THE UNIVERSITY OF CALGARY

URBAN LAND POLICY AND ENERGY CONSUMPTION

by

TERRENCE JOHN ZDAN

A Masters Degree Project

Submitted to the Faculty of Environmental Design

in partial fulfillment of the requirements for the

Degree of Master of Environmental Design

(Urbanism)

FACULTY OF ENVIRONMENTAL DESIGN

Calgary, Alberta

December, 1979

THE UNIVERSITY OF CALGARY

FACULTY OF ENVIRONMENTAL DESIGN

The undersigned certify that they have read, and recommend to the Faculty of Environmental Design for acceptance, a Master's Degree Project entitled
URBAN LAND POLICY AND ENERGY CONSUMPTION
submitted by Terrence John Zdan in partial fulfillment of the requirements for the degree of Master's of Environmental Design (Urbanism).

W.A.Ross, Chairman
Faculty of Environmental Design

D.D.Detomasi,
Faculty of Environmental Design

L.O.Sinkey,
Faculty of Environmental Design

J.H.Marean,
Faculty of Education

80 01 03
Date

TABLE OF CONTENTS

Chapter Page

Chapter Page

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

URBAN LAND POLICY AND ENERGY CONSUMPTION

BY

TERRENCE JOHN ZDAN

Completed in partial fulfillment of the requirements
for the degree for Master of Environmental Design, Urbanism.

Project Supervisor: Dr. W.A. Ross
Faculty of Environmental Design, University of Calgary

December, 1979.

Emphasis on energy conservation in the design of urban environments is needed. Urban land policy can direct improvements in such factors as density, pattern and form, and transportation--reducing energy consumption in Canadian cities by as much as 25 per cent. Energy consumption per capita and per gross national product is currently higher for Canada than in other western industrial countries. Since most of Canada's energy consumption occurs in cities, energy-sensitive urban land policy should be an important objective of federal, provincial and municipal governments. Urban energy audits and energy impact assessments are needed for both new development and urban redevelopment. Rational, incremental, and mixed-scanning models as well as Hawkins' input-output approach and Detomasi's constraints hierarchy are useful in the analysis of formulating and implementing an energy-sensitive urban land policy. Analysis of two recently-proposed growth strategy options for Calgary, Alberta, indicates that the Compact City alternative is preferable to the Balanced Growth strategy on the basis of energy consumption.

ACKNOWLEDGEMENTS

This master's degree project is dedicated to my parents.

I wish to express my sincere appreciation and gratitude to my project committee members: Dr. W. A. Ross; Dr. D. D. Detomasi; and Mr. J. Marean. Their advisory consultation and assistance throughout the drafting and revisions of this document have been most helpful to me. Dr. I. M. Robinson has given me his encouragement and advice for which I am also thankful.

There are several friends and relatives who have contributed their time and effort for my benefit and to whom I am very thankful. Included in this list are: Rhonda Gotleib and Richard Zabrodski; Leslie Buckle; Gary Sykes; Doug Marteinson; Jim Love; Pat Adams; Stephen Tyler and John McLaughlan. I also wish to thank John Chibuk for providing me with copies of his reports.

Larry Johnson and Ken Persson contributed much of their spare time for proof reading and providing editorial suggestions. I am very grateful for their unselfish contributions to my project.

Terry Silvestro typed the final draft.

Last, but not least, my heart and hand go to Debra. With this completed we can now move on to newer things.

Chapter I

ENERGY CONSUMPTION IN CANADA: A PROBLEM OF CITIES

I.I Introduction

Canada is a net importer of oil. This fact raises immediate concern about Canada's energy supply and demand. There is a host of variables influencing the cost and supply of both domestic and foreign energy supplies and these are discussed in Chapter 5. But it is general knowledge that Canada faces a future of increasingly higher primary energy costs. A combination of high costs for domestic energy sources coupled with the increasing uncertainty about importing foreign supplies creates a climate of concern about whether to maintain or decrease present levels of energy consumption in Canada.

In this chapter I will illustrate that, compared with other countries, Canada is a large consumer of energy. This fact becomes abundantly clear by examining ratios of total energy consumption to the gross domestic product and to Canada's population. I will argue that an accounting of energy end uses reveals that a majority of energy is used in urban activities and, therefore, that energy consumption in Canada is predominantly urban in nature. My discussion will posit that, historically, urban development in Canada has taken place in order to accomplish either the colonial goals of expanding empires or the national goals of economic progress and development.

I will also argue that the evolution of urban areas from colonial entrepôts to central and regional cities was accompanied by technological improvements in transportation, building construction, communications and industrial/manufacturing processes. I will illustrate that these technological improvements have had a significant impact on urban form and energy demand.

N. H. Lithwick has argued that the growth of urban areas in Canada has occurred as the direct consequence of the pursuit of national goals such as economic development; hence the growth of urban areas, prompted by the desire for economic progress and the development of both secondary industry and tertiary production[1] has been accompanied by problems in and of cities. I will argue that Canada's gross energy consumption in the sense that it is wasteful, inefficient or excessive is another problem of cities.

1.2 International Comparison of Energy Consumption

Ratios of total energy consumption to economic indicators, such as the gross national or gross domestic products, and to populations are commonly used as indicators for international comparative analyses.[2]

The comparison of isolated total energy consumptions of randomly chosen countries does not give much information other than to say that one country's consumption is simply greater, smaller or the same as others. Ratios employing economic and population indicators provide more meaningful comparisons between countries' energy consumptions per dollar of domestic product or per capita. Ratio comparisons of this nature reveal striking differences among various countries in terms of energy consumption; these ratios provide us with a sound means for qualitative and quantitative analysis of energy consumption.

Data concerning gross domestic products, populations, total energy consumption and ratios are provided in Table I-I for Canada, the United States, Japan, Sweden and the U.K. Total energy consumption is expressed in million tonnes of oil equivalent (MTOE).

Canada is shown to have high total energy consumption per gross domestic product (TEC/GDP = .806 MTOE/Billion $) and total energy consumption per population (TEC/Pop. = 5.5 MTOE/Million persons) ratios compared to the U.K., Japan and Sweden. Canada and the U.S. coincide very closely in terms of these energy to GDP/Pop. ratios.

A closer comparison between Canada and Sweden reveals some striking features about Canada's energy consumption. Sweden's GDP/Capita ratio in 1975 is 20 per cent greater than that of Canada. In accomplishing these GDP's Canada consumed 60 per cent more energy per GDP dollar than Sweden. On a per capita basis, Canada consumed 30 per cent more energy than Sweden.

The price of energy is perhaps one variable which influences the rate of its consumption. It is noted that as energy prices increase, energy consumption decreases. A comparison[3] between the energy consumptions of Sweden and the United States suggests that institutional and social factors such as mortgage policies, building codes, government policies, life styles and efficiencies are important in influencing energy consumption. A closer examination of energy consumption end uses provides a means by which one can observe how these aforementioned variables influence patterns of consumption. Data of energy end use consumption for Canada, the U.S., Japan, Sweden and the U.K. for 1975 are presented in Table I-2.

TABLE I-1

GROSS DOMESTIC PRODUCT, POPULATION AND TOTAL ENERGY CONSUMPTION FOR CANADA AND SELECTED COUNTRIES: 1975

Country	Gross Domestic Product (a) (billion dollars)	Population (million)	GDP$/ Capita	Total Energy Consumption (b) (MTOE)	TEC/ GDP (MTOE/ billion)	TEC/ Pop. (MTOE/ million)
Canada	156.6	22.83	6859	126.25	.806	5.5
U.S.A.	1514.3	213.63	7088	1210.84	.8	5.68
Japan	489.	110.95	4407	233.27	.477	2.10
Sweden	69.2	8.2	8439	35.14	.51	4.3
U.K.	227.8	56.04	4065	140.42	.616	2.51

(a) at 1976 prices and Canadian dollars.
(b) MTOE: Million tonne of oil equivalent.

Sources: Organization for Economic Co-Operation and Development, *Main Economic Indicators: Historical Statistics, 1960/1975*, (OEDC, Paris, 1976), *Energy Balances of OECD Countries*, 1974/1976 (OECD, Paris, 1978).

TABLE I-2

TOTAL ENERGY CONSUMPTION BY END USE SECTORS
FOR CANADA AND SELECTED COUNTRIES: 1975

Country	Total Energy Consumption (MTOE)	END USES MTOE/POPULATION[1]					
		INDUSTRY	TRANSPORTATION	RESIDENTIAL	COMMERCIAL	AGRICULTURE	OTHER[2]
Canada	22.83	1.6	1.6	1.1	0.8	0.05	0.3
U.S.A.	213.63	1.6	1.9	1.4	0.5	0.01	0.2
Japan	110.95	1.1	0.4	0.4	0.04	0.06	0.07
Sweden	8.2	1.8	0.7	1.4	.12	0.07	0.01
U.K.	56.04	0.9	0.5	0.9		0.03	0.2

[1]Population x 1,000,000; MTOE: Million Tonne Oil Equivalent

[2]Other end uses include non-energy uses and/or public service.

Source: OECD, *Energy Balances of OECD Countries 1974/76*, (Paris, 1978).

The comparison of end-use energy consumption sectors points out the following:

Canada compared with Sweden is clearly a big user of energy for commercial and transportation end uses. On the other hand, Sweden directs a larger proportion of its energy consumption towards industrial and residential end uses.

Coincidentally, the conventional method of accounting energy end use consumption makes a clear reference to the energy requirements of secondary industry and tertiary production activities which are largely urban-centred activities. Cities, or urban areas, are interrelated centres of industrial, commercial and residential activities linked together by transportation systems. Even without sophisticated discrete accounting methods it can be shown that indeed the greatest proportion of energy consumption does take place in cities.

With reference to Table I-2, the end use sectors of "agriculture" and "other" represent a final consumption range of 4 to 8 per cent of total national energy consumptions. Transportation end uses represent consumptions for both intra- and inter-urban types of transportation. In Canada, 1975, these transportation end uses represented 30 per cent of the total consumption. The residential, commercial and industrial end uses are clearly urban. Therefore, discounting agricultural and transportation end uses, total energy consumption in Canada is at least 60 per cent concentrated in urban areas. It is not unrealistic to estimate that greater than 70 per cent of Canada's total energy consumption occurs in cities.

Accepting the fact that Canada is a large per capita consumer of energy raises energy consumption as an important issue for Canada. Although the preceding discussion makes the assertion that most of the

energy consumption occurs in Canada's cities it is my intention to describe Canada's problem of energy consumption as a problem of cities, not a problem in cities. This distinction is important because it shifts the problem solving approach to a larger group of actors including provincial and federal levels of government and agencies rather than focussing a concentration on urban or municipal actors and authorities.

1.3 The Historical Perspective of Canadian Urban Development

N. H. Lithwick, in his study of urban problems in Canada has argued that national goals of economic development and progress are the catalyst for the development and evolution of cities in Canada. Secondary industries and tertiary activities require urban populations composed of producers and consumers. This urban development scenario and relationship is articulated in the following quotation:

> The urban system in (Canada) evolved largely in pursuit of economic development which is one dimension of the objective of progress, ...The urban context for development is made necessary by the demands of modern technology, particularly the requirements of large scale production and hence mass markets, industrial specialization and hence close inter-industrial linkages, and large and specialized labour and capital resources. Because all these can occur in large dense centres, cities are the sine qua non for industrialization and economic development.[4]

In general, Canada's historical development towards an industrialized nation is based on national goals of economic development. Economic development is achieved through the encouragement of resource development, industrial processing, manufacturing and commerce. Both national and provincial governments provide stimulus to these activities through combinations of policies and programmes. An urban area actively pursues the acquisition of industrial and commercial activities to

enhance the tax base of the community. A discussion of the historical trend of the role of cities in accomplishing the goals of imperial and national governments is presented here to develop further argument that the problem of Canada's large per capita energy consumption is a problem of cities.

Historically, the roots of Canada's cities play an important role in Canada's development, dating back to the 17th Century and the establishment of settlements on the Atlantic Coast by France and Great Britain. The relationship of these settlements to the theory of urban development is an interesting one.

Max Weber has classified the roles of medieval cities of Europe,[5] while Louis Mumford has observed the pattern and shaping forces of urban areas in his text *The City in History*. Jane Jacobs has made an important contribution to the theory and history of urban development accounted in her text *The Economy of Cities*.[6]

Jacobs has posited that in North America, settlements which later became cities and towns were established as a means of occupying and defending new territories, followed or accompanied by the development of primary (agricultural) industries. Evidence of the historical development of major Canadian cities are documented by Gilbert Stelter and Alan Artibise in their work *The Canadian City: Essays in Urban History*.

Ever since the exploration days of Cartier and Champlain, Canadian-based outposts of the French and English empires were colonially established and populated. These outposts evolved into communities and gradually developed to become the 19th and 20th Century centres

of their particular regions. This has been the case for: St. Johns, Newfoundland; Halifax, Nova Scotia; Saint John and Fredericktон, New Brunswick; Toronto, Hamilton, Ottawa, London and Kingston, Ontario; Quebec and Montreal, Quebec.[7]

These outposts, many of them fortresses and naval harbors, were established as settlement modes to develop and maintain the planned colonial exploitation of the hinterland for fish, furs or timber. From the beginning of their implantation until the 20th Century these historical towns have evolved as provincial capitals, regional centres and manufacturing and industrial centres. In short, they have become urban centres housing secondary industry and tertiary activities. As stated by Stelter and Artibise:

> The importance of towns and cities in the emergence of Canada should not be underestimated. From the beginning outposts of empire the little enterpôts evolved into communities which became the cores of their particular regions.[8]

The importance of the colonial entrepôts was in providing military or strategic locations or facilitating the exploitation of timber and furs from the hinterland. As they matured, most of these cities "... passed through several economic stages of development-colonial entrepôt, commercial town, commercial-manufacturing city, diversified metropolis."[9] This evolutionary process was a direct consequence of the implementation of the policies and goals of the prevailing British or French colonial expansion.

Both the French Louisburg and the British Halifax were established as planned military bases to defend territorial control in North America during the 17th and 18th Centuries. It was the European com-

mercial demand for fur products, timber and a direct westward sea route to Asia which instigated the exploration and settlement of the west. Following the American Declaration of Independence in 1776, territorial protection policies were responsible for the settlement and development of western Canada. Settlement policies were later developed to counter the threat of the "American Manifesto": a threat of U.S. takeover of what is now Western Canada. Once the confederation of Canada had taken place it was a national goal to establish a rail link from the Atlantic to the Pacific. It was envisioned that the railway would encourage the development of agriculture on the prairies and stimulate the growth of western cities, primarily Winnipeg, Regina, Saskatoon, Edmonton, Calgary and Vancouver.

There were other important variables which stimulated the development of Canadian cities. Basically a combination of location, initial advantage, dynamic internal leadership, favourable outside government, corporate decisions and rich hinterlands were the impetus for the growth of cities.[10] However, it has been documented in historical accounts that, regardless of their location and the variables noted above, Canadian cities were not masters of their own destiny as they were "...subject to the vagaries of the international market staples and vulnerable to outside government and corporate decisions beyond their control."[11] The importance of national aspirations for progress and hence the growth of cities was evidenced by the "...national political policies on tariffs and railroads (which) strengthened the growth of manufacturing in central cities."[12]

Thus major cities in Canada are seen to have evolved to their present status primarily as a result of national goals and corresponding

policies to stimulate economic progress through the development of secondary and tertiary activities. Along the course of history which has recorded the evolution of Canada's urban areas were many technological advances which have enhanced the urban process. Many of them have had significant implications for the increase in demand and consumption of energy. In the following section the discussion presents a brief overview of some of the technological improvements and is aimed at providing a link between the urban evolution and corresponding energy consumption.

1.4 The Link Between Urban Development and Energy Consumption

Coinciding with, and assisting, the development of urban areas were transformations in technological processes, especially in manufacturing and transportation.[13] Transformations from "wood and sail" energy drives to "steel and steam" had a significant impact on cities. The industrial revolution provided the capability of mass production and required large labour forces. The British example illustrates a transformation whereby sheep became more common in the countryside and the farmers became workers in the factories in the cities. As a developing colony, Canada was suited for adopting the new technology. Rail transportation in Canada in the late 19th Century provided a new means of transporting bulk freight; this established growing cities as distribution centres. The use of steel in construction allowed for transitions in building forms as exemplified by the Eiffel Tower: the forerunner to the high rise and the skyscraper of 20th Century cities. Electricity was developed in the later half of the 19th Century to serve a growing number of industrial needs and domestic services.

Natural gas became an important source of heat and light at this time also. In addition, a growing steel industry in Southern Ontario placed large demands on the supply of coal for the smelting process.

Communications and transportation technologies such as radio and telephone and the automobile powered either by steam or internal combustion engines, initiated the demand for more electrical energy and the use of mobile fossil fuels for urban purposes. The implementation of assembly line processing, and the automation of industrial and agricultural processes served to develop urban areas as vehicles of economic growth.

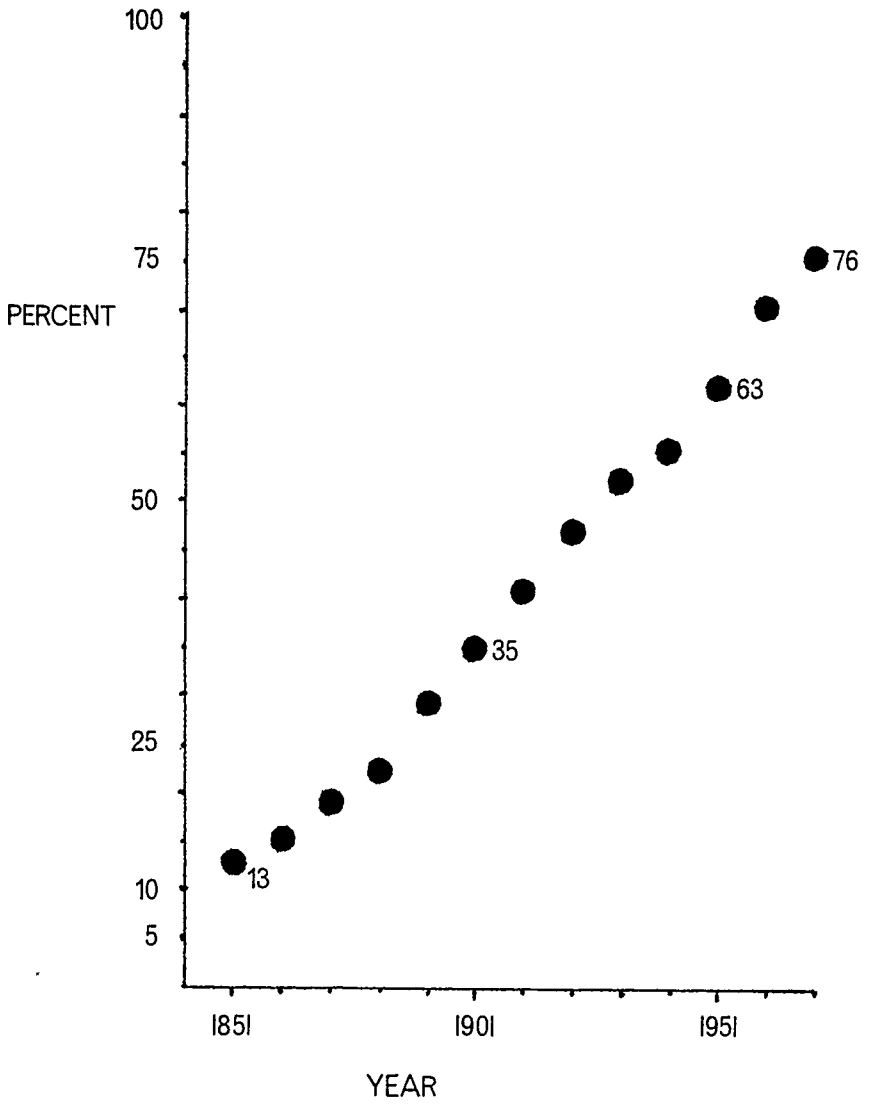
Gradually the rural areas, developed through homesteading settlement programmes and immigration, declined in populations as the younger generations, displaced due to growing mechanization in farming, were lured to urban centres in search of employment. Cities required large pools of labour for industrial and manufacturing production, while cities also provided large concentrations of consumers providing a ready market for the large scale of production.

Evidence which supports the argument that growing industrialization and hence growth in energy consumption is related to urban growth can be gleaned from Figure 1-1: Percent of Population Urban: Canada: 1851-1971 and Figure 1-2: Occupational Structure of Canadian Labour Force: 1881-1971.

The data in these figures reflect urban trends in Canada revealing that the proportion of urban resident population has increased significantly in the 120 year data period. Similarly, the occupational structure of the Canadian labour force has shifted dramatically from

FIGURE 1-1

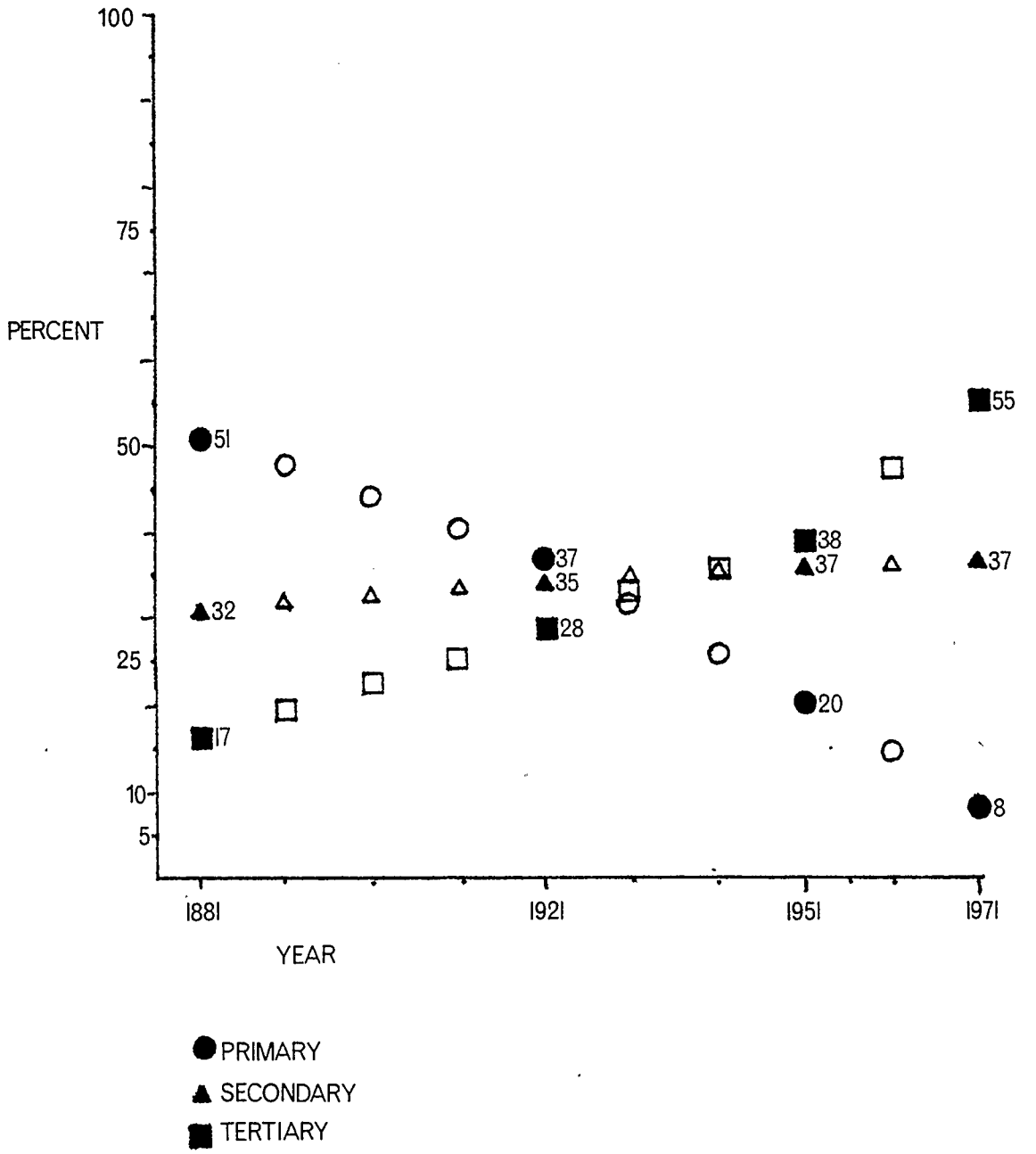
PERCENT OF POPULATION URBAN: CANADA, 1851-1971



Sources: L. O. Stone, *Urban Development in Canada*, (Ottawa: Dominion Bureau of Statistics, 1967).
D. Michael Ray, Graham Murchie, Terrence W. Irwin, Margaret L. Pendleton, David H. Douglas, *Canadian Urban Trends, National Perspective, Volume 1*, (Toronto: Copp Clark, 1976).

FIGURE 1-2

OCCUPATIONAL STRUCTURE OF CANADIAN LABOR FORCE: 1881-1971



Source: M. Ray, *Canadian Urban Trends, National Perspective, Volume 1,* (Toronto: Copp Clark, 1976).

the primary industries in the 19th Century to secondary and tertiary urban occupations in the 1970's. The increase in the urban concentration of the population and the growth in secondary and tertiary employment accompany a corresponding increase in energy demand.

The comparative data in the aforementioned tables indicate that Canada's population has become 76 per cent urban compared to 13 per cent in 1851. In 1881, 51 per cent of Canada's labour force were employed in rural primary industries and by 1971 this percentage fell to only 8 per cent. The corollary of this phenomemon is that employment in urban based occupations grew from 49 per cent in 1881 to 92 per cent in 1971.

This overview of Canadian urban evolution has shown that it occurred in step with technical transformations, increasing urban population, and growing employment in secondary and tertiary occupations. These, taken together, imply a growing urban energy consumption.

