses Census Consolidated Subdivisions 1B, 1C, and 1U to 1X. The Burin Peninsula has the same boundaries as Census Division 2.

Figure 5.2

AVALON PENINSULA FUEL PEAT DEMAND REGIONS AND SUB-REGIONS

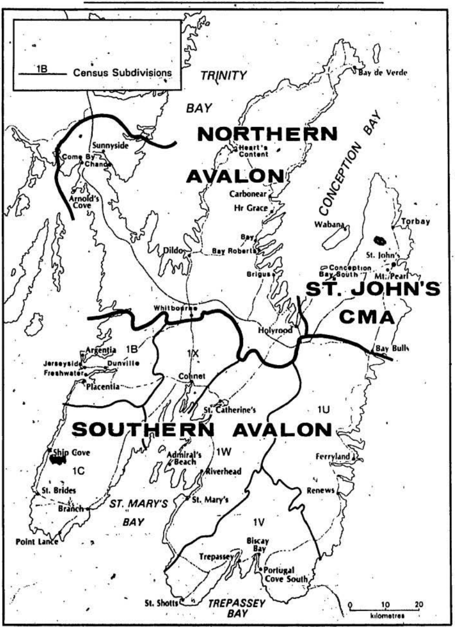
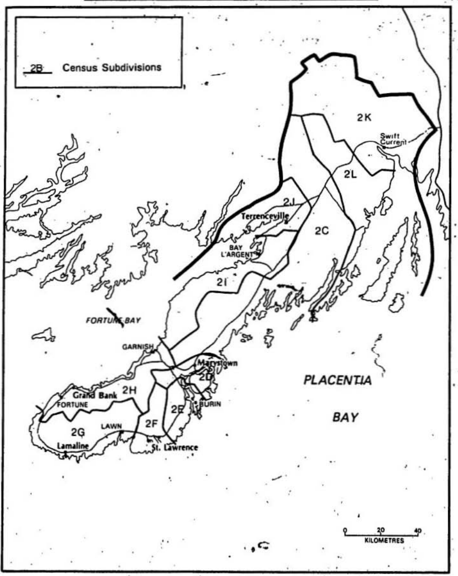


Figure 5.3

BURIN PENINSULA FUEL PEAT DEMAND REGION AND SUB-REGIONS



this study. St. John's is treated as a separate demand region for physical and socio-economic reasons. There are limited quantities of high quality fuel peat in close proximity to St. John's, and most energy customers were judged to be less willing, or able, to trade-off the time and inconvenience of using solid fuels for lower energy costs than would energy customers in rural areas. The supply and inconvenience related drawbacks would be mitigated, however, by the regular delivery of fuel peat in a highly densified form.

The remainder of the Avalon Peninsula and the Isthmus of Avalon form the fourth fuel peat demand region, the Northern Avalon.[5] Most energy customers in this region wishing to convert from conventional fuels to a solid fuel have access to fuel wood. However, the annual allowable cut is currently being exceeded and the availability of this resource will soon be more restricted in many areas.[6] There are three large fuel peat concentrations in this region, at Holyrood, Harbour Grace and Sunnyside (see Figure 4.4). This region would also be included in the marketshed of a densified fuel peat operation in the Southern Avalon Demand Region.

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[5] The Northern Avalon is comprised of Census Consolidated Subdivisions 1A, 1E to 10, as well as 1R and 1Y.

[6] Based upon a personal interview with an official of the Newfoundland Department of Forest Resources and Lands, 1984.

The potential demand for fuel peat in each region is analyzed for both the residential and industrial-commercial energy sectors. The analysis of potential fuel peat demand in the residential energy sector, presented in Section 5.2, and industrial-commercial demand analysis provided in Section 5.3, employs two fuel peat demand scenarios. The two scenarios are based on the six and eight percent conventional energy price growth scenarios presented in Section 3.3 and are used in the financial analysis of fuel peat production and combustion in Chapter 6. Scenario A assumes that conventional energy prices will increase by six percent yearly during the next decade. Scenario B is based upon tight conventional energy supplies, and eight percent annual price escalation rates. A possible third demand scenario would be characterized by surplus conventional energy and decreasing real prices, and would likely result in no commercial fuel peat developments in Southeastern Newfoundland by 1994.[7]

The fuel peat demand projections presented under Scenarios A and B are heavily influenced by the fuel peat supply, financial and economic analysis presented in Chapters 4, 6 and 7. Other important input factors

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[7] This third scenario is referenced in Section 8.3, which presents the conclusions pertaining to fuel peat development prospects in Southeastern Newfoundland between 1984 and 1994.

influencing the fuel peat demand projections included background fuel peat utilization, and regional economic and energy considerations, analyzed in Chapter 8. The fuel peat demand projections also incorporated the results of field research carried out by the writer in Southeastern Newfoundland between 1979 and 1984,[8] in addition to regional demographic and energy demand data.

As discussed in Section 2.3, the lack of historical fuel peat utilization data prevented the use of regression analysis or other econometric techniques to project demand levels based upon statistical relationships between fuel peat consumption and price or any other relevant exogenous and endogenous variables. Unfortunately, the fuel peat consumption and price data limitations cannot be overcome through additional research since historical fuel peat consumption was very localized and little peat has been consumed since 1960. Also, most fuel peat was extracted by the user and no financial records likely exist. Given the background data constraints, the writer was forced to rely more upon the subjective types of analysis referenced above.

[8] Additional fuel peat marketing research is detailed in Research Associates, St. Shotts Peat Project - Marketing Study, St. John's, 1984.

in developing the two fuel peat demand scenarios presented in this chapter.[9]

A summary of the major findings and conclusions from the analysis of potential fuel peat demand in Southeastern Newfoundland are presented in Section 5.4.

5.2 RESIDENTIAL FUEL PEAT DEMAND

Total conventional energy demand in the residential sector in Newfoundland is forecast to decrease at an average annual rate of 0.18 percent from the 1984 consumption level of 18,080 terajoules to 17,720 terajoules in 1994.[10] A breakdown of conventional energy demand by fuel peat demand region is presented in Table 5.1. This geographic breakdown of energy demand was derived by applying regional household percentage shares from Table 5.2 to the Newfoundland

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[9] Demand analysis associated with petroleum products, electricity and many other energy forms can be based more upon econometric relationships between consumption and relevant economic, demographic and other types of variables.

[10] Newfoundland Department of Mines and Energy, Submission to the National Energy Board in the Matter of the 1984 Energy Supply and Demand Update (St. John's: Newfoundland Department of Mines and Energy, 1984), Appendix I.

Table 5.1

RESIDENTIAL ENERGY DEMAND BY FUEL PEAT DEMAND REGION (1)

(terajoules)

Demand Region (2)	1984	1994
Southern Avalon	610	570
Burin Peninsula	890	880
St. John's	5,420	5,520
Northern Avalon	2,100	1,920
Remainder of Newfoundland	9,070	8,830
Province of Newfoundland	18,080	17,720

Notes:

(1) Province of Newfoundland projections were obtained from Newfoundland Department of Mines and Energy, Submission to the National Energy Board in the Matter of the 1984 Energy Supply and Demand Update, St. John's, 1984, Appendix I.

(2) Based upon application of regional household percentage shares presented in Table 5.2 to the total energy demand projections for the residential sector.

Table 5.2

NUMBER OF HOUSEHOLDS BY FUEL PEAT DEMAND REGION

Demand Region	1981 (1)	1984 (2)	1994 (2)
Southern Avalon	4,985	5,500	6,700
Burin Peninsula	7,545	8,100	10,300
St. John's	43,300	49,100	64,800
Northern Avalon	16,825	19,000	22,600
Remainder of Newfoundland	75,765	82,200	103,800
Province of Newfoundland	148,420	163,900	208,200

Notes:

(1) Statistics Canada, Population Census Divisions and Subdivisions, Ottawa, 1982.
(2) Projections were based upon average number of persons per household and population of each fuel peat demand region presented in Tables 5.3 and 5.4.

conventional energy projections for 1984 and 1994.[11] This top-down methodological approach was acceptable for the residential energy sector because of the high level of homogeneity among energy customers with respect to annual energy consumption. This regional energy demand data was used to present the projected regional demand for fuel peat in a total energy demand context.

The forecast of the number of households in each fuel peat demand region was based upon the 1984 and 1994 projections of the average number of persons per household in, and population of, each fuel peat demand region, provided in Tables 5.3 and 5.4. The forecast of household size assumed that the mean annual percentage decrease in household size in each fuel peat demand region between 1971 and 1981 would continue until 1994. By 1994, based on these trends, St. John's, with an average of 2.8 persons per household, will be the only demand region with a mean household size as small as the 1981 Canadian average of 2.9.[12] The Newfoundland population projection scenario used incorporates the assumptions that the fertility rate will remain constant during the study period and that total net out-migration will decrease from 4,000 in 1984 to 2,200 in

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[11] Detailed regional energy consumption data is available only for electricity sales by Newfoundland Light and Power Company Limited.

[12] Statistics Canada, Census Canada, 1981, 92-904.

Table 5.3

AVERAGE HOUSEHOLD SIZE BY FUEL PEAT DEMAND REGION

Demand Region	1981 (1)	1984 (2)	1994 (2)
Southern Avalon	4.0	3.8	3.2
Burin Peninsula	4.0	3.8	3.2
St. John's	3.5	3.3	2.8
Northern Avalon	3.6	3.4	3.9
Remainder of Newfoundland	3.9	3.7	3.0

Notes:

(1) Statistics Canada, Census Canada, 1981, 92-904.
(2) Projections were based upon mean decrease in the average number of persons per household from 1971 to 1981 in each fuel peat demand region.

Table 5.4

POPULATION BY FUEL PEAT DEMAND REGION

Demand Region	1981 (1)	1984 (2)	1994 (2)
Southern Avalon	20,640	21,900	21,500
Burin Peninsula	30,368	30,900	33,100
St. John's	154,820	161,900	181,400
Northern Avalon	63,950	64,600	65,600
Remainder of Newfoundland	297,903	304,000	311,300
Province of Newfoundland	567,681	582,400	612,900

Notes:

(1) Statistics Canada, Population Census Divisions and Subdivisions, Ottawa, 1982.

(2) Province of Newfoundland projections obtained from Newfoundland Statistics Agency, Population Projections Newfoundland and Labrador - 1983-2005, Scenario NSA84.2, St. John's, 1984. Breakdown in population by fuel peat demand region was based on population shares from 1951 to 1981, adjusted for geographic boundary changes.

1994.[13] The regional breakdown of population was facilitated through the extrapolation of trends in regional population shares during the period 1951 to 1981 out to 1994. Adjustments were made to account for the expansion of the boundaries of St. John's.[14]

Since more detailed energy demand related research and analysis was aimed at the Southern Avalon and Burin Peninsula Demand Regions, household projections at the census consolidated subdivision level are provided in Table 5.5. These projections employed the household growth rates stemming from the household forecasts for the Southern Avalon and Burin Peninsula Demand Regions.

The projected number of households burning fuel peat and the annual fuel peat demand in the residential energy sector in Southeastern Newfoundland in 1994 are presented in Table 5.6 under the two fuel peat demand scenarios used in this study. Projections at the census consolidated subdivision level are also provided in Table 5.7 for the Southern Avalon and Burin Peninsula Demand Regions.

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[13] Newfoundland Statistics Agency, Population Projections Newfoundland and Labrador - 1983-2005, St. John's, 1984.

[14] Based on information provided by an official of the Newfoundland Executive Council, March 1985.

Table 5.5

HOUSEHOLDS IN SOUTHERN AVALON AND BURIN PENINSULA DEMAND REGIONS

Census Consolidated Sub-division (1)	1981	1984	1994
1B Placentia	1,765	1,947	2,372
1C St. Bride's	375	414	505
1U Southern Shore	1,180	1,302	1,586
1V Trepassey Bay	500	552	672
1W St. Mary's	965	1,065	1,298
1X Colinet	200	221	269
Southern Avalon	4,985	5,500	6,700
2C Placentia Bay West Centre	535	574	730
2D Mortier Bay	1,780	1,911	2,430
2E Burin	1,040	1,117	1,420
2F St. Lawrence	505	542	689
2G Lamaline	575	617	785
2H Fortune, Grand Bank	2,080	2,233	2,839
2I Bay L'Argent	470	505	642
2J Terrenceville	300	322	410
2K Swift Current	260	279	355
2L Western Channel	5	5	7
Burin Peninsula	7,545	8,100	10,300

Note:

(1) Household projections by Census Consolidated Sub-division employ the growth rates for the Southern Avalon and Burin Peninsula Demand Regions in Table 5.2.

Table 5.6

RESIDENTIAL FUEL PEAT DEMAND IN SOUTHEASTERN NEWFOUNDLAND - 1994

Region.	Total Household(1)	Fuel Peat Households Scenario A(2)	Fuel Peat Households Scenario B(3)	Total Fuel Peat Demand Scenario A(4)	Total Fuel Peat Demand Scenario B(4)
Southern Avalon (5)	6,700	200	1,150	2,120	12,190
Burin Peninsula (5)	10,300	100	700	1,060	7,420
St John's	64,800	100	2,000	1,060	21,200
Northern Avalon	22,600	100	1,000	1,060	10,600
Totals	104,400	500	4,850	5,300	51,410

Notes:

(1) From Table 5.2.
(2) Scenario A assumes that conventional energy prices will increase by an average annual rate of eight percent between 1984 and 1994. Fuel peat prices will increase by six percent yearly.
(3) Scenario B assumes both conventional energy and fuel peat prices will increase annually by six percent between 1984 and 1994.
(4) Assumes that an average of 70 percent of the space heating requirements of each household converting to fuel peat will be derived from 10.6 tonnes of fuel peat.
(5) A breakdown of projected fuel peat demand by Census Consolidated Sub-division is presented in Table 5.7.

Table 5.7

RESIDENTIAL FUEL PEAT DEMAND IN SOUTHERN AVALON AND BURIN PENINSULA DEMAND REGIONS - 1994

Census Consolidated Sub-division (1)	Total Households(1)	Fuel Peat Scenario A(2)	Fuel Peat Scenario B(3)	Total Demand Scenario A(4)	Total Demand Scenario B(4)
1B Placentia	2,372	0	300	0	3,180
1C St. Bride's	505	50	150	530	1,590
1U Southern Shore	1,586	0	200	0	2,120
1V Trepassey Bay	672	100	200	1,060	2,120
1W St. Mary's	1,298	50	250	530	2,650
1X Colinet	269	0	50	0	530
Southern Avalon	6,700	200	1,150	2,120	12,190
2C Placentia Bay West Centre	730	0	0	0	0
2D Mortier Bay	2,430	0	100	0	1,060
2E Burin	1,420	0	100	0	1,060
2F St. Lawrence	689	50	150	530	1,590
2G Lamaline	785	50	150	530	1,590
2H Fortune, Grand Bank	2,839	0	200	0	2,120
2I Bay L'Argent	642	0	0	0	0
2J Terrenceville	410	0	0	0	0
2K Swift Current	355	0	0	0	0
2L Western Channel	7	0	0	0	0
Burin Peninsula	10,300	100	700	1,060	7,420

Notes:

(1) From Table 5.2.
(2) Scenario A assumes that conventional energy prices will increase by an average annual rate of eight percent between 1984 and 1994. Fuel peat prices will increase by six percent yearly.
(3) Scenario B assumes both conventional energy and fuel peat prices will increase annually by six percent between 1984 and 1994.
(4) Assumes that an average of 70 percent of the space heating requirements of each household converting to fuel peat will be derived from 10.6 tonnes of fuel peat.

In 1994, it was projected that 500 households would be burning peat under Scenario A, while Scenario B would yield 4,850 fuel peat customers in the residential energy sector of Southeastern Newfoundland. The 4,850 households represented 4.6 percent of the total occupied housing stock of the four fuel peat demand regions. The 1994 fuel peat household penetration rates for the four demand regions under Scenario A were: (1) Southern Avalon - 3.0 percent, (2) Burin Peninsula - 1.0 percent, (3) St. John's - 0.2 percent, and (4) Northern Avalon - 0.4 percent. Scenario B penetration rates for the four regions were 17.2, 6.8, 3.1 and 4.4 percent, respectively.

The projected residential fuel peat penetration rates were highest in the Trepassey Bay and St. Bride's Census Consolidated Subdivisions of the Southern Avalon Demand Region and in the Lamaline and St. Lawrence Subdivisions of the Burin Peninsula Demand Region. All four subdivisions contain large fuel peat deposits and limited fuel wood resources. It was evident from the analysis of background fuel peat development considerations in Section 3.2 and from the fuel peat supply analysis in Section 4.3 that early commercial fuel peat production would likely be situated near Lamaline or Trepassey, or in the St. Bride's-Placentia area. From a demand perspective, many residential energy customers in this area appear receptive to the idea of using fuel peat.[15]

The lower fuel peat penetration rates bordering on the four census consolidated subdivisions mentioned above reflect the expectation that fuel peat market penetration will be negatively correlated with distances from developed fuel peat supplies and with the availability of fuel wood. Residents of the Southern Avalon responding to a 1984 fuel peat market survey[16] indicated that the average distance they would be willing to travel to obtain their fuel peat supply would be 26 kilometres. Seventy-two percent of St. John's respondents to the same survey stated that they would not be willing to travel to St. Shotts on the Southern Avalon to obtain fuel peat.

Based upon the fuel peat transportation experiences of companies in Finland and Ireland, the boundaries of the

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[15] Thirty-four out of 41 heads of households who were interviewed in the community of St. Shotts during preliminary fuel peat market research (conducted under the direction of the author while employed at the Newfoundland Department of Mines and Energy in 1982), indicated that they were interested in purchasing peat if it cost less than petroleum. Only 27 percent of those interviewed were using or had any intentions of converting to wood. All respondents claimed to be familiar with the use of peat as a fuel and 93 percent indicated that they knew of households which had burned fuel peat in the past. The results of this research, referenced in Section 2.2, were not used in this thesis because of concerns pertaining to validity of findings.

[16] Research Associates, op. cit., p.10.

marketshed of a Southern Avalon sod peat production operation would be restricted to a maximum radius of 80 road kilometres. This radius would extend up to 150 kilometres for peat briquettes and pellets, because of lower distribution costs associated with these more densified fuels. Scenario B assumes that a densified fuel peat operation located in the Southern Avalon Demand Region will be supplying 20,000 tonnes of briquettes or pellets,[17] catering mainly to residential and small industrial-commercial energy customers in the St. John's and Northern Avalon Demand Region, by 1994.[18]

The role of fuel wood as an intervening energy opportunity would be severely weakened by a distribution system which would make regular deliveries of fuel peat at a delivered cost of 40 dollars per tonne in 1984 dollars. This price would be approximately the same price as purchased wood and would be about 40 percent less expensive than conventional fuels.[19] Also, fuel peat would be more convenient to handle and store than fuel wood because of

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[17] One tonne of densified peat has the energy value of two tonnes of sod peat, due to the 50 percent reduction in moisture content during processing.

[18] The financial feasibility of this densification plant was not assessed in Chapter 6, however, it would likely be similar to existing plants in Finland.

[19] Based on a personal interview with an official of the Newfoundland Department of Mines and Energy.

lower bulk densities, especially when processed in the form of briquettes or pellets.

The fuel peat demand projections are based on the expectation that an average of 70 percent of a mean annual space heating requirement of 100 megajoules of energy for each household will be supplied by 10.6 tonnes of fuel peat.[20]

5.3 INDUSTRIAL-COMMERCIAL FUEL PEAT DEMAND

Total conventional energy consumption in the industrial-commercial energy sector in Newfoundland was projected to increase at a mean annual rate of 2.9 percent from 1984 to 1994. Consumption is expected to increase from 63,211 terajoules in 1984 to 86,379 terajoules by 1994.[21] A breakdown of industrial-commercial energy demand by fuel peat demand region under both conventional energy pricing scenarios is presented in Table 5.8. Regional population

[20] Energy conversion factors are presented in Appendix B.