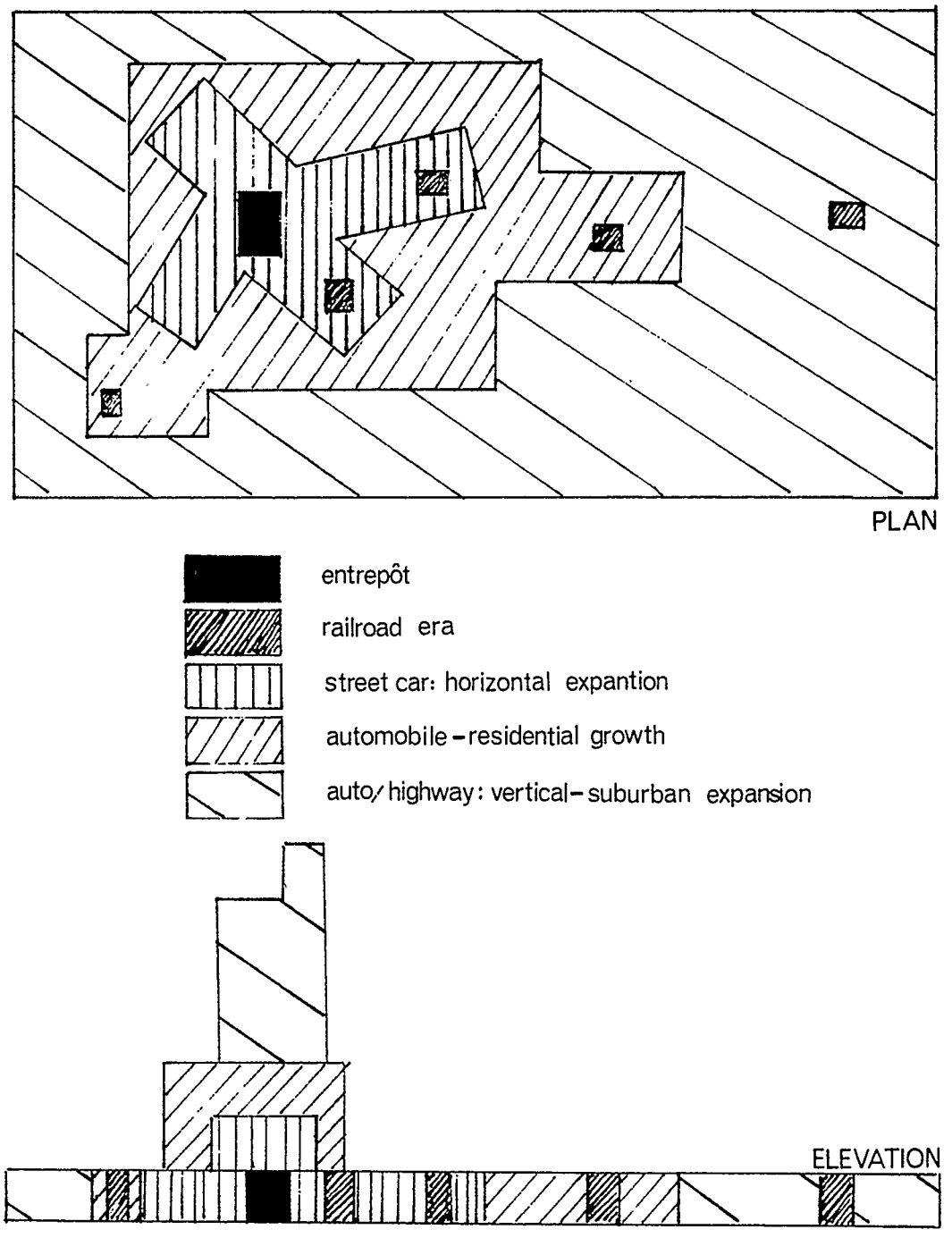
In the following section, the presentation is focussed toward linking these urban trends of population, technological progress, occupational activities and, in essence, energy consumptions to urban form. The term urban form refers to the spatial dimensions of urban area and urban height.

1.5 Urban Transformations and Urban Form

The influence of the growth of Canadian urban populations, technological changes and occupational activities on urban form is graphically illustrated in Figure 1-3.[14] In this figure a plan of an hypothetical city is presented in elevation to illustrate the evolution of the urban area and form over a period of time. The changes in shape and size are indicative of the manner in which growth

THE EVOLUTION OF URBAN FORM

FIGURE I-3



Source: Adapted from Dirk Rygole, *Energy and Urban Form: The Need for Energy Conscious Urban Planning*, (Baltimore: Centre for Metropolitan Planning and Research, The Johns Hopkins University, 1978).

and technological progress determine urban form.

As technical advancements occurred in transportation, it became possible to decentralize urban growth and urban activities on a larger scale, which resulted in a scattered or sprawl urban form. Technological progress in manufacturing, industry and construction implied greater and newer forms of space requirements to house linear assembly line processes. Taller buildings were constructed to contain larger volumes of manufactured goods because storage was facilitated by the elevator. A shift occurred in commercial trade practice from the small general store to the large department store. An increase occurred in the development of land around the city's periphery as suburban areas housed a growing population.

Both the development of suburban areas and the economics of land value contributed to the decentralization of the former urban core warehousing activities. Commercial, financial and service industries began to play a more significant role in the urban centre, contributing to a sprawling urban form characterized by a skyward-reaching bulge of tall buildings at the centre. Thus, the dominant functions of the urban core were expressed in visual impressions made by its architecture and the transportation network which served the modern city in its sprawl form.[15] The ever upward glass-skinned structures standing in the centres of major Canadian cities are indicative of the 55 per cent of the national population which is occupied in retail and wholesale commercial activity, and in finance and service industries. Similarly, the low profile suburban sprawl of single family houses, regional shopping centers and acres of parking lots illustrates the residential

location of the urban population and strongly suggests a high dependency on energy for support of the urban system.

Figure I-3 suggests that the urban transportation modes, building types and occupations in urban areas have evolved over time. These evolutions in turn represent the implementation of technological developments and coincide with the growing concentration of the national population in urban areas. Two major outcomes of this relationship are the expansion of the urban area in order to service suburban housing areas and the reliance on a flexible transportation system dependent on the private automobile. It is general knowledge that single-family detached houses and the automobile are the most energy consumptive forms of housing and transportation respectively. The elaboration of these and other variables along with their influences on energy consumption is presented in Chapter 2. But it is the primary intention here to establish the coincidence of urban growth with these two variables to show evidence of increasing urban trends in energy consumption. Table I-3 presents a summary of housing characteristics for Canada 1951-1971, providing data on dwellings, populations, and automobile ownership.

The data in this table support the notion that as Canada's population became more urbanized due to increasing secondary and tertiary economic activities, there was a corresponding increase in the frequency of single-family detached dwellings and in the percentage of private automobile ownership per dwelling. The data also indicate that occupancy rates of housing decreased, which caused a greater demand for dwelling units and for more urban land per capita.

Today, Canada's urban settlements are composed of specialized

TABLE I-3

HOUSING CHARACTERISTICS IN CANADA
1951-1971

CHARACTERISTICS	1951	1961	1971
# of private[1] dwellings	3.4	4.55	6.0
# of single detached[1] dwellings	2.3	2.6	3.6
Persons per dwelling	3.975	3.922	3.456
% dwellings with automobiles	42.3	68.4	77.7

[1]Data rounded to nearest hundred thousand.

Source: M. Ray, *Canadian Urban Trends, National Perspective Volume 1,* (Toronto: Copp Clark, 1976), p. 288.

segments occupied by residential, industrial, commercial and recreational areas. The pattern is scattered and access to these different areas requires a flexible form of transportation for goods and people. Public forms of transportation such as bus systems tend to be inadequate in terms of providing an alternative transportation mode to give access to these areas and therefore they foster the trend towards increasing use of the car.

The Canadian urban experience, although successful in advancing economic progress, is consumptive of land, expensive or even wasteful of transportation time, and thirsty for energy to operate and maintain the urban system.[16] The consumption of agricultural land for urban uses is a major problem of cities in Canada. Pollution from the combustion of fossil fuels in industry and transportation is another serious problem of Canadian cities.[17] Another problem of cities is that of noise pollution.[18] I now place the problem of energy consumption in urban areas in equal rank to these and other problems of cities.

From these examples it is easily seen that Canada's urban problem is the basic contradiction of the goal of economic progress by resulting degradation of agricultural land, air and noise pollution, consumption of time and enormous consumption of energy. Introducing the definition of energy consumption as a "problem of cities" N. H. Lithwick elaborates:

> Economic progress has occurred, but the consequential destruction of our environment and the other familiar costs of economic growth - waste, built in obsolescence, human redundancy, and so forth - must be deducted in measuring overall progress. ... these problem areas are natural outcomes of the urbanization process. In other words, the serious imbalance in achieving our national goals, involving sacrifices of most others for the sake of economic progress,

> is inherently linked to the evolution of our urban system. This is the central aspect of problems of the city ...[19]

Extending the argument which N. H. Lithwick posits in the above quotation, one might add that efficient use of nonrenewable energy in cities has been sacrificed for the pursuit of other goals. In this context, Canada's problem of energy consumption may be viewed as a problem of cities.

Energy use in cities is thus an important area for consideration by those who would reduce energy consumption. Aside from the ability to increase efficiencies in industrial, transportation and residential sectors, features of urban form hold additional possibilities and opportunities for managing energy consumption. These potentials and their implications for urban land policy are presented in Chapter 2.

1.6 Conclusion

This chapter concludes with the assertion that Canada's gross energy problem is a problem of cities. In the process of developing this notion a comparison between Canada's total energy consumption, gross domestic product and population to those of other selected countries provides evidence of Canada's enormous per capita energy demand.

The greater proportion of energy consumption in Canada takes place in cities as opposed to rural areas. The evolutionary process of urban development in Canada is observed to have been the natural outcome of the pursuit of economic goals.

Historical trends and technological innovations are shown to have significant impacts on urban form and energy consumption. Thus Canada's gross energy consumption problem is a problem of cities.

FOOTNOTES

[1]Explanatory Footnote: The definition of three industrial categories: primary, secondary and tertiary, as used in this MDP are borrowed from D. M. Ray, *Canadian Urban Trends, National Perspective, Vol. 1,* (Toronto: Copp Clark, 1976), p. 62.

> The primary industries include agriculture, forestry and mining, fishing and trapping. These activities involve retrieving raw materials directly from land and sea and, where possible, working jointly with nature to generate and proliferate them. Secondary industries include manufacturing and construction activities. All remaining activities can be grouped into a category termed tertiary production which includes the retail and wholesale trades, service activities and transportation.

[2]See: Lee Schipper and Allan J. Lictenberg, "Efficient Energy Use and Well-Being: The Swedish Example," *Science,* 194:4269, (December 3, 1976).

[3]*Ibid.*

[4]N. H. Lithwick, *Urban Canada, Problems and Prospects,* (Ottawa: 1970), p. 16.

[5]The reader is referred to Max Weber's essay "The Nature of the City" in Richard Sennett, *Classic Essays on the Culture of Cities* (New York, Appleton-Century-Crofts, 1969), pp. 23-46 and Max Weber, *The City,* (New York, The Free Press, 1958), trans. by D. Martindale and S. Neuwirth to gain an appreciation of the contribution Max Weber made to the theory and history of urban development.

[6]See: Jane Jacobs, *The Economy of Cities,* (New York, Random House, 1969). Chapter I of this book is titled "Cities First-Rural Development Later" (pp. 3-48). Jacobs presents an overview of the evidence with which she develops her theory of urban development.

[7]Author's Note: Discussions of the origin and development of eastern Canadian cities is provided in G. Stilter and A. Artibise, *The Canadian City, Essays in Urban History,* (Toronto: McClelland and Stewart, 1977), see "Cities in the Wilderness - Canadian Urban History Before 1850," pp. 5-50.

[8]G. Stilter and A. Artibise, *The Canadian City: Essays in Urban History,* (Toronto: McClelland and Stewart, 1977), p. 14.

[9]*Ibid.*, p. 52.

[10]Author's Note: For an historical account of Canadian Metropolitan growth see: G. Stilter and A. Artibise, *The Canadian City: Essays in Urban History*, (Toronto: McClelland and Stewart, 1977), "Section III: Metropolitan Growth and the Spread of the Urban Network 1850-1920," pp. 51-124.

[11]*Ibid.*, p. 51.

[12]*Ibid.*

[13]Author's Note: For a more detailed and expanded discussion of this subject area the reader is referred to Lewis Mumford, *Techniques and Civilization*, and Singer, *The History of Technology*. R. Buckminster Fuller provides an anecdotal comment on the impacts of technology in *A Guide for Space Ship Earth*. A humorous visual animation of this "technical-growth-syndrome" is presented in the National Film Board's production, *Boomsville*. An account of social and cultural factors, in an historical perspective, influencing technological progress and negative externalities of environmental degradation is provided by Lynn White, Jr., in *The Dynamo and Virgin Reconsidered*.

[14]See: Dirk Rygole, "Energy and Urban Form: The Need for Energy Conscious Urban Planning," unpublished, (Baltimore, Maryland: Center for Metropolitan Planning and Research, The Johns Hopkins University, no date).

[15]Author's Note: The reader is encouraged to consult L. Mumford, *The City in History*, for further elaboration on the relationship between urban form and dominant social functions, culture, and economic activity.

[16]Author's Note: John Hix presents a discussion of energy waste and land waste in "Energy Demand for Future and Existing Land Use Patterns," in *Royal Commission on Electric Power Planning*, (Ontario: 1977), pp. 4-11.

[17]Author's Note: The reader is referred to texts such as: National Research Council Committee on Medical and Biological Effects of Environmental Pollutants, *Carbon Monoxide*, (Washington: National Academy of Sciences, 1977); U.S. Department of Health, Education and Welfare, Public Health Science, *Symposium on Environmental Lead Contamination*, (March, 1966); World Health Organization, *Health Hazards of the Human Environment*, (Belgium, 1972); and WHO International Agency for Research in Cancer, *Environmental Pollution and Carcinogenic Risks*, Inseam Symposia Series Volume 52, IARC Scientific Publication No. 13, (Paris, 1976) for

elaboration on urban sources of air pollution and the related issues of their impacts on human health.

[18]Author's Note: See H. Still, *In Quest of Quiet*, (Harrisburg: Stack Pole Books, 1970) for an elaboration on noise pollution and urban sources. Special reference is made to Section I, "The Sounds of Civilization," pp. 19-86.

[19]N. H. Lithwick, *Urban Canada, Problems and Prospects*, (Ottawa, 1970), p. 17.

CHAPTER II

URBAN FORM FACTORS INFLUENCING ENERGY CONSUMPTION

2.1 Introduction

Chapter I has presented and developed the argument that excessive energy consumption in Canada is a problem of cities. Contributing factors to the evolution of Canadian urbanism have determined the characteristic sprawl features of urban form and have demanded an increased consumption of energy.

This chapter focusses on the relationship between urban form and energy consumption; this focus is in harmony with the general desire to conserve energy. That urban form as it determines energy consumption is significant for energy conservation is confirmed in the following points:

1) Responses to excessive energy consumption may be quickly implemented;
2) There are practical opportunities in urban trends for effecting energy relevant changes in urban forms;
3) Greater opportunity at the urban level exists to bring the energy issue to a local level of management with greater public involvement;
4) A focus on urban form increases available alternatives for conserving energy and permits the development of more efficient urban settlements.[1]

These four points will be elaborated in the following paragraphs.

Firstly, changes in land use planning regulations and practices, such as subdivision design which have impact on urban form, can usually be implemented within a 5 year period. Compared to the length of time required for implementing additional energy supply systems, a 5 year period is a quick response to the pursuit of energy conservation. This relatively short time frame also introduces a notion of incremental changes in urban form over a long term period of time which further suggests a logistical implementation of energy conservation policies.[2]

Secondly, predictions of urbanization in Canada suggest that if trends continue over 90 per cent of Canada's population will live in communities greater than 1,000 persons. The present housing stock would be doubled from six to more than twelve million units: and residential development in cities of over 25,000 persons would require over two hundred thousand hectares of new land by the turn of the century.[3] With this view of the future, a strong suggestion is made that "...the private sector as well as the public sector can capitalize on these sorts of opportunities to achieve energy conserving changes in the various components in urban form."[4]

Thirdly, a successful alteration of consumption of energy requires public education to develop within society an understanding of energy issues and a spirit of cooperation towards implementing changes in consumption patterns. Public participation advanced through a focus on urban form can assist in bringing energy conservation issues to local political levels. Public education and participation also contribute to the development of a more democratic process which complements and assists in legislative and behavioural changes.[5]

Energy issues in Canada are complex and a problem solving approach to them requires a broad scope of understanding and a variety of perceptions. The urban form approach is one such alternative which contributes to our knowledge and understanding of energy issues. As well, the focus on urban form "...not only paves the way for an increased understanding of how to respond to the energy issue but also provides the opportunity for involving more decision makers and developing more mutually supportive causes of action."[6]

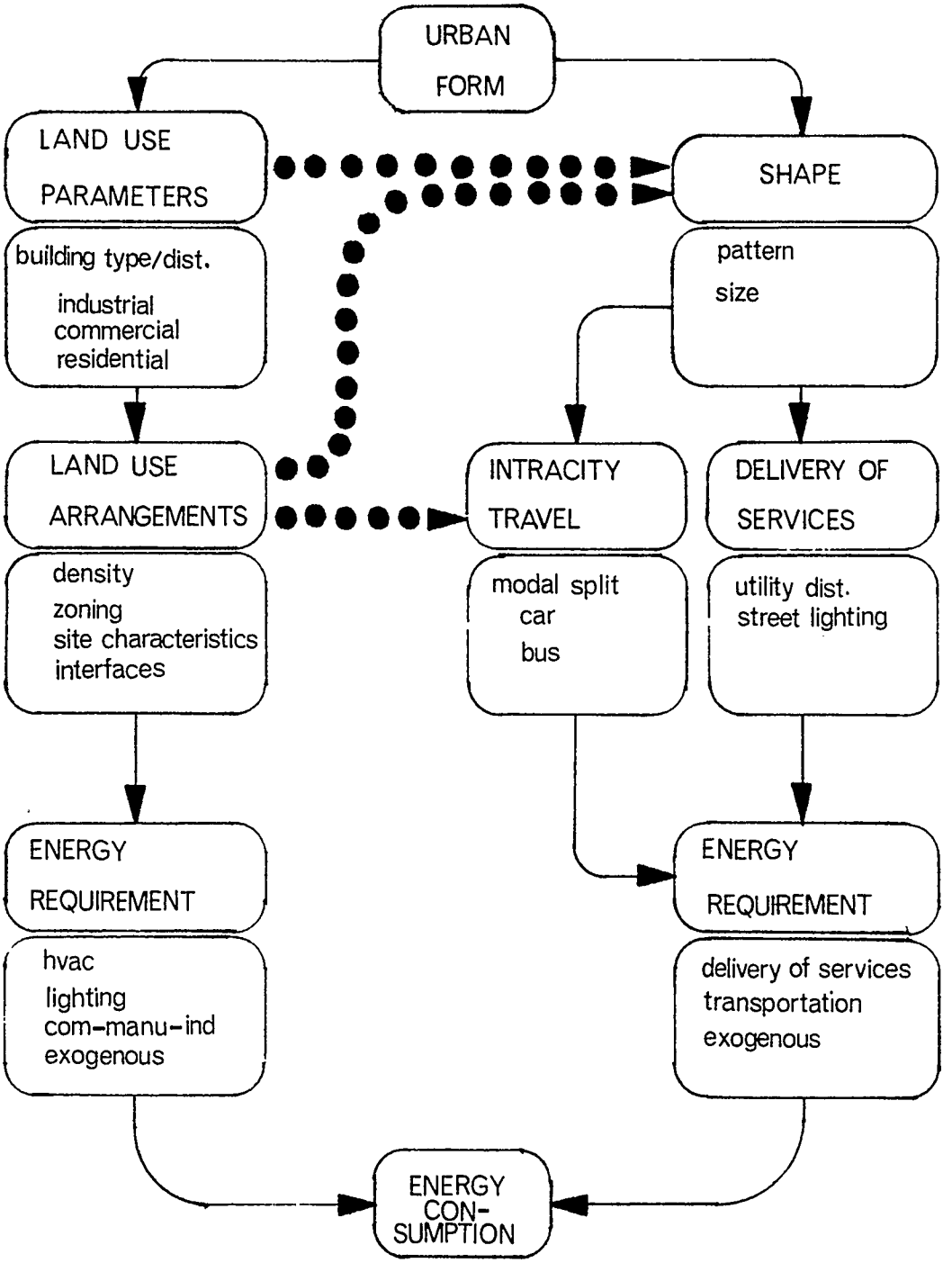
2.2 The Relationship Between Urban Form and Energy Consumption

The relationship between urban form and energy consumption is illustrated in a conceptual framework in Figure 2-1. The diagram presents the interrelated characteristics of urban land use parameters and arrangements influencing the urban shape. The variables of building type and distributions refer to buildings used for industrial, commercial and residential activities and how these activities determine the shape of cities. The degree of compactness or sprawl of urban development and the pattern of location of urban centres to other intra-city activities characterize the shapes of cities. Specific land use arrangements imply a reference to the regulation of the use of urban land. These have an impact on the overall urban shape and determine distance and locational characteristics which require the service of transportation networks. The movement of people and goods requires energy.

Energy requirements for space conditioning (heating and cooling), indoor and commercial advertising lighting, and commercial-industrial

FIGURE 2-1

THE RELATIONSHIP BETWEEN URBAN FORM AND ENERGY CONSUMPTION



Source: Adapted from Dirk Rygole, *Energy and Urban Form: The Need for Energy Conscious Urban Planning*, (Baltimore: Center for Metropolitan Planning and Research, The Johns Hopkins University, 1978).

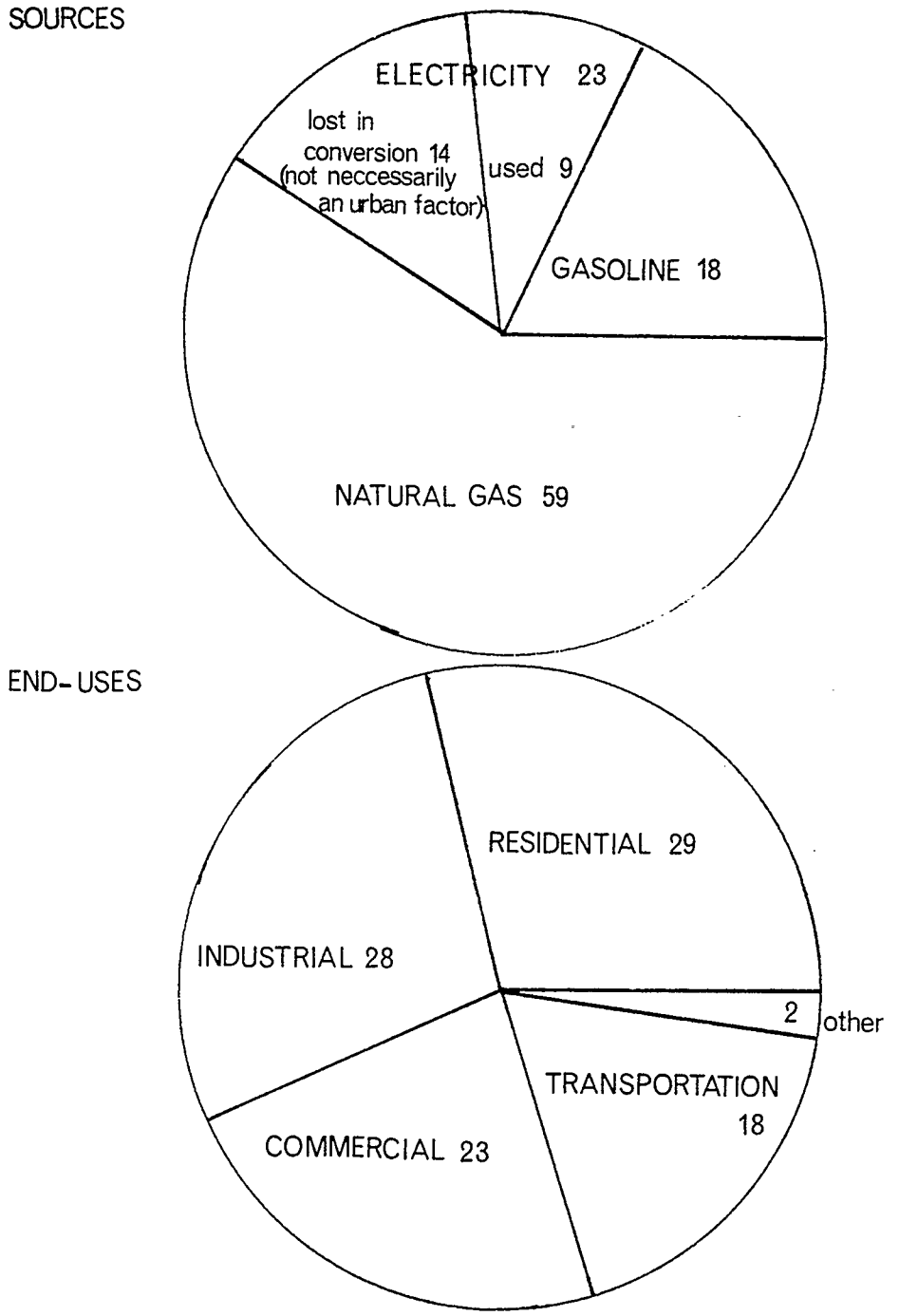
activities, combined with the requirements of intra-city transportation networks and the delivery of urban services, represent the total urban energy consumption.

Included in the equation for deriving urban energy consumption are exogenous factors of social attitudes and the behaviour of urban residents as well as natural environmental conditions such as topography and climate which are specific to geographical location. Although the alteration of the natural environmental conditions conjures doubtful implementation techniques and success, opportunities present themselves for taking advantage of renewable energy sources such as solar and wind power. Human behaviour, attitudes and habits in homes, attitudes towards urban transportation and attitudes in work activity all influence the consumption of energy in the residential, commercial, industrial and transportation sectors.

An understanding of urban energy consumption can be gleaned from an examination of the sources and end uses of urban energy presented in an energy budget as illustrated in Figure 2-2. Calgary, Alberta is the represented city. Three primary energy sources supply Calgary: electricity, (which is primarily supplied by a thermal process using coal), natural gas and gasoline. About 59 per cent of the energy supply to Calgary is natural gas, 23 per cent is electricity, primarily from coal, and 18 per cent is gasoline. The production of electricity from a coal-steam process (thermal) is only about 33 per cent efficient, i.e. the value of the electrical energy produced is equal to about a third of the energy value of the coal. Thus, most of the energy required to produce electricity is lost in conversion.

FIGURE 2-2

CALGARY, ALBERTA: ENERGY BUDGET (1975)
(Per Cent)



Source: G. Beck, *et. al.*, *Energy Efficient Townhousing for Calgary, Alberta,* (Calgary: Faculty of Environmental Design, University of Calgary, 1978).

This particular pattern of energy sources is specific to Calgary. Other Canadian cities have their own unique selection and proportion of energy sources. For example, eastern Canadian cities have a larger proportion of their energy sources supplied by oil. Electricity in other cities is often produced by other means, for example by hydro generation, nuclear processes or oil or natural gas combustion.

In Canada the production of electrical energy varies greatly from province to province depending upon availability of resources. In British Columbia, Quebec, Newfoundland and Manitoba, more than 90 per cent of each province's electrical energy is derived from hydro generation. In New Brunswick, Saskatchewan and Ontario, about half the electrical energy is generated from hydro and the other half from thermal generation by combustion of fossil fuels. In Ontario about 10 per cent of the thermal generation is supplied by nuclear generation. In Nova Scotia and Alberta about 10 per cent of the electrical power is hydro and the remainder is thermal generation. The difference between Nova Scotia and Alberta is that thermal generation in Alberta is from the combustion of indigenous coal, while in Nova Scotia it is from the combustion of imported oil. In Prince Edward Island, electrical energy is supplied solely through the combustion of foreign oil.[7]

Energy conservation in cities means a conservation of various energy supplies. A reduction in the use of natural gas for heating in Calgary or Edmonton would be analogous to a reduction of oil in Montreal. In Calgary, homes are heated with natural gas. In cities such as Montreal, Halifax and Fredricton, oil, or occasionally electricity, is used for this purpose.

Both electricity and natural gas in Calgary are distributed among three principal end uses: residential, industrial and commercial activities. Gasoline is used exclusively for transportation. These end uses are fairly straightforward and easily conceptualized except that commercial end uses include apartment residential activities and transportation includes inter- and intra- urban travel. No attempt has been made to adjust the statistics to provide a more accurate representation of these sectoral end uses. These end use sectors are also illustrated in Figure 2-2 where it is shown that residential end uses consume 29 per cent of Calgary's energy supply, industrial 28 per cent, commercial 23 per cent and transportation 18 per cent.

Percentages of the total energy supply by energy source to end use are presented in Table 2-1. Indications are that Calgary's residential and commercial sectors are the largest consumers of natural gas. Industry uses the largest proportion of electrical energy and transportation uses all of the gasoline. These energy budgets vary from one city to another. Nonetheless, this energy budget documents urban energy supply and demand and also provides insights into opportunities for urban-form-related energy conservation.

Elaboration of urban form and energy consumption relationships will be presented in discussions of the three main purposes of this chapter. First, a selected review of literature in this subject area will be presented to document the relationship between factors of urban form and energy consumption. Recommendations for urban land policy will be gleaned from the review of the literature. A summary of recommendations for urban land policy, which follow from review of the literature, will be presented.

TABLE 2-1

TOTAL ENERGY CONSUMPTION: CALGARY, ALBERTA (1975)
PER CENT BY ENERGY SOURCES AND BY END USE SECTORS

ENERGY SOURCES	END USE SECTORS					
	Residental	Commercial	Industrial	Transportation	Other	% Energy Source
Natural Gas	23	21	15			59
Electricity	6	2	13		2	23
Gasoline				18		18
% End Use Sector	29	23	28	18	2	100

Source: G. Beck, *et. al.*, *Energy Efficient Townhousing for Calgary, Alberta*, (Calgary: Faculty of Environmental Design, University of Calgary, 1978).

Information on urban form factors and energy consumption is provided in a review of existing studies by a Canadian author.[8] Despite his heavy reliance on American literature, Chibuk's method for cataloguing urban form factors and their impact on energy consumption summarizes consistencies in the studies and provides general conclusions about the relationship between urban form and energy consumption.[9] This project approaches the subject area in essentially the same manner as that presented by J. Chibuk in *Energy and Urban Form.* Opportunities for energy conservation through manipulation of urban form are disaggregated into four areas of investigation. These are: density; urban patterns and shape; land use arrangements; and other exogenous factors.

2.3 Urban Density and Energy Consumption

Density refers to a ratio of people, buildings or activities over area. Numerous studies and related articles discuss the existence of a relationship between urban density and energy consumption.[10] About this relationship it is the popular opinion that as urban density increases per capita energy consumption decreases. The theoretical explanation for this relationship is that higher densities reduce the amount of energy required for the heating and cooling of residential units, the amount of energy required for transportation purposes, and the amount of energy required in utility transmissions.

In higher density situations, residential units share common walls and ceilings/floors. This feature of common walls reduces the ratio of surface area to volume of a unit. Because of a reduced exposure of the external walls of a unit to climatic elements, less

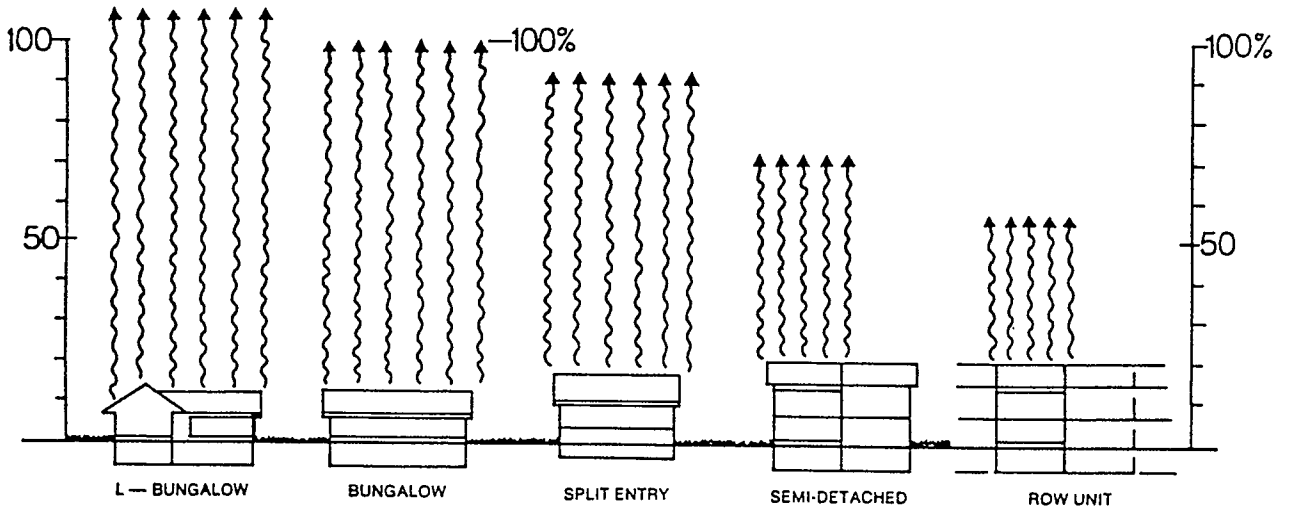
energy is required to maintain internal temperatures at a comfortable level. Complementary to this is the general tendency for residential units in a high density development to be smaller in size than those in a low density development. The volume of air within the unit which requires heating or cooling is smaller than the volume in a single family detached house and thus the former requires less energy to maintain it at a comfortable level. Thirdly, higher density developments often share common heating and cooling systems as opposed to individual heating, ventilation and cooling (HVAC) systems in detached houses. Common HVAC systems in large structures can provide economy of energy consumption and offer the potential of implementing an energy management programme to reduce wasteful consumption of energy on a large population basis.

Residential densities are reflected in occupancy rates per unit and dwelling types. Occupancy rates are subject to social/behavioural factors such as marriage rates, divorce rates, family formation and family size. The energy requirements of building types is theoretically examined in one publication which illustrates that row-unit and semi-detached housing units are considerably less energy consumptive than L-shaped bungalows, or bungalows or split entry housing units.[11] The comparative relationships of these housing types to energy efficiency are graphically illustrated in Figure 2-3. The semi-detached and row-unit forms of housing provide opportunities for greater density if the occupancy rates for all types of units are the same.

Another Canadian study of energy consumption for residential end uses of energy in different dwelling types in Toronto quantifies the

FIGURE 2-3

RESIDENTIAL BUILDING TYPE AND ENERGY EFFICIENCY



TOTAL HEAT LOSSES RELATING TO HOUSE SHAPE AND FORM
(Construction practice as typical until 1975)

Source: HUDAC, *A Builder's Guide to Energy Conservation*, (Toronto: HUDAC, 1975).

relationship between residential unit type and energy consumption.[12] Single-family detached dwelling units, attached dwelling units, and apartment dwelling units are compared for consumption of oil, natural gas and electricity for end uses in space heating, water heating and air conditioning. The data for this comparison are presented in Table 2-2. Apartment units are shown to be the least consumptive of all forms of energy for all three end uses. Attached units are less consumptive than single-family detached units for space heating and air conditioning but are shown to be slightly greater in consumption of energy for hot water heating than single-family detached units. Less than 15 per cent of the energy in all building types in Toronto is used for water heating and about 74 per cent is used for space heating.[13] Furthermore, with less than 20 per cent of Toronto's entire housing stock being attached units, the significance of attached units having higher energy consumption for water heating is negligible.[14] It is thus indicated that higher density dwelling units, with more units per area of land, are less energy consumptive.

Transportation energy requirements in high population density areas are reduced because of a closer proximity among residential, commercial/employment and recreational activities compared to areas of low density or sprawl development. The closer interface between urban activities and high density residential areas reduces the dependency on flexible, autonomous automobile transportation. The economic viability of public transit systems is enhanced in high density origin zones, and greater opportunities for pedestrian and bicycle modes of urban transportation are presented. Public transportation is also

TABLE 2-2

ANNUAL ENERGY CONSUMPTION BY DWELLING UNIT TYPE
AND END USE: METRO TORONTO
($\times 10^9$ J)

	Space Heating		Hot Water Heating		Air Conditioning	
	Pre 1966	1966-1970	Pre 1966	1966-1970	Pre 1966	1966-1970
Single Detached						
Oil	217.3	200.5	34.3	34.3	3.6	3.4
Natural Gas	216.3	199.4	34.2	34.2		
Electric	83.3	83.3	20.5	20.5	2.6	2.7
Attached						
Oil	142.4	131.9	36.2	36.2	2.6	2.4
Natural Gas	141.4	130.8	35.9	33.9		
Electric	53.8	53.8	21.6	21.6	2.0	2.0
Apartment						
Oil	27.4	27.4	12.9	12.9	1.2	1.0
Natural Gas	27	27	12.8	12.8		
Electric	11.8	11.8	10.1	10.1	0.87	0.87

Source: Informetricia Ltd., *Analysis of Technical Factors Affecting Residential Energy Consumption*, November 1, 1977 in:
G. Desfor, *et. al.*, "Patterns of Urban Energy Utilization," *Considerations and Opportunities for Energy Conservation in Urban and Regional Planning*, (Kingston, 1979).

enhanced when employment density is increased. A study on residential and work area density found that:

> ... for every 10,000 persons per square mile increase in population density of the origin zone, there is an increase in public transport usage of almost 2 per cent.
> ... for every 10,000 jobs per square mile increase in employment density of the work zone, there is an increase in public transport usage of about 3/4 per cent.[15]

In terms of intra-city transportation modes it is well established that private automobiles are the most energy consumptive. Aside from walking and bicycling, public transportation modes such as bus and light rail transit are less consumptive of energy than automobiles when compared on energy per passenger mile ratios. For example, it is estimated that Toronto's 1971 energy consumption in transportation was about 8 passenger-kilometres per litre for automobiles and about 57 passenger-kilometres per litre for public transit modes.[16] These aspects of urban transportation are more dramatically pronounced during peak periods of traffic flows. Congestion of major and arterial roads during early morning and later afternoon is a result of a less than 2 person per vehicle passenger ratio in automobiles.

The reliance on the private automobile to serve as an urban transportation system is also more consumptive of urban space than are transportation systems based on the bus as the principal mode of transit. The relationship between the type of transportation system used in an urban area and the amount of space it required is documented to show that for an equal number of person-trips per day, cars require more land than do subways and buses.[17]

This relationship between transportation mode and land requirement applies when considering density of the urban area. If more land

is required for a car centred transportation system, the density of the area is decreased and at the same time, a corresponding increase in energy consumption occurs.

These findings are congruous with the relationship between car ownership and public transit usage. A decrease in car ownership results in an increase in public transit ridership, which is a more energy efficient form of urban transportation. It is documented that:

> ...for every 10 per cent decrease in the percentage of car owning households along the route of the work journey, there is a 9 per cent increase in public transport usage ...
> ...the effect of car ownership is equally important to both ends of a trip. For each 10 per cent decrease in the percentage of car-owning households at either end of the trip, there is a 4½ per cent increase in public transport use.[18]

It appears that there is a multiple thrust towards saving transportation energy provided by higher density development. Higher density and closer proximity reduce the demand for automobile usage and increase potential for economical and less energy consumptive public transit. Less space is required for a public transit system than for cars, this increases the density of development and further enhances the usage of public transportation. In a higher density urban development, with a public transportation system in place, the need for car ownership may diminish and this may produce a corresponding increase in public transit usage.

Substantial reductions in transportation energy requirements are estimated possible from increasing densities of urban development. An urban density model concludes that increasing the density of developments would reduce transportation energy requirements to one tenth of that required for more dispersed developments.[19]

American studies such as *The Cost of Sprawl*[20] and *Regional Energy Consumption*[21] have received much attention because of their focus on density and energy consumption. In the *Cost of Sprawl* study, variations of neighbourhoods of 1,000 dwelling units of different types were organized to form six types of communities of 10,000 dwelling units varying in density. Keeping populations constant, it was observed that the highest-density planned community had the lowest per capita energy consumption.

The *Regional Energy Consumption* study examined the New York City (including Manhattan) region and derived per capita energy consumption data on a density basis. The study indicated a decrease in per capita consumption as density increased from the outlying regions towards the center, but then an increase again at the city centre; this in Manhattan, the highest population density in the U.S. The anomaly was explained by the methodological procedure which made calculations of per capita energy consumption related to resident population and not the daytime population. Chibuk has stated that "...Manhattan has the lowest per capita consumption of any county in the region when the calculation is made in relation to daytime and not resident population."[22] This interpretation was confirmed by the Regional Plan Association whose Vice President of the Research and Planning Staff also "...concluded that energy consumption per capita decreases as urban density . . .increases."[23] Among the findings of the New York regional study were the sectoral analyses indicating residential per capita consumption remains constant at all densities; commercial per capita energy consumption falls as density increases but increases towards the urban centre as density increases, and energy consumption

per capita for transportation decreases by more than 50 per cent with a forty fold increase in density.[24]

It is clear from these studies that per capita energy consumption can be decreased by means of an increase in the density of development. Especially significant is the opportunity for reducing the demand for transportation energy--motor gasoline, which is a derivative of oil. With oil contributing half of Canada's energy supply, and Canada being a net oil importer, reductions in Canada's oil demand through conservation in urban transportation are very desirable.

2.4 Urban Density and Energy: Land Policy Directions

Based on the studies, and the existing state of knowledge and opinion, there is an urban land policy which can be advanced and implemented through complementary urban design and planning guidelines:

> ...urban form should be developed at higher densities in all sectors than is currently taking place. This could be achieved through the use of clusters, centres, corridors, infilling and compact development. A host of means such as the following would probably have to be simultaneously applied to achieve the desired change: 1) a shift to higher density dwelling types by the population; 2) an increased commitment to public oriented modes of transport; 3) the use of larger more centralized commercial/public institution complexes; 4) the use of multistory industrial building configurations; and 5) the application of infrastructure technologies such as district heating...[25].

These suggested approaches to increasing urban density focus on the residential, commercial, industrial and transportation sectors. As well, the concentration of urban development provides opportunities for the application of alternative energy supplies such as district heating, in order to take advantages of such potentials as industrial waste heat. District heating allows a substitution of industrial

energy by-products for primary energy sources such as natural gas or oil. Industrial energy by-products are contained to heat water for space heating and cooling of residential, commercial/institutional and industrial areas.

2.5 Urban Pattern and Shape and Energy Consumption

Urban pattern and shape have also been examined with reference to an urban form and energy consumption relationship.[26] The focus of this urban form factor concerns itself with energy consumptions of varying urban shapes. There is an overlap between urban form factors such as density and shape, because density influences shape. The studies suggest that energy savings attributable to urban shape characteristics are those realized in transportation and utility infrastructure sectors:

> ...the most energy conserving patterns are those which reduce travel distances and the extent of infrastructure networks and utility lines. By reducing the distances for transporting and transmitting goods, services and utilities, an urban settlement can achieve certain economies and savings by requiring less energy per capita for transportation and network operations.[27]

There is a general perception that a sprawl pattern of urban form, typified by single family dwelling units composing uncontiguous or separated neighborhoods and communities ("leap frog") with long commuting distances is more energy consumptive than other planned urban shapes which are contiguous, or one mass. Size is also a factor influencing shape. The least energy consumptive urban shapes or patterns are estimated to be ones which are small to medium in population size (50,000 to 100,000 people.)[28] The preferred patterns,

dependent on the ability to manage the population size and its distribution, are compact rectangular, or concentric and polynuclear, or concentric in patterns:[29]

> ...if the population size and distribution can be managed, then the most efficient pattern is one of small to medium sized compact rectangular or concentric settlements arranged in a polynucleated fashion. ...if population size and distribution cannot be as effectively managed, then the linear pattern or concentric pattern would be the energy-efficient choices. Contiguous and continuous shapes, ...are considered to be more energy efficient than discontinuous and dispersed shapes which are characterized by sprawl and leap-frogging.[30]

Based on these considerations six alternative urban shapes are developed. These are illustrated graphically in Figure 2-4 and are represented by basic community cells of between 50,000 to 100,000 population of compact rectangular/concentric forms arranged in polynuclear, linear or concentric patterns and shapes.

2.6 Urban Pattern and Energy: Land Policy Directions

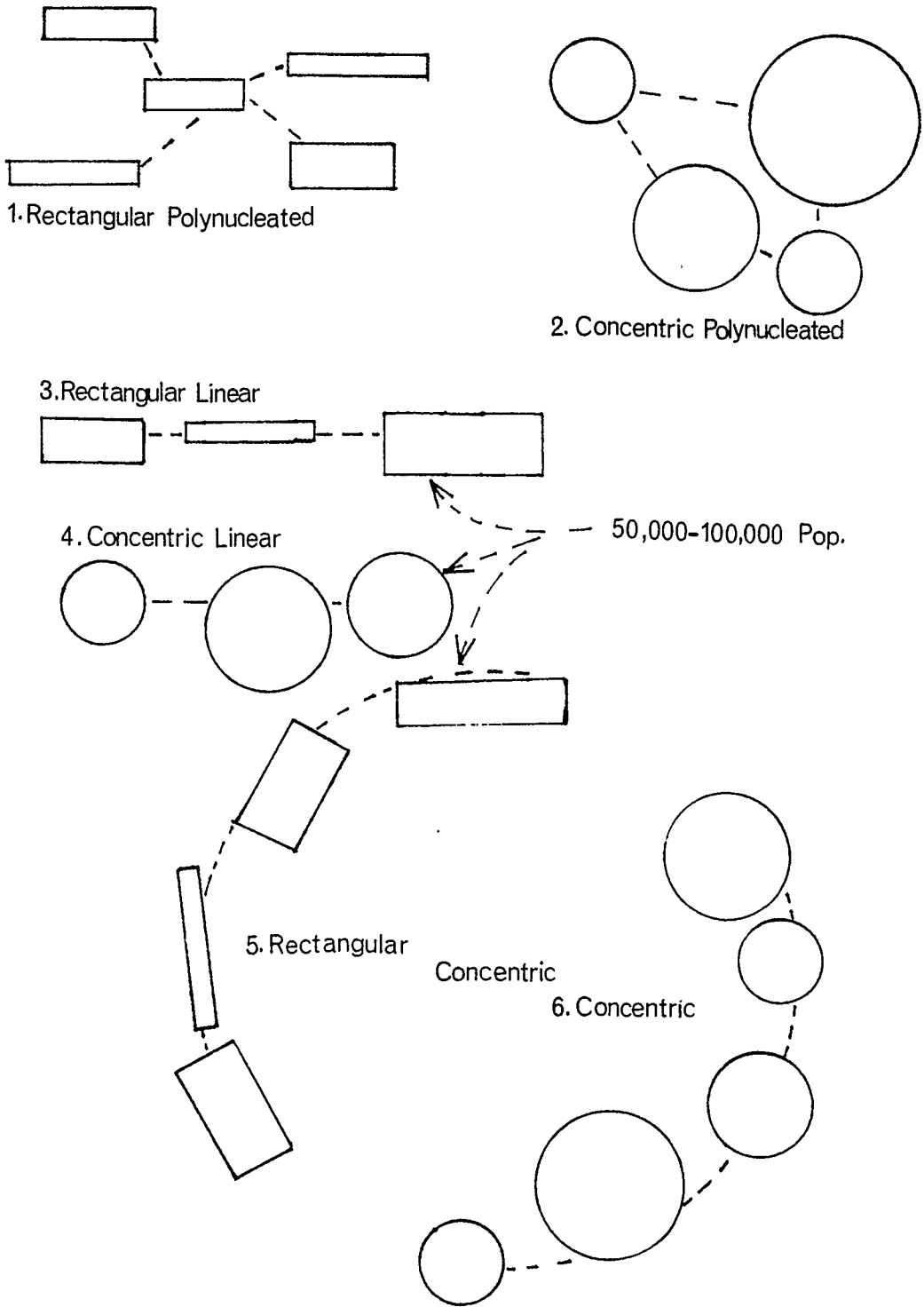
Recommendations for urban land policy stemming from the examination of urban shape and pattern studies and energy consumption indicate a preference towards the development of urban land into planned patterns of the above arrangements. The recommendations are opposed to urban peripheral growth, uncontiguous and sprawling in nature. The shape is dependent upon the ability to manage the population size and distribution.

Specifically, urban land policy can guide energy-efficient urban shape in two possible directions:

> ...if population size and distribution can be well managed, then patterns of small to medium sized compact rectangular or concentric settlements arranged in a

FIGURE 2-4

ENERGY EFFICIENT URBAN SHAPES AND PATTERNS



> polynucleated fashion should be pursued. ...if population size and distribution cannot be so managed, then the linear pattern or the concentric pattern would be energy-efficient alternatives. Proper shapes could be achieved by developing transportation and network systems in such a way as to establish potentials for urban development.[31]

Clearly the implementation of energy-efficient patterns and shapes is also dependent upon a transportation system which is specific to serving a network of polarized centres of dense origin zones and dense destination zones. Urban transit systems such as bus and light rail transit, which are less energy and space consumptive than private automobiles, are already in existence and are suitable for encouraging the desirable urban patterns and shapes outlined in this section.

To achieve the desired pattern and shape of cities a number of concurrent urban land policies and transportation policies are required. In general, urban land policies are needed to concentrate residential developments and locate them closer to major transportation corridors. Land policies are also required to direct the development of urban land which decreases the separation between employment, shopping and residential areas. Urban land policy is also required to discourage segregated and specialized land uses and to encourage multi-use facilities. Needed are urban transportation policies which enhance the increased use of public oriented modes such as buses and light rail transport.

2.7 Urban Land-Use Arrangements and Energy Consumption

A third urban form factor influencing urban energy consumption is land-use arrangement. Land-use arrangement refers to the features

of segregation, (or the separation of) and integration, (or the mixing of) various urban activities. Traditional urban development practices are inclined to segregate one land activity from another. For example, residential areas are separated from commercial and industrial areas, and vice versa. In terms of the influence of land-use arrangement on energy consumption, the studies tend to display theoretical prejudgements rather than to present structured and substantive analyses.[32]

The relationship between urban land-use arrangements and energy consumption gives evidence that integration of land uses on both horizontal and vertical planes is less energy consumptive.[33]

Following from integrated land-use arrangements there are a number of features which permit energy savings. Integration of activities provides opportunities for sharing servicing and infrastructure facilities such as heating systems, ventilation systems, air conditioning systems, elevators and parking. Related to this is the notion that centralization of services and infrastructure reduces the duplication of capital equipment and may provide operational economies. Integration of activities is a method for reducing travelling distances between activities. Integration of urban activities provides the opportunity for converting what might be "waste heat" from industrial activities to useful purposes in the residential and commercial sectors. The closer proximity between different urban activities in mixed-use arrangements reduces transmitting costs of converted industrial waste heat.

2.8 Urban Land-Use Arrangements and Energy: Land Policy Directions

Urban land policy which aims to take advantage of land-use arrangements for the reduction of urban energy consumption requires that different urban land uses should be mixed and integrated.

Although the urban land policy direction is fairly straightforward, there are a number of concurrent programmes, not necessarily related to land policy, which are required to implement this policy successfully. These would include:

1) Increasing the use of multi-functional or mixed-use buildings such as community and public school buildings, residential/commercial and institutional complexes.
2) Development and implementation of district heating facilities and other centralized infrastructure systems.
3) Development of complementary institutional arrangements to facilitate mixed-use integration between the private and public sectors.[34]

2.9 Exogenous Factors

These complementary programmes listed above concern areas of decision-making exogenous to urban land policy. But their acceptance is desirable in order to take full advantage of the potentials of mixed-use and integrated land-use arrangements. Potentials for reducing energy consumption for transportation and building purposes are viewed as strong advantages of mixed-use land arrangements when seen in the context of urban form and energy consumption.

There are other exogenous factors which influence urban energy

consumption. These are common to all settlements and include such things as climate, population size, individual building characteristics, automobile efficiencies and individual behaviour and attitudes. These are not directly related to urban form and urban land policy but their importance to energy conservation, although outside of the scope of this paper, is of interest to other researchers who represent other approaches to energy conservation.

2.10 Summary of Recommendations for Urban Land Policy

From the review of the literature on urban form and energy consumption, a number of recommendations for urban land policy have been drawn out. For recapitulation purposes, they have been summarized according to the respective parameters of urban density; urban pattern and shape; and urban land-use arrangements.

Density: It is recommended to develop the urban form at higher densities in residential, commercial and industrial sectors.

Pattern and Shape: Dependent on the ability to manage population size and distribution, urban areas are recommended to be of 50,000 to 100,000 population.

These urban cells are recommended to be of either compact rectangular or concentric form and to be arranged in polynuclear, linear or concentric patterns and shapes.

Land-Use Arrangements: Urban land uses are recommended to be mixed and integrated.

2.11 Conclusion

This chapter has presented a discussion of urban form factors

as they influence energy consumption. Factors such as density, pattern and shape, and land-use arrangements were presented as having impacts on urban transportation energy consumption and sectoral consumption for residential, commercial and industrial space heating activities.

From a review of the literature it was recommended that urban land policy is required to direct urban development towards higher densities than currently exist; to develop urban growth into planned areas in rectangular or concentric shapes, which are distributed in polynucleated, linear, rectangular or concentric patterns; and to direct a greater mix and integration of land uses. Complementary programmes to assist the implementation of the recommended policies were also presented.

FOOTNOTES

[1]J. H. Chibuk, *Urban Form and Energy: A Selected Review*, (MSUA, July, 1977), unpublished. The reader is given reference to Section 3 "Relevance to Decision Making" pp. 51-72, especially Sub-section 3.1 "Relevance of Urban Form/Energy Consumption Focus", pp. 51-56.

[2]*Ibid.*, p. 51.

[3]*Ibid.*, p. 52.

[4]*Ibid.*

[5]*Ibid.*, p. 53.

[6]*Ibid.*

[7]Energy, Mines and Resources, *Electricity, Yesterday, Today and Tomorrow*, (Ottawa: Information Canada, 1976), Cat. No. M 27-13/1976.

[8]J. H. Chibuk, *Energy and Urban Form*, (Ministry of State for Urban Affairs, June, 1977), submitted as a Topic Paper to the ECE Conference, October, 1977.

[9]*Ibid.*

[10]Studies and related articles discussing density and energy consumption include:

John F. Kain and Gart R. Ruth, *The Effects of Urban Structure on Auto Ownership and Journey to Work Mode Choices*, (Harvard University, Department of City and Regional Planning, August, 1976); Real Estate Research Corporation, *The Costs of Sprawl*, Vol. I, Detailed Cost Analysis, (April, 1974); Regional Plan Association Inc. and Resources for the Future Inc., *Regional Energy Consumption*, (New York: Regional Plan Association, January, 1971); Edmund N. Bacon, "Energy and Land-Use," *Urban Land*, (July-August, 1973); David J. Benson, "Bonus or Incentive Zoning-Legal Implications," *Syracuse Law Review*, Vol. 27, (Spring, 1970), pp. 895-906. Patrick Hailstone, "Energy in Urban Planning: Settling for Less," *Habitat*, Vol. 21, No. 1, (1978), pp. 8-10; Patrick Hailstone, "Planning for Energy Conservation," *Habitat*, Vol. 21, No. 2, (1978), pp. 35-39; J. Hix, *Energy Demand for Future and Existing Land Use Patterns*, Toronto: prepared for the Royal Commission on Electric Power Planning, 1977); J. Hix, *Urban Planning Considerations*

for Energy Efficiency, (Kingston: prepared for Considerations and Opportunities for Energy Conservation in Urban and Regional Planning Conference, March 9-11, 1979); IBI Group, *Energy Conservation Through Land-Use Decision*, (Ottawa: Environment Canada, March, 1976); Dale L. Keyes, "Energy and Land Use," *Energy Policy*, Vol. 4, No. 3, (September, 1976);J. S. Roberts, *Energy Land-Use and Growth Policy: Implications for Metropolitan Washington*, second edition, (Chicago Real Estate Research Corporation, August, 1975); Urban Land Institute, "Energy and Land Use: A Statement by the ULI," *Environmental Comment*, (September, 1974), pp. 1-7; Dan Yurman, "Can Density Bonuses Pay Off," *Practicing Planner*, (April, 1976), pp. 14-20; Hittman Associates Inc., *Residential Energy Consumptions--Multifamily Housing: Final Report*, (HUD, June, 1974); G. B. Jamieson, W.R. Mackay and J.C.R. Latchford, "Transportation and Land-Use Structures," *Urban Studies*, Vol. 4, No. 3, (November, 1967), pp. 201-17; R. Sharpe, "The Effects of Urban Form on Transport Energy Patterns," *Urban Ecology*, Vol. 3, No. 2, (June, 1978), pp. 125-35; Urban Transportation Development Corporation Ltd., *Moving Into an Energy-Efficient Society*, (Toronto: submission to the Ontario Royal Commission on Electric Power Planning, 1976).