[21] The Newfoundland industrial-commercial energy consumption for 1983 shown in (Table 3.5), is escalated by the energy growth rates for the industrial-commercial energy sector presented in Newfoundland Department of Mines and Energy, Submission to the National Energy Board in the Matter of the 1984 Energy Supply and Demand Update, St. John's, 1984, Appendix I.

Table 5.8

INDUSTRIAL-COMMERCIAL ENERGY DEMAND BY

FUEL PEAT DEMAND REGION (1)

(terajoules)

Demand Region (2)	1984	1994
Southern Avalon	1,190	1,790
Burin Peninsula	1,751	2,755
St. John's	8,928	15,100
Northern Avalon	3,688	5,461
Remainder of Newfoundland	47,654	61,273
Province of Newfoundland	63,211	86,379

Notes:

(1) Province of Newfoundland projections were 1983 energy consumption (Table 5.1) escalated by the energy growth rates for the industrial-commercial sector used in Newfoundland Department of Mines and Energy, Submission to the National Energy Board in the Matter of the 1984 Supply Demand Update, St. John's, 1984, Appendix I.

(2) Regional energy demand projection were based upon regional population shares (Table 5.4). The total projected demand in the mining and pulp and paper industries was included in the Remainder of Newfoundland Region.

shares from Table 5.4 were utilized to obtain a regional breakdown of conventional energy demand for the years 1984 and 1994. Since most of the mining and pulp and paper related operations are located off the Avalon and Burin Peninsulas, none of the energy consumption for these energy intensive industries was allocated to Southeastern Newfoundland.

The lack of regional data pertaining to the number of customers and energy consumption prevented the forecasting of fuel peat demand for the industrial-commercial energy sector at the census consolidated subdivision level, as was done in Section 5.2. Unlike the residential energy sector, the industrial-commercial energy sector was composed of a heterogeneous customer mix. This mix, plus the influence of many non-demographic location factors, such as proximity to raw materials, prevented the derivation of credible spatial energy consumption information at a more micro geographic level than the fuel peat demand region (by correlating energy demand with available regional population or household data). Limitations stemming from the lack of published regional energy data, however, were offset by the considerable amount of information, gathered during field trips to Southeastern Newfoundland,[22] pertaining to the

[22] Included in these field trips (1980-1982) were meetings with the owners and operators of approximately 20 industrial-commercial operations to discuss possible

numbers, characteristics and locations of energy customers. A bottom-up approach is therefore used to overcome the energy demand forecasting problem posed by the heterogeneous nature of energy customers in the industrial-commercial sector. The fuel peat demand scenarios shown in Table 5.9 were based upon projections of the number of customers in each of the 250, 500, and 2,000 kilowatt classes that could conceivably convert to fuel peat.[23]

Under Scenario A, demand was restricted in 1994 to three customers in the 250 kilowatt class and one customer in the 500 kilowatt group. It is likely that these customers would be public institutions with dual peat-fired and conventional energy systems.[24] The 1994, Scenario B projection of 34 fuel peat customers reflected an expectation that fuel peat could conceivably mature into a real alternative to conventional fuels in the industrial-commercial energy sector of Southeastern Newfoundland. In

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conversions to fuel peat.

[23] The selection of these three fuel peat combustion categories was based upon the energy demand requirements of industrial-commercial customers in Southeastern Newfoundland as per the recommendations of Technopeat Inc. Large industrial customers, such as the chemical plant at Long Harbour, were not perceived as likely markets for fuel peat by 1994.

[24] A major aim of these conversions would likely be to demonstrate the technical and financial feasibility of fuel peat combustion. Also there would likely be substantial involvement by governments, including the injection of risk capital and funding targeted for information dissemination.

Table 5.9

INDUSTRIAL-COMMERCIAL FUEL PEAT DEMAND IN SOUTHEASTERN NEWFOUNDLAND - 1994

Demand Region	Fuel Peat Customers - Scenario A 250kW	500kW	2,000kW	Fuel Peat Customers - Scenario B 250kW	500kW	2,000kW	Total Demand Scenario A(1) (tonnes)	Total Demand Scenario B(1) (tonnes)
Southern Avalon	3	1	0	6	2	1	3,185	11,466
Burin Peninsula	0	0	0	4	2	1	0	10,192
St. John's	0	0	0	10	2	0	0	8,918
Northern Avalon	0	0	0	5	1	0	0	4,459
Totals	3	1	0	25	7	2	3,185	35,035

Note:

(1) The mean annual consumption of fuel peat for the 250, 500 and 2,000 kilowatt combustion systems would be 637, 1,274 and 5,096 tonnes, respectively. It was assumed that 80 percent of the total energy requirement would be met from fuel peat and that the average load factor would be 60 percent.

addition to public institutions, it was assumed that private industrial-commercial energy customers, including fish plants, would be relying on fuel peat for the bulk of their energy requirements. The forecasted mean annual average peat consumption of customers in the 250, 500, and 2,000 kilowatt classes would be equivalent to 871, 1,782, and 7,127 tonnes of sod peat. These consumption figures assume that an average of 80 percent of the total energy requirement of each customer, operating at a 60 percent load factor, would be met by fuel peat.[25] The projection of 1994 consumption levels of fuel peat in the industrial-commercial energy sector in Southeastern Newfoundland was 3,185 and 35,035 tonnes, respectively, in Scenarios A and B.

5.4 MAJOR FINDINGS

Fuel peat demand projections for 1994 for the residential and industrial-commercial energy sectors of Southeastern Newfoundland are summarized in Table 5.10 for each of the four demand regions. Under Scenario A, fuel peat demand was projected to total 8,485 tonnes, two-thirds of which would be consumed in the residential sector. Fuel

[25] The fuel peat utilization percentages employed are the average of the levels used in the financial analysis of industrial-commercial fuel peat combustion systems presented in Section 5.3. Energy conversion factors are presented in Appendix B.

Table 5.10

TOTAL FUEL PEAT DEMAND IN SOUTHEASTERN NEWFOUNDLAND - 1994

(tonnes)

	Residential (1)		Industrial-Commercial (2)		Total	
Demand Region	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
Southern Avalon	2,120	12,190	3,185	11,466	5,305	23,656
Burin Peninsula	1,060	7,420	0	10,192	1,060	17,612
St. John's	1,060	21,200	0	8,918	1,060	30,118
Northern Avalon	1,060	10,600	0	4,459	1,060	15,059
Totals	5,300	51,410	3,185	35,035	8,485	86,445

Notes:

(1) From Table 5.6.
(2) From Table 5.9.

peat demand was expected to reach 86,445 tonnes by 1994 under Scenario B. This scenario assumed that a fuel peat densification plant located in the Southern Avalon Demand Region would be producing approximately 20,000 tonnes of densified peat briquettes or pellets, which would be delivered on a regular basis to residential and small industrial-commercial energy customers on the Avalon Peninsula.

The demands for fuel peat are placed in the context of the total 1994 conventional energy forecast for each fuel peat demand region in Table 5.11. The projected fuel peat demand level for Southeastern Newfoundland was only 0.2 percent of the projected conventional energy demand under Scenario A. Under Scenario B, the energy value of the 86,445 tonne total fuel peat consumption was equivalent to only 2.1 percent of the forecasted conventional energy demand.

The analysis of regional fuel peat demand revealed that the relative size of fuel peat demand is highest in the Southern Avalon Demand Region under both demand scenarios. Under Scenario A, fuel peat consumption was forecasted to be equivalent to 8.1 percent of conventional energy demand in this demand region. The relative share of fuel peat in the total energy market was second highest on the Burin

Table 5.11

TOTAL FUEL PEAT DEMAND RELATIVE TO CONVENTIONAL ENERGY DEMAND IN SOUTHEASTERN NEWFOUNDLAND - 1994

(terajoules)

Fuel Peat Demand Regions	Total Energy Demand (1)	Fuel Peat Demand Scenario A(2)	Percent Fuel Peat Scenario A	Fuel Peat Demand Scenario B(2)	Percent Fuel Peat Scenario B
Southern Avalon	2,360	43	1.8	192	8.1
Burin Peninsula	3,635	9	0.2	143	3.9
St. John's	20,620	9	0.0	244	1.2
Northern Avalon	7,381	9	0.1	122	1.7
Totals	33,996	69	0.2	701	2.1

Notes:

(1) From Tables 5.1 and 5.8.
(2) A conversion factor for tonnes of peat to terajoules of 0.00811 was applied to the fuel peat demand projections presented in Table 5.10.

Peninsula. The St, John's Demand Region, however, accounts for one-third of the total fuel peat demand under Scenario A, despite the small importance of fuel peat compared to total energy requirements.[26] Projected fuel peat demand levels in all regions are modest when compared to fuel peat market penetration rates in Ireland and Finland, discussed in Section 3.2. In 1980, for example, fuel peat accounted for 20 percent of the total energy requirements of Ireland.[27]

The fuel peat demand analysis presented in this chapter indicates that potential markets exist in Southeastern Newfoundland large enough to sustain small to medium scale fuel peat resource developments. Chapter 6 integrates the fuel peat demand projections presented for Scenarios A and B, with the results of the analysis of background fuel peat development considerations and fuel peat supply in the assessment of the financial feasibility of fuel peat developments in Southeastern Newfoundland.

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[26] This is a reflection of the relatively large energy consumption of the St. John's Census Metropolitan Area.

[27] The Ministry of Trade and Industry, Report on Energy Use of Peat, Helsinki, Finland, 1980, p.4.

Chapter 6

ANALYSIS OF FINANCIAL FEASIBILITY OF FUEL PEAT DEVELOPMENTS

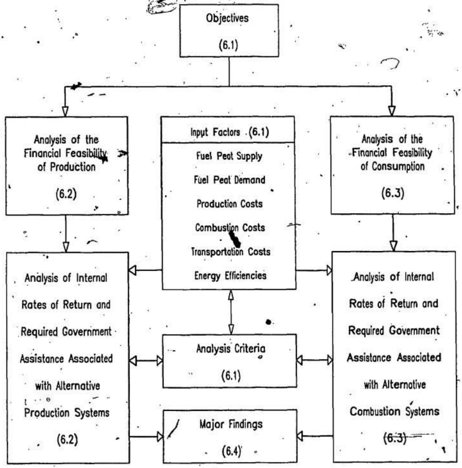
6.1 INTRODUCTION

The analysis of the financial feasibility of resource developments represents an important bridge between the resource supply and resource demand analysis. This chapter systematically integrates the major quantitative and qualitative outputs from the fuel peat supply and demand analysis within a capital budgeting analysis framework in order to examine one of the major unknowns influencing fuel peat development prospects in Southeastern Newfoundland. The prime objective of this chapter is to ascertain if fuel peat production and combustion projects in this region would be financially feasible during the next decade, from the perspective of the potential investor. The fuel peat development financial analysis process, illustrated in Figure 6.1, is documented below.

The financial analysis of fuel peat developments conducted here involved an examination of six fuel peat

Figure 6.1

THE FUEL PEAT DEVELOPMENT FINANCIAL ANALYSIS PROCESS (1)



Note:

(1) Sections are indicated in parentheses.

production systems and four fuel peat combustion systems. The production systems included a small, labour intensive operation designed to produce 100 tonnes of fuel peat per year and a highly mechanized and capital intensive 10,000 tonne system. The other four systems have targeted production capacities of 500, 1,000, 3,000 and 6,000 tonnes of fuel peat per annum. The four combustion systems examined are a manually fed residential combustion unit and three automated solid fuel systems designed for industrial-commercial energy applications. These larger systems have rated energy output capacities of 150, 500 and 2,000 kilowatts. The selection of these production and combustion systems is based upon the analysis of background fuel peat development considerations in Chapter 3 and the location and size of recoverable fuel peat reserves and potential fuel peat markets in Southeastern Newfoundland, examined in Chapters 4 and 5, respectively.[1]

Three capital budgeting analysis indicators were employed in the financial analysis of fuel peat production in Section 6.2 and fuel peat combustion in Section 6.3.

[1] The choice of production and combustion systems was also based upon personal interviews with officials of the Newfoundland Department of Mines and Energy and Technopeat Inc. These systems were judged typical of the types and range of systems which would likely become operational during the first ten years of commercial fuel peat developments. Large industrial fuel peat applications and peat-fired electricity generation are very project specific and were not examined in this thesis.

Emphasis was placed upon project internal rates of return, however, the net present values and discounted payback associated with each type of fuel peat development were also examined.[2] The analysis was extended to the derivation of the level of government assistance[3] needed for a project to yield a 15 percent internal rate of return for projects not meeting that critical profitability criterion.[4] A 20 percent internal rate of return, however, was used in the financial analysis of fuel peat combustion in the residential energy sector.[5]

The capital cost and mix of equipment, as well as operations and maintenance cost estimates associated with

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[2] The capital budgeting analysis technique, including the rationale for relying upon the internal rate of return indicator, is documented in Section 2.4.

[3] Government grants, subsidies, tariffs, loan guarantees, tax expenditures or other direct or indirect financial assistance is an integral element in most natural resource development projects in Canada.

[4] The required 15 percent nominal internal rate of return used in this study was based on a personal interview with officials of the Newfoundland Department of Finance and Newfoundland Executive Council in September, 1984. This rate, which incorporates a 12 percent mean annual effective cost of capital to the investor and a three percent risk factor, is similar to nominal internal rates of return deemed appropriate for other medium risk resource projects in Canada. It is assumed that higher demand related risks associated with the larger production systems and higher supply risks connected with the larger combustion systems would likely be offset by lower management related risks.

[5] This higher rate reflects the need for a greater return on investments and the shorter financial planning horizons usually associated with residential investments.

each of the six production and four combustion systems examined were the primary data inputs in the financial analysis. The capital costs represent an aggregation of the costs of the components of the machinery mix considered appropriate for each system.[6] Operation and maintenance costs for the fuel peat production systems were assumed to be a function of the capital cost of the system.[7] Other information inputs in the financial analysis of fuel peat production and combustion included fuel peat distribution cost estimates as well as fuel peat and conventional energy price projections.

Distribution cost estimates were based upon an average road distance from the recoverable fuel peat reserves to the potential fuel peat markets of 80 kilometres and trucking

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[6] The machinery mix and cost estimates, detailed in Appendix B, were based to a large extent upon personal communications with officials of Technopeat Inc. and the Newfoundland Department of Mines & Energy between 1981 and 1985.

[7] The annual operating and maintenance cost estimates for the three smallest systems were 20 percent of the capital cost of the production system. This is a "rule-of-thumb" measure used in the peat industry in Finland. The operations and maintenance cost estimates for the three largest systems were adjusted upward from this 20 percent criterion as a result of a review of the cost assumptions by the Newfoundland Department of Mines & Energy in 1984. These adjustments indicate that economy-of-scale forces influence operation and maintenance costs to a lesser extent than they do capital costs. This is reflected in the higher proportion of per unit fixed costs versus variable costs in the operation and maintenance category.

rates proposed by the Newfoundland Public Utilities Board.[8] It was assumed that fuel peat distribution would be contracted out to trucking companies, as is the case in Finland.

The assumed 40 dollar per tonne cost in 1981 of delivered fuel peat was based largely upon the detailed financial analysis of peat combustion relative to other fuels, which was presented in Section 6.3. This price also took into consideration the cost of fuel peat production and distribution to markets in Southeastern Newfoundland examined in Section 6.2.[9] It was predicted that fuel peat prices would increase by six percent annually during the study period, since the cost of most of the factors of production, including labour and other operating, maintenance and distribution costs, are expected to be driven by the forecasted six percent inflation rate. Two conventional energy price scenarios are employed in the financial analysis of fuel peat combustion. These scenarios incorporate six and eight percent average annual increases in Newfoundland retail energy prices, based on the same

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[8] Newfoundland Public Utilities Board, Rates, Tolls and Charges Schedule (St. John's: Newfoundland Public Utilities Board, 1983).

[9] A 1984 fuel peat market study prepared for the Southern Avalon Development Association proposed a $35 per tonne price for fuel peat, based upon market considerations. Research Associates, St. Shotts Peat Project - Market Study, 1984, p. 13.

petroleum price outlook presented in Section 3.3, and the expectation that any new electricity demand on the Island of Newfoundland during the next decade would have to be met by petroleum-fired generation.

The ten year time horizon used in this study is appropriate for the financial analysis of fuel peat development prospects. Most recoverable fuel peat reserves in Southeastern Newfoundland are able to sustain ten years of production, and most fuel peat production and combustion equipment can be expected to last at least ten years. In addition, ten years is a frequently used timeframe for judging the financial merits of small to medium scale resource development investments.

The major findings from the analysis of the financial feasibility of fuel peat production and combustion are presented in Section 6.4.

6.2 FINANCIAL ANALYSIS OF FUEL PEAT PRODUCTION

The analysis of the financial feasibility of fuel peat production was based upon the application of the capital budgetary analysis technique to the cost and financial data developed for each of the six fuel peat production systems.

Emphasis was placed upon internal rate of return associated with each system, however, the projected net present values and discounted payback periods were also provided. The financial analysis of the six production systems is presented in this section.

An examination of Table 6.1 reveals that the three smallest mechanized production systems will not yield the required rate of return to the investor without direct government assistance. The 1984 constant dollar value of government assistance required to make these systems financially viable ranges from $134,000 for the 3,000 tonne system to $205,400 for the 1,000 tonne system. The required amount of government assistance per tonne of production during the first ten years of operation would be 32 dollars for the 500 tonne system. The 1,000 and 3,000 tonne system would require 21 and 4 dollars respectively, for each tonne of fuel peat produced.

The financial analysis of the 100 tonne system, a small labour intensive operation involving little capital investment, is not directly comparable to the analysis of the larger fuel peat production systems.[10] The

[10] It is assumed that the only machinery which would have to be purchased for the 100 tonne system would be an $8,000 sod peat extruder.

Table 6.1

FINANCIAL ANALYSIS OF FUEL PEAT PRODUCTION SYSTEMS (1)

Annual Fuel Peat Production (tonnes)	Required Government Assistance(2) (1984 dollars)	Internal Rate of Return (percent)	Discounted Payback Period (years)	Net Present Value (1984 dollars)	Total Production 1985-1994 (tonnes)	Government Assistance Per Tonne (1984 dollars)
100	0	15.8	10	400	1,000	0
500	158,600	15.0	1	0	5,000	31.72
1,000	205,400	15.0	1	0	10,000	20.54
3,000	134,000	15.0	10	0	30,000	4.47
6,000	0	19.5	8	105,400	60,000	0
10,000	0	32.0	5	550,100	100,000	0

Notes:

(1) Detailed calculations are provided in Tables C-1 to C-6.

(2) Amount of government assistance required for system to achieve a 15% internal rate of return.

progressively lower per unit amounts of government assistance needed to achieve the required rates of return for the three systems geared to the annual production of 500 to 3,000 tonnes of sod peat, however, were greatly influenced by economy-of-scale factors. These factors were reflected directly in the capital costs estimates derived, and indirectly in the operation and maintenance cost estimates. With the inclusion of government assistance needed to achieve the required 15 percent rate of return, the net present value of each of the 500, 1,000 and 3,000 tonne systems was zero, and the discounted payback period was the ten year time horizon of the system.