[11]Housing and Urban Development Association of Canada (HUDAC), *A Builder's Guide to Energy Conservation*, (Toronto: HUDAC, 1975).

[12]Information Ltd., Analysis of Technical Factors Affecting Residential Energy Consumption, (November, 1977) as reported in G. Desfor, *et. al.*, "Patterns of Urban Energy Utilization," *Considerations and Opportunities for Energy Conservation in Urban and Regional Planning: Conference Proceedings*, (Kingston: March 9-11, 1979).

[13]*Ibid.*, pp. 2-19.

[14]*Ibid.*, pp. 2-17.

[15]R. Sammons and P. Hall, "Urban Structure and Modal Split in the Journey to Work," *Urban Studies*, No. 14, (1977).

[16]G. Desfor, G. Hare and L. Hass, "Patterns of Urban Energy Utilization," *Considerations and Opportunities for Energy Conservation in Regional Planning: Conference Proceedings*, (Kingston: March 9-11, 1979), pp. 2.22-2.23, Tables 11 & 12).

[17]Norman D. Lea, *The Efficiency of Land-Use for Urban Transportation*, (Oakville, Ontario: N.D. Lea and Associates Ltd.); J. H. Chibuk, *Energy and Urban Form*, (MSUA, June, 1977), p. 3.

[18]R. Sammons and P. Hall, "Urban Structure and Modal Split in the Journey to Work," *Urban Studies*, No. 14, (June, 1977), p. 3.

[19]Corbin C. Harwood, *Using Land to Save Energy* (Cambridge: Ballinger Publishing Company, 1977), p. 13.

[20]Real Estate Research Corporation, *The Costs of Sprawl*, 3 volumes, (Washington, D.C.: Superintendent of Documents, U.S. Government Printing Office, April, 1974).

[21]Regional Plan Association Inc., and Resources for the Future Inc., *Regional Energy Consumption*,(New York: Regional Plan Association, January, 1974).

[22]J. H. Chibuk, *Urban Form and Energy: A Selected Review*, (MSUA, July, 1977), p. 5.

[23]*Ibid.*, p. 7.

[24]*Ibid.*, p. 4.

[25]J. H. Chibuk, *Energy and Urban Form*, (MSUA, June, 1977), p. 3.

[26]Studies directing focus on urban pattern and shape with energy consumption include:

T. Owen Carroll, *et. al.*, *Land-Use and Energy Utilization*, Interm. Report, (New York: Brookhaven National Laboratory and State University of New York, 1975), BNL 20577;Jerry L. Edwards and Joseph L. Schofer, *Relationships Between Transportation Energy Consumption and Urban Structures: Results of Simulation Studies*,(Minneapolis, Minnesota and Evanston, Illinois: University of Minnesota and Northwestern University, January 1975); G. B. Jamieson, W.E. Mackay and J.C.R. Latchford, "Transportation and Land-Use Structures," *Urban Studies*, Vol. 4, No. 3, (November, 1967), pp. 201-217; Real Estate Research Corporation, *The Costs of Sprawl*, (Washington, D.C.: U.S. Government Printing Office, April, 1974); James S. Robert, *Energy, Land-Use and Growth Policy: Implications for Metropolitan Washington*, second edition, prepared for the Metropolitan Washington Council of Governments, (Chicago: Real Estate Research Corporation, August, 1975); P.A. Stone, *The Structure, Size and Costs of Urban Settlements*, (Cambridge: The University Press, 1973); Edmonton Regional Planning Commission, *Conserving Our Resources*, Paper No. 5 in the Edmonton Regional Growth Studies, (July, 1976); Edmund N. Bacon, "Energy and Land-Use," *Urban Land*, (July-August, 1973); Corlin C. Harwood, *Using Land to Save Energy*, (Cambridge: Ballinger Publishing Company, 1977); Robert W. Barchell and David Listokin (eds.) *Future Land Use/Energy, Environmental and Legal Constraints*, (New Brunswick, N.J.; Rutgers University Press, 1975); J. H. Chibuk, *Energy and Urban Form*, (MSUA, June, 1977); J. H. Chibuk, *Urban Form and Energy: A Selected Review*, (MSUA, July, 1977);

George C. Hemmens, "Experiments in Urban Form and Structure," *Highway Research*, Record 207. (1967), pp. 32-41; J. Hix, *Energy Demand for Future and Existing Land-Use Patterns*, (Toronto: prepared for the Royal Commission on Electric Power Planning, 1977); IBI Group, *Energy Conservation Through Land-Use Decisions*, (Ottawa: Environment Canada, 1976).

[27]J. H. Chibuk, *Energy and Urban Form*, (MSUA, June, 1977).

[28]J. H. Chibuk, *Urban Form and Energy: A Selected Review*, (MSUA, July, 1977), p. 27; J. H. Chibuk, *Energy and Urban Form*, (MSUA, June, 1977), p. 4; P.A. Stone, *The Structure, Size and Costs of Urban Settlements*, (Cambridge: The University Press, 1973).

[29]Interpretation from J. H. Chibuk, *Energy and Urban Form*, (MSUA, June, 1977), p. 4.

[30]J. H. Chibuk, *Energy and Urban Form*, (MSUA, June, 1977), p. 4.

[31]*Ibid.*, p. 5.

[32]*Ibid.*, studies in this subject area include:

Dimitri Procos, *Mixed Land-Use: From Revival to Innovation*, (Strondsberg, Pennsylvania: Dowden, Hutchinson and Roes, Inc., 1975); Urban Land Institute, "Energy and Land-Use" *Environmental Comment*, (September, 1974), pp. 1-7; H. P. D. Van Ginkel, "Design of Communities: A Planner's View of Energy Conservation," First Canadian Congress: Energy and Buildings, (Ottawa: Sponsored by the National Research Council in Toronto, 1977), NRCC 15870; Robert E. Witherspoon, *et. al.*, *Mixed-Use Developments: New Ways of Land-Use*, (Washington, D.C.: Urban Land Institute, 1976).

[33]J. H. Chibuk, *Energy and Urban Form*, (MSUA, June, 1977), p. 5.

[34]*Ibid.*, p. 6.

[35]Examples of reports and/or studies in these exogenous areas include:

J. E. Arnonin, *Climate and Architecture*, (New York: Reinhold Publishing Corporation, 1953); ASHRAE, *Energy Conservation in New Building Design*, (New York: ASHRAE Standard, 1975), pp. 75-90. Victor Olgyay, *Design with Climate*, (Princeton: Princeton University Press, 1963); P. A. Stone, *The Structure, Size and Costs of Urban Settlements*, (Cambridge: The University Press, 1973); B. M. Morrison, *Socio-Physical Factors Affecting Energy Consumption in Single Family Dwellings*, Ph.D. Thesis, Michigan State University, (1975); Lee Schipper and Allan J. Lichtenberg, "Efficient Energy Use and Well-Being: The Swedish Example," *Science*, Vol. 19, No. 4269, (December, 1976); S. Warkov (ed.), *Energy*

in America: Social and Behavioural Dimensions, (New York: Praeger, Special Studies, 1973); K. Hollands and J. Orgill, *Potential for Solar Heating in Canada*, (Waterloo: University of Waterloo Research Institute, 1977); Acres Shawinigan Ltd., *District Heating Study*, (Toronto: Ministry of Energy, 1976).

CHAPTER III

AN ASSESSMENT OF THE FEASIBILITY OF FORMULATING AND IMPLEMENTING AN ENERGY-SENSITIVE URBAN LAND POLICY

3.1 Introduction

Several authors have recognized the need for an energy-sensitive urban land policy and for complementary urban planning as a means of managing energy demand and consumption in human settlements.[1] Discussion presented in Chapters I and II has shown that depletion of domestic supplies of oil, reliance on foreign imports, insecurity of foreign supply, and the pricing policies of exporting oil countries, are combining to pose serious national economic problems for Canada. These points will be elaborated in Chapter 5, but the economic consequences of high energy costs are briefly addressed here to point out the opportunity an urban land policy provides for managing urban energy consumption. Following this, the present chapter will conduct a discussion concerning the feasibility of the formulation and implementation of an energy conscious urban land policy.

As oil is a major primary source of energy in industrial processing, inflated energy prices lead to higher consumer prices for domestic products. This weakens the ability of Canadian manufacturers to compete in domestic and world markets which are therefore alternatively supplied with foreign goods. This energy-economic relationship in the industrial sector is a factor contributing to unemployment and inflation in Canada. By converting the waste heat into useable energy

for other sectoral uses, urban form and urban land policies can complement existing programmes aimed at increasing energy efficiency in processing. Reduction in energy consumption in the industrial sector and development of district heating facilities to utilize waste heat would enhance energy conservation at the urban level. Land policies to regulate use of and interface between urban activities are recommended.

Transportation demands 19 per cent of Canada's total energy supply, all of it oil. Urban land policy can direct the urban form into patterns and land-use arrangements which reduce the urban transportation dependency on cars and conversely enhance the use of public transit. These modes of transit are more energy efficient and would therefore reduce Canada's dependency on foreign oil.

Current arrangements of residential land use are consumptive of both land and energy. Urban land policy can direct residential development into more compact, less energy consumptive patterns. Urban land policy which gives direction toward the integration of land-use activities enhances the potentials for utilizing waste heat from industrial processes and for reducing automobile usage, thus further reducing Canada's energy demand.

There are still many needs for research in Canada relating to urban settlements and energy.[2] Variables suggested for study include: urban form factors, urban form parameters, urban form levels, urban settlement sectors, energy dimensions, household incomes, household tenure, level of education, and energy analysis, among others.

A consultant's report on urban form and energy consumption pre-

pared for MSUA reviewed the literature documented in Chibuk's report. The consultant's report presented six recommendations for further study. These recommendations were: 1) develop an aggregate residential energy consumption model based on Statistics Canada census tract units; 2) develop a site specific residential energy model; 3) prepare a planner's guide to energy conservation; 4) develop municipal energy audit capability; 5) develop a municipal energy conservation information and network system; 6) develop a model for assessing the impact of urban form on transportation energy consumption.[3]

The above recommendations for further research and study are aimed at quantifying the precise relationships between urban form factors and energy consumption. While it is desirable to enhance the body of knowledge about these relationships, there is sufficient evidence gleaned from the existing studies which provide direction for energy-sensitive urban land policy as outlined in Chapter II. In addition a survey by Middleton Associates of Toronto local and regional municipalities; urban related organizations; and experts who have published reports and studies, confirms the opinion that density and land use arrangements are key urban form variables influencing energy consumption. The survey documents the opinions: that higher densities were less energy consumptive; that urban form could directly influence residential space heating and cooling energy requirements; and that mixed land use and public transit would alter both a municipality's economic status and its energy consumption.[4] The research done to quantify the relationships, to develop data bases, and to develop models is justified but the question of implementing a desirable course of action is another area of needed investigation. The intent

of this chapter is to present a discussion of the parameters which influence the formulation and implementation of a desirable urban land policy which would promote an urban form which would be less energy consumptive than urban forms have been in the past.

Whereas it is fairly clear that urban policy recommendations outlined in Chapter II can contribute to a reduction in urban energy demand and consumption, a research gap remains in terms of gauging the feasibility of implementing these changes. Once urban policy directions and strategies are articulated, " ..research and analysis is required to assess the existing urban situation in terms of the feasibility for implementing the desired courses of action within existing ...urban forms."[5]

This chapter addresses itself to this need for research analysis in assessing the feasibility or implementing desired courses of action. It is the intent of this chapter to focus on models of decision-making at the urban level. A review of prominent models of decision-making provides the reader with insights into urban land policy formulation and implementation processes. Energy-sensitive urban land policy is presented as an example in context with the various models.

The notion of energy-sensitive urban land policy implies an overall or "comprehensive" approach to solving the problem of urban energy consumption. Decision-making for the public good in western democracies also implies a societal context. Therefore, a comprehensive approach to problem solving has both opponents and proponents. Opponents to comprehensive approaches assume society is pluralistic. A pluralistic society is a collection of individuals or groups who

have differing opinions, attitudes and values and for whom a comprehensive solution would not be suitable due to varying degrees of opposition. Proponents of a comprehensive approach to problem solving tend to view society as being more of a collective of individuals or "...an organic whole, something which is, in a metaphorical way, more real than the collection of individuals which it embraces."[6] From the standpoint of these two camps, one of opponents and the other of proponents, three of the existing theoretical and empirical behavioural models of decision-making are discussed in order to illustrate some of the complexities involved in implementing comprehensive problem solving approaches such as an energy-sensitive urban land policy.

3.2 The Rational Model

One of the most controversial theoretical models of decision-making is the "Rationalistic Model."[7] This theoretical model of policy-making proposes that:

> Policies are formulated through a series of sequential steps where the policy makers (1) recognize a policy problem exists, (2) identify the nature of the problem through investigations, (3) call for the presentation of alternatives, (4) rank their priorities, (5) make predictions on the risks and consequences of various alternatives, and finally (6) come to a decision by combining the qualitative and quantitative values they have considered.[8]

Rational models must be viewed in two modes: instrumental rationality and comprehensive rationality. Instrumental rationality refers to a consistently rational set of techniques, tools, or other objects which are mutually supportive in achieving a specific goal. Comprehensive rationality refers to an encompassing concept for achieving a specific goal. A. Etzioni clarifies this distinction by

stating that instrumental rationality:

> ...deals with the relations among means: comprehensive rationality deals with the relations among goals and their respective instrumental rationalities.[9]

For example, a desirable urban policy is enhanced through higher density, public transportation and mixed land use arrangements. The tools and techniques of accomplishing these aspects of the policy refer to a pool of instrumentally rational means. Energy-sensitivity is, however, only one aspect of a comprehensive urban policy which also addresses other urban issues such as the development of the economic base and provision of municipal services.

In the context of the urban land policy and energy consumption subject area, the rational model first requires decision makers to realize that the relationship between urban form and energy consumption is valid and that urban land policies can alter the relationship in desirable ways. Following this are several particularities of the paradigm for rational decision making.[10] These particularities include: information, calculations, agreed-upon values and exhaustive surveys. Specifically rational decision-making requires:

> ... (a) information about alternative courses of action and their consequences; (b) calculations of the alternative outcomes in terms of their meaning for the various values, and for various combinations of means; (c) a set of agreed-upon values on the basis of which to select goals and to judge the consequences of alternative courses of action; and (d) an exhaustive survey of all relevant alternatives, since an unstudied alternative may be the optimal one... (optimal not being)... a "good" one but the best among a set of "bad" ones... its merits...established only if it is systematically compared to the alternatives.[11]

For clarification A. Etzioni points out that an additional requirement not included in all the versions of the rational model is that of

an interdisciplinary theory. As he argues:

> ...a requirement...which is of special interest to the social scientist, is that a full-fledged interdisciplinary theory is needed to carry out the calculations discussed above. Without such a theory, the effects of changes the decision-maker is considering could not be understood and safely forecasted.[12]

Criticisms of the rational model suggest that the requirements, assumptions and processes of the rational model are unrealistic.[13] Most information for decision-makers is incomplete, and a puzzling question is: "How does one know what information for decision-making is necessary?" The collection of data, and the organization and the analysis of data may require a time element greater than that available to decision-makers. The calculation of outcomes is dependent upon values established as criteria for evaluating different alternatives.

The calculations requirement of the rational model assumes that prerequisites exist for determining values and that sufficient information about outcomes is provided. Policy-making is not an individual act but a group or social activity. It is difficult for groups to agree upon values or to weigh outcomes unanimously. Also, it is difficult to assure that complete information is provided concerning all possible outcomes. This prerequisite assumes that the range of possible outcomes is finite and limited; however, the universe of future consequences is infinite. K. J. Arrow argues that the rational model of decision-making calls for "an impossible amount of calculation" and A. Etzioni further adds that the impossibility of these calculations is not caused simply by the limitations of computers but also by "a difficulty in our ability to describe the world in a

fixed linguistic structure."[14]

The rational model is an unrealistic approach to behaviour in decision-making because it also disregards the actual political nature of policy formulation. Conflicts between the values and opinions of actors in the process are real. Compromise of positions occurs. For example, energy-sensitive urban policy would favour the redevelopment of inner city areas at higher residential densities to reduce peripheral growth and reduce distances of journeys to work, but land development corporations would pursue the annexation of peripheral land for future development of single detached housing. Inner city resident land owners would also oppose redevelopment of their neighbourhoods to higher density because they perceive it as a negative transition in both their social ambiance and their physical environment. The ward alderman is faced with the choice between the advice of the technical experts in the city planning department and the sentiments of his constituents.

The rational model of decision-making behaviour is thus observed to be plagued with real world behaviour for which it cannot account. It is therefore not surprising that some proponents of the rational model defend it as a model to which actual decisions are compared.

Others interested in modelling decision-making behaviour choose another model--the incrementalist approach.

3.3 The Incremental Model

With the questionable validity of rational models for decision-making a search for an alternative model begins. Several philosophers

are noted to have advocated less demanding alternatives.[15] It is K. Popper who is credited with providing the philosophical support for the incremental approach, which is often referred to as the "art of muddling-through".[16] C. Lindblom in *The Intelligence of Democracy* presents a recent comment on this approach in order to describe the behaviour of policy-makers. Basically the incremental model views the policy-making process:

> ...as a series of actions in which those who are responsible for arriving at decisions "muddle through" a limited number of closely related alternatives (incrementally rather than qualitatively different) without evaluating all the possible ramifications and consequences of each one. Furthermore, the set of policy-making actors does not arrange its policy deliberations and decisions in such a way to match interacting policies but proceeds in a rather disjointed fashion. This is done on the assumption... that the interrelatedness of policies and their outcomes cannot be fully explored or predicted given the practical limitations of time, data and analytical techniques. A further assumption is that policy-makers do not place a high priority on overcoming such limitations.[17]

Based on this above description the incrementalist model is very unstructured compared to the rational model. Also, it is very conservative. For example, if alternative policy proposals are only incrementally different than the existing policies, it is obvious that the existing policies will be continued to a high degree. Compared to the rational model which adjusts means to accomplish set goals, the incrementalist approach adjusts goals which are fairly appropriate to the means available.[18] Because fewer alternatives are considered and the analyses are less exhaustive than those of the rational model, the incrementalist approach is less demanding of information and computation and is favourable from a time and cost perspective.

The incrementalist model of policy-making is useful in describing the manner in which some decisions are made. Political, economic, social and environmental factors either influencing or being influenced by policy decisions are detectable, although not necessarily in quantified form, in the incrementalist approach. It is agrued that incrementalism should be used in decision-making situations because it permits ready detection of both positive and negative changes and allows for quick adjustments to the various impacts of change.

An inadequacy of the incrementalist model is its inability to account for radical shifts in policy which may occur. For example, an urban government might proclaim a policy of support for public transportation facilities and development at one moment in time and later decide to spend more money proportionally on road construction and downtown parking for private automobiles. These two policy options are completely opposite to each other and do not follow a logical path of conservative policy development under the incremental paradigm.

From the perspective of energy-sensitive land policy, the incrementalist approach to policy denies the possibility of an articulated end goal. The possibility for desirable changes in land policy is present only to the extent that it fits into the available land use management tools which are implemented at the discretion of the local government. Shifts towards higher density of urban development, mixed land-use arrangements and overall urban form, which incidentally and unintentionally reduce urban energy consumption, are feasible through incremental implementation of a variety of land management restraints. With the incremental approach, however, the goal of urban

energy management is not clearly articulated and the implementation of land management techniques occurs in a haphazard manner.

Within the paradigm of the incrementalist model the goals are not clearly fixed. Any movement toward achieving them is slow and piecemeal. Incremental decision-making implies that outcomes are the result of indirect events. Critics of the incrementalist model, such as Etzioni, argue that good policy-making, although not comprehensive or rational, is not purely left to chance.

Considered by other writers to be a respectable approach to the study of policy formulation[19] is the mixed-scanning approach credited to A. Etzioni.

3.4 The Mixed-Scanning Model of Policy-Making

This approach to policy and decision-making is a compromise between the rational and incremental approaches. The mixed-scanning model has a focus on an underlying goal, analogous to the end goal of a rational approach, and a battery of implementing techniques or tools to employ as opportunities present themselves for achieving the desired goals. Rather than attempting to implement a comprehensive set of mutually beneficial techniques, the mixed-scanning approach describes a decision-maker as implementing means towards ends, employing a strategy of achieving goals. It is argued that effective decision-makers rely on a mixed-scanning approach in which they:

> ...differentiate contextuating (or fundamental) decisions from bit (or item) decisions. Contextuating decisions are made through an exploration of the main alternatives seen by the actor in view of his conception of his goals, but unlike what comprehensive rationality would indicate--details and specifications are omitted so that overviews are feasible.

> Bit decisions are made "incrementally" but within the context set by fundamental decisions (and reviews). Thus, each of the two elements in the mixed-scanning strategy helps to neutralize the peculiar shortcomings of the other: Bit-incrementalism overcomes the unrealistic aspects of comprehensive rationalism (by limiting it to contextuating decisions), and contextuating rationalism helps to right the conservative bias of incrementalism.[20]

In this approach to policy-making there is the assumption that there are several goals which are important for the decision-makers to consider. There are different values and weights which are given to establish priorities for goals and these values and weights are in a dynamic state. Thus incremental application of techniques is made in the context of the priorities of decision-makers.

Compared to the rational and incremental models, the mixed-scanning approach to policy-making provides the most realistic opportunity for considering an energy-sensitive urban land policy. Although there are several different goals important to urban governments, the mixed-scanning model provides for a simultaneous overview of them and accounts for differing values assigned to them on the basis of political advantage, economic benefit or other criteria. The greater priority given to an energy-sensitive urban land policy is reflected in a greater frequency of incremental "bit decisions" made in this direction.

3.5 Policy-Making as an Output of a Political System

The models of policy-making presented above have been helpful in providing an overview of the circumstances under which a successful implementation of an energy-sensitive urban land policy is most likely. The discussion has thus far not considered the preferences

of decision-makers.

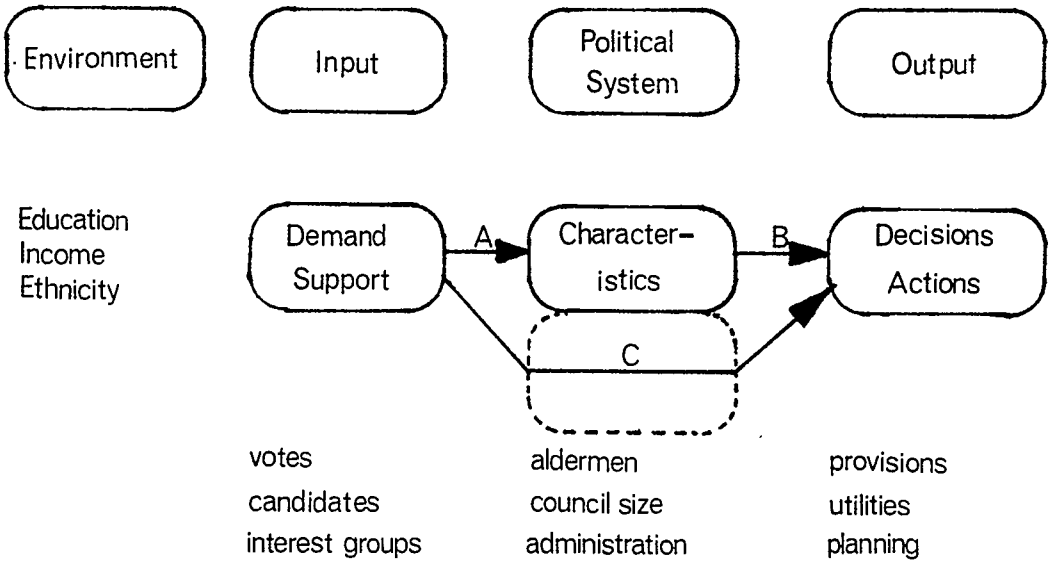
A model useful for these purposes is presented to discuss how policy decisions are a product of a political system's social environment and its demands and its supports. This model is illustrated in Figure 3-1. The political system evolves within a societal context from which decision-makers are chosen, designated or elected. The socioeconomic environment of the system is characterized by a number of variables including income, education, and preferences about certain issues. This environment creates policy demands and policy supports. Constituents may request decision-makers to proceed in a certain policy direction or to react by supporting decisions or by opposing them with some manner of protest. The decision-maker is theoretically represented in this model as governing his actions according to the support or opposition which emanates from the socioeconomic environment.

Characteristics of the political system also shape policy-decision outcomes. Through system characteristics such as the size of the council, the powers of the mayor, or the type and size of the administration are variables which are shaped by inputs both of supports and demands, they in turn influence outputs.

A direct line "C" from inputs to outputs illustrates a direct influence of inputs on outputs, independent of the system characteristics. For example, strong support or demand for a particular policy choice may be demonstrated by a strong pressure group or by an influential individual. Legitimate policy outputs are made as a direct consequence of the support or demand in question regardless

FIGURE 3-1

AN URBAN POLITICAL SYSTEM: ITS ENVIRONMENT, INPUTS AND OUTPUT



Source: Adapted from Brett W. Hawkins, *Politics and Urban Policies*, (New York: Bobbs-Merrill), 1971, p. 12.

of the system's characteristics. The existence of inputs directly influencing outputs (line C) and inputs impacting on the system characteristics (line A) which in turn influence the outputs (line B) is substantiated by study and research:

> Research results confirm the existence of both linkages (Lines A and B and Line C). Many studies indicate that environmental or socioeconomic factors shape policy output directly and that political system characteristics have little independent effect, even though policies are formulated or promulgated through the system. Other studies show that system characteristics significantly affect policy outputs.[21]

Studies in the area of urban policy process are abundant.[22] A partial list of studies in terms of their author, the primary focus, and the principal findings is presented in Table 3-1. Examples of direct inputs influencing outputs gleaned from urban policy research are found in Bernstein (1970), Crain and Rosenthal (1967), Palunbo and Williams (1970) and Scism (1971). Examples of inputs influencing system characteristics are found in Clarke (1969), Morgan (1973) and Schaller (1964). Studies illustrating system characteristics influencing outputs include Kochler (1973), Kuo (1973), Mushkin (1969) and Reynolds (1965).

Viewing policy as the output of a political system, hypothetical policy decisions can be discussed as anticipated socioeconomic forces shaping inputs, system characteristics and outputs.

At the present time, an energy-sensitive urban land policy in Canadian cities has no significant socioeconomic demand. Academics and experts in fields of energy management, and urban planning and research, are the principal proponents of such policies. To the vast majority of Canadians the benefits of such an urban land policy are

TABLE 3-1

STUDIES OF THE URBAN POLICY PROCESS

CITATION	FOCUS	FINDINGS
Bernstein (1970)	Income Distribution	Income Distribution affects urban policy.
Clarke (1969)	Urban Government Structure	Political process variables affect policy.
Costello (1970)	Psychological aspects of decision-making	Non-rational factors affect the determination of policy.
Crain & Rosenthal (1967)	Socioeconomic status and urban policy formulation	High levels of citizen participation can immobilize the urban policy making process.
Koehler (1973)	Policy development and legislative oversight in council-manager cities	Council manager and staff major source of information for council members.
Kuo (1973)	Mayoral	Mayors have a great influence on policy.
Morgan (1973)	Electorate-policy linkages	Urban policy is affected by the electorate.
Moynihan (1969)	Urban Policy	Urban policy should be a goal of the Federal Government.
Musnkin (1969)	Plan-prog-bud in ten cities	Can improve staff work and better information for decision-making.
Overby (1967)	Proposal for Plan-prog-bud system in local decision-making process	Systems analysis should be applied to decision-making in local governments.
Palunbo & Williams (1967)	Public Policy Model	Degree of urbanism affects policy decisions.

TABLE 3-1 (Cont'd)

CITATION	FOCUS	FINDINGS
Quindry & Soule (1963)	Local government revenue	Tax structure affects revenue policy.
Reynolds (1965)	Role of administrators at the local level.	Career administrators are active in policy decisions.
Pondimelli (1971)	Theory of adjunctive planning to explain policy making	Must utilize ecological and organizational variables to facilitate adjunctive policy-making.
Schaller (1964)	Use of citizen advisory committee in urban decision-making	Are advantages but not the final answer.
Schnore (1962)	Municipal annexation policy	Governmental structure influenced movement to suburbs.
Scism (1971)	Local policy and public opinion	Public opinion plays a large role in policy making.
Sears (1972)	Urban and Regional policy models	Policy makers need valid urban models.
Shepard & Godwin (1975)	Per capita municipal expenditures	Recursive causal models are inadequate tools in the study of municipal policy determination.
Sigil & Fruseina (1965)	Political leaders - public opinion.	Community leaders are not accurate judges of public opinion.
Straayer (1971)	Political Theory	American policy process precludes implementation of values.
Walter & Wirt (1971)	Policy implications of urban variety	Policy-makers must realize the political consequences of sub-urban variety.

Source: T.R. Carr and Stephanie Colston, *State and Urban Policy Analysis: An Annotated Bibliography*, Bureau of Government Research, University of Oklahoma, Workman, Oklahoma, 73069. (no date).

imperceptible and therefore there is no demand for such policy. Energy-sensitive urban land policy may even be viewed by some as negative. Support for an energy-sensitive urban land policy is perhaps more encouraging in the oil dependent regions of Canada, especially in Southern Ontario communities, Quebec, Newfoundland and the Maritime provinces. The perception of energy issues is probably greater in these areas as they are most dependent on exogenous supplies of oil and natural gas, either from foreign supplies or from Alberta. Some basis for this speculation is provided by a recent Canadian survey of twenty-six local and regional municipalities in the Census Metropolitan Area (CMA) of Toronto which demonstrated that:

> ...municipalities at least in CMA Toronto are becoming increasingly interested in energy conservation, particularly in their own municipal operations. If the response to the... survey is an indication there would also appear to be a growing municipal interest in conserving energy through land use (policy).[22]

Optimism for support for energy-sensitive land policy at the urban level is encumbered by jurisdictional, administrative, resource and motivational obstacles.[23] The most perplexing political reality is the fact that the CMA Toronto survey indicated that "...there is not a regular and consistent demand (from municipal residents) for energy-sensitive planning."[24] It is questionable whether there is significant political support or demand at the local level for an urban land policy which is energy-sensitive. Factors influencing this desirable urban land policy direction are examined in the following section.

3.6 Policy Constraints

The question of support and demand for an appropriate urban land policy to manage urban energy consumption raises the issue of constraints to policy formulation and implementation. A useful model developed by D. Detomasi[25] is presented to illustrate a series of constraints which impact upon all policy alternatives. Specific reference is made to illustrate how these oonstraints impact upon an energy-sensitive urban land policy.

The Detomasi model describes policy output (decisions) as being subject to the influence of four generic constraints: universal; societal; organizational and individual. The constraints act as filters of policy options which reduce the number of alternatives from an unlimited to a restricted number. Universal constraints are viewed as a first level of constraint and the remaining policy options are subject to the impact of societal, organizational and individual constraints.

Universal constraints apply to all societies. They include principles of: logical arguments; physical laws and limits; and standards of moral evaluation. The first law of thermodynamics which states the principle of conservation of energy is one example of physical laws acting as a universal constraint on policy options. Newton's laws are another. Of the policy studies presented in Table 3-1, those of Palunbo and Williams; Pendemelli; Sears; Shepard and Godwin; and Straayer may be catalogued as dealing with universal constraints.

Urban land policy aimed at managing urban energy consumption is subject to a universal constraint of logic which examines both the

relationship of urban form to energy consumption and the theoretical capability of urban policy to influence the urban form. If it is true that urban form factors such as density, pattern and land use arrangement do influence energy consumption (Statement P) and if it is also true that urban land policy can control urban form (Statement Q) then the argument that urban land policy can influence energy consumption is valid (Conjunction P.Q.). If it is the case that either Statement P or Statement Q is false, or both are false then the conjunction may also be false and the relationship may not be valid. Chapter II provides evidence that the statements and conjunction are valid. The constraints, however, continue to act as filters on this policy option and massage it in a variety of ways. Examples of how policy is filtered are elaborated further in the following text.

Societal constraints in the Detomasi model refer to broad societal attitudes and values such as those concerning the differing ideologies of democracy and totalitarianism, and issues such as capital punishment, sex education and energy conservation. They also include social institutions such as: the concept of private property; markets; and the concept of individual rights. L. White Jr. presents a discussion of these and other societal constraints in the book *Dynamo and Virgin Reconsidered.*[26] The policy studies listed in Table 3-I which deal with societal constraints include: Bernstein; Crain and Rosenthal; Morgan; Moynihan; Quindry and Soule; Scism; Sigil and Fruseina; Straayer; and Walter and Wirt.

Examples of societal constraints which filter aspects of energy-sensitive urban land policy are the legal and jurisdictional provisions

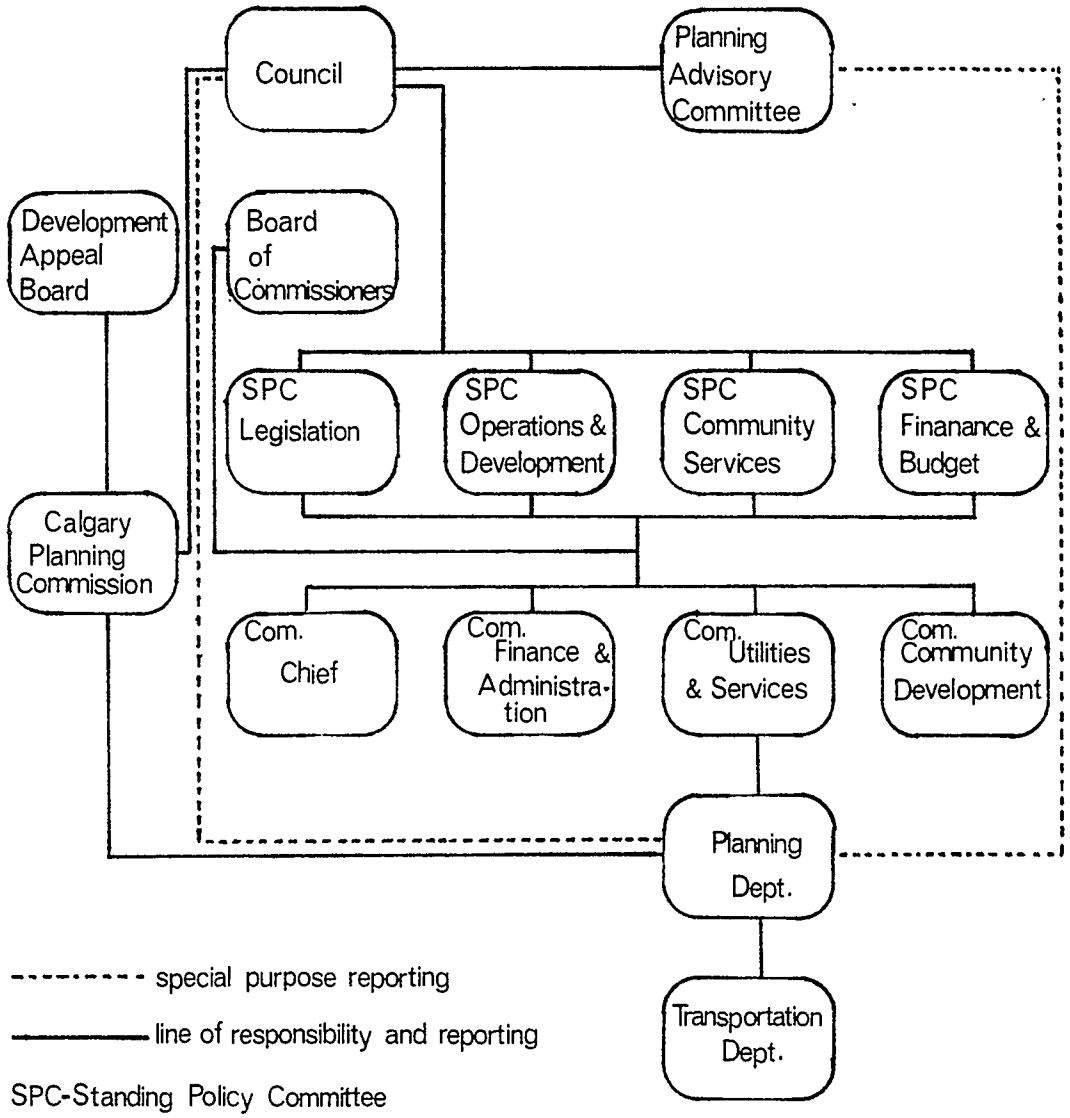
which allow municipalities to regulate energy consumption. Also, political demand and support for this policy reflect societal values. There are also conflicts between the nature of an energy-sensitive urban land policy and other individual and societal goals including those of segregated land uses, low-density residential development, large lots and single-family detached houses. Underlying these individual and societal goals are the concepts of private land ownership and freedom of choice.

The organizational constraints which Detomasi outlines refer to the techniques for administering municipal affairs in terms both of relevant organizations and the arrangements among these including defined roles and aspects of their internal operations. A large number of the policy studies listed in Table 3-1 fall into this category. These include: Clarke; Costello; Kochler; Kao; Mushkin; Overby; Reynolds; Schaller and Schnore. The focus of these studies varies from the analysis of urban government structures to analysis of the roles of administrators, mayors and citizen-advisory committees in urban policy-making.

As an example of the complexity of the organizational structure of the municipal civic bodies involved in urban land policy formulation and implementation, Figure 3-2 presents the formal structure which exists in Calgary. Fifteen civic bodies are represented in this diagram. Formal lines of reporting are delineated. Informal lines of communication between these fifteen bodies are not indicated in the diagram; however, they exist and are highly relevant in the decision-making process.

FIGURE 3-2

CIVIC BODIES INVOLVED IN URBAN LAND POLICY FORMULATION AND IMPLEMENTATION FOR CALGARY, ALBERTA



Source: Adapted from Andre Bernard, *Profile: Calgary*, (Ottawa: Ministry of State for Urban Affairs, 1975).

Desfor and Miloff have presented a number of organizational constraints in their study of urban form and energy. Specifically, these constraints to the development and implementation of a desirable urban land policy include: the lack of manpower in local government administrations to develop and enforce an appropriate policy; the inability of municipalities to develop programmes to accomodate policies; and the complex hierachy of regional and local levels of government which complicates jurisdictional responsibilities and adds to the difficulty in arriving at agreement on courses of action.

The last level of constraints that the Detomasi model describes is the individual filter. The universe of human endeavors, societies and organizations is a sum of its constituent parts--the individuals. In policy-making, the individual actors in the process carry within themselves personal values, beliefs, attitudes, abilities, talents and skills. These are often quite different and distinct from person to person. A good example of how this constraint acts in policy-formulation is seen in the role that subjective judgement or attitude toward risk plays in decision-making. The policy studies listed in Table 3-I which focus on individual constraints include those by Bernstein; Kuo; Reynolds; and Sigil and Fruseina.

Individual constraints impacting on the formulation and implementation of an energy-sensitive urban land policy overlap with some of those listed under societal and organizational constraints. Individual values and attitudes towards a desirable policy are reflected in the support of or demand for the policy within the political system. Individuals must consider the personal tradeoff between policy com-

ponents of higher density and attached housing and mixed land use with their preferences towards low residential densities, single-family detached housing and segregated land uses. Individuals in positions of power or of influence in the policy process are similarly swayed by personal biases which may or may not be congruous with the larger public interest.

3.7 Conclusion

This chapter has presented a discussion of the formulation and implementation of an energy-sensitive urban land policy. As a response to one of a variety of research needs, this chapter focussed on assessing the feasibility of formulating and implementing desired courses of action.

This assessment of feasibility has been accomplished through a review of models of policy-making: the rational, the incremental and the mixed-scanning. This review has provided a view of a realistic policy-making approach in which a suitable urban land policy has the most likelihood of being formulated and implemented; that of mixed-scanning.

The shift towards a more compact, higher density, mixed land-use urban form resulting from a suitable urban land policy will be gradual if it happens at all. The mixed-scanning approach recognizes the goal of energy-conserving urban form to be in competition with other urban goals which also demand the attention and resources of municipal governments.

A descriptive model of the urban political system reveals that the formulation of a desirable urban land policy is subject to the

political forces of the urban environment. Constituent support and demand are required for positive steps towards energy-sensitive urban land policies.

Finally, a descriptive model summarizes the role of universal, societal, organizational and individual constraints impacting on policy alternatives. The example of an energy-sensitive urban land policy has been examined while passing through the constraints outlined in this model.

FOOTNOTES

[1]The reader is referred to:

J. H. Chibuk, *Urban Form and Energy: A Selected Review*, (MSUA, July, 1977), unpublished; Dirk Rygole, *Energy and Urban Form The Need for Energy Conscious Urban Planning*, (The Johns Hopkins University: Center for Metropolitan Planning and Research, 1978); Corbin C. Harwood, *Using Land to Save Energy* (Cambridge: Ballinger, 1977); Peter Boothroyd, *Future Urban Form and Energy Efficiency*, paper prepared for the Environment Conservation Authority and the Conference on the Urban Environment, (October, 1976); Edmonton Regional Planning Commission, *Conserving our Resources*, Paper No. 5, Edmonton Region Growth Studies, (July, 1976).

[2]J. H. Chibuk, *Urban Form and Energy: A Selected Review*, (MSUA, July, 1977), unpublished.

[3]These are elaborated on in Gene Desfor and Michael Miloff, *Urban Form and Energy Consumption*, (Toronto, Middleton Associates, March, 1979), Executive Summary and pp. 85-91.

[4]Gene Desfor and Michael Miloff, *Urban Form and Energy Consumption*, (Toronto: Middleton Associates, March, 1979), pp. 11-12.

[5]J. H. Chibuk, *Urban Form and Energy: A Selected Review*, (MSUA, July, 1977), unpublished, p. 84. Also the Desfor and Miloff study documents jurisdictional, administrative, resource and motivational constraints impeding energy conscious land use planning in Toronto. See Desfor and Miloff, *Urban Form and Energy Consumption*, (Toronto: Middleton Associates, March, 1979), pp. 12-13.

[6]Andreas Faludi, *A Reader in Planning Theory*, Urban and Regional Planning Series Volume 5, (Oxford: Permagon Press, 1973), pp. 12-13.

[7]For a discussion on rational decision making see:

Amitai Etzioni, *The Active Society: A Theory of Societal and Political Processes*, (New York: The Free Press, 1978), pp. 254-268; Harold Lasswell and Daniel Lerner, *The Policy Science: Recent Developments in Scope and Method*, (Stanford: Stanford University Press, 1951); Harold Lasswell, "The Emerging Conception of the Policy Sciences," *Policy Sciences*, Vol. 1, No. 1, (Spring, 1970); G.B. Doern and P. Aucoin, *The Structures of Policy-Making in Canada*, (Toronto: Macmillan, 1971), pp. 14-15; Martin Meyerson, "Building the Middle-Range Bridge for Comprehensive Planning,"; Edward C. Banfield, "Ends and Means in Planning"; and Charles E. Lindblom, "The Science of Muddling Through" in : Andreas Faludi, *A Reader in Planning Theory*,

Urban and Regional Planning Series Volume 5, (Oxford: Permagon Press, 1973); Jan Tinbergen, *Economic Policy, Principles and Design*, (Amsterdam, North Holland, 1956), p. 11 f.f.; Marshall Dimcock, *A Philosophy of Administration*, (New York: Harper and Row, 1958), p. 140 f.f.; Arthur Smithies, *The Budgetary Process in the U.S.*, (New York: McGraw-Hill, 1955), p. 192 f.f.; from Amitai Etzioni, *The Active Society: A Theory of Societal and Political Processes*, (New York: The Free Press, 1978), p. 278.

[8]G. B. Doern and P. Aucoin, *The Structure of Policy-Making in Canada*, (Toronto: Macmillan, 1971), p. 14.

[9]Amitai Etzioni, *The Active Society: A Theory of Societal and Political Processes*, (New York: The Free Press, 1978), p. 261.

[10]Amitai Etzioni, *The Active Society: A Theory of Societal and Political Processes*, (New York: The Free Press, 1978) references: Jan Tinbergen, *Economic Policy, Principles and Design*, (Amsterdam, North Holland, 1956), p. 11 f.f.; Marshall Dimcock, *A Philosophy of Administration*, (New York: Harper and Row, 1958), p. 140 f.f.; Arthur Smithies, *The Budgetary Process in the U.S.*, (New York: McGraw-Hill, 1955), p. 192 f.f.

[11]Amitai Etzioni, *The Active Society: A Theory of Societal and Political Processes*, (New York: The Free Press, 1978), p. 264.

[12]*Ibid.*, p. 279.

[13]As footnoted in A. Etzioni, *The Active Society*, see Jerome S. Bruner, Jacqueline J. Goodnow, and George A. Auston, *A Study of Thinking*, (New York: Wiley, 1956), Chapters 4 and 5; David Bragbrooke and C. Lindblom, *The Intelligence of Democracy*, (New York: Free Press, 1965), pp. 137-139; R.A. Dahl, *A Preface To Democratic Theory*, (Chicago: University of Chicago Press, 1956), pp. 145-156.

[14]*Ibid.*, p. 278 with further reference to Kenneth J. Arrow, review of *Strategy of Decision*, (Braybrooke and Lindblom) in *Political Science Quarterly*, Vol. 79 (1974), p. 585. Other references in this area are: Herbert A. Simon, *Models of Man*, (New York: Wiley, 1957), p. 198; and Aaron Wildavsky, *Politics of the Budgetary Process*, (Boston Little, Brown, 1964), pp. 147-152.

[15]Amitai Etzioni lists Gunnar Myrdal, John Dewey and David Hume among this list. See *Ibid.*, p. 268.

[16]*Ibid.*

[17]G. Bruce Doern and Peter Aucoin, *The Structures of Policy-Making In Canada*, (Toronto: Macmillan, 1971), pp. 13-14.

[18]Amitai Etzioni, *The Active Society: A Theory of Societal and Political Processes*, (New York: The Free Press, 1978), p. 270.

[19]The reader is referred to: G. Chadwick, *A System View of Planning*, (Oxford: Permagon Press, 1971); A. Faludi, "Towards a Three-Dimensional Model of Planning Behaviour," *Environment and Planning*, Vol. 3, (1971); "Teaching the Planning Process," *Journal of the Royal Town Planning Institute*, Vol. 58, (1972); *A Reader in Planning Theory*, (Oxford: Permagon Press, 1973), p. 125.

[20]Amitai Etzioni, *The Active Society: A Theory of Societal and Political Processes*, (New York: The Free Press, 1978), p. 283.

[21]Brett W. Hawkins, *Politics and Urban Policies*, (New York: Bobbs-Merrill,1971), p. 13.

[22]Gene Desfor and Michael Miloff, *Urban Form and Energy Consumption*, (Toronto: Middleton Associates, March, 1979), p. 12.

[23]*Ibid.*, p. 13. Desfor and Miloff summarize seven major obstacles in their study. They are reproduced here for the reader's benefit:

1) A major perceived constraint is the current lack of legislative power through which municipalities can regulate the energy consuming aspects of buildings.

2) The majority of municipalities have very small planning staffs (often 2-3 people) and are not equipped to either develop energy-sensitive plans or to enforce them.

3) There is not a regular and consistent demand from their constituency for energy-sensitive planning.

4) With the exception of a few municipalities, local governments appear to be slow to translate the general resolution to conserve energy (often officially passed by council) into specific programmes and research activities.

5) The particular circumstances of some municipalities mitigate against their desire and capacity to implement energy-sensitive land use planning. For instance, small slow-growing rural-oriented municipalities have fewer opportunities to conserve energy than large, rapid-growing ones. Regional municipalities, which tend to be more interested than local ones in the broader issues of energy conservation have, however, less direct powers to implement such measures.

6) The goals of energy-sensitive planning may conflict with such traditional municipal objectives as low density, detached homes, large lots and the segregation of land uses.

7) Municipalities see a lack of clear research and knowledge which they can apply to their current situation.

[24]Gene Desfor and Michael Miloff, *Urban Form and Energy Consumption*, (Toronto: Middleton Associates, March, 1979), p. 13.

[25]D.D. Detomasi outlines and elaborates on this model in a discussion paper (no title, no date). The model is discussed in lectures and seminars as a part of the curriculum in the Faculty of Environmental Design: Introduction to Policy Analysis course, the University of Calgary, Calgary, Alberta.

In his discussion and elaboration, Dr. Detomasi presents universal, societal, organizational and individual constraints as analagous to "filters." He represents them with "funnel" symbols. All possible policy alternatives are poured into the initial funnel, are filtered, and drip through the successive filters until the final policy decision is represented by a single drop. As a complementary graphic image I perceive the same filtering process analagous to a photographic system. A stack of four filters simultaneously restrict the "stream-of-light" policy alternatives. The result of the combination of filters is a specific policy "snap-shot."

[26]Lynn White, Jr. *Dynamo and Virgin Reconsidered*, (Cambridge: MIT Press, 1968). See Chapters 1 to 5 inclusive, pp. 1-94.

Chapter IV

URBAN LAND POLICY ANALYSIS: GROWTH STRATEGY OPTIONS AND ENERGY CONSUMPTION

4.1 Introduction

This chapter presents a discursive analysis of the formulation and evaluation of urban land policy. Urban land policy is represented in this chapter by growth strategy alternatives for the City of Calgary. The Planning Department of the City of Calgary has documented several technical, quantitative and qualitative evaluations and analyses of alternative growth strategies in a policy discussion paper.[1] This writer finds the analyses of the growth strategy options prepared by the Planning Department deficient in the evaluation of respective energy consumption implications for Calgary.

The first section of this chapter summarizes the methods of generating the alternative growth strategies. Processes of issue-raising and problem-raising are described and the issue of energy consumption as an urban problem which the strategies would have to address is discussed.

The following sections of this chapter describe the evaluations of the strategies and the selection of a particular strategy for Calgary. An evaluation of the impact on energy consumption of two growth stategy options is undertaken as a means of demonstrating the potential for managing urban energy consumption through urban land policies.

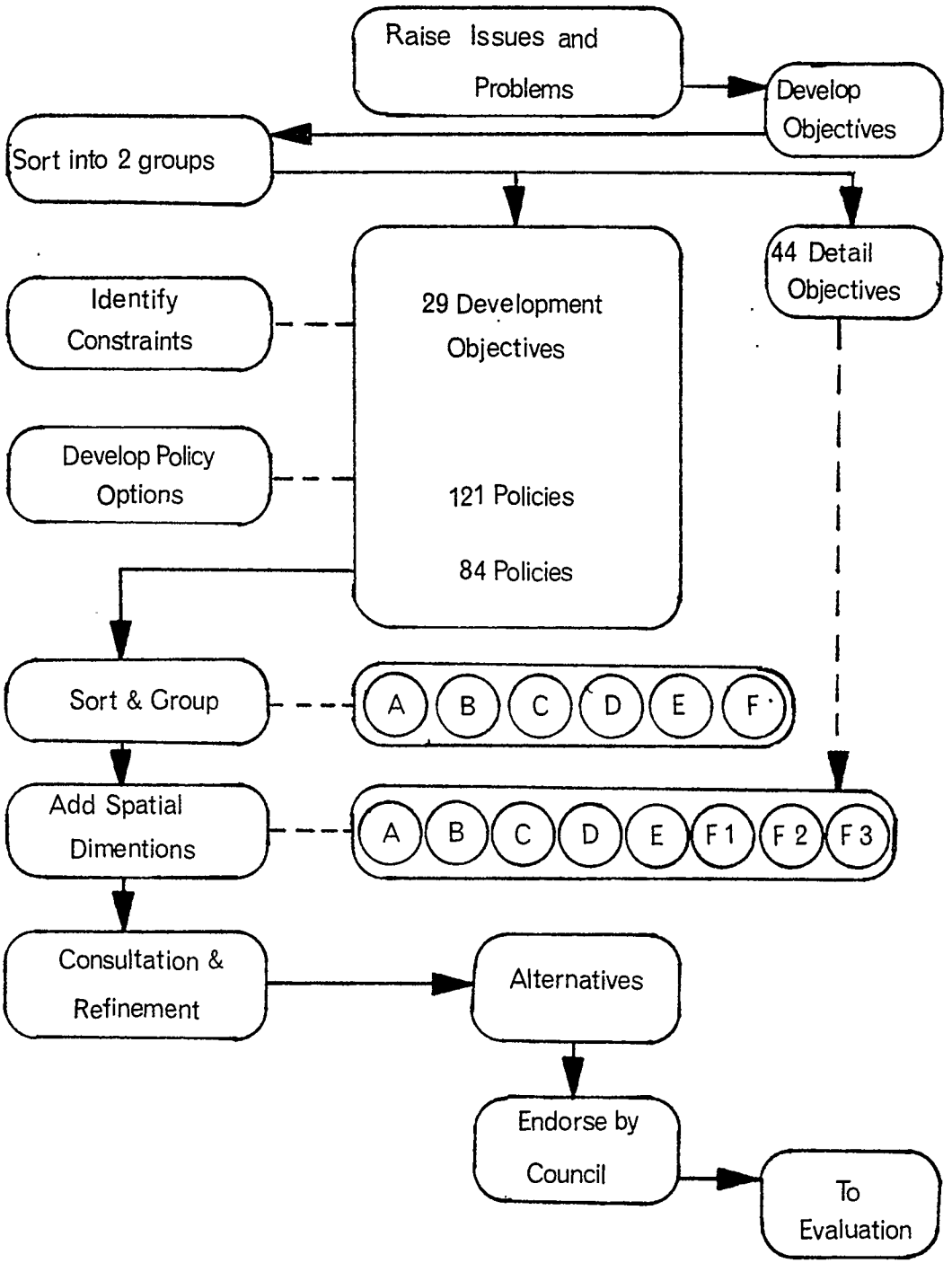
Chapter III has presented models of policy-making useful in assessing the feasibility of implementing energy-sensitive urban land policy. This chapter provides a case study of policy-making. Section 4.6 reviews some aspects of the growth strategy generation, evaluation and selection processes in terms of the analytical frameworks which the models provide.

4.2 Method of Generating Alternative Growth Strategy Options in Calgary

The development of a growth strategy for Calgary was viewed by the City Council and the Administration as the foundation upon which a general plan for the city could be revised. An outline of the review process used to generate growth strategies has been summarized in *The Calgary Plan* 1977 (proposed, I.3.9 to I.3.25). The method included: (i) developing a consensus on problems and issues facing Calgary; (ii) matching the problems with objectives; (iii) sorting the lists of problems and objectives into 2 groups: (A) one that had a bearing on the development of a growth strategy; and, (B) those relevant to detailing the strategy at a later point in time; (iv) identifying major constraints the alternative strategies would need to recognize; (v) developing policy options to meet the objectives; (vi) sorting and grouping the policies into internally coherent packages of mutually compatible policies; (vii) identifying and naming six themes of policy packages as strategy options; (viii) adding spatial dimensions to the policy packages; (ix) refining the options through a public participation process; (x) and endorsing the alternatives in council. This method of generating the alternatives is illustrated in Figure 4-1.