As a result of economy-of-scale considerations, the 6,000 and 10,000 tonne fuel peat production systems would yield a rate of return on the investment greater than the minimum level required.[11] The net present value of the 6,000 tonne system was $105,400, and the discounted payback period was eight years. The corresponding values for the larger system were $550,100 and five years, respectively. The internal rate of return for the 10,000 tonne system was a very attractive 32 percent.

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[11] It is likely that sod peat systems greater than 10,000 tonnes would suffer from diseconomies-of-scale since no additional machinery mix benefits would be derived beyond the 10,000 tonne level, and distribution costs would be higher as a result of spatially extended marketsheds.

In addition to the assessment of the relative financial attractiveness of six different sizes of fuel peat production systems, the 3,000 tonne system was examined in detail to determine the sensitivity of changes to selected exogenous variables. This analysis revealed that the financial feasibility of fuel peat production was sensitive to major changes in the 1984 base price of 40 dollars per tonne for fuel peat and to deviations from the annual six percent fuel peat price escalation rate. The results of this sensitivity analysis are presented in Tables 6.2 and 6.3. Any positive or negative adjustment to these exogenous variables had the inverse absolute impact upon the per tonne amount of government assistance needed to make the system financially viable. The required amount of government assistance was highly sensitive to changes to the mean annual production cost escalation rate of six percent, as is shown in Table 6.4. Table 6.5 illustrates that the financial feasibility was relatively insensitive to five percent adjustments to the 15 percent base discount rate. The financial feasibility of fuel peat production would also be influenced by other exogenous variables, not examined in this thesis, including variations to the reference capital, operation and maintenance and distribution costs.

The above analysis revealed that the financial feasibility of fuel peat production was heavily influenced

Table 6.2

FINANCIAL SENSITIVITY OF PRODUCTION TO FUEL PEAT PRICE CHANGES (1)

Annual Fuel Peat Per tonne (1984 dollars)	Required Government Assistance(2) (1984 dollars)	Internal Rate of Return (percent)	Discounted Payback Period (years)	Net Present Value (1984 dollars)	Government Assistance Per Tonne (3) (1984 dollars)
30	331,000	15.0	10	0	11.03
35	232,500	15.0	10	0	7.73
40	134,000	15.0	10	0	4.47
45	35,600	15.0	10	0	1.19
50	0	18.6	9	63,000	0
55	0	23.0	7	161,300	0
60	0	28.7	6	259,900	0

Notes:

(1) Detailed calculations are provided in Tables C-7 to C-12 and in Table C-4.
(2) Amount of government assistance required for system to achieve a 15% internal rate of return.
(3) Based on a total production of 30,000 tonnes between 1985 and 1994.

Table 6.3

FINANCIAL SENSITIVITY OF PRODUCTION TO FUEL PEAT ESCALATION RATE CHANGES (1)

Fuel Peat Price Escalation (percent)	Required Government Assistance(2) (1984 dollars)	Internal Rate of Return (percent)	Discounted Payback Period (years)	Net Present Value (1984 dollars)	Government Assistance Per Tonne(3) (1984 dollars)
0	283,300	15.0	6.	0	9.44
2	238,100	15.0	10	0	7.94
4	188,500	15.0	10	0	6.28
6	134,000	15.0	10	0	4.47
8	74,300	15.0	10	0	2.48
10	8,800	15.0	10	0	0.29

Notes:

(1) Detailed calculations are provided in Tables C-13 to C-17 and in Table C-4.
(2) Amount of government assistance required for system to achieve a 15% internal rate of return.
(3) Based on a total production of 30,000 tonnes between 1985 and 1994.

Table 6.4

FINANCIAL SENSITIVITY OF PRODUCTION TO COST ESCALATION CHANGES (1)

Production Cost Escalation (percent)	Required Government Assistance(2) (1984 dollars)	Internal Rate of Return (percent)	Discounted Payback Period (years)	Net Present Value (1984 dollars)	Government Assistance Per Tonne (3) (1984 dollars)
0	36,400	15.0	10	0	1.21
2	66,000	15.0	10	0	2.20
4	98,400	15.0	10	0	3.28
6	134,000	15.0	10	0	4.47
8	173,100	15.0	10	0	5.77
10	216,000	15.0	10	0	7.20

Notes:

(1) Detailed calculations are provided in Tables C-18 to C-22 and in Table C-4.
(2) Amount of government assistance required for system to achieve a 15% internal rate of return.
(3) Based on a total production of 30,000 tonnes between 1985 and 1994.

Table 6.5

FINANCIAL SENSITIVITY OF PRODUCTION TO DISCOUNT RATE CHANGES (1)

Discount Rate (percent)	Required Government Assistance(2) (1984 dollars)	Internal Rate of Return (percent)	Discounted Payback Period (years)	Net Present Value (1984 dollars)	Government Assistance Per Tonne (3) (1984 dollars)
5	0	6.4	10	30,900	0
10	66,000	10.0	10	0	2.20
15	134,000	15.0	10	0	4.47
20	183,100	20.0	10	0	6.10
25	219,500	25.0	10	0	7.32

Notes:

(1) Detailed calculations are provided in Tables C-[illegible] to C-26 and in Table C-4.
(2) Amount of government assistance required for system to achieve a 15% internal rate of return.
(3) Based on a total production of 30,000 tonnes between 1985 and 1994.

by economy-of-scale factors. The two largest systems would be financially viable without direct government assistance, while the 3,000, 1,000, and 500 tonne systems would require progressively larger amounts of assistance for each tonne of sod peat produced. Also, the sensitivity analysis illustrated that minor variations to exogenous variables would not alter the financial feasibility of fuel peat production significantly.

6.3 FINANCIAL ANALYSIS OF FUEL PEAT COMBUSTION

The financial feasibility of fuel peat combustion in the residential and industrial-commercial energy sectors is examined in this section. As in the financial analysis of fuel peat production, this analysis was facilitated through the use of the capital budgeting analysis model. The internal rates of return of each fuel peat combustion system was the main indicator of financial feasibility, however, discounted payback periods and net present values are also referenced.

The financial analysis of fuel peat use in the residential energy sector, summarized in Table 6.6, revealed that it would be a very attractive space heating fuel residential energy sector, from a financial perspective.

Table 6.6

FINANCIAL ANALYSIS OF RESIDENTIAL FUEL PEAT COMBUSTION SYSTEMS (1)

Type of System	Fuel Peat Price Per Tonne (1984 dollars)	Petroleum Price Escalator (percent)	Required Government Assistance(2) (1984 dollars)	Internal Rate of Return (percent)	Discounted Payback Period (years)	Net Present Value (1984 dollars)
Conversion (3)	40	6	0	30.8	6	600
Conversion (3)	40	8	0	35.0	6	1,000
Conversion (3)	30	6	0	41.2	5	1,200
Conversion (3)	60	6	0	20.0	10	0
New System	40	6	0	102.4	2	1,600

Notes:

(1) Detailed calculations are provided in Tables C-27 to C-31.
(2) Amount of government financial assistance required for system to achieve a 20% internal rate of return.
(3) Conversion from petroleum to fuel peat heating system.

The internal rate of return associated with a residential fuel peat conversion from petroleum was 31 percent within the reference scenario. This scenario assumed a delivered 1984 base price of fuel peat of 40 dollars per tonne and annual fuel peat and petroleum price increases of six percent during the study period.

The discounted payback and net present value associated with this conversion was six years and 600 dollars respectively.[12] A mean annual petroleum price escalation rate of eight percent yielded the investor an even more attractive 35 percent return on the fuel peat combustion investment. Residential conversions with fuel peat prices at 30 dollars per tonne in 1984 yielded the investor a 41.2 percent return on the investment.

The financial analysis of residential fuel peat combustion was even more attractive if the investor had to purchase a space heating system, as opposed to converting from or duplicating an already functional unit. The increased financial feasibility resulted from the need to include only the incremental 400 dollar cost of a peat combustion system, relative to the conventional energy

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[12] As indicated in Section 5.1, a 20 percent internal rate of return was used in the financial analysis of residential combustion systems. As a result, a 20 percent private discount rate was used in the net present value and discounted payback calculations.

alternative, in the capital cost. The reference scenario would result in an internal rate of return of 102 percent, a discounted payback period of two years and a net present value of $1,600 for a new residential fuel peat combustion system.

A summary of the financial analysis of the conversion of 12 industrial combustion systems to fuel peat from petroleum is presented in Table 6.7. Three sizes of systems, with maximum rated energy output capacities of 250, 500, and 2,000 kilowatts, were examined with fuel peat utilization factors of 35 and 63 percent. The 35 percent level assumed a load factor of 50 percent and that 70 percent of the total energy requirement was supplied by fuel peat. A load factor of 70 percent, coupled with fuel peat's 90 percent share of the total fuel consumption, resulted in the 63 percent utilization factor. Two petroleum price escalation rates of six and eight percent were examined for each system.

At the 35 percent fuel peat utilization level, both the 250 and 500 kilowatt conversions required government financial assistance to yield the targeted 15 percent internal rate of return to the investor. The amount of financial assistance per tonne of fuel peat consumption during the first ten years of operation ranged from $3.23

Table 6.7

FINANCIAL ANALYSIS OF CONVERSION OF INDUSTRIAL-COMMERCIAL COMBUSTION SYSTEMS TO FUEL PEAT (1)

Rated Capacity (kilowatts)	Fuel Peat Utilization Factor (2) (percent)	Petroleum Price Escalator (percent)	Required Government Assistance(2) (1984 dollars)	Internal Rate of Return (percent)	Discounted Payback Period (years)	Net Present Value (1984 dollars)	Total Consumption 1985-1994 (tonnes)	Government Assistance Per Tonne (1984 dollars)
250	35	6	30,000	15.0	10	0	4,550	6.59
250	35	8	14,700	15.0	10	0	4,550	3.23
250	63	6	0	26.0	6	50,900	8,190	0
250	[illegible]	8	0	30.5	6	80,900	8,190	0
500	35	6	110,000	15.0	10	.0	9,100	12.09
500	35	8	76,700	15.0	10	.0	9,100	8.42
500	63	6	0	19.7	8	51,600	16,380	0
500	63	8	0	24.0	7	81,500	16,380	0
2,000	35	6	0	15.9	10	21,900	36,400	0
2,000	35	8	0	20.4	8	155,500	36,400	0
2,000	63	5	0	37.6	4	667,600	65,520	0
2,000	63	8	0	42.0	4	907,800	65,520	0

Notes:

(1) Conversions from petroleum combustion systems. Detailed calculations are provided in Tables C-32 to C-43.

(2) Fuel Peat utilization factor is the product of total energy requirements supplied by fuel peat and the energy load factor. Load factor refers to the energy output of a system as a percent of rated capacity.

(3) Amount of government financial assistance required for system to achieve a 15% internal rate of return.

for the 250 kilowatt system with a petroleum price escalation rate of eight percent to $8.42 for the 500 kilowatt system with yearly petroleum price increases of six percent. The 500 and 250 kilowatt systems yielded attractive internal rates of return between 19.7 and 30.5 percent without government assistance under all 63 percent fuel utilization scenarios. Because of economy-of-scale factors, the 2,000 kilowatt system would be financially viable without government assistance under the two fuel peat utilization levels petroleum price escalation rates. Internal rates of return ranged from 15.9 percent to a high of 42 percent. The discounted payback periods were between ten and four years, and the net present values of the combustion systems varied from $21,900 to $907,800.

The diseconomies-of-scale between the 250 and 500 kilowatt combustion system scenarios, reflected in most of the financial indicators, resulted from the $250,000 capital cost of the larger system compared to $100,000 for the 250 kilowatt system. The major cause for this 150 percent cost increase was the inclusion of the cost of a fully mechanized fuel handling and ash removal system.

The financial feasibility of fuel peat conversions in the industrial-commercial energy sector was influenced more by variations in the fuel peat utilization factor than by moderate shifts in petroleum prices, as shown in Table 6.7. The results of the sensitivity analysis on fuel peat production presented in Section 6.2 suggest that the financial feasibility of fuel peat consumption would likely be relatively insensitive to small shifts in the base price of fuel peat, fuel peat price escalation rates, capital costs, operation and maintenance costs, discount rates and most other exogenous variables.

In the industrial-commercial energy sector, as in the residential sector, the analysis revealed that the fuel peat combustion option was very attractive from a financial perspective if the investor had to install a combustion system. With the 250 kilowatt combustion system, for example, the capital cost factored into the financial feasibility analysis is $20,000 instead of $100,000, as a result of the inclusion of only the incremental cost of the solid fuel versus a petroleum combustion system. Table 6.8 showed that the 40 dollar per tonne fuel peat reference price would yield the new 250 kilowatt combustion system a 61.7 percent internal rate of return. This compared very favourably with the $30,000 financial assistance required for the fuel peat conversion project to achieve a 15 percent internal rate of return under the same circumstances, as was shown in Table 6.7.

Table 6.8

FINANCIAL ANALYSIS OF NEW 250 KILOWATT INDUSTRIAL-COMMERCIAL FUEL PEAT COMBUSTION SYSTEM (1)

Fuel Peat Per tonne (1984 dollars)	Required Government Assistance(2) (1984 dollars)	Internal Rate of Return (percent)	Discounted Payback Period (years)	Net Present Value (1984 dollars)	Government Assistance Per Tonne (3) (1984 dollars)
40	0	61.7	3	49,900	0
60	9,600	15.0	10	0	2.12

Notes:

(1) Detailed calculations are provided in Tables C-44 to C-45.
(2) Amount of government assistance required for system to achieve a 15% internal rate of return.
(3) Based on a total production of 4,550 tonnes between 1985 and 1994.

6.4 MAJOR FINDINGS

The analysis presented in Section 6.2 revealed that the financial feasibility of fuel peat production was heavily influenced by economy-of-scale factors. The two largest production systems were financially viable without direct government assistance, while the 3,000, 1,000, and 500 tonne systems required progressively larger amounts of assistance for each tonne of sod peat produced. The sensitivity analysis revealed that minor variations to fuel peat prices, production escalation rates, discount rates and other exogenous variables would not significantly alter the financial feasibility of fuel peat production.

The financial combustion analysis presented in Section 6.3 showed that fuel peat combustion would be a financially attractive space heating option in the residential energy sector in Southeastern Newfoundland, unless there were major negative aberrations from the reference scenario with respect to one or more of the exogenous variables examined. In both the residential and industrial-commercial energy sectors, the choice between new fuel peat and petroleum fired combustion systems was strongly oriented to fuel peat from a financial perspective. Large scale fuel peat conversions from petroleum in the 2,000 kilowatt range also appeared to be very attractive financially. The financial analysis of small commercial and industrial conversions from petroleum to fuel peat indicated that they would be very sensitive to the level of fuel peat use.

The financial analysis of fuel peat production and combustion in Southeastern Newfoundland included in this chapter is presented from the perspective of the investor. A broader economic analysis of potential fuel peat developments is contained in Chapter 7, which involves an examination of the effects of two fuel peat development scenarios on the Government of Newfoundland and Labrador. Through the facilities of a benefit-cost model, additional Government of Newfoundland and Labrador revenues generated from fuel peat stimulated economic activities are compared with the required levels of government financial assistance needed to finance these fuel peat developments.

Chapter 7

ANALYSIS OF ECONOMIC FEASIBILITY OF FUEL PEAT DEVELOPMENTS

7.1 INTRODUCTION

An important consideration in the analysis of the development potential of a natural resource in Canada is the economic feasibility of the resource development from the perspective of the regional economy. Despite the fact that direct or indirect public funding is associated with the majority of Canadian resource developments, the analysis of the macro-economics of most small to medium scale resource projects is often ignored. The primary objective of this chapter is to analyze the economic feasibility of fuel peat developments in Southeastern Newfoundland, from the perspective of the Government of Newfoundland and Labrador.[1] This analysis involves the assessment of the impact of fuel

[1] As was stated in Section 2.5, the decision to examine the economic feasibility of fuel peat developments from the primarily perspective of the Newfoundland government was influenced by its sponsorship of much of the research and analysis reflected in this study, as well as by the judgement that the economic costs and benefits to government would serve as a proxy for the impact on the Newfoundland economy as a whole. The examination of all public and private costs and benefits of fuel peat developments was considered to be too ambitious an undertaking to attempt in this integrated study.

peat developments on the Newfoundland economy as well as the effects of these developments on government revenues and expenditures. As is discussed in Section 2.5, this quantitative analysis was facilitated through the development and use of a computer-based benefit-cost analysis model. The fuel peat economic analysis process, illustrated in Figure 7.1, is presented in this section.

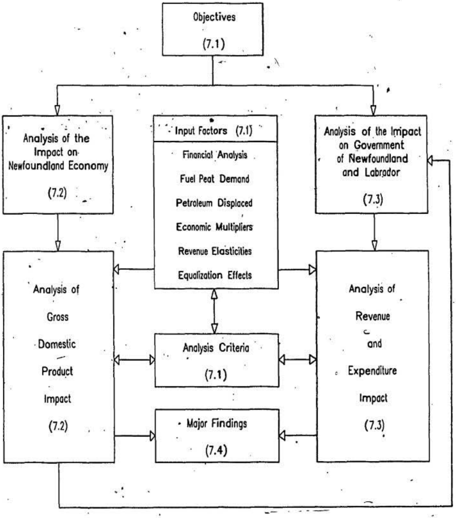
An analysis of the impact of fuel peat developments in Southeastern Newfoundland on the Newfoundland economy is presented in Section 7.2. This analysis involves the examination of the impact of two fuel peat development scenarios on Newfoundland gross domestic product.[2] The fuel peat development scenarios are based on the fuel peat supply analysis presented in Chapter 4, the two fuel peat demand scenarios used in Chapter 5 and the financial analysis from Chapter 6. Other inputs include gross domestic product multipliers from Statistics Canada's input-output model of provincial economies, and an energy conversion factor to determine the amount of petroleum products displaced in the two fuel peat development scenarios.

The impact of fuel peat developments on Government of Newfoundland and Labrador revenues and expenditures is analyzed in Section 7.3. The net revenues accruing from

[2] Gross domestic product at factor cost.

Figure 7.1

THE FUEL PEAT DEVELOPMENT ECONOMIC ANALYSIS PROCESS (1)



Note:

(1) Sections are indicated in parentheses.

fuel peat induced economic activities are compared to the amount of public financial assistance required to stimulate the fuel peat developments identified under the two scenarios in a benefit-cost analysis framework.[3] The Government of Newfoundland and Labrador revenue analysis incorporates revenue elasticity factors from the analysis of econometric relationships between historical gross domestic product and revenue data, plus peat induced increments to Newfoundland gross domestic product. Equalization adjustment factors are also integrated into the revenue analysis to facilitate the computation of any change in Newfoundland's equalization entitlement resulting from fuel peat driven changes in fiscal capacity. The amount of government subsidies stems from the financial analysis of the six fuel peat production and four combustion systems (see Chapter 6) and the two fuel peat development scenarios.

A summary of the major findings from the analysis of the economic feasibility of fuel peat developments in Southeastern Newfoundland is presented in Section 7.4.

[3] See Section 2.5 for details pertaining to the benefit-cost analysis methodology.

7.2 IMPACT ON THE NEWFOUNDLAND ECONOMY

This section examines the impact of the two fuel peat development scenarios on the Newfoundland economy. Fuel peat development Scenarios A and B were based on total annual demands for fuel peat in Southeastern Newfoundland of 8,485 and 86,445 tonnes in 1994 respectively.[1] Under Scenario A, two fuel peat production systems were considered necessary to supply the fuel peat demands of the residential and industrial-commercial energy sectors in Southeastern Newfoundland. One system would be designed to produce 6,000 tonnes of fuel peat annually, and the other systems would have the capacity to produce 3,000 tonnes. Eight 10,000 tonne and one 6,000 tonne fuel peat production systems would produce 86,445 tonnes of fuel peat per year by 1994 under Scenario B.

The number and size of the fuel peat production systems reflected the regional breakdown of fuel peat demand provided in Table 5.10. The capital costs used were based on the financial analysis of the 1,000, 6,000 and 10,000 tonne systems, summarized in Table 6.1. The number and type

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[1] The inputs into and outputs from the two fuel peat development scenarios are shown in Appendix D. As in the financial analysis presented in Chapter 6, all capital investment was assumed to occur in the base year and the analytical timeframe extends to the end of the tenth year of operation.

of fuel peat conversions for the residential and industrial-commercial energy sectors were obtained from Tables 5.6 and 5.9, respectively. The $1,400 capital cost of each residential conversion was used in the financial analysis of residential fuel peat conversions and the $100,000, $250,000 and $600,000 capital costs for the 250, 500, and 2,000 kilowatt combustion systems were derived from Tables C-27 to C-43 in Appendix C.

Gross domestic product multipliers for the machinery and equipment and construction components of capital costs were used to simulate the impact of fuel peat production and combustion developments on the economy. The multiplier for machinery and equipment was 0.092, compared to the construction multiplier of 0.826.[5] The large differential reflects the low provincial value added and the limited induced and indirect economic activity resulting from machinery and equipment purchases in Newfoundland.

In addition to the impact of the initial capital cost of fuel peat production and combustion systems, the displacement of imported petroleum products by an endogenous energy source like fuel peat would have a positive net impact on the Newfoundland economy. The total investment on

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[5] Statistics Canada, Input-Output Model Provincial Economies, Ottawa, 1979.

energy decreases by four million dollars and 40.5 million dollars annually under Scenarios A and B, due to the higher costs of petroleum products displaced (see Appendix D for details). The difference in the gross domestic product multipliers used for investments on petroleum and fuel peat of 0.2 and 0.9,[6] however, more than compensated for the difference in energy costs. The annual net gross domestic product impact of the substitution of fuel peat for petroleum was 3.2 for Scenario A (see Table 7.1) and 30.4 million dollars under Scenario B (see Table 7.2).

The relative impact of fuel peat developments on Newfoundland's gross domestic product would be greatest during the construction phase for both Scenario A and B. Table 7.3 shows that the relative impact on the Newfoundland gross domestic product was only 0.012 percent for Scenario A. For Scenario B, however, the impact on the economy was larger, adding 0.085 percent to the gross domestic product (see Table 7.4). The incremental impact on this macroeconomic indicator would be small during the operating phase of the development scenarios, averaging 0.003 percent for Scenario A and 0.034 percent under Scenario B, during the ten year economic life of the development scenarios.

[6] Ibid.

Table 7.1

NET IMPACT OF FUEL PEAT DEVELOPMENTS ON NEWFOUNDLAND GROSS DOMESTIC PRODUCT - SCENARIO A (1)

(thousands of dollars)

Year	Production and Combustion (2)	Fuel Peat Utilization	Petroleum Displacement	Net Impact
0	652	0	0	652
1	0	324	(132)	192
2	0	343	(140)	203
3	0	364	(149)	215
4	0	386	(158)	228
5	0	409	(167)	242
6	0	433	(177)	256
7	0	459	(188)	272
8	0	487	(199)	288
9	0	516	(211)	305
10	0	547	(223)	324
Totals	652	4,268	(1,743)	3,178

Notes:

(1) The detailed benefit-cost analysis methodology is presented in Section 2.5. The input to and output from the benefit-cost analysis model are presented in Appendix D.

(2) Includes machinery and equipment plus construction impact on gross domestic product.

Table 7.2

NET IMPACT OF FUEL PEAT DEVELOPMENTS ON NEWFOUNDLAND GROSS DOMESTIC PRODUCT - SCENARIO B (1)

(thousands of dollars)

Year	Production and Combustion (2)	Fuel Peat Utilization	Petroleum Displacement	Net Impact
0	4,635	0	0	4,635
1	0	3,299	(1,347)	1,952
2	0	3,497	(1,428)	2,069
3	0	3,707	(1,514)	2,193
4	0	3,929	(1,601)	2,325
5	0	4,165	(1,701)	2,464
6	0	4,415	(1,803)	2,612
7	0	4,679	(1,911)	2,769
8	0	4,960	(2,025)	2,935
9	0	5,258	(2,147)	3,111
10	0	5,573	(2,276)	3,297
Totals	4,635	43,480	(17,751)	30,361

Notes:

(1). The detailed benefit-cost analysis methodology is presented in Section 2.5. The input to and output from the benefit-cost analysis model are presented in Appendix D.

(2) Includes machinery and equipment plus construction impact on gross domestic product.

Table 7.3

RELATIVE IMPACT OF FUEL PEAT DEVELOPMENTS ON NEWFOUNDLAND GROSS DOMESTIC PRODUCT - SCENARIO A (1)

(thousands of dollars)

Year	Without Fuel Peat (2)	Net Impact Fuel Peat (3)	With Fuel Peat	Percent Change
0	5,452,000	652	5,452,652	0.012
1	5,779,100	192	5,779,292	0.003
2	6,125,900	203	6,126,103	0.003
3	6,493,400	215	6,493,615	0.003
4	6,883,000	228	6,883,228	0.003
5	7,296,000	242	7,296,242	0.003
6	7,733,800	256	7,734,056	0.003
7	8,197,800	272	8,198,072	0.003
8	8,689,700	288	8,689,988	0.003
9	9,211,000	305	9,211,305	0.003
10	9,763,700	324	9,764,024	0.003

Notes:

(1) The detailed benefit-cost analysis methodology is presented in Section 2.5. The input to and output from the benefit-cost analysis model are presented in Appendix D.
(2) Newfoundland gross domestic product at factor cost escalated six percent annually.
(3) From Table 7.1.

Table 7.4

RELATIVE IMPACT OF FUEL PEAT DEVELOPMENTS ON NEWFOUNDLAND GROSS DOMESTIC PRODUCT - SCENARIO B (1)

(thousands of dollars)

Year	Without Fuel Peat (2)	Net Impact Fuel Peat (3)	With Fuel Peat	Percent Change
0	5,452,000	4,635	5,456,635	0.085
1	5,779,100	1,952	5,781,052	0.034
2	6,125,900	2,069	6,127,969	0.034
3	6,493,400	2,193	6,495,593	0.034
4	6,883,000	2,325	6,885,325	0.034
5	7,296,000	2,464	7,298,464	0.034
6	7,733,800	2,612	7,736,412	0.034
7	8,197,800	2,769	8,200,569	0.034
8	8,689,700	2,935	8,692,635	0.034
9	9,211,000	3,111	9,214,111	0.034
10	9,763,700	3,297	9,766,997	0.034

Notes:

(1) The detailed benefit-cost analysis methodology is presented in Section 2.5. The input to and output from the benefit-cost analysis model are presented in Appendix D.
(2) Newfoundland gross domestic product at factor cost escalated six percent annually.
(3) From Table 7.2.

Even though the impact on the Newfoundland economy is projected to be small, the economic impact in areas such as the Southern Avalon Demand Region, would be much more pronounced. For example, an estimated 50 percent of the additional 1,000 man-years of employment resulting from fuel peat developments under Scenario B would be created in this region.[7] In addition, the combined effects of several medium scale endogenous resource developments catering to Newfoundland markets, as would be the case with fuel peat, would likely result in a stronger Newfoundland economy than would result from the reliance on large, exported-oriented resource developments.

7.3 IMPACT ON GOVERNMENT OF NEWFOUNDLAND AND LABRADOR

This section examines the financial benefits and costs of fuel peat developments from the perspective of the Government of Newfoundland and Labrador. As indicated in Section 7.2, the primary purpose of this analysis is to determine whether calculated levels of government expenditures on fuel peat production and conversions are

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7 Based on additional labour income of $1,209,000 per year and average employment earnings of $12,700. Labour income was based on fuel peat investment information and labour income multipliers contained in Statistics Canada, Input-Output Model of Provincial Economics, 1979. Employment earnings was based on Statistics Canada, The Labour Force, 71-001.

justified on the basis of additional government revenues generated from fuel peat developments in Southeastern Newfoundland.

The estimated impacts of fuel peat developments on Government of Newfoundland and Labrador revenues for Scenarios A and B are presented in Tables 7.5 and 7.6. With the exception of fuel peat royalties, which were based on fuel peat royalty rates,[8] revenues were driven by the incremental effect of fuel peat developments on Newfoundland's gross domestic product. The projections were based on historical relationships between revenues and gross domestic product as determined by simple linear regression. The revenue bases were adjusted for tax rate and base changes as well as to exclude revenue sources, such as mineral and forestry taxes, which were judged not to be sensitive to fuel peat developments.

Like gross domestic product, the impact of fuel peat developments was greatest on government revenues during the construction phase for both Scenarios A and B. Over the life of the development scenarios, total revenues were projected to increase by 293,600 dollars and 2,685,700

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[8] As stipulated under <u>Quarry Materials Act</u>, (Revised Statutes of Newfoundland, 1976), St. John's: Government of Newfoundland and Labrador, 1976.

Table 7.5

IMPACT OF FUEL PEAT DEVELOPMENTS ON GOVERNMENT OF NEWFOUNDLAND AND LABRADOR REVENUES - SCENARIO A (1)

(thousands of dollars)

Discounted		Discounted		
Year	Total Revenues	Total Revenues	Net Revenues	Net Revenues
0	98.8	98.8	24.0	24.0
1	32.0	27.8	7.0	6.1
2	33.8	25.5	7.5	5.6
3	35.6	23.4	7.9	5.2
4	37.6	21.5	8.4	4.8
5	39.6	19.7	8.9	4.4
6	41.8	18.1	9.4	4.1
7	44.2	16.6	10.0	3.7
8	46.6	15.2	10.6	3.5
9	49.2	14.0	11.2	3.2
10	52.0	12.9	11.9	2.9
Totals	511.3	293.6	116.6	67.5

Note:

(1) The government revenue analysis methodology was presented in Section 2.5., The detailed revenue calculations are contained in Appendix D.

Table 7.6

IMPACT OF FUEL PEAT DEVELOPMENTS ON GOVERNMENT OF NEWFOUNDLAND AND LABRADOR REVENUES - SCENARIO B (1)

(thousands of dollars)

Year	Discounted Total Revenues	Discounted Total Revenues	Discounted Net Revenues	Net Revenues
0	701.5	701.5	170.1	170.1
1	326.3	283.7	71.6	62.3
2	344.0	260.1	75.9	57.4
3	362.8	238.5	80.5	52.9
4	382.7	218.8	85.3	48.8
5	403.8	200.8	90.4	44.9
6	426.2	184.2	95.8	41.4
7	449.9	169.1	101.6	38.2
8	475.0	155.3	107.7	35.2
9	501.7	142.6	114.1	32.4
10	529.9	131.0	121.0	29.9
Totals	4,903.8	2,685.7	1,114.0	613.5

Note:

(1) The government revenue analysis methodology was presented in Section 2.5. The detailed revenue calculations are contained in Appendix D.

dollars for the two scenarios, respectively.[9] The net benefit of these revenue flows was reduced largely as a result of equalization losses.[10] Net revenue gains were 67,500 dollars under Scenario A and 613,500 dollars under Scenario B. These revenue projections are small relative to forecasted Government of Newfoundland and Labrador revenues of 20 billion dollars during the period 1984 to 1995.[11]

The amount of financial assistance which the Government of Newfoundland and Labrador would have to provide to make fuel peat developments financially viable was determined by calculating the cash subsidy needed to yield the specified internal rate of return on each category of fuel peat investment and the fuel peat development profiles presented in Scenarios A and B. Table 7.7 shows that the total amount of government financial assistance required under Scenario A was 234,000 dollars, and 453,800 dollars for Scenario B.

[9] Revenue flows are discounted by 15 percent.

[10] Newfoundland is one of six Canadian provinces currently receiving equalization payments. The analysis of the equalization effects of resource developments further complicates resource analysis in equalization recipient provinces. See, for example, T.J. Gourchene, Equalization Payments: Past, Present and Future (Toronto: Ontario Economic Council, 1984).

[11] Information obtained from the Newfoundland Department of Finance.

Table 7.7

IMPACT OF FUEL PEAT DEVELOPMENTS ON GOVERNMENT OF NEWFOUNDLAND AND LABRADOR EXPENDITURES (1)

(thousands of dollars)

Year	Scenario A Discounted Government Assistance	Scenario B Discounted Government Assistance
0	234.0	453.8
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
Totals	234.0	453.8

Note:

(1) The government expenditure analysis methodology was presented in Section 2.5. The detailed expenditure calculations are contained in Appendix D.

Government of Newfoundland and Labrador net revenues and expenditures pertaining to fuel peat production and consumption under Scenario A were 67,500 and 234,000 dollars, respectively, resulting in a benefit-cost ratio of 0.3 to 1. Excluding the negative impact of equalization entitlement declines on government revenues, the benefit-cost ratio would be 1.3 to 1. The benefit cost ratio under Scenario B was 1.4 to 1 as a result of net revenues of 613,500 dollars and required government expenditures of 453,000 dollars. Ignoring equalization revenue losses, the benefit-cost ratio would be 5.9 to 1.

7.4 MAJOR FINDINGS

The analysis presented in Section 7.2 revealed that the economic impact of fuel peat developments in Southeastern Newfoundland identified in Scenarios A and B on the Newfoundland economy was small. Fuel peat developments, however, would have a larger positive economic effect in the immediate impact region.

The benefit-cost ratios presented in Section 7.3 revealed that the amount of government assistance required to make fuel peat production and combustion projects financially feasible would be recovered 1.4 times by the

Government of Newfoundland and Labrador during the first ten years of operation, under Scenario B. However, fuel peat development prospects would not be economically attractive, given Scenario A demand and supply assumptions.

The analysis presented in this chapter shows that commercial scale fuel peat developments in Southeastern Newfoundland could be economically feasible from a Government of Newfoundland and Labrador perspective, given the levels of financial assistance identified in Chapter 5 and the fuel peat demand scenarios developed in Chapter 6. The economic feasibility of such developments, however, appears to be very sensitive to the level of fuel peat demand and magnitude of fuel peat production projects.[12]

The most salient findings from the analysis of fuel peat resource development prospects presented in Chapters 2 to 7 are highlighted in Chapter 8. The major conclusions pertaining to fuel peat development prospects in Southeastern Newfoundland are reviewed, as is the resource analysis methodology used in this study.

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[12] It is likely that the Government of Canada would provide part of the required levels of government financial assistance. There would be a positive correlation between the amount of government assistance provided by the Government of Canada and the financial benefit-cost ratio for the Government of Newfoundland and Labrador.

Chapter 8

SUMMARY AND CONCLUSIONS

8.1 INTRODUCTION

The most salient findings stemming from the analysis of fuel peat resources, fuel peat production and combustion, and fuel peat demand in Southeastern Newfoundland are highlighted in Section 8.2. Major conclusions pertaining to fuel peat development prospects in Southeastern Newfoundland and the use of the resource analysis approach and methodologies used in this study are presented in Section 8.3.

8.2 SUMMARY OF MAJOR FINDINGS

Chapter 1 revealed that the resource analysis literature presents many approaches and methods suitable for the assessment of specific aspects of fuel peat supply and demand, as well as many of the major influencing variables and inter-relationships. This study attempted to integrate several of these research and analytical methodologies into an assessment of fuel peat development prospects in Southeastern Newfoundland, which was documented in Chapter 2. The need for a broad analytical approach to the resource analysis increased as a result of the absence of a fuel peat development information base in Newfoundland, and economic, social and physical constraints preventing direct transfers of European fuel peat supply, demand, financial and economic information and development experiences.

No previous integrated assessment had been made of the energy development potential of the Newfoundland peatlands, despite the fact that they comprise about 12 percent of the landmass of the Island of Newfoundland and that the Province of Newfoundland relies upon imported petroleum products for 71 percent of the total energy requirements. A review of peatland utilization options, the energy use of peat and historical and recent fuel peat development efforts in Newfoundland was presented in Chapter 3. This review revealed four critical factors influencing fuel peat development prospects in this province, which were examined in this thesis, namely: (1) fuel peat supply, (2) fuel peat demand, (3) financial feasibility, and (4) economic feasibility. Chapter 3 also examined background regional economic and energy considerations influencing fuel peat developments in Southeastern Newfoundland. This analysis revealed that because of the need for economic activity and employment in Newfoundland and the energy supply-demand imbalance, the production and utilization of fuel peat resources would be viewed positively from regional economic and energy perspectives.

Chapter 4 analyzed the fuel peat resources of Newfoundland, focusing on the determination and assessment of the location, size, quality and energy value of deposits. This analysis revealed that high quality fuel peat deposits exist in all four fuel peat supply regions examined. However, the best deposits occur in Southeastern Newfoundland, especially on the southern halves of the Avalon and Burin Peninsulas. The recoverable fuel peat deposits in those two areas compare favorably with European reserves, based on the resource assessment criteria used, and could supply the fuel peat demand requirements projected for 1994 under Scenario B for 150 years.

In Chapter 5, the demand for fuel peat was projected for the years 1989 and 1994 under two fuel peat demand scenarios, in light of the research and analysis presented in other chapters. The projected demands for fuel peat in 1994 were 8,485 and 86,445 tonnes under Scenarios A and B, respectively. The energy values of these projected fuel peat demand levels were 0.2 and 2.1 percent of the total forecasted energy requirements of Southeastern Newfoundland. Sixty percent of fuel peat demand under both scenarios would be concentrated in the residential energy sector.

Scenario A assumed that delivered fuel peat and petroleum prices will both escalate from the 1984 base prices at an annual rate of six percent. Petroleum prices were escalated at eight percent under Scenario B. The differences in the demand projections were based primarily upon the impact of the different petroleum price escalation rates on the financial feasibility of fuel peat combustion relative to petroleum, which were analyzed in detail in Chapter 6. The projected demand levels also reflected the perception of the writer as to how energy customers would react to petroleum price changes based on reactions in developed nations to real conventional price increases during the late 1970s and early 1980s.[1]

A capital budgeting analysis model facilitated the detailed financial analysis of the financial feasibility of fuel peat production and combustion in Chapter 6. This analysis showed that production systems producing 6,000 and

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[1] As was discussed in Section 5.1, the demand analysis could not integrate the results of any statistical analysis of the relationship between consumption and price or any other relevant exogenous and endogenous variables, due to data limitations. These data problems could not be overcome through additional research and analysis.

10,000 tonnes of fuel peat would require no government assistance to yield an acceptable internal rate of return to the investor(s). Diseconomy-of-scale factors, however, would result in the need for government assistance for the 500, 1,000 and 3,000 systems of, respectively, 32, 21 and four dollars per tonne of fuel peat produced during the first ten years of operation. The sensitivity analysis of the financial feasibility of fuel peat production relative to changes in key exogenous and endogenous variables revealed that the required amount of government assistance, net present values and payback were influenced to a large extent by variations from the 1984 base price of fuel peat of 40 dollars per tonne, and by deviations from the six percent mean annual fuel peat price and production cost escalation rates. The financial feasibility of fuel peat production would be relatively insensitive to five percent variances in the base 15 percent discount rate.

The results of the financial analysis of fuel peat combustion revealed that fuel peat would be a low cost alternative to conventional fuels, especially when homeowners are in a situation where a new heating system is required. A residential conversion to fuel peat from petroleum would yield the homeowner a 20 percent internal rate of return without government assistance if the 1984 base price of delivered fuel peat were increased to 50 dollars.