FIGURE 4-1

THE PROCESS OF GENERATING ALTERNATIVE GROWTH STRATEGIES FOR CALGARY, ALBERTA



To raise public debate on issues and problems which the growth strategy would have to address, a set of background papers on planning topics was published. This set of papers included: *The Changing Population of Calgary; Transportation in Calgary; Housing in Calgary; The Role of the Downtown; Leisure Time Activities in Calgary; Growth in Calgary; The Role of the General Plan.* To increase public awareness and involvement in the review process, a condensed version of these background papers was distributed by a local newspaper.

As a means of investigating the extent to which energy consumption and urban form were presented as an issue, this writer has reviewed the set of background papers. From this review it has been found that the only reference to energy issues documented was in *Transportation in Calgary*, Background Paper No. 3. Under a section entitled "Environmental Issues", the energy consumption for transportation was discussed with reference to fuel shortages and increasing prices. It was stated that:

> ...disproportionate increases (in fuel prices) will reflect in greater demand for public transportation, or higher car occupancies. It is apparent that the use of private vehicles with low occupancies must be discouraged. Financial policies may be implemented to strike the correct balance between transportation systems.[2]

The authors of the transportation background paper assume that the demand for transportation energy is elastic and that pricing mechanisms can be used to manage transportation mode preferences. This background paper is successful in raising the issue of enhancing the use of public transit, but it does not go so far as to raise the issue of managing urban transportation energy consumption by manipulating urban form factors.

Also, the transportation background paper has recognized the relationship between transportation techniques and urban form which this paper has outlined in Chapter I. The background paper has raised the issues of urban form being influenced by, and influencing transportation systems:

> The nature, size, direction and density of urban land use has a significant effect on the level of service on a transportation system and the choice of the most effective service mode. Conversely, it has been shown that the nature of a transportation system and the accessibility it provides exerts pressures on the direction and nature of growth. ...[3]

It is this writer's assessment that the background papers' treatment of energy and urban form issues, as independent issues and as a related issue, is too restrictive. They do not clearly recognize urban form and energy consumption as an issue to be addressed by a growth strategy or by the general plan. Therefore, it is my conclusion that this process has shortcomings in terms of generating issues for public debate. Furthermore, additional evidence of this failure has been gleaned from this writer's review of supplementary working papers dealing with research on specific topics.[4]

The working paper entitled *Development and Policy Constraints* presents a study of political, financial and physical constraints which the planning department has identified as directly impinging on the range and characteristics of policies put forward in the Calgary Plan as means of direction.[5] Under Section 4, Sub-Section 4.1, "Inventory of Physical Constraints" a list of environmental and infrastructural constraints to the development of land within a five mile radius of Calgary have been documented and illustrated in graphic form. This

list does not include energy supply or cost as a constraint to future development. In fact, a discussion of electricity supply addresses the issue of the administrative ability of Calgary Power to expand its power grid in order to service the development of peripheral growth.

A total of 73 objectives were developed.[6] They were presented to City Council to get the assistance of its members in sorting the problems and objectives into two groups: one for developing a strategy; and one for detailing the strategy at a later time. Of this large group of objectives and problems, 29 were identified as important in shaping the growth strategy. These are listed in Appendix A for the benefit of the reader. The other 44 were laid aside for the time being. The 29 important objectives, identified and documented in *The Calgary Plan* (proposed June, 1977), were used to generate the alternative strategies. The strategies in turn identified various feasible ways of achieving the 29 objectives.

Once identified as the major objectives, these 29 objectives were also submitted to the council members for the purpose of establishing weighted preference. Establishing an hierarchy of the objectives was an important aspect of the Goals Achievement Matrix method of evaluation (described in Section 4.3). Not all the councillors participated in this exercise; notably missing was the participation of the Mayor. This writer has not been able to account for these absences of the Mayor and some council members.

Identification of constraints that any strategy would have to recognize was accepted as a precondition under which the review process was to operate. These constraints were elaborated in two working

papers: *Development and Policy Constraints;* and, *Generation of Alternative Growth Strategies.* The major constraint[7] as identified in *The Calgary Plan* (proposed June, 1977) included the restriction that the City Council and the Administration were committed to a "uni-city" concept, which precluded strategies involving satellite cities as means of accommodating future growth. It was believed that urban fragmentation of this sort would be very disadvantageous and there was no interest from the council or the administration in decentralizing urban growth. Another major constraint was that the council was interested only in a strategy that would accommodate growth, not one which would influence its own rate, either positively or negatively.

A third major constraint was based on the population projections for Calgary to the year 1996. Developed from the extrapolation of past trends it was suggested that Calgary's population will increase from 470,000 in 1976 to 617,900 in 1986 and to 778,000 by 1996.

A fourth major constraint concerned the amount of additional land that would be required to accommodate the population growth to 1996. It was found that 4520 hectares of land had been approved for development. This land was assumed to house 242,000 people if developed at densities agreed upon for design purposes. From an assessment of actual densities in the past, the potential population for the approved areas was lowered by a factor of 25 percent to 181,000 people. It was concluded that of the 308,000 population growth expected by 1996, 127,000 would have to be accommodated in new areas.

A fifth major constraint was dependent on the above constraint of areas committed for new development. Commitments to transportation improvements which would serve the areas of new development were also

accepted as constraints.

Following the sorting out of problems and objectives, and the identification of constraints, policy options were generated as a beginning to the development of growth strategies. For each of the 29 objectives (documented in Appendix A) one or more policy options were stated as means of meeting the objective. This process generated 121 policy statements. By grouping similar policies the list was reduced to 84.[8] A process of grouping these 84 policies resulted in the identification of eight policy areas: efficiency of land use and facilities; housing supply and cost; decentralization of employment; transportation; environment, concerning natural areas, open space, agricultural land and pollution; conservation and rehabilitation of buildings and areas; the city's economy; and other policies, dealing with senior levels of government, public participation and community facilities.[9] From a review of public and political responses to the objectives, eight discernable themes emerged:

1) higher densities of residential development,
2) public transit emphasis,
3) greater emphasis on the role of Downtown,
4) growth based on trend patterns with slight modifications,
5) decentralization of employment,
6) greater efficiency of investment and resources,
7) emphasis on conservation and rehabilitation,
8) emphasis on reducing the rate of increase of house prices.[10]

Themes 1, 2 and 3 above were amalgamated to form one theme and the policies were grouped into "...internally coherent packages of mutually compatible policies..."[11] Finally, six themes crystallized as the alternative strategies to which another theme, spatial requirements, based on where population and employment were to be located, was added. These alternatives have been described in *Generation of Alternative*

Growth Strategies, but are briefly summarized in Table 4-1 for the benefit of the reader.

The spatial requirements for the strategies assessed land requirements for utility and transportation and indicated the distribution of residential and employment populations. For Strategy F, three alternative spatial possibilities were developed, creating a total of eight growth strategy alternatives. These alternatives were circulated to the Administration, the public and City Council. Subject to minor refinements resulting from the consultation process, they were then endorsed by the City Council and passed on for evaluation and selection of the best strategy.

This section has provided a summary of the process used to generate the growth strategy options which the City of Calgary was intending to use for revising the *Calgary Plan*. Once generated, they were to be subjected to a series of evaluations in order to select the best alternative. Section 4.3 will present an overview and discussion of the evaluation of the alternative strategies.

4.3 Evaluations of Alternative Growth Strategies For Calgary

The method for evaluating the growth strategy options was first outlined in working paper No. 6, *Techniques to be Used in the Generation and Evaluation of Alternative Strategies* (September, 1976). The evaluations were documented in policy discussion paper No. 3, *The Evaluation of Alternative Growth Strategies for Calgary* (January, 1977). They were summarized in the *Calgary Plan* (proposed June, 1977).

This section will review these evaluation techniques. The intent

TABLE 4-I

DESCRIPTION OF ALTERNATIVE GROWTH STRATEGIES

A. COMPACT CITY: This strategy emphasizes a compact form for the city with higher densities within the existing built-up area and limited outward expansion. Public transit is favoured over the car with an emphasis on light rail transit where it is viable, improved transportation to the Downtown, and a more limited role for the car in the inner city. (See Appendix B).

B. MODIFIED TREND: This strategy continues the existing trend of outward development in many different directions by making more land available for residential development on the periphery of the city and by maintaining a strong downtown. Concurrently, the strategy would maintain existing residential densities and the present proportion of car and transit travel. By the same token, the strategy would allow some decentralization of employment and activities with an emphasis on transit corridors.

C. DECENTRALIZATION OF EMPLOYMENT: This strategy diffuses the role of the Downtown as a major employment centre and allocates new employment to suburban centres, focussing on transportation corridors. ...new industrial employment would be located in all sectors of the city in order to balance the distribution of work trips away from the Downtown and the south-east sector. This strategy would tend to facilitate the use of cars throughout the city and reduce the effectiveness of transit in some areas. ...this alternative would encourage more multi-purpose developments and stress a stronger role for suburban shopping centres. The strategy assumes that relatively low residential densities would continue in the future.

D. MAXIMUM EFFICIENCY OF INVESTMENT AND RESOURCES: ...this strategy focusses on the use of land and infrastructure in a more efficient manner principally by increasing densities along transit routes and making better use of vacant and under-used land by increasing infill and redevelopment. The alternative stresses an increase in the proportion of people using transit, especially for work trips, by making better use of the existing transportation system. More specifically, the strategy would encourage selective decentralization along transit routes, car pooling, flexible working hours, and a preference given to transit vehicles, by such means as bus lanes, priority signals for buses, and...land banking...is advocated.

TABLE 4-1 (Cont'd.)

E. CONSERVATION AND REHABILITATION: This strategy places a greater emphasis on the conservation and rehabilitation of buildings and environmental areas within the city. The strategy includes policies which suggest that the municipality and senior governments should increase funding for conservation and rehabilitation as well as encouraging the involvement of the private sector.

F. LOWER HOUSE PRICES: This strategy focusses on the cost of housing and attempts to minimize the rate of increase. Emphasis is placed on increasing residential densities in new development areas in order to reduce wastages of land. Concurrently, the strategy would increase the proportion of dwelling types in all parts of the city. In general, this strategy would increase the supply of residential land and encourage more competition in land development by private and public enterprise.

Source: The City of Calgary Planning Department, *Generation of Alternative Growth Strategies* (Working Paper No. 7, December, 1976), pp. 24-41.

of this section is to discuss the method of selecting the "best" strategy for Calgary resulting from several evaluation techniques. The evaluation techniques include: a Goals Achievement Matrix; a method of frequency ranking of objectives; scenario descriptions which indicated the degree of change in areas of the city; an inventory of physical infrastructure requirements; financial implications; a review by civic departments; and an assessment of "flexibility."

Originally, a Goals Achievement Matrix (GAM) was the method chosen for evaluating the alternatives.[12] An overview of this technique, providing a discussion of its origin, cost benefit analysis, the nature of the technique, the procedures required in using it, and its advantages and disadvantages has been documented in *Working Paper No. 6*. Essentially the GAM is:

> ...a means of determining how well different strategies are likely to contribute to the attainment of a given set of objectives ...(which) have flowed from a list of problems which was widely canvassed. ...
>
> ...to do this, it is necessary to begin by examining the probable impact of each strategy on each objective ...the sums of these separate impacts provide indicators of the effectiveness of the different strategies in total.[13]

The GAM is intended to quantify the relationship between objectives and strategies by assigning weights in order to rank the importance of objectives (refer to Section 4.2). This feature supports the assumption that the different objectives are favoured according to varying subjective value judgements and other characteristics of decision-makers. By a procedure of ranking the eight strategies in relation to the 29 objectives and multiplying the rank by a weighted value of the corresponding objective, a sum is generated for each strategy. The method

for determining the weights which members of Calgary's City Council attached to the various objectives is documented in Appendix III of *Policy Discussion Paper No. 3.* The results of the GAM technique, applied to the evaluation of the growth strategies, are:[14]

STRATEGY A:	Compact City	580.1 Points
STRATEGY D:	Maximum Efficiency of Use of Investment and Resources	570.3 Points
STRATEGY E:	Conservation and Rehabilitation	512.5 Points
STRATEGY C_1:	The Decentralization of Employment	482.1 Points
STRATEGY F_2:	The Price of Housing	480.5 Points
STRATEGY F_3:	The Price of Housing	448.9 Points
STRATEGY F_1:	The Price of Housing	448.3 Points
STRATEGY B:	The Modified Trend	304.8 Points

The GAM method thus finds Strategy A, Compact City (See Table 4-1), the best in terms of achieving the 29 objectives, and Strategy B, Modified Trend, as the worst. Strategy A is calculated to be 10 points better than D according to the weighting by decision-makers. I interpret this to mean Strategy A accomplishes the objectives better than any other strategy.

A second method of evaluating the strategies using data from the GAM was used. This method recorded the frequency of rank of each objective for each strategy in order to indicate how many times each objective ranked first, second, third and so on. Each time an objective ranked first in a strategy, the strategy was awarded 8 points, second 7 points, and so on until eighth 1 point. Summing the scores for each strategy resulted in the following:[15]

STRATEGY D:	Maximum Efficiency of Investment and Resources	166 Points
STRATEGY A:	Compact City	164 Points
STRATEGY F_2:	The Price of Housing	148 Points
STRATEGY E:	Conservation and Rehabilitation	143 Points
STRATEGY C:	The Decentralization of Employment	143 Points
STRATEGY F_3:	The Price of Housing	138 Points
STRATEGY F_1:	The Price of Housing	135 Points
STRATEGY B:	The Modified Trend	89 Points

Strategy D, in this method, is the top choice, edging out Strategy A by 2 points. This writer must argue, however, that this method of evaluating the alternatives is highly arbitrary because it is not supported by a sound theoretical basis.

This technique of scoring according to frequency of the rank of objectives conflicts with the merits of the GAM. The GAM is a more meaningful method because it assigns weights to various objectives in order to determine the greater importance of one objective over another. The frequency-of-rank procedure described above treats all objectives as equal and cancels out the merits of weighted objectives. With this method of simple ranking it is theoretically possible for a strategy which accomplishes a large number of unimportant objectives to appear as a better choice than a strategy which accomplishes a smaller number of more important objectives.

For example, consider two hypothetical strategies with objectives for the inner city areas. One strategy is successful in ensuring that: (1) bus service is fairly regular and distances to bus stops are

reasonable, (2) fire hydrants are painted earth brown colours, and (3) fence posts are regulated for height and width. It is only partially successful in reaching an objective of (4) enforcing redevelopment design guidelines. The second strategy is successful only in (1) implementing a traffic management programme to restrict through traffic in established communities, but is partially successful in its objective of (2) getting assistance for conservation and rehabilitation projects, and is totally unsuccessful in the objective of (3) downzoning an area of older but non-resident owned housing.

In the above example, the objectives of the first strategy are of minor importance. In the second strategy all of the objectives are important. The technique used to evaluate the alternatives by choosing strategies with more successes is absurd if it concludes that the first strategy is better than the second!

A third way of evaluating the alternative strategies was to compare them on the basis of scenario descriptions. The scenarios were intended to present descriptions of Calgary's future according to each strategy. The scenarios took into account constraints to development as described in Section 4.2 and they discussed in general terms the questions of where people would live; where they would work; how people would travel; and how the city would change. These scenarios were documented in Policy Discussion Paper No. 3, *The Evaluation of Alternative Strategies for Calgary* in Section 8, "Scenarios of the Alternative Strategies." The scenarios were very sketchily described and detailed information about the alternative forms of the city was absent.

There was no reference to the effect on energy consumption in Calgary of the different strategies in the scenario exercise. The evaluation did result in a summary of the effects of the strategies in the different areas of the city. This has been reproduced in Table 4-2.

The scores in Table 4-2 indicate that Strategy A, Compact City, foresees a great deal of change in the downtown, in inner city areas and in the northwest, the south and the southwest areas of Calgary. These impacts result from the location of most of the population growth in the present built up area, increasing the residential densities. The downtown is envisaged to become a more important employment centre as well as a residential and commercial area. The northwest area is expected to have increased residential development along mass transportation routes.

The method of evaluating the alternative strategies with scenarios was not intended as a means of selecting one strategy over another. It was intended to outline how the growth policies achieved the theme of each strategy. The Compact City, the best alternative based on the GAM, was to generate the greatest changes in the built-up areas of Calgary.

A review of different physical infrastructural requirements for each strategy discussed transportation improvements, water facilities, sewer facilities, public buildings, and capital and operating costs for the eight strategies.[16] This review indicated that the Decentralization of Employment (C) and Maximum Efficiency (D) strategies required the least infrastructural improvements, while the Conservation

TABLE 4-2

DEGREE OF CHANGE EXPECTED IN SECTORS OF THE CITY IN RELATION TO EACH STRATEGY

SECTORS OF THE CITY	STRATEGIES							
	A	B	C	D	E	F_1	F_2	F_3
Downtown	3	2	0	3	2	2	1	1
Inner City North	3	1	0	3	2	1	1	0
Inner City South	3	1	0	3	1	1	0	1
Northwest	3	2	0	0	3	1	3	0
North	0	2	3	1	3	2	3	0
Northeast	0	0	1	0	1	1	1	1
Southeast	0	3	3	0	0	3	0	3
South	2	2	1	1	0	0	0	2
Southwest	2	2	0	2	0	0	0	0
West	0	0	0	0	2	0	0	0

NOTE: Scores indicate the expected degree of change in each sector of the city (3 greatest - 0 least).

Source: The City of Calgary Planning Department, *The Evaluation of Alternative Strategies for Calgary*, (Policy Discussion Paper No. 3), (January, 1977), p. 73.

and Rehabilitation Strategy (E) required the most.[17] The Compact City (A) and Maximum Efficiency (D) strategies required major infrastructural investments in public transit but required less sewer and water infrastructure "...because a large percentage of the population will be utilizing existing infrastructure in the built up area."[18] The Compact City and Maximum Efficiency strategies were also assessed as requiring fewer new public buildings and smaller capital expenditures.[19]

It was assumed that the detailing of infrastructural requirements would occur in a later exercise conducted with only "the preferred" strategy. It was argued that identifying the requirements in broad terms would provide a basis for choosing between strategies. This evaluation seemed to suggest that the Compact City (A) and Maximum Efficiency (D) strategies were better choices than other strategies in terms of sewer, water and public building infrastructural requirements, but that the Decentralization of Employment (C) and Maximum Efficiency (D) strategies were better choices in terms of transportation infracstructural requirements.

An evaluation of the financial implications of the strategies was also cursory and undetailed.[20] Estimates of capital and financial resources available to Calgary had been published earlier;[21] this financial evaluation assessed the strategies in broad terms of relative cost differentials. The authors of the financial evaluation argued that all the strategies represented realistic alternatives from a financial point of view but that:

> ...those strategies that incur disproportionately high capital and current threshold costs, (thus leaving proportionately less that could be devoted to other community

> facilities and activities), are relatively worse from a financial standpoint.[22]

Following the discussion on differential impacts of transportation costs, it was tentatively concluded that the Decentralized Employment (C) strategy was the least expensive. Maximum Efficiency (D) ranked fourth, Compact City (A) was more expensive, and Conservation and Rehabilitation (E) was the most expensive. The evaluation also concluded that since "... density has a major impact on capital and operating costs, with greater economies coming about with higher densities, ..."[23] the Compact City and Maximum Efficiency strategies were favoured.

A review of the strategies by 12 civic departments, as well as the Calgary Board of Education and the Separate School Board, was undertaken to obtain opinions about how well the alternative strategies would satisfy the following objective: "To encourage development that will lead to the more efficient utilization of public and private investments in all parts of the City."[24]

This author has been able to discern neither the purpose nor the rationale behind this method of analysis, although the question of which strategy is likely to be more efficient is an interesting one. Why the formal survey of impressions and opinions on this question was limited to the "public" sector is also an interesting question in view of the fact that the objective deals with both public and private sector issues. Was this survey intended to result in documenting "the preference" of the civic bodies and school boards?

The results of the survey are summarized in Table 4-3 which gives the departmental ranking of the strategies.[25] It is clear from this

TABLE 4-3

RESPONSES OF CIVIC DEPARTMENTS AND SCHOOL BOARDS ON SURVEY OF THE EFFICIENCY OF THE STRATEGIES

DEPARTMENT	STRATEGY RANKING							
	A	B	C	D	E	F_1	F_2	F_3
Electric System	3	2			1			
Engineering	+1	4	5	+2	3	6		7
Fire				1				
Industrial Development	+2	+1	4	3	5	6		
Land	4	3	2	5	7		6	1
Library Board	+2	-5=	-5=	+1	3	4		
Police	3=	1=	1=	3=	5	6		
Public School Board	+1	5=	4	+2	3	5=		
Separate School Board	+1	-7	-6	+2	3	4	5	
Social Services	+2	3	4	+1	5	6		
Transportation	2=		1	2=				

1 = Most Desirable 7 = Least Desirable
\+ Much more desirable than the rest.
\- Much less desirable than the rest.

The Assessment, Board of Health and Parks & Recreation Departments responded but were unable, for various reasons, to provide ranking of the strategies.

Source: The City of Calgary Planning Department, *The Evaluation of Alternative Strategies for Calgary*, (Policy Discussion Paper No. 3, January, 1977), p. 99.

table that the Compact City (A) and Maximum Efficiency (D) strategies are those preferred by the school boards and the majority of civic departments.

A final method of evaluating the alternatives was based on an analysis of their "flexibility." Flexibility was defined in terms of "intrinsic flexibility": "...the capacity of a plan to cope with unexpected events," and "robustness": "...the ability of a plan to survive ... changes ...(in) social values and goals."[26] Flexibility analysis took the form of identifying thresholds that would be met by the alternative strategies since:

> ...the crossing of a threshold is not only expensive (as more infrastructure requirements are needed); it also results in a commitment to develop in a particular direction or form, and thereby entails the foregoing of other options. In short, it leads to more rigidity and less flexibility. It necessarily follows, therefore, that those strategies that would require the crossing of fewer thresholds, and those that would defer the crossing of thresholds the longest are the more flexible.[27]

An assessment of the flexibility of alternative strategies was based on the financial evaluation of the transportation requirements. The rationale for this approach was that "...it was pointed out that the transportation requirements of the different alternatives are the most important variables (transportation costs are financed out of the city budget and represent over half of the total capital budget."[28] The consideration of the number and size (measured in dollars) of the thresholds for the different strategies resulted in the preference order of: Decentralized Employment (C); Modified Trend (B); Maximum Efficiency (D) and Price of Housing (F_1); Compact City (A); Price of Housing (F_3); and Conservation and Rehabilitation (E).

Discussion of strategies incorporating Land Banking, the Price

of Housing strategies, and Decentralizing Employment (C), indicated them to be inflexible. The executive summary provided other assessments of flexibility.

Specifically, it was argued that the Modified Trend strategy (B) was more flexible than the Compact City (A), if a high priority was given to keeping several development area options available for long term planning. But Compact City (A) was suggested to be more "robust" than the Modified Trend strategy (B) when energy prices and transportation issues were considered:

> ...In the long run, ...(Compact City) might very well be more "robust" than B, depending on whether or not one believes the preeminence of the private car and supplies of cheap petroleum are guaranteed in perpetuity. Despite its rigidity in relation to transportation thresholds, (Compact City) would remain a viable strategy in circumstances that would totally disrupt (the Modified Trend Strategy).[29]

The nature of evaluating flexibility does not result in any firm conclusions that suggest one strategy is better than others. From this writer's review of the evaluation technique it seems that the flexibility of the strategies is largely determined by the very process of generating the strategies. Given that a list of policies was generated to meet objectives and that they were then grouped into "...internally coherent packages of mutually compatible policies," as described in Section 4.2, the exercise of assessing flexibility merely confirms the coherency of compatible policies. The process of generating the alternatives thus restricts and predetermines the intrinsic flexibility of strategies and their robustness.

This section discussing the methods of evaluating the alternative strategies is now concluded. From this writer's review of the methods,

the following observations have risen:

1) The Compact City (A) was the best alternative according to the method of the Goals Achievement Matrix.

2) A frequency/rank method indicated a greater point score for the Maximum Efficiency Strategy (D) closely followed by the Compact City (A). This writer considers the results of this technique of evaluation to be misleading.

3) A scenario description of the strategies indicated that all the strategies would impose some degree of change upon various parts of the city. The Compact City (A) was found to impose the greatest degree of change upon the downtown, inner city and the northwest areas of the city, due to increases in population densities in these areas and to enhancing the downtown as the principal employment area for the city.

4) An evaluation of physical infrastructural requirements indicated that the Compact City (A) and Maximum Efficiency (D) strategies were better choices than other strategies in terms of sewer, water and public building infrastructures and smaller capital budgets. The Decentralization of Employment (C) and Maximum Efficiency (D) strategies were better choices in terms of transportation infrastructural requirements.

5) An evaluation of financial implications indicated that the Decentralized Employment strategy would be the least expensive. Based on the economic benefit of higher density development it was concluded that the Compact City (A) and Maximum Efficiency (D) strategies were better choices than other strategies.

6) A review of the strategies by civic departments and school boards assessed the strategies in terms of how well they achieved the objective of efficient utilization of public and private investments. The Compact City (A) was judged more desirable than other strategies by the majority of departments.

7) An assessment of the flexibility of the strategies in terms of their respective transportation requirements found the Decentralization of Employment (C) strategy to be more flexible than the others. Strategies incorporating land banking, Price of Housing (F_1, F_2, F_3) and Decentralized Employment (D) were indicated to be inflexible. The Compact City (A) strategy was more flexible than the Modified Trend (B) if energy prices and transportation issues were considered. This writer contends that the method of evaluating the flexibility of alternatives is limited by the process of generating the alternatives. The degree of flexibility of an alternative is a reflection of how coherent and mutually compatible the policy packages making up the strategy are. This technique of evaluation is severely limited and thus choosing a flexible alternative over an inflexible one, or vice versa, is a matter of subjective decision making.

8) The Compact City (A) strategy emerged as the best alternative according to: the Goals Achievement Matrix method of evaluation; physical infrastructural requirements; a higher density-financial implication evaluation; and a review by civic departments and school boards. Based on these criteria, The Compact City (A) strategy has been selected along with the growth strategy

ultimately chosen by the City Council for a comparative evaluation of energy consumption implications in Section 4.5.

The following Section, 4.4, will present a discussion of the selection of the growth strategy which has been adopted for Calgary - the Balanced Growth strategy. Section 4.5 will evaluate the energy consumption implications of the Compact City and the Balanced Growth strategies.

4.4 Selecting a Growth Strategy for Calgary

It was the intent of the evaluations described in Section 4.3 to provide information upon which a growth strategy decision for Calgary could be based. Specifically, the purpose of the policy discussion paper, *The Evaluation of Alternative Strategies for Calgary* was:

> ...to draw together as much information as possible with a bearing on the selection of a growth strategy. In particular, there is a concern with the implications, in terms of costs and benefits, of the various choices that are open. If the report serves its purpose adequately, then the decision that is eventually taken should be both enlightened and informed.[30] (And) the underlying aim is to facilitate the taking of an informed decision on the question of what is the "best" strategy for Calgary to adopt.[31]

The policy discussion paper indicated that according to the technical analysis of the strategies, using a Goals Achievement Matrix, the Compact City (A) and the Maximum Efficiency (D) strategies appeared as "strong candidates for selection".[32] This writer has reviewed the methods of evaluation in Section 4.3 and has concluded that the Compact City (A) strategy emerged as the best strategy according to the methods discussed in Point 8 on page 108. No basis for suggesting the Maximum Efficiency (D) strategy is ultimately equal to or better than the Compact City (A) strategy was found in the review of the evaluations.

This writer expected following the evaluation process that the Compact City (A) alternative was the logical choice. Others may have considered Maximum Efficiency (D) to be the chosen strategy. In fact, a totally different strategy: The Balanced Growth strategy was selected.

The reasons for this turn of events are based on senior level administrators' discontentment with the strategies generated. The issue is confusing because of the references to the process of generating the new alternative. A reference in a public document states:

> In the course of the debate that occurred between the conclusion of the evaluation project and the holding of (a) public hearing, a strong feeling developed amongst members of Council and the Board of Commissioners that the short-list of 29 objectives was not sufficiently comprehensive. ...[33]

The above reference suggests that City Council and the Board of Commissioners acted in concert and that their concerns were real and legitimate. This writer has not been able to document the strong feelings among the members of City Council and considers the above reference somewhat deceptive.

From a review of one Commissioner's Report another course of events emerges. The Commissioner's report indicated that the new strategy was developed "...at a meeting involving the City Commissioners and representatives of a number of Civic Departments."[34] The reasons for the new strategy's development are also documented to be different from what was stated in the reference quoted earlier. The new strategy, called the Balanced Growth strategy:

> ...was developed because City Commissioners feel that none of the strategies so far developed and evaluated represents a growth alternative which they feel they could recommend to City Council for adoption.[35]

The question as to whether members of City Council shared the same strong feelings as the Board of Commissioners at the same time, or were convinced that they should share them following a presentation by the Commissioners now arises. This writer is of the opinion that if indeed City Council, themselves, had some misgivings about the alternatives, then the development of a new strategy would be a justified action. However, evidence documented below suggests that the concerns about the alternative strategies so far generated were primarily the Commissioners'. The gist of this argument is that the Commissioners were acting independently of City Council and were acting as a strong influence in guiding the decision on a growth strategy for Calgary. In another Commissioner's report it is stated:

> The Commissioners wish to bring to Council's attention our concern that the Growth Strategies which to date have been developed and reviewed are "pure" planning strategies, each developed to address a specific issue, such as a compact city, efficient use of land, the lowest cost of housing, etc. Because each of these strategies places major emphasis on only one major concern, the Commissioners believe it is necessary for Council's information that a (new) strategy be developed ... Accordingly, the Commissioners with the assistance of a few key Department Heads, have developed a growth strategy which we ... called "The Balanced Growth Strategy".[36]

The Commissioners recommended that Council adopt the Balanced Growth strategy and instructed the preparation of a general plan for Calgary based on this strategy.[37]

The Balanced Growth strategy[38] was not evaluated along with the other strategies but was compared to the Maximum Efficiency (D) strategy in terms of: how well it achieved the 29 objectives; its advantages

and disadvantages; and its flexibility. The evaluation stated that:

> ... it appears that in relation to the 29 objectives established by Council the Balanced Growth strategy is worse than (the Maximum Efficiency strategy).[39]

This writer has evaluated the Balanced Growth strategy using the Goals Achievement Matrix method. In doing this I have made simple assumptions about the weighting of goals in which impacts were assessed as significantly positive or negative. The results of this exercise support the above conclusion. The Balanced Growth strategy scored 562.7 points compared to 580.1 for the Compact City strategy and 570.3 for the Maximum Efficiency strategy.[40] I interpret this as an indication that the Compact City strategy is better than the Balanced Growth and Maximum Efficiency strategies.

However, the Balanced Growth strategy was adopted by Council and the revision of the *Calgary Plan* was based on this strategy. The next section will evaluate the Compact City and the Balanced Growth strategies in terms of their impact on energy consumption.

4.5 Evaluation of Implications for Energy Consumption of Growth Strategies for Calgary

This section presents an evaluation of the energy consumption implications for the Balanced Growth and the Compact Ctiy growth strategies. These two strategies are described in Appendix B. The Compact City has been chosen for evaluation as a result of this writer's review of an evaluation process which concluded that the Compact City is the best of all the alternatives generated. The basis for my conclusion is documented in Section 4.3. The Balanced

Growth strategy has been selected for evaluation because it is the strategy that the revision of the *Calgary Plan* has been based upon.

The method for evaluating the energy consumption of growth strategies is highly dependent upon the list of 29 objectives which are documented in Appendix A. From this list, those objectives which this writer judges to have the potential of addressing urban form and energy consumption issues and problems have been selected. The success of each of the two strategies in achieving the selected objectives will be judged in much the same manner as used by the Goals Achievement Matrix in technically evaluating the full slate of strategies.[41] This method allows a conclusion as to which strategy is better in terms of managing urban energy consumption based on its ability to meet the specific objectives.

Discussions of the strategies' influences on urban form reveal implicit assumptions about density, land use arrangements, urban shape and pattern and transportation modes. Also revealed are implications for energy consumption.

The twenty-nine objectives which all of the alternatives, including the Balanced Growth strategy, were required to fulfill, are listed in Appendix A. My review of these objectives, based upon my subjective interpretation, indicates that three have the potential to address issues and problems of urban form and energy consumption. Specifically, these are:

3) To make more efficient use of the land.

This was directed towards the development of vacant, but serviced, sites.[42] The development of this vacant land is assumed by

this writer to increase the density of urban development and reduce the developmental pressure on peripheral areas. The result is a higher density; a more compact urban form; enhancement of public transportation; mixed land uses; and potentials for waste heat utilization. (Weighted 2.1, the weight refers to the preference Council ascribed to their importance as explained on page 96).[43]

8) To increase the density of residential development.

This objective was directed towards a relatively low density of residential development with a view to increasing it to use land more efficiently. Increasing the density enhances the use of public transportation and the construction of more efficient building types. (Weighted 3.7).[44]

13) To encourage the shift towards public transit by investing more energy and resources in the development of improved public transportation facilities.

This objective was directed towards restricting the use of private cars. This objective does not use the term "energy and resources" to mean primary energy, but rather refers to efforts of the City towards improving public transportation. This results in a more energy efficient mode of transportation. (Weighted 7.5).[45]

With regard to Objective 3 above, the Compact City was evaluated as the best alternative by the City of Calgary's investigation. This was based on comparison of the spatial allocations of the Compact City which allocated 80,000 as the population growth to the existing built-up area and a greater employment population to the downtown.[46] Comparatively the Balanced Growth Strategy locates only 32,000 new population in the existing built-up area and places fewer employed in the downtown. The

Balanced Growth strategy actually ...

> ... spreads population out among a greater number of areas and opens up one completely new development area, all of which are likely to lead to less efficient use of land.[47]

The Compact City, I assume, restricts the continuation of sprawl growth. Redevelopment of existing built up areas to accommodate a substantial amount of the anticipated population has the potential for reducing the urban energy consumption for residential and transportation end-uses. First, the redevelopment areas are older residential districts and the housing types are generally energy-inefficient due to lack of insulation and older types of furnaces. Retrofitting is a viable alternative to solve this problem. Redevelopment of these areas, which would replace these dwelling units with more energy-efficient, higher density building types would reduce energy demand for heating and cooling purposes. Second, the resulting higher residential densities would enhance the economic viability of public transportation--a more energy efficient mode of urban transportation than the automobile.

The redevelopment of existing built up areas offers new opportunities to rearrange land use patterns and implement mixed land uses which integrate residential, commercial, industrial, institutional and recreational activities. These mixed land-use arrangements provide opportunities for the sharing of infrastructure and the utilization of waste heat. A variety of activities reduces the need for long intra-urban travel and the pedestriam mode is enhanced.

The weighted value of objective 3 was low (2.1) compared to the other 29 objectives. This value reflects the subjective attitude of

the City Council towards this objective. The most heavily weighted objective was 1: to accommodate growth (9). The lowest weighted objective was 21: to decentralize office development (1). The implications for energy consumption of the more efficient use of land were not recognized as issues to address. It has not been determined whether a revised consciousness of the problem of urban energy consumption would result in a change in the value of this objective.

The Compact City alternative was evaluated by the City as the best strategy for achieving Objective 8: to increase residential density. This assessment stressed the facts that the Compact City allocated a greater population to the existing built up areas, proposed more employment in the downtown, and provided an LRT facility. Comparatively, the Balanced Growth strategy does not advocate an increase in population density.

The impacts of increased residential density on urban form and energy consumption have been discussed in Section 2-3. The Compact City strategy is consistent in providing opportunities for managing urban energy consumption. This objective of increasing residential densities was given low value by City Council (3.7). It is not known whether this value would increase if the implications for energy consumption were addressed as a problem area of this objective.

The third objective outlined above deals with a shift to public transportation. This objective focussed on urban transportation issues and was not related to urban form and energy consumption. Nonetheless, the Compact City was evaluated by the City as having "...a heavy commitment to public transit"[48] and was concluded to be the best strategy for achieving this objective. An evaluation of the Balanced Growth

Strategy, comparing it to the Maximum Efficiency strategy, concluded that:

> ... the Balanced Growth strategy is best in relation to (the objective of encouraging a shift to public transit) because it requires less expenditure on roads and more would be available for transit.[49]

The evaluation made reference to a policy-discussion report and indicated that two of twenty-three transportation improvements to serve areas approved for development would not be required, nor would one requirement that was held constant for the other strategies.[50] The evaluation report indicated that there would be an additional transportation requirement.[51] There were no cost estimates of the savings or additional expenditures associated with these transportation requirements. The Commissioners' evaluation of the transportation requirements and the strategy's ability to meet the objective of encouraging public transit is questionable on the basis that the proposed *Calgary Plan* documented over fifty primary network transportation improvements. This writer has not been able to account for the discrepancy. This writer did not arrive at the same conclusion as did the commissioners' evaluation for the Balanced Growth strategy.

Evidence which suggests that the Balanced Growth strategy is a weaker strategy than a Compact City is gleaned from reference to another objective: to ensure adequate transportation facilities to all social groups (Objective #12). It is stated that the Balanced Growth strategy is weak in achieving this objective because the population is spread out, making it "...more difficult to provide a public transit service."[52] Furthermore, the evaluation of the Balanced

Growth strategy in achieving objectives 16, 17 and 18 indicated that this strategy would:

> ... encourage more use of the private automobile (with regard to Objective 16).
> ... (would not) enable better use to be made of public transit ... (with relation to Objective 17).
> ... (and) would enable less use to be made of transit (serving the downtown).[53]

Based on the discussion above the implications of the Balanced Growth strategy for energy consumption are negative. The population of the City of Calgary continues to be dispersed, rather than concentrated, reducing residential densities and restricting the viability of public transportation services. The use of the automobile is encouraged and, although the evaluation suggested that the required transportation improvements for the Balanced Growth strategy are less than for other strategies, the emphasis of the improvements is on road networks, and not on public transit. This strategy does not encourage the use of transit into the downtown. The potential for concentrating employment to form a large origin zone and enhance public transit is eroded by the low density of residential areas (destination zones).

In contrast, the Compact City alternative has a key policy component of "...boosting ... the role of public transit particularly for the journey to work."[54] Under this strategy, besides developing transit facilities:

> ...the movement of cars would be restricted, especially during peak periods. It is under conditions of higher density and a minimum number of traffic "attractors" that public transit works best. It is envisaged that the increased levels of transit service would lure people out of their cars rather than forcing them out. ...This strategy envisages an increase in the (proportions of people using transit and a decrease in the proportion using cars).[55]

This writer concludes that the Compact City alternative is the best alternative for managing energy consumption in Calgary. Higher residential densities created by redevelopment of existing areas would reduce the residential end use consumption by constructing new, more energy-efficient dwelling types to replace the existing housing. Redevelopment would also provide the opportunity to rearrange current activities and allow for mixed land uses. More energy efficient modes of intra-urban transportation such as buses and light-rail transit would be encouraged and the potential for utilizing waste heat from industrial activities in commercial, residential, institutional and recreational uses would be enhanced.

Section 4.6 will review the method which the city used, that of generating and evaluating the strategies as a case study of policy-making. Frameworks for analysis of policy-making described in models presented in Chapter 3 are employed to assess the feasibility of implementing an energy-sensitive urban land policy, exemplified by the Compact City Growth strategy.

4.6 Use of Policy Models for the Analysis of the Generation, Evaluation and Selection of Growth Strategies

Chapter 3 presented a discussion of models useful for the analysis of policy-formulation. These models were: the rational, the incrementalist and the mixed-scanning models; an output of political system model; and the Detomasi "constraint" model. They were discussed with reference to the research need of assessing the feasibility of implementing an energy-sensitive urban land policy. The models provided a variety of analytical frameworks for approaching this

research need.

It will be shown that these models are not mutually exclusive. Aspects of the different models can be used in the context of others.

Thus far, Chapter 4 has presented an analysis of the generation and evaluation of urban growth strategies. The process of selecting a specific growth strategy, accompanied by a set of policies, was documented. An evaluation of two strategies found the Compact City alternative to be the better strategy for managing urban energy consumption.

The intention of this section is to present an analysis of the policy-making process, documented in Sections 4.2, 4.3 and 4.4, within the frameworks of the models described in sections of Chapter 3. It is also the intention to provide a summary of the difficulties of formulating and implementing an energy-sensitive urban land policy.

The rationalist, incrementalist and mixed-scanning models of policy making were described in Chapter 3, Sections 3.2, 3.3 and 3.4 respectively. The descriptions of the generation, evaluation and selection of a growth strategy in Chapter 4, Sections 4.2, 4.3 and 4.4 have provided different examples which illustrate aspects of the above models.

These aspects include: difficulties of a comprehensive rational approach in generating alternatives; the development of the Balanced Growth strategy which is only incrementally different from the Maximum Efficiency strategy; and, the weighting of objectives to determine priorities and to develop a strategy for achieving goals as well as the selecting processes identified with the mixed-scanning model.

The rational model assumes that all futures are foreseeable and a comprehensive overview of problem solving is possible. The generation of alternative strategies described in Section 4.2, is basically an attempt to ensure that all important issues facing the City of Calgary are included in the process. Despite the claim by the Planning Department that:

> ... a large number and variety of issues were raised for public and technical debate ...that preliminary analysis and accumulated experience suggested might be problems, either now or in the future ...the scope of the exercise was deliberately broad, in order to ensure that no significant body of opinion was ignored, or overlooked, and that nothing of relevance was neglected ...[56]

the issue of energy consumption was unaccounted in the process of generating the alternatives. The above example illustrates one criticism of the rational model: the impossibility of considering all future possibilities.

The incrementalist model of policy-making describes the choice of policy as being only slightly, hence "incrementally," different from present policies. The results of this are policy choices which are conservative in their approach to change. The selection of the Balanced Growth strategy over the Compact City alternative clearly illustrates the above aspect of the incrementalist model.

The Compact City is a strategy which is expected to impose significant change in existing areas of the city. Redevelopment, higher residential densities, limited peripheral growth and restrictions on private automobile travel are the major features of change anticipated in this strategy. These proposed features are substantial and significant departures from the normal situation in Calgary which typically

has experienced new development, low residential densities, annexation of adjacent rural areas and frequent use of automobiles. The Balanced Growth strategy is considerably more conservative than the Compact City in its policy thrusts and, frankly, merely perpetuates the practices of accommodating growth which Calgary has employed in the past.

This writer has not been able to account for the peculiarity in the selection process that has presented the Maximum Efficiency alternative as a better choice than the Compact City alternative. The Compact City alternative was shown to be better, both in the City's evaluation and in the evaluation undertaken by this writer. The Commissioners compared the Balanced Growth strategy to the Maximum Efficiency strategy but not to the Compact City. Why?

The incrementalist model again provides insights which allow the opportunity to theorize about the peculiarity noted above. Evaluations of the alternatives, by the City, indicate the Maximum Efficiency to be a relatively good alternative compared to the Compact City. The Maximum Efficiency alternative, analogous to the Balanced Growth strategy, is not as radical in its proposals as is the Compact City. The conservative aspect of the Maximum Efficiency strategy is thought by this writer the basis for its preference by the Commissioners.

The mixed-scanning model of policy-making provides descriptions of policy-making which are illustrated in the processes of generating alternatives and selecting a strategy. The use of a Goals Achievement Matrix method articulates the weights, or values, decision makers place on different objectives. The best alternative is the one which achieves these objectives most effectively.

Another example of mixed-scanning policy-making was illustrated by the selection process. Disregarding the technical processes used for evaluations by the different decision makers in the process, the selection of the Balanced Growth strategy was made by comparison with other strategies in terms of how well they achieve, or are thought to achieve, certain objectives. Flexibility of the strategies seemed to be a highly valued performance criterion and the Commissioners stressed that the Balanced Growth strategy was the most flexible. This writer has assumed that the City Council would view the flexibility issue of how many different objectives each strategy could intrinsically achieve and still reflect robustness, as more important than how well a strategy could achieve the weighted objectives.

The model describing policy as the output of a political system, discussed in Chapter 3, Section 3.5, provides another framework for analysis of the policy formulation process of developing a growth strategy for Calgary. The public participation process for raising issues and generating strategies can be viewed as a means of indicating policy demands and policy support from the constituents in the political environment. Issues such as the price of housing, transportation and growth were reflected in the output of policies designed to manage these issues. The issue of urban energy consumption received little attention and generated very little demand or support for policies which addressed this issue.

The weighting of the 29 objectives is an illustration of how characteristics of the political system, in this case the policy preferences of the aldermen, are intended to influence policy outputs.

The exercise of weighting the objectives is intended to provide criteria on which to base decisions that one alternative is the best. The final choice of a specific growth strategy is also a reflection of the council members' preference.

The role that the Commissioners played in developing a new strategy may be viewed in two aspects. On one hand this illustrates how strong support or demand for a policy, especially from the administration, can directly influence policy outputs (line C of the model in Figure 3-1). The process of generating and evaluating the Balanced Growth strategy is independent of those processes of which the other alternatives were a part. The failure of the original alternatives to gain the support of senior level administrators ensured their demand for another alternative.

On the other hand, the development of the Balanced Growth strategy illustrates how system characteristics shape policy outputs (line B of the model in Figure 3-1). The Commissioners, a part of the system, are administratively responsible for the management of the civic departments. Within their professional role, it is their responsibility to recommend to council the best alternative. Their review and criticism of the eight generated alternatives and their development of the Balanced Growth strategy is within their authority. Whether or not they are correct in their evaluations, judgements and conclusions is another matter.

The Detomasi constraints model, described in Chapter 3, Section 3.6, contributes another framework for analysis of the policy-making process. Several societal, organizational and individual types of

constraints present themselves in the process of generation, evaluation and selection of the growth strategies.

For example, the failure of the process to generate urban form and energy consumption issues demonstrates: a societal constraint in the voter's inability to perceive this issue or to face up to its consequences for lifestyles; an organizational constraint in the planning department's and the civic government's inability to develop an alternative growth strategy directed at management of urban energy consumption; and, individual constraints illustrated, for example, by the Commissioners, whose "feeling" seemed to be a large factor in determining the policy outcome. The reader can thus observe that the Commissioners offer examples of both organizational and individual constraints. They have both the positional power and the personal abilities to use it effectively in city hall environments.

A specific example of societal constraints impeding the implementation of an energy-sensitive urban land policy is gleaned from this writer's interpretation of a recommendation to council by the Planning Advisory Committee (an ad hoc committee having general public representation providing advice to Council). This committee recommended that Calgary's City Council should not adopt a growth strategy which is disruptive of established communities. The Compact City is shown in this chapter as presenting the most impact on existing areas in Calgary, but it is also the most energy-sensitive, compared to the other alternatives.

A specific example of an organizational constraint impeding the implementation of an energy-sensitive urban land policy is the procedure used by the planning department to evaluate the alternatives. Clearly,

the Compact City strategy may be evaluated by several methods as the best alternative. Despite this fact, preference within the Planning Department seemed to sway towards the Maximum Efficiency alternative. The Civic Administration, notably the Commissioners, expressed a mysterious fondness for the Maximum Efficiency strategy, with the consequence that the Compact City disappeared from the list of strong contenders for selection.

Individual constraints acting upon the process of the formulation and implementation of an energy-sensitive urban land policy described are numerous. For example, the reluctance, or failure for whatever reasons, of certain aldermen to participate in the weighting exercise of the 29 objectives to assist in the evaluation of the alternative strategies is illustrative of individual constraints on the policy formulation process. The failure of the Mayor to participate in this process is another example. A Mayor of strong or weak leadership can influence policy outputs.[57] The nonparticipating members of council and Mayor impose individual constraints upon a method of policy-making and evaluation which was envisioned and designed by technical experts to result in a set of policy options based on weighted objectives.

This section has presented an analysis of the feasibility of implementing an energy-sensitive urban land policy. Policy models presented in Chapter 3 were used to provide frameworks for analysis of the generation, evaluation and selection of a growth strategy for Calgary. The models have proved to be useful for assessing the feasibility of implementing energy-sensitive urban land policy.

4.7 Summary

This chapter was intended to present a discursive analysis of the formulation and evaluation of urban land policy. Growth strategies for the City of Calgary have stood as an example of the selection of urban land policies.

Section 4.2 has described the process under which the alternatives were generated and this was illustrated in Figure 4-1. It was noted that urban form as it relates to energy consumption was not considered as a major issue in developing the alternatives. Consequently, another form of evaluation was used in Section 4.5 to compare the implications of two different strategies for urban energy consumption.

Section 4.3 has reviewed the processes of evaluating the growth strategy alternatives. The Compact City alternative was evaluated as a better strategy in several methods including: the Goals Achievement Matrix; sewer, water and public building infrastructural requirements; economy of density and financial implication analysis; and, civic department and school board preferences. The Compact City alternative was also noted to be more flexible in response to transportation and energy price issues.

The selection of a growth strategy for Calgary was described in Section 4.4. The City Commissioners were shown to exercise a great deal of influence in the selection and adoption of the Balanced Growth strategy.

An evaluation of the implications for energy consumption resulting from the implementation of either the Balanced Growth strategy or the Compact City alternative was presented in Section 4.5. The Compact

City was chosen for this evaluation because it represented the best choice amongst the eight alternative growth strategies generated. The Balanced Growth strategy was selected for evaluation since it was the adopted strategy. The evaluation indicated that the Compact City had a better capability of reducing and managing energy consumption in Calgary. The Compact City increased residential density in existing areas of the city, thus providing the opportunity for redevelopment to replace housing stock with more energy-efficient housing types and the opportunity for mixed land-uses. As well, mixed land-uses create opportunities for employing waste heat from industrial activities and enhancing the use of more efficient urban transit modes. These were advantages of the Compact City for managing urban energy consumption.

Finally, Section 4.6 presented an analysis of the process of generating, evaluating and selecting the growth strategy for Calgary in order to assess the feasibility of implementing an energy-sensitive urban land policy. The models of policy-making described in Chapter 3 were used to provide a framework for the analysis. Several factors and constraints influencing the feasibility were identified.

FOOTNOTES

[1]The reader is referred to Policy Discussion Paper No. 3: *The Evaluation of Alternative Strategies for Calgary,* (January, 1977). This discussion paper documents: a technical process of evaluation for the growth strategies --the Goals Achievement Matrix; several quantitative analyses - scenarios, physical infractural requirements, and financial implications; and qualitative analyses --reviews by civic departments, analysis of flexibility, and an assessment of compatibility with the Calgary Regional Growth Study.

[2]City of Calgary Planning Department, *Transportation in Calgary,* (Background Paper No. 3), (May, 1976), p. 7.

[3]*Ibid.,* p. 6.

[4]A total of eight working papers have been published. These are: *Financial Resources,* (No. 1, August 1976, 79 pp.); *Development and Policy Constraints,* (No. 2, September 1976, 41 pp.); *Provisional Guidelines for the Development of a Strategic Monitoring System,* (No. 3, February 1977, 12 pp.); *Review of Policies and Trends,* (No. 4, Forthcoming); *Techniques to be Used in The Generation and Evaluation of Alternative Strategies,* (No. 6, September 1976, 43 pp.); *Generation of Alternative Growth Strategies,* (No. 7, December 1976, 197 pp.).

[5]See: The City of Calgary Planning Department, *Development and Policy Constraints,* (Working Paper No. 2), (September, 1976).

[6]An elaboration of the process of developing the problems and the objectives is documented in other publications of the City of Calgary Planning Department. These include: *Generation of Alternative Growth Strategies,* (Working Paper No. 7, December 1976), 107 pp.; *Identification of Objectives and Population Groups for the Goals Achievement Matrix,* (Policy Discussion Paper No. 1, October 1976), 38 pp.; *Evaluation of Alternative Strategies for Calgary,* (Policy Discussion Paper No. 3, January 1977) 110 pp.; and *The Adopted Strategy,* (Policy Discussion Paper no. 4). A list of the seventy- three objectives used in the Calgary Plan Review Process can be found in Appendix B of *The Calgary Plan* (Proposed June 1977).

[7]An elaboration of the constraints is documented in *The Calgary Plan,* (Proposed, June 1977) and *Generation of Alternative Growth Strategies,* (Working Paper No. 7, December 1976), Section 2, pp. 5-14.

[8]Should the reader desire to review these policy statements, they are documented in Appendicies 2, 3, and 4 in the City of Calgary Planning Department, *Generation of Alternative Growth Strategies,* (Working Paper No. 7, December 1976).

[9]City of Calgary Planning Department, *Generation of Alternative Growth Strategies*, (Working Paper No. 7, December, 1976), Appendix 4. There is no definition of what is intended or meant by the various groupings. It is the assumption of this writer that the groupings served the purpose of merely cataloging the policy statements under subject categories.

[10]*Ibid.*, p. 18.

[11]City of Calgary Planning Department, *The Calgary Plan*, (Proposed, June 1977), I.3.22.

[12]This is the interpretation I made after reading: *Techniques To Be Used in The Generation and Evaluation of Alternative Strategies*, (Working Paper No. 6, September 1976).

[13]City of Calgary Planning Department, *The Evaluation of Alternative Strategies for Calgary*, (Policy Discussion Paper No. 3, January 1977), p. 7. For an elaboration on the Goals Achievement Matrix and its application in evaluating alternatives, the reader is referred to Morris Hill, "A Goals Achievement Matrix for Evaluating Alternative Plans," *Journal of the American Institute of Planners*, (1968), pp. 19-29, and also "A Method for the Evaluation of Transportation Plans," *JAIP*, (1968), pp. 21-34.

[14]*Ibid.*, Executive Summary," p. viii and pp. 40-41.

[15]*Ibid.*

[16]See: City of Calgary Planning Department, *The Evaluation of Alternative Strategies for Calgary*, (Policy Discussion Paper No. 3, January, 1977), Section 9, "The Physical Infrastructure Requirements", pp. 75-85.

[17]*Ibid.*, p. 85.

[18]*Ibid.*

[19]*Ibid.*, pp. 84-85. A quantitative assessment of the amount of infrastructural requirements or the capital expenditures was not detailed and these assessments were gleaned from impressions of the strategies. For example, in the Summary of Section 10, it was stated that: "In terms of public buildings, it has not proven possible to go into any detail. However, it is clear that strategies A and D, which place population in the existing built-up area, will have the least requirement for new public buildings."

[20]See Section 10, "Financial Implication of the Alternative Strategies," in *The Evaluation of Alternative Strategies for Calgary*, pp. 87-96.

[21]See: *Financial Resources*, (Working Paper No. 1, August 1976), 79 pp. and Appendix IV in *The Evaluation of Alternative Strategies for Calgary*.

[22]City of Calgary Planning Department, *The Evaluation of Alternative Strategies for Calgary*, (Policy Discussion Paper No. 3, January, 1977), p. 96.

[23]*Ibid.*

[24]*Ibid.*, Section 11, "review of Alternative Strategies by Civic Departments," pp. 97-99.

[25]The replies from the civic departments and school boards are documented in Appendix V of *The Evaluation of Alternative Strategies for Calgary*.

[26]An elaboration of "flexibility" is provided in Section 12, "The Analysis of Flexibility," in *The Evaluation of Alternative Strategies for Calgary*. The definitions of intrinsic and flexibility are taken from the above document pp. 101 and 102 respectively.

[27]City of Calgary Planning Department, *The Evaluation of Alternative Strategies for Calgary*, (Policy Discussion Paper No. 3, January, 1977), p. 103.

[28]*Ibid.*

[29]*Ibid.*, p. x.

[30]*Ibid.*, p. 1.