The financial analysis of three industrial-commercial combustion conversions from petroleum to fuel peat revealed that no government assistance would likely be required for large systems, such as the 2,000 kilowatt system examined in this study, because of economy-of-scale influences. The amount of government assistance required for the 250 and 500 kilowatt systems ranged from 20 dollars to zero dollars per tonne of fuel peat consumed during first the ten years of operation. The 500 kilowatt system is not as financially attractive as the 250 kilowatt system, because the capital cost of mechanized fuel handling systems required only for the 500 kilowatt system is greater than the economy-of-scale related savings. The financial feasibility of fuel peat combustion in the industrial-commercial energy sector is sensitive to changes to conventional energy price escalation rates, and is extremely sensitive to variations in fuel peat utilization factors.[2]

A benefit-cost analysis model facilitated the economic analysis of fuel peat developments analyzed in Chapter 7. This analysis combined the fuel peat demand and customer-

[2] The fuel peat utilization factor is the energy value of fuel peat consumed annually expressed as a percent of the annual rated energy capacity of the combustion system.

mix projections presented under Scenarios A and B in Chapter 5 and the results from the corresponding fuel peat production and combustion analysis provided in Chapter 6. The application of input-output multipliers to the fuel peat development profiles resulting from the two demand scenarios revealed that the impact of fuel peat developments on the Newfoundland gross domestic product would be small. The relative economic impact of fuel peat developments would be larger in the Southern Avalon Fuel Peat Demand Region, where an estimated 1,000 man-years of employment would be created during the first ten years of operation. In addition, the combined effect of several medium scale endogenous resource developments, such as fuel peat, would strengthen the economic base of Newfoundland.

The analysis of the impact of fuel peat developments on Government of Newfoundland and Labrador revenues and expenditures revealed that the Scenario B development profile is more attractive from a financial perspective than the profile presented under Scenario A. The respective benefit-cost ratios for Scenario A and B during the ten year time horizon are 0.3 : 1 and 1.4 : 1. The difference resulted from the greater economies-of-scale associated with the larger fuel peat production and combustion systems included in the Scenario B development profile, and the resulting need for less government assistance per tonne of output to make the operations financially viable. The benefit-cost ratios for Scenarios A and B would increase to 1.3 : 1 and 5.9 : 1, respectively, if the effects of equalization losses on net revenues are were ignored.

The broad assessment of fuel peat development prospects revealed major uncertainties pertaining to fuel peat supply and demand, and the financial and economic feasibility of fuel peat production and combustion. The research and analysis of these factors relied heavily on approaches and methods used extensively in resource analysis, including field studies and literature reviews as well as capital budgeting analysis, benefit-cost analysis, regression analysis and scenario building. The integrated use of capital budgeting analysis and benefit-cost analysis facilitated the analyses of the financial and economic feasibility of fuel peat production and combustion. The analytical framework used involved the identification and measurement of many of the major variables and inter-relationships influencing fuel peat developments in Southeastern Newfoundland. This enabled the results of the fuel peat and demand, financial and economic analyses to be examined in a systematic, iterative manner.

The major conclusions pertaining to fuel peat development prospects in Southeastern Newfoundland and the resource analysis approach and methodologies used in this study are presented in Section 8.3.

8.3 CONCLUSIONS

The analysis summarized in Section 8.2 revealed that the quality and quantity of fuel peat resources in Southeastern Newfoundland are sufficient to support commercial fuel peat developments. The analysis also showed that fuel peat developments could be financially viable from the perspective of investors and economically attractive to the Government of Newfoundland and Labrador. The fuel peat demand uncertainty remains unresolved, however, especially in light of falling petroleum prices.

In order for commercial scale fuel peat developments to be economically attractive, demand has to be large enough to warrant at least a 6,000 tonne per year production system. This demand has to be spatially concentrated within 50 kilometre radii, unless the fuel peat is processed into briquettes or pellets. In addition, for fuel peat to be economical, the mix of customers must not be heavily focused on the small and medium industrial-commercial categories, because of the need for high levels of government financial assistance. Rather, emphasis should be on large industrial-commercial and residential conversions as they would require no subsidies to be profitable.

The major exogenous variable influencing fuel peat demand in Southeastern Newfoundland is expected to be the price of petroleum. Real price increases are projected to result in fuel peat demand levels large enough to support medium scale fuel peat developments (Scenario B); while constant real petroleum prices would likely support small developments, on the southern halves of the Avalon and Burin Peninsulas (Scenario A). No commercial fuel peat developments would likely occur if petroleum prices declined in real terms during the study period, due to low levels of fuel peat demand.

The integrated approach used in this thesis facilitated the systematic analysis of fuel peat supply and demand, and the financial and economic feasibility of fuel peat developments in Southeastern Newfoundland. The application of this broad approach yielded a greater understanding of the development potential of the fuel peat resources of this region. Also, integration of the capital budgeting analysis and benefit-cost analysis techniques, within the context of two resource development scenarios, represents a useful contribution to the field of resource analysis. This integration enabled the analysis of economic benefits and costs to governments of each development scenario to be linked with the assessment of the profitability and financial requirements of each type of production and utilization system. The financial analysis was performed from the perspective of both the fuel peat producer and consumer. The computer modelling of the capital-budgeting analysis and benefit-cost analysis techniques allowed for sensitivities to be performed on selected exogenous variables, and enabled the identification of critical factors affecting the financial and economic feasibility of fuel peat developments.

With modifications, the integrated analytical approach employed in the analysis of fuel peat development potential could be applied effectively to the assessment of the development potential of fuel wood or other small to medium scale energy resources in Newfoundland.[3] This broad based, predictive approach would be particularly pertinent for evaluating other potential resource developments (or allocations) which have not been systematically analyzed.

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[3] The detailed historical fuel wood consumption data base would enable demand projections to be based more strongly upon econometric relationships than was possible in the fuel peat demand analysis.

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APPENDIX A

MAJOR NEWFOUNDLAND FUEL PEAT DEPOSITS

Recoverable fuel peat reserves were derived by applying fuel peat development criteria used by the peat industry in Finland to Peatland Inventory Tables.

Table A-1

MAJOR DEPOSITS IN NORTHEASTERN FUEL PEAT SUPPLY REGION

(millions cubic metres)

Rank	Location	Volume	Area (hectares)
1	Sheffield	21	1,200
2	Weir's Pond	11	1,100
3	Springdale	4	400
4	King's Point	3	300
5	Hampden	2	200
6	Gander River	2	100
7	Comfort Cove	1	100
8	Gambo	1	100
9	Wesleyville	1	100
10	Musgrave Harbour	1	100
11	Carmanville	1	100
Totals		48	3,800

Table A-2

MAJOR DEPOSITS IN WESTERN FUEL PEAT SUPPLY REGION

(millions cubic metres)

Rank	Location	Volume	Area (hectares)
1	Harry's River	42	2,500
2	Codroy	22	1,300
3	Main Gut	21	1,500
4	Lomond	18	1,500
5	Little Friar's Cove	14	800
6	Port aux Basque	6	300
7	Flat Bay	6	400
8	Stephenville	5	500
9	Deer Lake	4	400
10	Serpentine	4	300
11	St. Fintan's	3	200
12	Corner Brook	3	300
13	Groudy's Lake	3	100
14	Dashwood Pond	2	100
15	Bay of Islands	1	100
16	Shag Island	1	100
17	Cormack	1	100
18	Rainy Lake	1	100
19	Pasadena	1	100
20	Little Grand Lake	1	100
Totals		159	10,800

Table A-3

MAJOR DEPOSITS IN EASTERN FUEL PEAT SUPPLY REGION

(millions cubic metres)

Rank	Location	Volume	Area (hectares)
1	Lamaline	117	12,200
2	Placentia	116	9,700
3	Grand Bank	85	8,900
4	St. Bride's	74	6,500
5	Holyrood	53	3,300
6	Port Blandford	51	4,800
7	St. Lawrence	44	1,600
8	St. Mary's	44	4,000
9	Tug Pond	41	3,900
10	Biscay Bay	39	3,400
11	Sunnyside	36	3,300
12	St. Catherine's	36	2,400
13	Sound Island	35	3,100
14	Renews	34	1,900
15	Marystown	34	3,500
16	Ship Cove	31	2,800
17	Trepassey	30	3,100
18	Argentia	29	2,300
19	Random Island	21	1,900
20	St. Shotts	19	1,900
21	Sweet Bay	10	900
22	Bay Bulls	9	900
23	Trinity	7	700
24	Terrenceville	5	500
25	Harbour Grace	3	300
26	Bonavista	3	300
27	Point Engree	3	200
28	Harbour Buffett	2	200
29	St. John's	2	200
30	Dildo	1	100
31	Bay de Verde	1	100
Totals		1,015	88,900

Table A-4

MAJOR DEPOSITS IN NORTHERN FUEL PEAT SUPPLY REGION

(millions cubic metres)

Rank	Location	Volume	Area (hectares)
1	Portland Creek	43	4,100
2	Port Saunders	27	2,600
3	Salmon River	25	2,500
4	Blue Mountain	19	1,800
5	Castor's River	15	1,300
6	Brig Bay	13	1,300
7	Bellburns	9	900
8	St. Anthony	7	700
9	St. Julien's	6	400
10	St. Paul's Inlet	3	300
11	Indian Lookout	3	300
12	Main River	2	200
13	Groais Island	2	100
14	Roddickton	2	100
15	Flower's Cove	2	200
16	Raleigh	1	100
17	Silver Mountain	1	100
Totals		180	17,000

APPENDIX B

BREAKDOWN OF FUEL PEAT DEVELOPMENT COSTS

AND ENERGY CONVERSION FACTORS

Table B-1

COST PROJECTIONS FOR SELECTED FUEL PEAT PRODUCTION SYSTEMS
(constant 1984 dollars)

ACTIVITY	DEVELOPMENT SIZE (Tonnes)				
	100	1,000	3,000	6,000	10,000
FIELD PREPARATION					
Road Construction	0	10,000	15,000	15,000	20,000
Culverts	0	2,000	4,000	8,000	12,000
Perimeter Ditches	0	5,000	14,000	18,000	20,000
Four W.D. Tractor	0	50,000	60,000	60,000	60,000
Ditcher	0	28,500	28,500	28,500	28,500
Profiler	0	20,000	20,000	20,000	20,000
Grader	0	0	11,000	11,000	11,000
Field Ditching	0	7,000	14,000	20,000	25,000
	5,000	137,500	209,000	225,000	241,500
PRODUCTION					
Consulting Fees	0	5,000	10,000	10,000	10,000
Four W.D. Tractor	0	5,000	60,000	120,000	180,000
Extruder (12,500)	0	12,500	25,000	25,000	25,000
Sod Turner (17,500)	0	17,500	35,000	35,000	35,000
Wagon	0	8,000	10,000	20,000	30,000
	0	48,000	140,000	210,000	280,000
ADMINISTRATION					
Labour, Acct., Ins., etc.	4,600	20,000	57,000	102,000	157,000
TOTAL	9,600	205,500	406,500	537,500	678,500

Table B-2

COST PROJECTIONS FOR SELECTED FUEL PEAT COMBUSTION SYSTEM
(constant 1984 dollars)

COMPONENT	SYSTEM SIZE (KW)		
	250	500	2,000
Combustion Unit	30,000	65,000	186,885
Storage & Handling Equipment	20,000	30,000	181,400
Site Civil Work	10,000	20,000	7,400
Engineering Design	10,000	20,000	18,815
Boiler House	0	40,000	50,000
Freight	10,000	15,000	30,000
Contingency	10,000	15,000	47,450
TOTAL	100,000	225,000	600,000

Note:

(1) Residential systems cost approximately $1,400, which includes stove, chimney and installation costs.

Table B-3

ENERGY CONVERSION FACTORS

PETROLEUM CONVERSIONS:

1 barrel = 35 gallons
1 cubic metre = 6.29 barrels
1 tonne = 6.39 barrels

MOISTURE CONTENT OF PEAT:

Peat Type	% Moisture (wet basis)
In situ	85-95
Milled	45-55
Sod	35-40
Briquettes	10-25

PEAT CONVERSIONS:

cubic metres (in situ) x . 190 = tonnes of peat (50% % m.c.)
tonnes (50 % m.c.) x .300 = cubic metres of petroleum
cubic metres (in situ) x .057 = cubic metres of petroleum
cubic metres (50 % m.c.) x 140 = watt hours of electricity

APPENDIX C

DETAILED FINANCIAL ANALYSIS CALCULATIONS

Table C-1

FINANCIAL ANALYSIS OF 100 TONNE FUEL PEAT PRODUCTION SYSTEM - $40 PER TONNE

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	4.2	4.5	4.7	5.0	5.3	5.6	6.0	6.3	6.7	7.1
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.0	0.0
Capital Costs (3)	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	1.7	1.8	1.9	2.0	2.1	2.3	2.4	2.6	2.7	2.9
Distribution Costs (4)	0.0	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.4	1.5
Undiscounted Cash Flows (5)	-9.6	1.6	1.7	1.8	1.9	2.0	2.1	2.3	2.4	2.6	2.7
Discounted Cash Flows (5)	-9.6	1.4	1.3	1.2	1.1	1.0	0.9	0.9	0.8	0.7	0.7
Cumulative Discounted Cash Flows (5,6)	-9.6	-8.2	-6.9	-5.7	-4.6	-3.6	-2.7	-1.8	-1.0	-0.3	0.[illegible]

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 6% annually.
(2) This system would yield a 15.8% internal rate of return to the investor without government assistance.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a $400 net present value.

Table C-2

FINANCIAL ANALYSIS OF 500 TONNE FUEL PEAT PRODUCTION SYSTEM - $40 PER TONNE

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	21.2	22.5	23.8	25.2	26.8	28.4	30.1	31.9	33.8	35.8
Government Assistance (2)	158.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	132.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	23.3	24.7	26.2	27.8	29.4	31.2	33.1	35.0	37.1	39.4
Distribution Costs (4)	0.0	2.2	2.3	2.5	2.6	2.8	2.9	3.1	3.3	3.5	3.7
Undiscounted Cash Flows (5)	26.6	-4.3	-4.6	-4.8	-5.1	-5.4	-5.8	-6.1	-6.5	-6.9	-7.3
Discounted Cash Flows (5)	26.6	-3.7	-3.4	-3.2	-2.9	-2.7	-2.5	-2.3	-2.1	-1.9	-1.8
Cumulative Discounted Cash Flows (5,6)	26.6	22.9	19.5	16.3	13.4	10.7	8.2	5.9	3.8	1.9	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 6% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines & Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $0.10 in 1984. This figure was derived from information contained in _Rates, Tolls and Charges Schedule_, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of one year and a zero net present value.

Table C-3

FINANCIAL ANALYSIS OF 1,000 TONNE FUEL PEAT PRODUCTION SYSTEM - $40 PER TONNE

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue(1)	0.0	42.4	44.9	47.6	50.5	53.5	56.7	60.1	63.8	67.6	71.6
Government Assistance(2)	205.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	198.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	35.0	37.1	39.3	41.7	44.2	46.8	49.6	52.6	55.8	59.1
Distribution Costs (4)	0.0	8.6	9.1	9.7	10.2	10.9	11.5	12.2	12.9	13.7	14.5
Undiscounted Cash Flows (5)	7.4	-1.2	-1.3	-1.3	-1.4	-1.5	-1.6	-1.7	-1.8	-1.9	-2.0
Discounted Cash Flows (5)	7.4	-1.0	-1.0	-0.9	-0.8	-0.8	-0.7	-0.6	-0.6	-0.5	-0.5
Cumulative Discounted Cash Flows (5,6)	7.4	6.4	5.4	4.5	3.7	2.9	2.2	1.6	1.0	0.5	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 6% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in <u>Rates, Tolls and Charges Schedule</u>, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of one year and a zero net present value.

Table C-4

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - $40 PER TONNE

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	127.2	134.8	142.9	151.9	160.6	170.2	180.4	191.3	202.7	214.9
Government Assistance(2)	134.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and, Maintenance Costs (4)	0.0	57.0	60.4	64.0	67.9	72.0	76.3	80.9	85.7	90.8	96.3
Distribution Costs (4)	0.0	26.2	27.8	29.4	31.2	33.1	35.1	37.2	39.4	41.8	44.3
Undiscounted Cash Flows (5)	-272.5	44.0	46.6	49.4	52.4	55.5	58.9	62.4	62.2	70.1	74.3
Discounted Cash Flows (5)	-272.5	38.3	35.3	32.5	30.0	27.6	25.5	23.5	21.6	19.9	18.4
Cumulative Discounted Cash Flows (5,6)	-272.5	-234.2	-198.9	-166.4	-136.4	-108.8	-83.3	-59.8	-38.2	-18.3	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 6% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-5

FINANCIAL ANALYSIS OF 6,000 TONNE FUEL PEAT PRODUCTION SYSTEM - $40 PER TONNE

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	254.4	269.7	285.8	303.0	321.2	340.4	360.9	382.5	405.5	429.8
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	537.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	98.0	103.9	110.1	116.7	123.7	131.1	139.0	147.4	156.2	165.6
Distribution Costs (4)	0.0	52.6	55.8	59.1	62.6	66.4	70.4	74.6	79.1	83.8	88.9
Undiscounted Cash Flows (5)	-537.5	103.8	110.0	116.6	123.6	131.0	138.9	147.2	156.1	165.4	175.4
Discounted Cash Flows (5)	-537.5	90.3	83.2	76.7	70.7	65.2	60.1	55.4	51.0	47.0	43.3
Cumulative Discounted Cash Flows (5,6)	-537.5	-447.2	-364.0	-287.3	-216.6	-151.4	-91.3	-35.9	15.1	62.1	105.4

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 6% annually.
(2) This system would yield a 19.5% internal rate of return to the investor without government assistance.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of eight years and a $105,400 net present value.

Table C-6

FINANCIAL ANALYSIS OF 10,000 TONNE FUEL PEAT PRODUCTION SYSTEM - $40 PER TONNE

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	424.0	449.4	476.4	505.0	535.3	567.4	601.5	637.5	675.8	716.3
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	678.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	138.0	146.3	155.1	164.4	174.2	184.7	195.8	207.5	220.0	233.1
Distribution Costs (4)	0.0	87.6	92.9	98.4	104.3	110.6	117.2	124.3	131.7	139.6	148.0
Undiscounted Cash Flows (5)	-678.5	198.4	210.3	222.9	236.3	250.5	265.5	281.4	298.3	316.2	335.2
Discounted Cash Flows (5)	-678.5	172.5	159.0	146.6	135.1	124.5	114.8	105.8	97.5	89.9	82.9
Cumulative Discounted Cash Flows (5,6)	-678.5	-506.6	-347.0	-200.4	-65.3	59.2	174.0	279.8	377.3	467.2	550.1

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 6% annually.
(2) This system would yield a 32.0% internal rate of return to the investor without government assistance.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $0.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of five years and a $550,100 net present value.

Table C-7

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - $30 PER TONNE

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	95.4	101.1	107.2	113.6	120.4	127.7	135.3	143.4	152.1	161.2
Government Assistance(2)	331.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	60.4	64.0	67.9	72.0	76.3	80.9	85.7	90.8	96.3
Distribution Costs (4)	0.0	26.2	27.8	29.4	31.2	33.1	35.1	37.2	39.4	41.8	44.3
Undiscounted Cash Flows (5)	-75.5	12.2	12.9	13.7	14.5	15.4	16.3	17.3	18.3	19.4	20.6
Discounted Cash Flows (5)	-75.5	10.6	9.8	9.0	8.3	7.7	7.1	6.5	6.0	5.5	5.1
Cumulative Discounted Cash Flows (5,6)	-75.5	-64.9	-55.1	-46.1	-37.8	-30.1	-23.0	-16.5	-10.5	-5.0	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $30 per tonne in 1984 escalated 6% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-8

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - $35 PER TONNE

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	111.3	118.0	125.1	132.6	140.5	148.9	157.9	167.4	177.4	188.0
Government Assistance(2)	232.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	60.4	64.0	67.9	72.0	76.3	80.9	85.7	90.8	96.3
Distribution Costs (4)	0.0	26.2	27.8	29.4	31.2	33.1	35.1	37.2	39.4	41.8	44.3
Undiscounted Cash Flows (5)	-174.0	28.1	29.8	31.6	33.5	35.5	37.6	39.9	42.3	44.8	47.5
Discounted Cash Flows (5)	-174.0	24.4	22.5	20.8	19.1	17.6	16.3	15.0	13.8	12.7	11.7
Cumulative Discounted Cash Flows (5,6)	-174.0	-149.6	-127.1	-106.3	-87.2	-69.6	-53.3	-38.3	-24.5	-11.8	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $35 per tonne in 1984 escalated 6% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-9

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - $45 PER TONNE

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	143.1	151.7	160.8	170.4	180.7	191.5	203.0	215.2	228.1	241.8
Government Assistance (2)	35.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	60.4	64.0	67.9	72.0	76.3	80.9	85.7	90.8	96.3
Distribution Costs (4)	0.0	26.2	27.8	29.4	31.2	33.1	35.1	37.2	39.4	41.8	44.3
Undiscounted Cash Flows (5)	-370.9	59.9	63.5	67.3	71.3	75.6	80.2	85.0	90.1	95.5	101.2
Discounted Cash Flows (5)	-370.9	52.1	48.0	44.3	40.8	37.6	34.7	31.9	29.4	27.1	25.0
Cumulative Discounted Cash Flows (5,6)	-370.9	-318.8	-270.8	-226.5	-185.7	-148.1	-113.4	-81.5	-52.1	-25.0	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $45 per tonne in 1984 escalated 6% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-10

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM--$50 PER TONNE

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	159.0	168.5	178.7	189.4	200.7	212.8	225.5	239.1	253.4	268.6
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	60.4	64.0	67.9	72.0	76.3	80.9	85.7	90.8	96.3
Distribution Costs (4)	0.0	26.2	27.8	29.4	31.2	33.1	35.1	37.2	39.4	41.8	44.3
Undiscounted Cash Flows (5)	-406.5	75.8	80.3	85.2	90.3	85.7	101.4	107.5	114.0	120.8	128.1
Discounted Cash Flows (5)	-406.5	65.9	60.8	56.0	51.6	47.6	43.9	40.4	37.3	34.3	31.7
Cumulative Discounted Cash Flows (5,6)	-406.5	-340.6	-279.8	-223.8	-172.2	-124.6	-80.7	-40.3	-3.0	31.3	63.0

Notes:

(1) Based upon a delivered price of fuel peat of $50 per tonne in 1984 escalated 6% annualy.
(2) This scenario would yield a 10.6% internal rate of return to the investor without government assistance.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $0.10 in 1984. This figure was derived from information contained in <u>Rates, Tolls and Charges Schedule</u>, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of nine years and a $63,000 net present value.

Table C-11

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - $55 PER TONNE

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	19
Revenue (1)	0.0	174.9	185.4	196.5	208.3	220.8	234.1	248.1	263.0	278.8	295.5
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	60.4	64.0	67.9	72.0	76.3	80.9	85.7	90.8	96.3
Distribution Costs (4)	0.0	26.2	27.8	29.4	31.2	33.1	35.1	37.2	39.4	41.8	44.3
Undiscounted Cash Flows (5)	-406.5	91.7	97.2	103.0	109.2	115.8	122.7	130.1	137.9	146.2	154.9
Discounted Cash Flows (5)	-406.5	79.7	73.5	67.7	62.4	57.6	53.1	48.9	45.1	41.5	38.3
Cumulative Discounted Cash Flows (5,6)	-406.5	-326.8	-253.3	-185.6	-123.2	-65.6	-12.5	36.4	81.5	123.0	161.3

Notes:

(1) Based upon a delivered price of fuel peat of $55 per tonne in 1984 escalated 6% annually.
(2) This scenario would yield a 23.8% internal rate of return to the investor without government assistance.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of seven years and a $161,300 net present value.

Table C-12

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - $60 PER TONNE

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	190.8	202.2	214.4	227.2	240.9	255.3	270.7	286.9	304.1	322.4
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	60.4	64.0	67.9	72.0	76.3	80.9	85.7	90.8	96.3
Distribution Costs (4)	0.0	26.2	27.8	29.4	31.2	33.1	35.1	37.2	39.4	41.8	44.3
Undiscounted Cash Flows (5)	-406.5	107.6	114.1	120.9	128.2	135.8	144.0	152.6	161.8	171.5	181.8
Discounted Cash Flows (5)	-406.5	93.6	86.2	79.5	73.3	67.5	62.3	57.4	52.9	48.8	44.9
Cumulative Discounted Cash Flows (5,6)	-406.5	-312.9	-226.7	-147.2	-73.9	-6.4	55.9	113.3	166.2	215.0	259.9

Notes:

(1) Based upon a delivered price of fuel peat of $60 per tonne in 1984 escalated 6% annually.
(2) This scenario would yield a 28.7% internal rate of return to the investor without government
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in <u>Rates, Tolls and Charges Schedule</u>, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of six years and a $259,900 net present value.

Table C-13

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - 0% REVENUE GROWTH

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	127.2	127.2	127.2	127.2	127.2	127.2	127.2	127.2	127.2	127.2
Government Assistance (2)	283.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	60.4	64.0	67.9	72.0	76.3	80.9	85.7	90.8	96.3
Distribution Costs (4)	0.0	26.2	27.8	29.4	31.2	33.1	35.1	37.2	39.4	41.8	44.3
Undiscounted Cash Flows (5)	-123.2	44.0	39.0	33.7	28.1	22.2	15.9	9.2	2.1	-1.5	-13.4
Discounted Cash Flows (5)	-123.2	38.3	29.5	22.2	16.1	11.0	6.9	3.5	0.7	-1.5	-3.3
Cumulative Discounted Cash Flows (5,6)	-123.2	-84.9	-55.4	-33.2	-17.1	-6.1	0.8	4.3	5.0	3.4	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 0% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of six years and a zero net present value.

Table C-14

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - 2% REVENUE GROWTH

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	127.2	129.7	132.3	135.0	137.7	140.4	143.2	146.1	149.0	152.0
Government Assistance (2)	238.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.8	60.4	64.0	67.9	72.0	76.3	80.9	85.7	90.8	96.3
Distribution Costs (4)	0.0	26.2	27.8	29.4	31.2	33.1	35.1	37.2	39.4	41.8	44.3
Undiscounted Cash Flows (5)	-168.4	44.0	41.6	38.9	35.9	32.6	29.1	25.2	21.0	16.4	11.5
Discounted Cash Flows (5)	-168.4	38.3	31.4	25.5	20.5	16.2	12.6	9.5	6.9	4.7	2.8
Cumulative Discounted Cash Flows (5,6)	-168.4	-129.9	-98.5	-73.0	-52.5	-36.3	-23.7	-14.2	-7.3	-2.7	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 2% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-15

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - 4% REVENUE GROWTH

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	127.2	132.3	137.6	143.1	148.8	154.8	160.9	167.4	174.1	181.0
Government Assistance (2)	188.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	60.4	64.0	67.9	72.0	76.3	80.9	85.7	90.8	96.3
Distribution Costs (4)	0.0	26.2	27.8	29.4	31.2	33.1	35.1	37.2	39.4	41.8	44.3
Undiscounted Cash Flows (5)	-218.0	44.0	44.1	44.1	44.0	43.8	43.4	42.9	42.3	41.5	40.5
Discounted Cash Flows (5)	-218.0	38.3	33.3	29.0	25.2	21.8	18.8	16.1	13.8	11.8	10.0
Cumulative Discounted Cash Flows (5,6)	-218.0	-179.7	-146.4	-117.4	-92.2	-70.4	-51.6	-35.5	-21.7	-9.9	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 4% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 40 kilometrés was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-16

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - 8% REVENUE GROWTH

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	127.2	137.4	148.4	160.2	173.1	186.9	201.9	218.0	235.4	254.3
Government Assistance (2)	74.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	60.4	64.0	67.9	72.0	76.3	80.9	85.7	90.8	96.3
Distribution Costs (4)	0.0	26.2	27.8	29.4	31.2	33.1	35.1	37.2	39.4	41.8	44.3
Undiscounted Cash Flows (5)	-332.2	44.0	49.2	54.9	61.1	68.0	75.6	83.8	92.9	102.8	113.7
Discounted Cash Flows (5)	-332.2	38.3	37.2	36.1	35.0	33.8	32.7	31.5	30.4	29.2	28.1
Cumulative Discounted Cash Flows (5)	-332.2	-293.9	-256.7	-220.6	-185.6	-151.8	-119.1	-87.6	-57.2	-28.0	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 8% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-17

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - 10% REVENUE GROWTH

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	127.2	139.9	153.9	169.3	186.2	204.9	225.3	247.9	272.7	299.9
Government Assistance (2)	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	60.4	64.0	67.9	72.0	76.3	80.9	85.7	90.8	96.3
Distribution Costs (4)	0.0	26.2	27.8	29.4	31.2	33.1	35.1	37.2	39.4	41.8	44.3
Undiscounted Cash Flows (5)	-397.7	44.0	51.7	60.4	70.2	81.2	93.5	107.3	122.8	140.1	159.4
Discounted Cash Flows (5)	-397.7	38.3	39.1	39.7	40.1	40.4	40.4	40.3	40.1	39.8	39.4
Cumulative Discounted Cash Flows (5)	-397.7	-359.4	-320.3	-280.6	-240.5	-200.1	-159.7	-119.4	-79.3	-39.5	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 10% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-18

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - 0% EXPENDITURE GROWTH

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	127.2	134.8	142.9	151.5	160.6	170.2	180.4	191.3	202.7	214.9
Government Assistance (2)	36.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	57.0	57.0	57.0	57.0	57.0	57.0	57.0	57.0	57.0
Distribution Costs (4)	0.0	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2
Undiscounted Cash Flows (5)	-370.1	44.0	51.6	59.7	68.3	77.4	87.0	97.2	108.1	119.5	131.7
Discounted Cash Flows (5)	-370.1	38.3	39.0	39.3	39.0	38.5	37.6	36.6	35.3	34.0	32.6
Cumulative Discounted Cash Flows (5,6)	-370.1	-331.8	-292.8	-253.5	-214.5	-176.0	-138.4	-101.8	-66.5	-32.5	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 6% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 0%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 0% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-19

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - 2% EXPENDITURE GROWTH

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	127.2	134.8	142.9	151.5	160.6	170.2	180.4	191.3	202.7	214.9
Government Assistance (2)	66.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	58.1	59.3	60.5	61.7	62.9	64.2	65.5	65.8	68.1
Distribution Costs (4)	0.0	26.2	26.7	27.3	27.8	28.4	28.9	29.5	30.1	30.7	31.3
Undiscounted Cash Flows (5)	-340.5	44.0	50.0	56.4	63.2	70.5	78.4	86.7	95.7	105.3	115.5
Discounted Cash Flows (5)	-340.5	38.3	37.8	37.1	36.1	35.1	33.9	32.6	31.3	29.9	28.5
Cumulative Discounted Cash Flows (5,6)	-340.5	-302.2	-264.4	-227.3	-191.2	-156.1	-122.2	-89.6	-58.3	-28.4	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 6% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 2%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $0.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 2% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-20

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - 4% EXPENDITURE GROWTH

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	127.2	134.8	142.9	151.5	160.6	170.2	180.4	191.3	202.7	214.9
Government Assistance (2)	98.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	59.3	61.7	64.1	66.7	69.3	72.1	75.0	78.0	81.1
Distribution Costs (4)	0.0	26.2	27.2	28.3	29.5	30.7	31.9	33.2	34.5	35.9	37.3
Undiscounted Cash Flows (5)	-308.1	44.0	48.3	52.9	57.9	63.3	69.0	75.2	81.8	88.9	96.5
Discounted Cash Flows (5)	-308.1	38.3	36.5	34.8	33.1	31.4	29.8	28.3	26.7	25.3	23.8
Cumulative Discounted Cash Flows (5,6)	-308.1	-269.8	-233.3	-198.5	-165.4	-134.0	-104.2	-75.9	-49.2	-23.9	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 6% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 4%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 4% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-21

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - 8% EXPENDITURE GROWTH

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	127.2	134.8	142.9	151.5	160.6	170.2	180.4	191.3	202.7	214.9
Government Assistance (2)	173.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	61.6	66.5	71.8	77.5	83.8	90.5	97.7	105.5	113.9
Distribution Costs (4)	0.0	26.2	28.3	30.6	33.0	35.6	38.5	41.6	44.9	48.5	52.4
Undiscounted Cash Flows (5)	-233.4	44.0	45.0	45.9	46.7	47.4	48.0	48.4	48.7	48.7	48.6
Discounted Cash Flows (5)	-233.4	38.3	34.0	30.2	26.7	23.6	20.7	18.2	15.9	13.9	12.0
Cumulative Discounted Cash Flows (5,6)	-233.4	-195.1	-161.1	-130.9	-104.2	-80.6	-59.9	-41.7	-25.8	-11.9	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 6% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated by 8%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.18 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board: A 8% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-22

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - 10% EXPENDITURE GROWTH

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	127.2	134.8	142.9	151.5	160.6	170.2	180.4	191.3	202.7	214.9
Government Assistance (2)	216.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	62.7	69.0	75.9	83.5	91.8	101.0	111.1	122.2	134.4
Distribution Costs (4)	0.0	26.2	28.8	31.7	34.9	38.4	42.2	46.4	51.1	56.2	61.8
Undiscounted Cash Flows (5)	-190.5	44.0	43.3	42.2	40.8	38.8	36.2	33.0	29.1	24.4	18.7
Discounted Cash Flows (5)	-190.5	38.3	32.8	27.8	23.3	19.3	15.7	12.4	9.5	6.9	4.6
Cumulative Discounted Cash Flows (5,6)	-190.5	-152.2	-119.4	-91.6	-68.3	-49.0	-33.3	-20.9	-11.4	-4.5	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 6% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 10%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $0.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 10% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value of zero dollars.

Table C-23

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - 5% DISCOUNT RATE

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	127.2	134.8	142.9	151.5	160.6	170.2	180.4	191.3	202.7	214.9
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	60.4	64.0	67.9	72.0	76.3	80.9	85.7	90.8	96.3
Distribution Costs (4)	0.0	26.2	27.8	29.4	31.2	33.1	35.1	37.2	39.4	41.8	44.3
Undiscounted Cash Flows (5)	-406.5	44.0	46.6	49.4	52.4	55.5	58.9	62.4	66.2	70.1	74.3
Discounted Cash Flows (5)	-406.5	41.9	42.3	42.7	43.1	43.5	43.9	44.4	44.8	45.2	45.6
Cumulative Discounted Cash Flows (5,6)	-406.5	-364.6	-322.3	-279.6	-236.5	-193.0	-149.1	-104.7	-59.9	-14.7	30.9

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 6% annually.
(2) This scenario would yield a 6.4% internal rate of return to the investor without government assistance.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a $30,900 net percent value.

Table C-24

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - 10% DISCOUNT RATE

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	127.2	134.8	142.9	151.5	160.6	170.2	180.4	191.3	202.7	214.9
Government Assistance (2)	66.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	-406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	60.4	64.0	67.9	72.0	76.3	80.9	85.7	90.8	96.3
Distribution Costs (4)	0.0	26.2	27.8	29.4	31.2	33.1	35.1	37.2	39.4	41.8	44.3
Undiscounted Cash Flows (5)	-340.5	44.0	46.6	49.4	52.4	55.5	58.9	62.4	66.2	70.1	74.3
Discounted Cash Flows (5)	-340.5	40.0	38.5	37.1	35.8	34.5	33.2	32.0	30.9	29.7	28.7
Cumulative Discounted Cash Flows (5,6)	-340.5	-300.5	-262.0	-224.9	-189.1	-154.6	-121.4	-89.4	-58.5	-28.8	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 6% annually.
(2) Amount of government assistance which would result in a 10% internal rate ofreturn to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $0.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-25

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - 20% DISCOUNT RATE

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	127.2	134.8	142.9	151.5	160.6	170.2	180.4	191.3	202.7	214.9
Government Assistance (2)	183.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	60.4	64.0	67.9	72.0	76.3	80.9	85.7	90.8	96.3
Distribution Costs (4)	0.0	26.2	27.8	29.4	31.2	33.1	35.1	37.2	39.4	41.8	44.3
Undiscounted Cash Flows (5)	-223.4	44.0	46.6	49.4	52.4	55.5	58.9	62.4	66.2	70.1	74.3
Discounted Cash Flows (5)	-223.4	36.7	32.4	28.6	25.3	22.3	19.7	17.4	15.4	13.6	12.0
Cumulative Discounted Cash Flows (5,6)	-223.4	-186.7	-154.3	-125.7	-100.4	-78.1	-58.4	-41.0	-25.6	-12.0	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 6% annually.
(2) Amount of government assistance which would result in a 20% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net percent value.

Table C-26

FINANCIAL ANALYSIS OF 3,000 TONNE FUEL PEAT PRODUCTION SYSTEM - 25% DISCOUNT RATE

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Revenue (1)	0.0	127.2	134.8	142.9	151.5	160.6	170.2	180.4	191.3	202.7	214.9
Government Assistance (2)	219.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	406.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance Costs (4)	0.0	57.0	60.4	64.0	67.9	72.0	76.3	80.9	85.7	90.8	96.3
Distribution Costs (4)	0.0	26.2	27.8	29.4	31.2	33.1	35.1	37.2	39.4	41.8	44.3
Undiscounted Cash Flows (5)	-187.0	44.0	46.6	49.4	52.4	55.5	58.9	62.4	66.2	70.1	74.3
Discounted Cash Flows (5)	-187.0	35.2	29.8	25.3	21.5	18.2	15.4	13.1	11.1	9.4	8.0
Cumulative Discounted Cash Flows (5.6)	-187.0	-151.8	-122.0	-96.7	-75.2	-57.0	-41.6	-28.5	-17.4	-8.0	0.0

Notes:

(1) Based upon a delivered price of fuel peat of $40 per tonne in 1984 escalated 6% annually.
(2) Amount of government assistance which would result in a 25% internal rate of return to the investor.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) The estimated cost of transporting each tonne of fuel peat an average road distance of 80 kilometres was $8.10 in 1984. This figure was derived from information contained in Rates, Tolls and Charges Schedule, Public Utilities Board. A 6% escalator was applied to this base cost.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-27

FINANCIAL ANALYSIS OF RESIDENTIAL COMBUSTION SYSTEM - CONVERSION FROM PETROLEUM TO FUEL PEAT

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.4	1.5	1.6
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Fuel Peat Costs (4)	0.0	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.9
Undiscounted Cash Flows (5)	-1.4	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7
Discounted Cash Flows (5)	-1.4	0.3	0.3	0.3	0.4	0.4	0.4	-0.4	0.1	0.1	0.1
Cumulative Discounted Cash Flows (5,6)	-1.4	-1.1	-0.8	-0.5	-0.3	-0.1	0.1	0.3	0.4	0.5	0.6

Notes:

(1) Assumes that 70% of an average annual residential consumption of 3,600 litres of petroleum would be displaced by fuel peat. The 1984 base price of $0.35 per litre was escalated 6% annually.
(2) This scenario would yield a 30.0% percent internal rate of return to the investor without government assistance.
(3) Based upon cost estimates obtained from solid fuel combustion systems suppliers. Operations and Maintaince costs were escalated annually by 6%.
(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $40 per tonne was escalated 6% per annum.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of six years and a $600 net present value.

Table C-20

FINANCIAL ANALYSIS OF RESIDENTIAL COMBUSTION SYSTEM - CONVERSION FROM PETROLEUM TO FUEL PEAT

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	1.0	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.8	1.9
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Fuel Peat Costs (4)	0.0	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.9
Undiscounted Cash Flows (5)	-1.4	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.9	1.0
Discounted Cash Flows (5)	-1.4	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Cumulative Discounted Cash Flows (5,6)	-1.4	-1.1	-0.8	-0.5	-0.2	-0.0	0.2	0.4	0.6	0.8	1.0

Notes:

(1) Assumes that 70% of an average annual residential consumption of 3,600 litres petroleum would be displaced by fuel peat. The 1984 base price of $0.35 per litre was escalated 8% annually.
(2) This scenario would yield a 35.0% internal rate of return to the investor without government assistance.
(3) Based upon cost estimates obtained from solid fuel combustion systems suppliers. Operations and Maintaince costs were escalated annually by 6%.
(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $40 per tonne was escalated 6% per annum.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of six years and a $1,000 net present value.

Table C-29

FINANCIAL ANALYSIS OF RESIDENTIAL COMBUSTION SYSTEM - CONVERSION FROM PETROLEUM TO FUEL PEAT

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.4	1.5	1.6
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Fuel Peat Costs (4)	0.0	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.7
Undiscounted Cash Flows (5)	-1.4	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9
Discounted Cash Flows (5)	-1.4	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.1
Cumulative Discounted Cash Flows (5,6)	-1.4	-1.0	-0.6	-0.3	-0.0	-0.3	0.5	0.7	0.9	1.0	1.2

Notes:

(1) Assumes that 70% of an average annual residential consumption of 3,600 litres of petroleum would be displaced by fuel peat. The 1984 base price of $0.35 per litre was escalated 6% annually.
(2) This scenario would yield a 41.2% internal rate of return to the investor without government assistance.
(3) Based upon cost estimates obtained from solid fuel combustion systems suppliers. Operations and Maintenance costs were escalated annually by 6%.
(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $30 per tonne was escalated 6% per annum.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of five years and a $1,200 net present value.

Table C-30

FINANCIAL ANALYSIS OF RESIDENTIAL COMBUSTION SYSTEM - CONVERSION FROM PETROLEUM TO FUEL PEAT

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.4	1.5	1.6
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Fuel Peat Costs (4)	0.0	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.1
Undiscounted Cash Flows (5)	-1.4	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4
Discounted Cash Flows (5)	-1.4	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Cumulative Discounted Cash Flows (5,6)	-1.4	-1.2	-1.0	-0.8	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	0.0

Notes:

(1) Assumes that 70% of an average annual residential consumption of 3,600 litres of petroleum would be displaced by fuel peat. The 1984 base price of $0.35 per litre was escalated 6% annually.
(2) This scenario would yield a 20% internal rate of return to the investor without government assistance.
(3) Based upon cost estimates obtained from solid fuel combustion systems suppliers. Operations and Maintenance costs were escalated annually by 6%.
(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of $60 per tonne was escalated 6% per annum.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-31

FINANCIAL ANALYSIS OF NEW RESIDENTIAL COMBUSTION SYSTEM - FUEL PEAT VERSUS PETROLEUM

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	0.9	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.6
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Capital Costs (3)	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Fuel Peat Costs (4)	0.0	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.9
Undiscounted Cash Flows (5)	-0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.7
Discounted Cash Flows (5)	-0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1
Cumulative Discounted Cash Flows (5,6)	-0.4	-0.1	0.2	0.5	0.7	0.9	1.1	1.3	1.4	1.5	1.6

Notes:

(1) Assumes that 70% of a average annual residential consumption of 3,600 litres of petroleum would be displaced by fuel peat. The 1984 base petroleum price of $0.35 per litre was escalated 6% annually.
(2) This system would yield a 102.4% internal rate of return to the investor without government assistance.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $40 per tonne was escalated 6% per annum.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of two years and a $1,600 net present value.

Table C-32

FINANCIAL ANALYSIS OF 250 KILOWATT COMBUSTION SYSTEM - CONVERSION FROM PETROLEUM TO FUEL PEAT

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	35.5	37.7	39.9	42.3	44.9	47.6	50.4	53.4	56.6	60.0
Government Assistance (2)	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	5.0	5.3	5.6	6.0	6.3	6.7	7.1	7.5	8.0	8.4
Fuel Peat Costs (4)	0.0	19.2	20.4	21.6	22.9	24.3	25.7	27.3	28.9	30.7	32.5
Undiscounted Cash Flows (5)	-70.0	11.3	12.0	12.7	13.5	14.3	15.1	16.0	17.0	18.0	19.1
Discounted Cash Flows (5)	-70.0	9.8	9.1	8.3	7.7	7.1	6.5	6.0	5.6	5.1	4.7
Cumulative Discounted Cash Flows (5,6)	-70.0	-60.2	-51.1	-42.8	-35.1	-28.0	-21.5	-15.5	-9.9	-4.8	0.0

Notes:

(1) Assumes that 70% of an average annual consumption of 136,000 litres of petroleum based on (a 50% load factor) would be displaced by fuel peat. The 1984 base petroleum price of $0.35 per litre was escalated 6% annually.

(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.

(3) Based upon machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.

(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $40 per tonne was escalated 6% per annum.

(5) Numbers may not add due to rounding.

(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-33

FINANCIAL ANALYSIS OF 250 KILOWATT COMBUSTION SYSTEM - CONVERSION FROM PETROLEUM TO FUEL PEAT

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	35.5	38.2	41.2	44.5	48.1	51.9	56.1	60.6	65.4	70.6
Government Assistance (2)	14.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	5.0	5.3	5.6	6.0	6.3	6.7	7.1	7.5	8.0	8.4
Fuel Peat Costs (4)	0.0	19.2	20.4	21.6	22.9	24.3	25.7	27.3	28.9	30.7	32.5
Undiscounted Cash Flows (5)	-85.3	11.1	12.5	14.0	15.6	17.5	19.5	21.7	24.1	26.8	29.7
Discounted Cash Flows (5)	-85.3	9.7	9.4	9.2	8.9	8.7	8.4	8.2	7.9	7.6	7.3
Cumulative Discounted Cash Flows (5,6)	-85.3	-75.6	-66.2	-57.0	-48.1	-39.4	-31.0	-22.8	-14.9	-7.3	0.0

Notes:

(1) Assumes that 70% of an average annual consumption of 136,000 litres of petroleum (based on a 50% load factor) would be displaced by fuel peat. The 1984 base petroleum price of $0.35 per litre was escalated 8% annually.
(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.
(3) Based upon machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $40 per tonne was escalated 6% per annum.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-34

FINANCIAL ANALYSIS OF 250 KILOWATT COMBUSTION SYSTEM - CONVERSION FROM PETROLEUM TO FUEL PEAT

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	64.0	67.8	71.9	76.2	80.8	85.6	90.7	96.2	102.0	108.1
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	5.0	5.3	5.6	6.0	6.3	6.7	7.1	7.5	8.0	8.4
Fuel Peat Costs (4)	0.0	34.6	36.7	38.9	41.2	43.7	46.3	49.1	52.1	55.2	58.5
Undiscounted Cash Flows (5)	-100.0	24.3	25.8	27.3	29.0	30.7	32.6	34.5	36.6	38.8	41.1
Discounted Cash Flows (5)	-100.0	21.2	19.5	18.0	16.6	15.3	14.1	13.0	12.0	11.0	10.2
Cumulative Discounted Cash Flows (5,6)	-100.0	-78.8	-59.3	-41.3	-24.7	-9.4	4.7	17.7	29.7	40.7	50.9

Notes:

(1) Assumes that 90% of an average annual consumption of 191,000 litres of petroleum (based on a 70% load factor) would be displaced by fuel peat. The 1984 base petroleum price of $0.35 per litre was escalated 6% annually.
(2) This system would yield a 26% internal rate of return to the investor without government assistance.
(3) Based upon machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $40 per tonne was escalated 6% per annum.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of six years and a $50,900 net present value.

Table C-35

FINANCIAL ANALYSIS OF 250 KILOWATT COMBUSTION SYSTEM - CONVERSION FROM PETROLEUM TO FUEL PEAT

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	64.0	69.1	74.6	80.6	87.0	94.0	101.5	109.6	118.4	127.9
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	5.0	5.3	5.6	6.0	6.3	6.7	7.1	7.5	8.0	8.4
Fuel Peat Costs (4)	0.0	34.6	36.7	38.9	41.2	43.7	46.3	49.1	52.1	55.2	58.5
Undiscounted Cash Flows (5)	-100.0	24.3	27.1	30.1	33.4	37.0	41.0	45.3	50.0	55.2	60.9
Discounted Cash Flows (5)	-100.0	21.2	20.5	19.8	19.1	18.4	17.7	17.0	16.4	15.7	15.1
Cumulative Discounted Cash Flows (5,6)	-100.0	-78.8	-58.3	-38.5	-19.4	-1.0	16.7	33.7	50.1	65.8	80.9

Notes:

(1) Assumes that 90% of an average annual consumption of 191,000 litres of petroleum (based on a 70% load factor) would be displaced by fuel peat. The 1984 base petroleum price of $0.35 per litre was escalated 8% annually.

(2) This system would yield a 30.5% internal rate of return to the investor without government assistance.

(3) Based upon machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.

(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $40 per tonne was escalated 6% per annum.

(5) Numbers may not add due to rounding.

(6) This system would have a discounted payback of six years and a $80,900 net present value.

Table C-36

FINANCIAL ANALYSIS OF 500 KILOWATT COMBUSTION SYSTEM - CONVERSION FROM PETROLEUM TO FUEL PEAT

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	71.1	75.4	79.9	84.7	89.8	95.1	100.9	106.9	113.3	120.1
Government Assistance (2)	110.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	250.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	10.0	10.6	11.2	11.9	12.6	13.4	14.2	15.0	15.9	16.9
Fuel Peat Costs (4)	0.0	38.5	40.8	43.3	45.9	48.6	51.5	54.6	57.9	61.4	65.0
Undiscounted Cash Flows (5)	-140.0	22.6	24.0	25.4	26.9	28.5	30.2	32.1	34.0	36.0	38.2
Discounted Cash Flows (5)	-140.0	19.7	18.1	16.7	15.4	14.2	13.1	12.1	11.1	10.2	9.4
Cumulative Discounted Cash Flows (5,6)	-140.0	-120.3	-102.2	-85.5	-70.1	-55.9	-42.8	-30.7	-19.6	-9.4	0.0

Notes:

(1) Assumes that 70% of an average annual consumption of 273,000 litres of petroleum would be displaced by fuel peat. The 1984 base petroleum price of $0.35 per litre was escalated 6% annually.

(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.

(3) Based upon machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.

(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $40 per tonne was escalated 6% per annum.

(5) Numbers may not add due to rounding.

(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-37

FINANCIAL ANALYSIS OF 500 KILOWATT COMBUSTION SYSTEM - CONVERSION FROM PETROLEUM TO FUEL PEAT

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	71.1	76.8	82.9	89.6	96.7	104.5	112.8	121.9	131.6	142.1
Government Assistance (2)	76.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	250.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	10.0	10.6	11.2	11.9	12.6	13.4	14.2	15.0	15.9	16.9
Fuel Peat Costs (4)	0.0	38.5	40.8	43.3	45.9	48.6	51.5	54.6	57.9	61.4	65.0
Undiscounted Cash Flows (5)	-173.3	22.6	25.4	28.4	31.8	35.5	39.6	44.0	48.9	54.3	50.2
Discounted Cash Flows (5)	-173.3	19.7	19.2	[illegible]	18.2	17.7	17.1	16.6	16.0	15.4	14.9
Cumulative Discounted Cash Flows (5,6)	-173.3	-153.6	-134.4	-115.7	-97.5	-79.4	-62.7	-46.1	-30.1	-14.8	0.0

Notes:

(1) Assumes that 70% of an average annual consumption of 273,000 litres of petroleum (based on a 50% load factor) would be displaced by fuel peat. The 1984 base petroleum price of $0.35 per litre was escalated 8% annually.

(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.

(3) Based upon machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.

(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $40 per tonne was escalated 6% per annum.

(5) Numbers may not add due to rounding.

(6) This system would have a discounted payback of ten years and a zero net present value.

Table C-38

FINANCIAL ANALYSIS OF 500 KILOWATT COMBUSTION SYSTEM - CONVERSION FROM PETROLEUM TO FUEL PEAT

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	128.0	135.7	143.8	152.5	161.6	171.3	181.6	192.5	204.0	216.3
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	250.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	10.0	10.6	11.2	11.9	12.6	13.4	14.2	15.0	15.9	16.9
Fuel Peat Costs (4)	0.0	69.3	73.5	77.9	82.5	87.5	92.7	98.3	104.2	110.5	117.1
Undiscounted Cash Flows (5)	-250.0	48.7	51.6	54.7	58.0	61.5	65.2	69.1	73.2	77.6	82.3
Discounted Cash Flows (5)	-250.0	42.3	39.0	36.0	33.2	30.6	28.2	26.0	23.9	22.1	20.3
Cumulative Discounted Cash Flows (5,6)	-250.0	-207.7	-168.7	-132.7	-99.5	-68.9	-40.7	-14.7	9.2	31.3	51.6

Notes:

(1) Assumes that 90% of an average annual consumption of 382,000 litres of petroleum (based on a 70% load factor) would be displaced by fuel peat. The 1984 base petroleum price of $0.35 per litre was escalated 6% annually.
(2) This system would yield a 19.7% internal rate of return to the investor without government assistance.
(3) Based upon machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $40 per tonne was escalated 6% per annum.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of eight years and a $51,600 net present value.

Table C-39

FINANCIAL ANALYSIS OF 500 KILOWATT COMBUSTION SYSTEM - CONVERSION FROM PETROLEUM TO FUEL PEAT

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	128.0	138.2	149.3	161.2	174.1	188.1	203.1	219.4	236.9	255.9
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	250.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	10.0	10.6	11.2	11.9	12.6	13.4	14.2	15.0	15.9	16.9
Fuel Peat Costs (4)	0.0	69.3	73.5	77.9	82.5	87.5	92.7	98.3	104.2	110.5	117.1
Undiscounted Cash Flows (5)	-250.0	48.7	54.2	60.2	66.8	74.0	82.0	90.6	100.1	110.5	121.9
Discounted Cash Flows (5)	-250.0	42.3	41.0	39.6	38.2	36.8	35.4	34.1	32.7	31.4	30.1
Cumulative Discounted Cash Flows (5,6)	-250.0	-207.7	-166.7	-127.1	-99.5	-88.9	-52.1	-16.7	17.4	50.1	81.5

Notes:

(1) Assumes that 90% of an average annual consumption of 382,000 litres of petroleum (based on a 70% load factor) would be displaced by fuel peat. The 1984 base petroleum price of $0.35 per litre was escalated 8% annually.
(2) This system would yield a 24% internal rate of return to the investor without government assistance.
(3) Based upon machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $40 per tonne was escalated 6% per annum.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of seven years and a $81,500 net present value.

Table C-40

FINANCIAL ANALYSIS OF 2,000 KILOWATT COMBUSTION SYSTEM - CONVERSION FROM PETROLEUM TO FUEL PEAT

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	284.3	301.4	319.5	338.6	359.0	380.5	403.3	427.5	453.2	480.4
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	600.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	30.0	31.8	33.7	35.7	37.9	40.1	42.6	45.1	47.8	50.7
Fuel Peat Costs (4)	0.0	153.9	163.1	172.9	183.3	194.3	206.0	218.3	231.4	245.3	260.0
Undiscounted Cash Flows (5)	-600.0	100.4	106.5	112.8	119.6	126.8	134.4	142.5	151.0	160.1	169.7
Discounted Cash Flows (5)	-600.0	87.3	80.5	74.2	68.4	63.0	58.1	53.6	49.4	45.5	41.9
Cumulative Discounted Cash Flows (5,6)	-600.0	-512.7	-432.2	-358.0	-289.6	-226.6	-168.5	-114.9	-65.5	-20.0	21.9

Notes:

(1) Assumes that 70% of an average annual consumption of 1,091,000 litres of petroleum (based on a 50% load factor) would be displaced by fuel peat. The 1984 base petroleum price of $0.35 per litre was escalated 6% annually.

(2) This system would yield a 15.9% internal rate of return to the investor without government assistance.

(3) Based upon machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.

(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $40 per tonne was escalated 6% per annum.

(5) Numbers may not add due to rounding.

(6) This system would have a discounted payback of ten years and a $21,900 net present value.

Table C-41

FINANCIAL ANALYSIS OF 2,000 KILOWATT COMBUSTION SYSTEM - CONVERSION FROM PETROLEUM TO FUEL PEAT

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	284.3	307.1	331.6	358.2	386.8	417.8	451.2	487.3	526.3	568.4
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	600.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	30.0	31.8	33.7	35.7	37.9	40.1	42.6	45.1	47.8	50.7
Fuel Peat Costs (4)	0.0	153.9	163.1	172.9	183.3	194.3	206.0	218.3	231.4	245.3	260.0
Undiscounted Cash Flows (5)	-600.0	100.4	112.1	125.0	139.1	154.7	171.7	190.3	210.8	233.2	257.7
Discounted Cash Flows (5)	-600.0	87.3	84.8	82.2	79.6	76.9	74.2	71.6	68.9	66.3	63.7
Cumulative Discounted Cash Flows (5,6)	-600.0	-512.7	-427.9	-345.7	-266.1	-189.2	-115.0	-43.4	25.5	91.8	155.5

Notes:

(1) Assumes that 70% of an average annual consumption of 1,091,000 litres of petroleum (based on a 50% load factor) would be displaced by fuel peat. The 1984 base petroleum price of $0.35 per litre was escalated 8% annually.
(2) This system would yield a 20.4% internal rate of return to the investor without government assistance.
(3) Based upon machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $40 per tonne was escalated 6% per annum.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of eight years and a $155,500 net present value.

Table C-42

FINANCIAL ANALYSIS OF 2,000 KILOWATT COMBUSTION SYSTEM - CONVERSION FROM PETROLEUM TO FUEL PEAT

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	511.8	542.5	575.1	609.6	646.1	684.9	726.0	769.6	815.7	864.7
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	600.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	30.0	31.8	33.7	35.7	37.9	40.1	42.6	45.1	47.8	50.7
Fuel Peat Costs (4)	0.0	277.1	293.7	311.3	330.0	349.8	370.8	393.1	416.7	441.7	468.2
Undiscounted Cash Flows (5)	-600.0	204.7	217.0	230.0	243.8	258.4	273.9	290.4	307.8	326.3	345.8
Discounted Cash Flows (5)	-600.0	178.0	164.1	151.2	139.4	128.5	118.4	109.2	100.6	92.7	85.5
Cumulative Discounted Cash Flows (5,6)	-600.0	-422.0	-257.9	-106.7	32.7	161.2	279.6	388.8	489.4	582.1	667.6

Notes:

(1) Assumes that 90% of an average annual consumption of 1,527,000 litres of petroleum (based on a 70% load factor) would be displaced by fuel peat. The 1984 base petroleum price of $0.35 was escalated 6% annually.

(2) This system would yield a 37.6 percent internal rate of return to the investor without government assistance.

(3) Based upon machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.

(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $40 per tonne was escalated 6% per annum.

(5) Numbers may not add due to rounding.

(6) This system would have a discounted payback of four years and a $667,600 net present value.

Table C-43

FINANCIAL ANALYSIS OF 2,000 KILOWATT COMBUSTION SYSTEM - CONVERSION FROM PETROLEUM TO FUEL PEAT

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	511.8	552.7	597.0	644.7	696.3	752.0	812.2	877.1	947.3	1023.1
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Costs (3)	600.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	30.0	31.8	33.7	35.7	37.9	40.1	42.6	45.1	47.8	50.7
Fuel Peat Costs (4)	0.0	277.1	293.7	311.3	330.0	349.8	370.8	393.1	416.7	441.7	468.2
Undiscounted Cash Flows (5)	-600.0	204.7	227.2	251.9	279.0	308.6	341.0	376.5	414.4	457.8	504.3
Discounted Cash Flows (5)	-600.0	178.0	171.8	165.6	159.5	153.4	147.4	141.6	135.8	130.1	124.6
Cumulative Discounted Cash Flows (5,6)	-600.0	-420.0	-250.2	-84.6	74.9	228.3	375.7	517.3	653.1	783.2	907.8

Notes:

(1) Assumes that 90% of an average annual consumption of 1,527,000 litres of petroleum (based on a 70% load factor) would be displaced by fuel peat. The 1984 base petroleum price of $0.35 was escalated 8% annually.

(2) This system would yield a 42% internal rate of return to the investor without government assistance.

(3) Based upon machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.

(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $40 per tonne was escalated 6% per annum.

(5) Numbers may not add due to rounding.

(6) This system would have a discounted payback of four years and a $907,000 net present value.

Table C-44

FINANCIAL ANALYSIS OF NEW 250 KILOWATT COMBUSTION SYSTEM

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	35.5	37.7	39.9	42.3	44.9	47.6	50.4	53.4	56.6	60.0
Government Assistance (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Capital Costs (3)	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	5.0	5.3	5.6	6.0	6.3	6.7	7.1	7.5	8.0	8.4
Fuel Peat Costs (4)	0.0	19.2	20.4	21.6	22.9	24.3	25.7	27.3	28.9	30.7	32.5
Undiscounted Cash Flows (5)	-20.0	11.3	12.0	12.7	13.5	14.3	15.1	16.0	17.0	18.0	19.1
Discounted Cash Flows (5)	-20.0	9.8	9.1	8.3	7.7	7.1	6.5	6.0	5.6	5.1	4.7
Cumulative Discounted Cash Flows (5,6)	-20.0	-10.2	-1.1	7.2	14.9	22.0	28.5	34.5	40.1	45.2	49.9

Notes:

(1) Assumes that fuel peat would account for 70% of the total energy requirements of 136,000 litre of petroleum equivalent (based on 50% load factor). The 1984 base petroleum price of $0.35 per litre was escalated 6% annually.
(2) This system would yield a 61.7% internal rate of return to the investor without government assistance.
(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.
(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $40 per tonne was escalated 6% per annum.
(5) Numbers may not add due to rounding.
(6) This system would have a discounted payback of three years and a $49,000 net present value.

Table C-45

FINANCIAL ANALYSIS OF NEW 250 KILOWATT COMBUSTION SYSTEM

($000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Petroleum Savings (1)	0.0	35.5	37.7	39.9	42.3	44.9	47.6	50.4	53.4	56.6	60.0
Government Assistance (2)	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Capital Costs (3)	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional Operations and Maintenance Costs (3)	0.0	5.0	5.3	5.6	6.0	6.3	6.7	7.1	7.5	8.0	8.4
Fuel Peat Costs (4)	0.0	28.9	30.6	32.4	34.4	36.4	38.6	40.9	43.4	46.0	48.8
Undiscounted Cash Flows (5)	-10.4	1.7	1.8	1.9	2.0	2.1	2.2	2.4	2.5	2.7	2.8
Discounted Cash Flows (5)	-10.4	1.5	1.3	1.2	1.1	1.1	1.0	0.9	0.8	0.8	0.7
Cumulative Discounted Cash Flows (5,6)	-10.4	-8.9	-7.6	-6.4	-5.3	-4.2	-3.2	-2.3	-1.5	-0.7	0.0

Notes:

(1) Assumes that fuel peat would account for 70% of the total energy requirements of 136,000 litres of petroleum equivalent (based on 50% load factor). The 1984 base petroleum price of $0.35 per litre was escalated 6% annually.

(2) Amount of government assistance which would result in a 15% internal rate of return to the investor.

(3) Derived from machinery mix and cost estimates developed during meetings with officials of Technopeat Inc. and the Newfoundland Department of Mines and Energy. Operations and maintenance costs were escalated annually by 6%.

(4) Assumes that one tonne of fuel peat at 50% moisture content is equivalent to 210 litres of petroleum (see Appendix B). The 1984 base price of fuel peat of $60 per tonne was escalated 6% per annum.

(5) Numbers may not add due to rounding.

(6) This system would have a discounted payback of ten years and a zero net present value.

APPENDIX D

DETAILED ECONOMIC ANALYSIS CALCULATIONS

BENEFIT - COST MODEL - SCENARIO A

MAJOR ASSUMPTIONS:

Pet.Price 6%
Inflation 6%
Peat Escalation 6%

FUEL PEAT DEVELOPMENT SCENARIO

Production Systems		Combustion Systems		Consumption
Tonnes	No.	Size	No.	Tonnes
100	0.0	Res.	500	8,485
500	0.0	250 kw	3	
1,000	0.0	500 kw	1	
3,000	1.0	2,000 kw	0	
6,000	1.0			
10,000	0.0			

SUMMARY RESULTS:

With Equalization

Benefit-Cost Ratio		0.3	to 1
Net Present Value	($000)	-166.5	

Without Equalization

Benefit-Cost Ratio		1.3	to 1
Net Present Value	($000)	59.6	

1. GOVERNMENT REVENUE MODEL ($000)

A. Economy Sub-Model

Production Systems (Tonnes)

	100		500		1000		3000		6000		1000	
Year	M.&E.	Cons.	M.&.E.	Cons.	M&E.	Cons.	M.&E.	Cons.	M.&E.	Cons.	M.&E.	Cons.
0	9.6	0.0	72.0	60.0	120.0	78.0	200.0	206.5	267.0	270.5	378.5	300.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Totals	9.6	0.0	72.0	60.0	120.0	78.0	200.0	206.5	267.0	270.5	378.5	300.0

Notes:

(1) M&E refers to machinery and equipment expenditures.
(2) Cons. refers to construction related expenditures.

Combustion Systems ($000)

Residential		250 kw		500 kw		2000 kw					
M.&E.	Cons.	M.&E.	Cons.	M.&E.	Cons.	M.&E.	Cons.	Total M.&E.	Total Cons.	M.&E. Impact GDP	Cons. Impact GDP
1.4	0.0	75.0	25.0	187.5	62.5	450.0	150.0	1,579.5	614.5	145.3	507.6
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.4	0.0	75.0	25.0	187.5	62.5	450.0	150.0	1,579.5	614.5	145.3	507.6

Note:

(1) GDP refer to Newfoundland gross domestic product.

Resource Utilization Impact ($000)

Year	Tonnes of Peat	Price per Tonne	Value of Peat Prodn.	Litres Petrol. Disp.	Price per Litre	Value Petrol. Disp.	Peat Impact on GDP	Petrol. Impact on GDP	Total Impact on GDP
0	0	40.0	0.0	0	0.3	0.0	0.0	0.0	652.9
1	8,485	42.4	359.8	1,781,850	0.4	661.1	323.8	132.2	191.6
2	8,485	44.9	381.3	1,781,850	0.4	700.7	343.2	140.1	203.1
3	8,485	47.6	404.2	1,781,850	0.4	742.8	363.8	148.6	215.3
4	8,485	50.5	428.5	1,781,850	0.5	787.3	385.6	157.5	228.2
5	8,485	53.5	454.2	1,781,850	0.5	834.6	408.8	166.9	241.9
6	8,485	56.7	481.4	1,781,850	0.5	884.7	433.3	176.9	256.4
7	8,485	60.1	510.3	1,781,850	0.5	937.7	459.3	187.5	271.8
8	8,485	63.8	541.0	1,781,850	0.6	994.0	486.9	198.8	288.1
9	8,485	67.6	573.4	1,781,850	0.6	1,053.6	516.1	210.7	305.3
10	8,485	71.6	607.8	1,781,850	0.6	1,116.9	547.0	223.4	323.7
Totals	84,850		4,742.0	17,818,500		8,713.4	4,267.8	1,742.7	3,178.0

B. Revenue Forecasting Sub-Model ($000)

Year	GDP W/O Peat	GDP With Peat	RST	PIT	CIT	Fuel Peat Area	Fuel Peat Volume	Fuel Peat Royalty	Other Govt. Revenue	Total Revenue	Dis. Total Revenue
0	5,452.0	5,452.7	36.6	31.3	4.6	0	0.0	0.0	26.3	98.8	98.8
1	5,779.1	5,779.3	10.7	9.2	1.3	84.8	1,613.1	3.0	7.7	32.0	27.8
2	6,125.9	6,126.1	11.4	9.7	1.4	84.8	1,613.1	3.0	8.2	33.8	25.5
3	6,493.4	6,493.6	12.1	10.3	1.5	84.8	1,613.1	3.0	8.7	35.6	23.4
4	6,883.0	6,883.3	12.8	11.0	1.6	84.8	1,613.1	3.0	9.2	37.6	21.5
5	7,296.0	7,296.2	13.5	11.6	1.7	84.8	1,613.1	3.0	9.8	39.6	19.7
6	7,733.8	7,734.0	14.4	12.3	1.8	84.8	1,613.1	3.0	10.3	41.8	18.1
7	8,197.8	8,198.1	15.2	13.0	1.9	84.8	1,613.1	3.0	11.0	44.2	16.6
8	8,689.7	8,689.9	16.1	13.8	2.0	84.8	1,613.1	3.0	11.6	46.6	15.2
9	9,211.0	9,211.3	17.1	14.7	2.1	84.8	1,613.1	3.0	12.3	49.2	14.0
10	9,763.7	9,764.0	18.1	15.5	22.3	84.8	1,613.1	3.0	13.1	52.0	12.9
Totals			178.0	152.5	22.2		16,131.2	30.3	128.2	511.3	293.6

Notes:

(1) RST refers to Newfoundland Sales Tax Revenue.
(2) PIT refers to Newfoundland Personal Income Tax Revenue.
(3) CIT refers to Newfoundland Corporate Income Tax Revenue.

C. Equalization Sub-Model ($000)

Dis. Total Revenue	Net RST	Net PIT	Net CIT	Net FRP	Net OGR	Total Net Rev.	Dis. Net Rev.
98.8	11.7	4.7	2.3	0.0	5.3	24.0	24.0
27.8	3.4	1.4	0.7	0.0	1.5	7.0	6.1
25.5	3.6	1.5	0.7	0.0	1.6	7.5	5.6
23.4	3.9	1.5	0.8	0.0	1.7	7.9	5.2
21.5	4.1	1.6	0.8	0.0	1.8	8.4	4.8
19.7	4.3	1.7	0.8	0.0	2.0	8.9	4.4
18.1	4.6	1.8	0.9	0.0	2.1	9.4	4.1
16.6	4.9	2.0	1.0	0.0	2.2	10.0	3.7
15.2	5.2	2.1	1.0	0.0	2.3	10.6	3.5
14.0	5.5	2.2	1.1	0.0	2.5	11.2	3.2
12.9	5.8	2.3	1.1	0.0	2.6	11.9	2.9
293.6	56.9	22.9	11.1	0.0	25.6	116.6	67.5

Notes:

(1) FPR refers to Newfoundland fuel peat royalities.
(2) OGR refers to other government revenues.

2. Government Expenditure Model ($000)

Year	Production Systems (Tonnes) 100	500	1000	3000	6000	1000	Combustion Systems (kw) Res.	250.0	500.0	2000.0	Total Govt. Assist.
0	0.0	158.6	205.4	134.0	0.0	0.0	0.0	15.0	55.0	0.0	234.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Totals	0.0	158.6	205.4	134.0	0.0	0.0	0.0	15.0	55.0	0.0	234.0

BENEFIT-COST MODEL - SCENARIO B

MAJOR ASSUMPTIONS:

Pet. Price 8%
Inflation 6%
Peat Escalation 6%

FUEL PEAT DEVELOPMENT SCENARIO

Production Systems		Combustion Systems		Consumption
Tonnes	No.	Size	No.	Tonnes
100	0.0	Res.	4,850.0	86,445
500	0.0	250 kw	25.0	
1,000	0.0	500 kw	7.0	
3,000	0.0	2,000 kw	2.0	
6,000	1.0			
10,000	8.0			

SUMMARY RESULTS:

With Equalization

Benefit-Cost Ratio 1.4 to 1

Net Present Value ($000) 159.7

Without Equalization

Benefit-Cost Ratio 5.9 to 1

Net Present Value ($000) 2,231.9

1. GOVERNMENT REVENUE MODEL ($000)

A. Economy Sub-Model

Production Systems (Tonnes)

	100		500		1000		3000		6000		1000	
Year	M.&E.	Cons.	M.&E.	Cons.	M&E	Cons.	M.&E.	Cons.	M.&E.	Cons.	M.&E.	Cons.
0	9.6	0.0	72.0	60.0	120.0	78.0	200.0	206.5	267.0	270.0	378.5	300.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0
Totals	9.6	0.0	72.0	60.0	120.0	78.0	200.0	206.5	267.0	270.0	378.0	300.0

Notes:

(1) M&E refers to machinery and equipment expenditures.
(2) Cons. refers to construction related expenditures.

Combustion Systems ($000)

Residential		250 kw		500 kw		2000 kw		Total	Total	M.&E. Impact	Cons. Impact
M.&E.	Cons.	M.&E.	Cons.	M.&E.	Cons.	M.&E.	Cons.	M.&E.	Cons.	GDP	GDP
1.4	0.0	75.0	25.0	187.5	62.5	450.0	150.0	14,172.5	4,033.0	1,303.9	3,331.3
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.4	0.0	75.0	25.0	187.5	62.5	450.0	150.0	14,172.5	4,033.0	1,303.9	3,331.3

Note:

(1) GDP refer to Newfoundland gross domestic product.

Resource Utilization Impact ($000)

Year	Tonnes of Peat	Price per Tonne	Value of Peat Prodn.	Litres Petrol. Disp.	Price per Litre	Value Petrol. Disp.	Peat Impact on GDP	Petrol. Impact on GDP	Total Impact on GDP
0	0	40.0	0.0	0	0.3	0.0	0.0	0.0	4,635.1
1	86,445	42.4	3,665.0	18,153,450	0.4	6,734.9	3,298.7	1,347.0	1,951.8
2	86,445	44.9	3,885.2	18,153,450	0.4	7,139.0	3,496.7	1,427.8	2,068.9
3	86,445	47.6	4,118.3	18,153,450	0.4	7,567.4	3,706.5	1,513.5	2,193.0
4	86,445	50.5	4,365.4	18,153,450	0.5	8,021.4	3,928.9	1,604.3	2,324.6
5	86,445	53.5	4,627.3	18,153,450	0.5	8,502.7	4,164.6	1,700.5	2,464.0
6	86,445	56.7	4,905.0	18,153,450	0.5	9,012.9	4,414.5	1,802.6	2,611.9
7	86,445	60.1	5,199.3	18,153.450	0.5	9,553.6	4,679.3	1,910.7	2,768.6
8	86,445	63.8	5,511.2	18,153,450	0.6	10,126.8	4,960.1	2,025.4	2,934.7
9	86,445	67.6	5,841.9	18,153,450	0.6	10,734.5	5,257.7	2,146.9	3,110.8
10	86,445	71.6	6,192.4	18,153.450	0.6	11,378.5	5,573.2	2,275.7	3,297.4
Totals	864,450		48,311.1	181,153.450		88,771.7	43,480.0	17,754.3	30,360.8

B. Revenue Forecasting Sub-Model ($000)

Year	GDP W/O Peat	GDP With Peat	RST	PIT	CIT	Fuel Peat Area	Fuel Peat Volume	Fuel Peat Royalty	Other Govt. Revenue	Total Revenue	Dis. Total Revenue
0	5,452.0	5,452.7	259.6	222.5	32.4	0	16,434	0.0	187.0	701.5	701.5
1	5,779.1	5,779.3	109.3	93.7	13.7	864.5	16,434	30.9	78.8	326.3	283.7
2	6,125.9	6,127.9	115.9	99.3	14.5	864.5	16,434	30.9	83.5	344.0	260.1
3	6,493.4	6,495.6	122.8	105.3	15.4	864.5	16,434	30.9	88.5	362.8	238.5
4	6,883.0	6,885.3	130.2	116.6	16.3	864.5	16,434	30.9	93.8	382.7	218.8
5	7,296.0	7,298.5	138.0	118.3	17.2	864.5	16,434	30.9	99.4	403.8	200.8
6	7,733.8	7,736.4	146.3	125.4	18.3	864.5	16,434	30.9	105.4	426.2	184.2
7	8,197.8	8,200.6	155.0	132.9	19.4	864.5	16,434	30.9	111.7	449.9	169.1
8	8,689.7	8,692.6	164.3	140.9	20.5	864.5	16,434	30.9	118.4	475.0	155.3
9	9,211.0	9,214.2	174.2	149.3	21.8	864.5	16,434	30.9	125.5	501.7	142.6
10	9,763.7	9,767.0	184.7	158.3	23.1	864.5	16,434	30.9	133.1	529.9	131.0
Totals			1700.2	1457.3	212.5		164,344.1	1,225.1	4,903.8	4,903.8	2,685.7

Notes:

(1) RST refers to Newfoundland Sales Tax Revenue.
(2) PIT refers to Newfoundland Personal Income Tax Revenue.
(3) CIT refers to Newfoundland Corporate Income Tax Revenue.

C. Equalization Sub-Model ($000)

Dis. Total Revenue	Net RST	Net PIT	Net CIT	Net FPR	Net OGR	Total Net Rev.	Dis. Net Rev.
701.5	83.1	33.4	16.2	0.0	37.4	170.1	170.1
283.7	35.0	14.1	6.8	0.0	15.8	71.6	62.3
260.1	37.1	14.9	7.2	0.0	16.7	75.9	57.4
238.5	39.3	15.8	7.7	0.0	17.7	80.5	52.9
218.8	41.7	16.7	8.1	0.0	18.8	85.3	48.8
200.8	44.2	17.7	8.6	0.0	19.9	90.4	44.9
184.2	46.8	18.8	9.1	0.0	21.1	95.8	41.4
169.1	49.6	19.9	9.7	0.0	22.3	101.6	38.2
155.3	52.6	21.1	10.3	0.0	23.7	107.7	35.2
142.6	55.7	22.4	10.9	0.0	25.1	114.1	32.4
131.0	59.1	23.7	11.5	0.0	26.6	121.0	29.9
2,685.7	544.1	218.6	106.3	0.0	245.0	1,114.0	613.5

Notes:

(1) FPR refers to Newfoundland fuel peat royalities.
(2) OGR refers to other government revenues.

2. Government Expenditure Model ($000)

Year	Production Systems (Tonnes)						Combustion Systems (kw)				Total Govt. Assist.
	100	500	1000	3000	6000	1000	Res.	250.0	500.0	2000.0	
0	0.0	158.6	205.4	134.0	0.0	0.0	0.0	7.4	38.4	0.0	453.8
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Totals	0.0	158.6	205.4	134.0	0.0	0.0	0.0	7.4	38.4	0.0	453.8