[31]*Ibid.*, p. vii.

[32]*Ibid.*, p. xi.

[33]City of Calgary Planning Department, *The Calgary Plan*, (Proposed, June 1977), 1.3.31.

[34]Commissioners' Report to City Council, *An Evaluation of a Balanced Growth Strategy*, (February 10, 1977).

[35]*Ibid.*

[36]*Commissioners' Report, E. 4. Re: A Balanced Growth Strategy For Calgary,* (February 16, 1977).

[37]*Ibid.*

[38]A description of the Balanced Growth strategy is documented in Appendix B, along with the Compact City.

[39]Commissioners' Report to City Council, *An Evaluation of a Balanced Growth Strategy,* (February 10, 1977).

[40]I have assessed this strategy using the GAM and my results indicate a score of 562.7 points, 7.6 points less than the 570.3 for the Maximum Efficiency strategy and 17.4 points less than the 580.1 points for the Compact City. The method for the calculation assessed the rank scores for this strategy against all the objectives on the basis of information provided in the Commissioners' Report, *Ibid.,* comparing the Balanced Growth strategy to the Maximum Efficiency strategy. For my calculations I assumed that a significant positive and/or negative impact to be equal to a value of three points. Once the rank scores were obtained they were multiplied by the respective weights for each objective and then summed to yield a total of 562.7 points. This exercise was straightforward, uncomplicated and not time consuming, in contrast to statements of the contrary documented in the Commissioners' Report, *Ibid.*

[41]See Section 4.3 and also: *The Evaluation of Alternative Strategies for Calgary,* pp. 17-34; Commissioners' Report to City Council, *An Evaluation of a Balanced Growth Strategy,* (February 10, 1977), pp. 5-9.

[42]*The Calgary Plan,* (Proposed, June 1977) Table 1.3.1 and also: *Identification of Objectives and Population Groups for the Goals Achievement Matrix,* (Policy Discussion Paper No. 1, October, 1976), Appendix B, p. 17; and *The Evaluation of Alternative Strategies for Calgary,* p. 19.

[43]City of Calgary Planning Department, *The Evaluation of Alternative Strategies for Calgary,* (Policy Discussion Paper No. 3, January, 1977), p. 41.

[44]*Ibid.*

[45]*Ibid.*

[46]*Ibid.*, p. 19.

[47]Commissioners' Report to City Council, *An Evaluation of the Balanced Growth Strategy*, (February 10, 1977), p. 5.

[48]City of Calgary Planning Department, *The Evaluation of Alternative Strategies for Calgary*, (Policy Discussion Paper No. 3, January, 1977), p. 26.

[49]Commissioners' Report to City Council, *An Evaluation of the Balanced Growth Strategy*, (February 10, 1977), p. 7.

[50]*Ibid.*, pp. 3 & 4.

[51]*Ibid.*, p. 14.

[52]*Ibid.*, p. 7.

[53]*Ibid.*, p. 8.

[54]City of Calgary Planning Department, *The Evaluation of Alternative Strategies for Calgary*, (Policy Discussion Paper No. 3, January, 1977), p. 47.

[55]*Ibid.*

[56]City of Calgary Planning Department, *The Calgary Plan*, (Proposed, June 1977), 1.3.11.

[57]See Chapter 3.

Chapter V

PROVINCIAL AND FEDERAL GOVERNMENT: POWERS AND POLICIES

5.1 Introduction

This chapter will discuss the policy role that provincial and federal governments might play in enhancing the development of energy-sensitive urban land policies. The advocacy for provincial participation in developing energy-sensitive urban land policy rests on the fact that local authorities are the creation of provincial legislatures. Within the limits of their jurisdiction, provincial governments have some control over factors determining city growth but "...a provincial government may decline to influence, beyond the limits of its overall regulatory guidelines on such matters as physical planning, the process of city growth."[1]

Federal government involvement in urban land policy is advocated on two grounds. First, the federal government has a history of having a tremendous impact upon Canadian cities. A federal urban study in the early 1970's found that there were "...117 federal programmes operating through 27 departments and agencies of the federal government which have a direct effect on the shape and growth of Canadian cities."[2] Second, the national public interest about the importance of energy and energy conservation is an established area of concern to the federal

government. Canada is a member of the International Energy Agency (IEA, basically NATO countries) and is engaged in comparative programmes with other countries to reduce the growth rate of primary energy consumption.

This chapter will discuss the supply of primary energy. The discussion will raise some of the economic, social, political and environmental issues related to energy supply facing Canada. A presentation of current federal and provincial activities in energy conservation will be made. This will be followed by a section advocating senior level government policy thrusts to enhance the development and implementation of energy-efficient urban land policies.

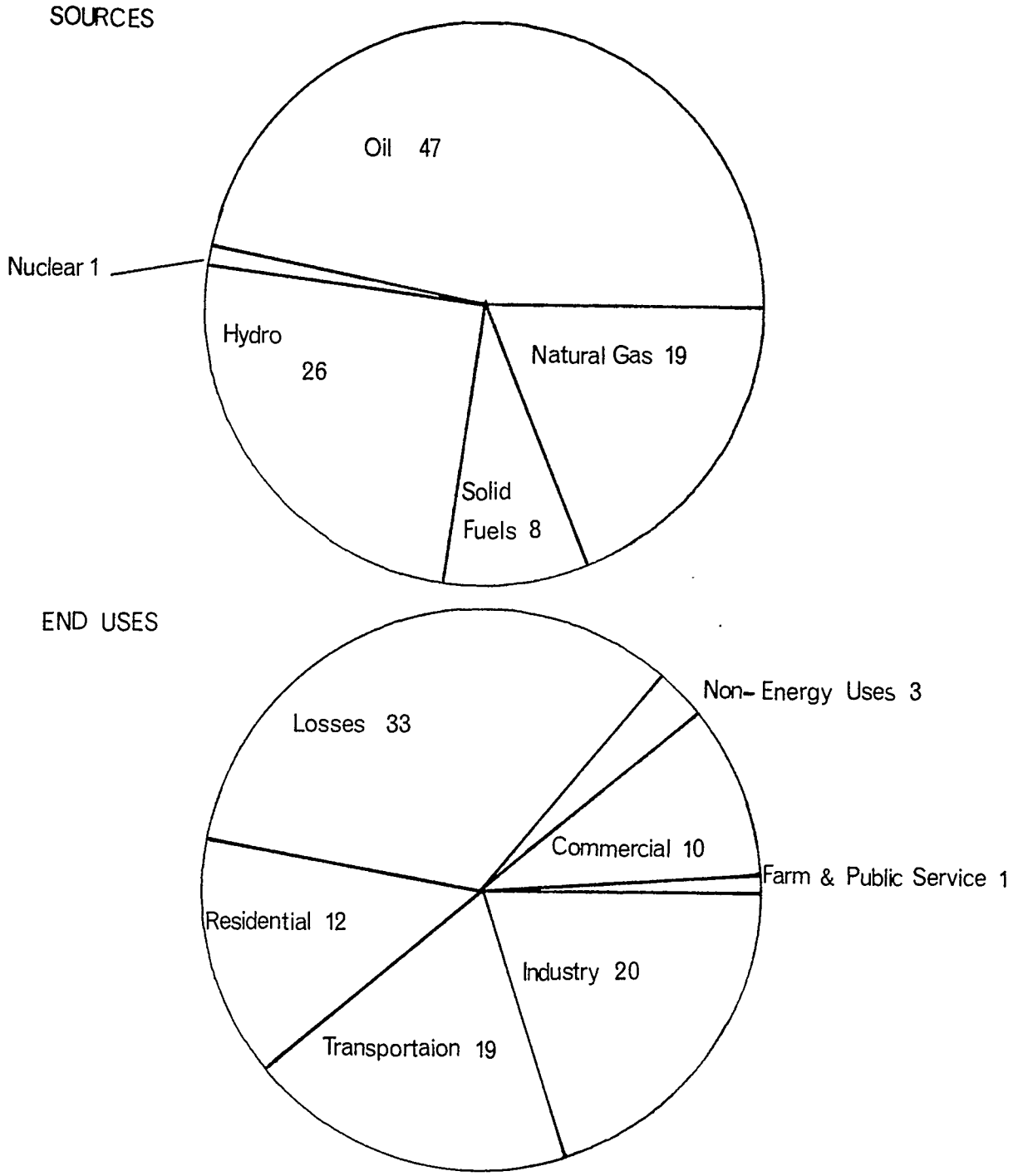
5.2 Canadian Primary Energy Supply

Primary energy in Canada is supplied from crude oil, hydro generation, natural gas, coal and other solid fuels, and nuclear sources. An energy budget which illustrates the sources of primary energy and the end uses of primary energy for Canada is presented in Figure 5-1. The energy budget illustrates that oil supplies nearly half of Canada's energy requirements. Other than hydro, renewable energy sources are currently insignificant contributors to the national energy budget. Recent events, both international and national in nature, raise concern about Canada's future oil supply. However:

> ...oil, despite price increases and supply uncertainties, remains the basis of planned energy for most countries through the 1980's. This situation is very evident in the Organization for Economic Co-operation and Development countries as evidenced by the scenarios presented in the *World Energy Outlook* prepared by the OECD in 1977, and in several other recent studies of the world energy situation.[3]

FIGURE 5-1

CANADA'S ENERGY BUDGET (1975)
(figures in per cent)



Source: OECD, *Energy Balances of OECD Countries: 1973/1975*, (Paris, 1975).

Canada is a net importer of both coal and oil. South eastern Ontario demands a large amount of coal for thermal electricity generation and for that province's regional steel industry. This coal is imported from the United States. Alberta and British Columbia, on the other hand, have deposits of coal which are exported, mainly to Japan. Transportation costs are the principal factor restricting the use of western coal in eastern Canada. The security of supply of oil from foreign sources, and the development of domestic primary energy supplies are laden with several economic, social, political and environmental issues.

With the understanding of the importance that oil has for supplying half of Canada's energy requirements, a further expansion of the issues relating to foreign and domestic oil supply is presented here.

Economic constraints affecting the supply of foreign oil are basically the production and pricing policies set down by the Organization of Petroleum Exporting Countries (OPEC). This group includes Saudi Arabia, Iran, and Venezuela, among others. The pricing policies of OPEC are established as commodity price indicators for domestic production and thus have an impact on the development of domestic supplies.

As oil is a non-renewable resource, established reservoirs of domestic supply become depleted as the oil is used. The processes of exploration for new sources of oil, land and sea drilling technologies, and the recovery of oil from tar sands are more expensive than these or equivalent activities have been in the past.

Also, in response to the higher prices for imported oil, a federal economic policy of increasing the price of the domestically produced

oil has been adopted in the effort to reduce demand and to stimulate the discovery of domestic resources. Higher prices for domestic oil encourage the private sector to expand its exploration activities.

Multi-national corporation policies, primarily economic/political in nature, may also impose constraints on security of supply.

Social/cultural issues, domestic and foreign in origin, also impose constraints on developing energy supplies. For example, growth related issues resulting from resource development in frontier towns such as Fort McMurray, Alberta and Lloydminster, Saskatchewan, impose a form of social constraint. The rapid rate of growth in these towns causes problems of adjusting to a large influx of population without the benefit of community and social amenities.[4]

Other social/cultural constraints on developing domestic energy supplies have been presented in those issues reflected in the opposition to pipeline construction in the Mackenzie Valley and the Yukon from Dene, Inuit and other associations of Indian tribes living in these areas. Similar forms of opposition by Indian associations to energy developments in Canada are noted in the histories of the James Bay hydro development in Quebec and the South Indian Lake, Churchill River Diversion in northern Manitoba.

The philosophy of the Islamic faith in Middle Eastern countries, including Saudi Arabia, Iraq, Kuwait and Iran, presents a social/cultural constraint affecting the supply of foreign energy, primarily oil.[5] Although Venezuela is the single largest source of Canadian oil imports, the impact of religious influences in Islamic countries on oil supply and prices is felt through the association of Oil Producing and

Exporting Countries (OPEC) of which Venezuela is a member.

Political constraints affecting oil supplies in Canada can also be of either a foreign or domestic nature. Several examples of foreign political constraints include: OPEC policies of price, production and distribution; multi-national corporation policies; and policies of their home countries. The oil embargo of 1973 is one example of a foreign political constraint. The OPEC policies on the price of oil reflect political priorities of the member countries. The support for high oil prices may be associated with political support of Islamic leaders and populations in the producing and exporting countries. Similarly, the fluctuation in levels of production, evidenced recently in Iran, is a result of internal political issues in these countries.

Nationally, the political constraints impacting on domestic resources would include the debate between provincial and federal jurisdictions over resource control and allocation. Other domestic political constraints include: the role of government corporations such as Petro Canada in acquiring foreign oil supplies and Petro Canada's competition with the private sector; and the political pressure exerted by provinces against each other in either the bid to share resources of one province with another (e.g. Ontario and Alberta) or the pressure of competition for resource development (e.g. Alberta and Saskatchewan).[6]

Environmental issues relevant to foreign oil supply are basically restricted to potential water pollution and negative impacts on the commercial fishing industry and tourism caused by oil tanker disasters in coastal waters. Concern for environmental issues related to national

oil resources includes those associated with off-shore and arctic exploration and recovery techniques, and the impacts on the environment affecting wildlife habitat.

Examples of impacts on wildlife habitats include those affecting migratory bird habitats and increased turbidity in and destruction of fish spawning areas as a result of pipeline construction. Furthermore, degradation of the natural environment is a vital concern and a constraint with respect to the development of oil recovery from the tar sands in northern Alberta and Saskatchewan. There are also environmental concerns associated with the processing of crude oil and the refining of petroleum products, specifically in terms of air and water pollution. The transportation of oil and its use by several sectors present similar environmental concerns, both locally and nationally.

This discussion briefly surveyed the main economic, social, political and environmental constraints and issues with respect to oil supply. It is pointed out here that varieties of these constraints may be applied as well to the supplies of other energy sources such as coal, nuclear power and electricity.

Given a high and growing demand for energy in Canada, the constraints mentioned above imply a strain on the supply of primary energy. Economically, these strains imply higher costs for energy. It is cautioned by one writer that:

> ...even if international (oil) supplies are not interrupted by political factors and even if ... Canadians respond by decreasing demand and developing domestic supplies so as to prevent physical shortages of energy, our energy future will inevitably be a high cost one. Of the various supply options we have, all are going to be costly in terms of capital costs, operating costs, and in many cases, environmental and social costs.[7]

The public interest in these energy issues should be guarded. The importance of recognizing the fact of high costs for oil as well as other forms of primary energy is surely of grave concern to the federal government given its jurisdiction over matters of monetary policy and general economic progress. Concern over the high cost associated with importing OPEC oil is directly proportional to the balance of trade deficit in oil. The inflationary tendencies of oil have repercussions in the economy as a whole.

Similarly, provincial governments have due cause for concern in that rising energy costs will affect/inhibit their attempts at maintaining or developing higher levels of industrial production within their jurisdictions. The following section provides more illumination of these issues in the context of a discussion of the demand for primary energy, particularly the demand for oil.

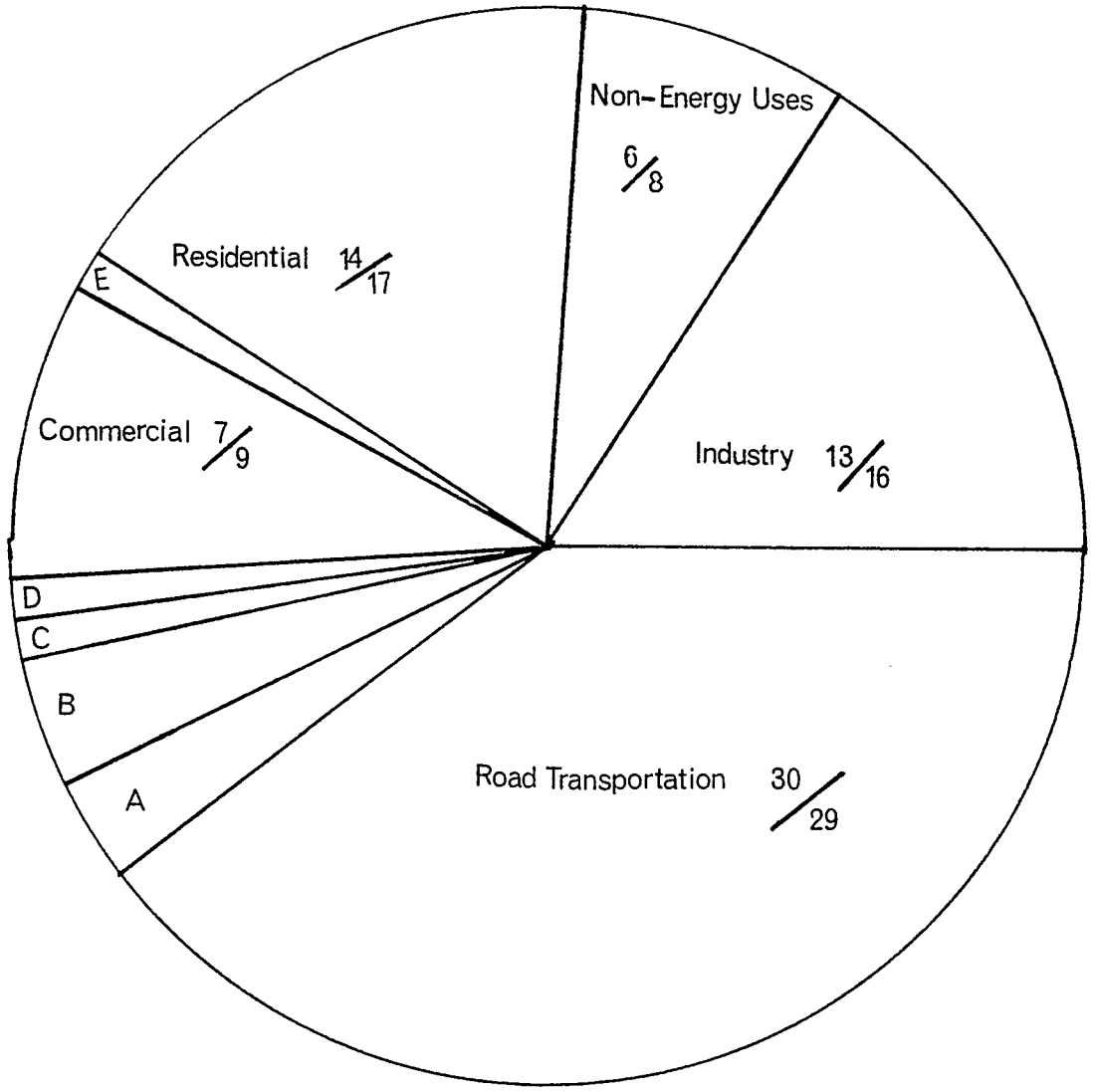
5.3 The Canadian Demand for Oil

An illustration of the annual distribution of end uses of primary energy in Canada has been presented in Figure 5-1. It was previously noted that oil represents half of Canada's primary energy supply. Whereas the end uses of all primary energy in Canada were illustrated in Figure 5-1 by sectoral uses, the distribution of end uses for oil are presented in Figure 5-2.

It is observed that oil is consumed by most common end uses; the predominant ones are road transportation, residential space heating, industrial processing and commercial uses. Chapter I has presented the argument that the distribution of energy consumption was predominantly

FIGURE 5-2

PETROLEUM END USES: CANADA 1975
(MTOE/PER CENT)



A Rail Transp. 2/3
B Air Transp. 3/4
C Navigation Transp. 1/1
D Agriculture 1/1
E Public Servce .5/1

Total per cent greater than 100 due to rounding.
Source: OECD, *Energy Balances of OECD Countries: 1973/1975.* (Paris, 1975).

urban rather than rural in nature.

Section 5.2 has discussed some of the economic consequences Canada and the provinces must suffer as a result of high costs of oil. The negative economic impacts are exacerbated by continuing high demand for oil by end use sectors listed above. This demand for oil has several major implications for the national economy which are presented in the following excerpt from a federal government publication:

> 1) The provision of additional domestic energy supplies will be expensive, requiring in the range of $180 billion worth of manpower and materials, purchased at 1975 prices, over the next fifteen years. The magnitude and timing of such investments suggests that strains on markets for labour and capital equipment may result. In addition these requirements may necessitate some adjustments in Canadian financial markets. Recourse to foreign capital, while it could ease the balance of payments strains with continued oil imports, could lead to conflicts with Canadian ownership and participation objectives of the federal government.
> 2) Even assuming that the world price does not increase in the future, it is estimated that the balance of trade in oil could swing from a surplus of about $1.0 billion in 1974 to a deficit of about $4.5 billion by 1985. In the early part of this period the deterioration in oil trade will be offset by higher prices for natural gas exports.
> 3) In addition to exacerbating Canadian supply/demand problems for energy, a continuation of current domestic oil prices could lead to substantial deficits in the Oil Compensation Fund, requiring the subsidization of oil consumers from general revenues.
> 4) The necessity, in light of our energy situation, of moving domestic oil prices towards international levels will impose additional costs on Canadians and will have implications for the federal government's Anti-Inflation Programme. Higher oil prices will lead to higher rates of inflation ...
> 5) The scenarios suggest that our medium-term supply/demand situation for energy poses serious potential problems, which could adversely affect domestic economic performance and Canadians' living standards over the next fifteen years.[8]

Another assessment of the impacts of high prices and high Canadian demand for oil suggests a reduction in industrial production, a reduced

demand for Canadian exports, higher domestic prices for goods, higher prices for alternative energy sources, higher inflation and higher prices for imported goods. Four major points of this assessment follow:

> 1) The energy-induced slowdown of industrial production abroad has resulted in a weakened demand for Canadian exports (other than energy products).
> 2) Higher domestic petroleum prices have led to higher domestic prices as a direct consequence of increased costs to domestic users of petroleum.
> 3) Higher domestic petroleum prices have stimulated increases in the price of competing energy sources such as natural gas.
> 4) Higher world petroleum prices have aggravated the rates of price inflation of Canada's trading partners and led to higher prices for imported goods.[9]

Unemployment and inflation are exacerbated by increasing energy costs. Also, the problems of controlling the deficit in the balance of trade and the management of budgetary allocations at federal and provincial levels are more difficult. Concern for reduced spending on energy by the federal government is exemplified in its involvement with the Internation Energy Agency and its participation in this OECD organization's policy development based on the premise that:

> Energy saved is energy produced, and for satisfactory economic and social performance, the costs of saving a unit of energy should be equated to the cost of supplying an extra unit of energy.[10]

The aim of this policy thrust is to enhance the conservation of energy. It is not intended to restrict development of economic progress, nor is it meant to imply a reduction in the standard of living for Canadians. The goals of this policy directive are towards reducing the waste of energy and increasing the efficiency of energy utilization. The development of this policy thrust grew out of the concern of an international organization over primary energy supply and demand. The next section reviews the Canadian examples to energy

conservation which were spawned by international initiatives.

5.4 Canadian Investigations and Initiatives in Energy Conservation

The focus of this project has been on the opportunity and ability of urban land policy to reduce energy consumption. It has been recognized that the attempts to control energy consumption through regulation and design of land use activities are embryonic at this time.

Research has been conducted to quantify the potential savings in annual urban energy consumption which would accrue from adjustments to urban form. In medium to large urban areas experiencing a rapid growth rate, the energy savings from changes in new development areas have been estimated to be from seven to eight per cent by the turn of the century.[11] The full potential for energy savings taking account of opportunities for redevelopment, has been estimated to be fifteen to twenty-five per cent.[12]

Attempts at energy conservation at the municipal level have generally been restricted to management programmes to reduce energy consumption in public buildings and civic vehicle fleets, etc. Nevertheless, it is recognized that there exists a concern for energy conservation at the municipal level. Difficulty exists in determining whether or not a lack of knowledge and understanding of urban form and energy consumption is real or simply an excuse for not taking action in this area. A participant at a recent conference on this topic summarizes this dilemma as follows:

> ... it became clear ... that there were in fact few good empirical studies relating to energy consumption and any of a series of planning factors, including land use, transportation or site design,... very little evidence was found to support many theoretically posited energy planning relationships ...[13]

Despite the uncertainty that prevails respecting the relationship between land use arrangements and energy consumption, there are several policy options and tools available at the municipal level which are applicable to the focus of energy conservation. Four policy areas, tools and foci are presented in Table 5-I which briefly lists these opportunities.

Policy options listed in Table 5-I include: land use planning; alternative energy supplies; public information; and using subsidies and grants to achieve energy conservation. The tools by which the policy options can be achieved are listed in the table. As well, the focus of the tools is indicated to present a comprehensive approach to energy conservation. Areas wherein urban land policy and urban form are seen to present opportunities for municipal energy conservation include: utilizing the official plan, zoning by-laws, and site plan agreements. Municipalities can use these tools for energy conservation by adopting a suitable set of policy guidelines for land use planning, such as those illustrated by the Compact City alternative outlined in Chapter 4.

The policy directions listed in this table indicate a shift in the role of municipal government. They suggest that the municipal governments should begin to take stronger leadership roles in directing the development and implementation of energy conservation. Urban governments should encourage energy conservation through land use planning and also act to facilitate solar, wind and district heating technologies. Municipal and provincial powers should be used to compel utilities to develop energy conservation and peak load

TABLE 5-1

URBAN POLICY OPPORTUNITIES FOR ENERGY CONSERVATION

POLICY THRUST	TOOLS	FOCUS
Land use planning and building design.	The Official Plan	- Encourage land use actors to guide their actions according to principles of energy conservation.
	Restricted area zoning by-law	- Regulate characteristics of built environment: density, building types and use; building and street orientation; set backs and heights; land use mix, open space, outdoor lighting. - Facilitate alternative energy systems - Facilitate public transit; restrict use of private cars; create mixed use activity centers/nodes; reduce road congestion.
	Subdivision/special projects site plan agreements	- Subdivision lot layout (orientation), building design' landscaping levels: building colour. - Agreements between developers and municipalities on building design; insulation and glazing levels; alternative energy technologies. - Bonusing techniques: higher density allowed in exchange for incorporating energy conserving features.
	Building inspection process	- Ensure energy conservation measures of provincial building codes are implemented.
Facilitation of alternative energy supplies	Zoning legislation	- Facilitate renewable technologies: solar, wind.
	Resource recovery programmes	- Conversion of waste to energy - Development of district heating and cogeneration system.

TABLE 5-I (cont'd)

POLICY THRUST	TOOLS	FOCUS
	Municipal powers	- Compel utilities to develop energy conservation and peak load management programmes.
Dissemination of information	Demonstration programmes	- Car pools, solar heating, energy efficient building designs, site planning, district heating, energy management.
	Provide technical advice to development industry	- Building design and construction methods. - Legal and zoning requirements. - Availability of senior government subsidies and programmes.
	Auditory and census facilities	- Facilitate projection of energy demand. - Conduct local sectoral audits of energy consumption patterns.
Use of subsidies and grants	Taxation, licensing	- Facilitate energy management by subsidizing consumers of energy efficient buildings/vehicles. - Rebate property taxes on conservation houses.
	Budget management	- Direct municipal grants to conservation organizations.
	Departmental duties	- Integrate urban strategies with those of provincial and federal governments.

Source: Michael Miloff, Nancy Singer, and Geoff Hare, "Municipalities and Energy Management," in Fred Curtis, *Considerations and Opportunities for Energy Conservation in Urban and Regional Planning: Conference Proceedings, March 9-11, 1979,* (Queen's University, Kingston: School of Urban and Regional Planning), pp. 4.2-4.8.

programmes as a means of initiating municipal energy budgeting programmes. Also, a strong leadership role is needed in initiating a variety of demonstration programmes as well as providing technical advice to the development industry on energy conservation practices.

These changes in municipal roles also mean significant changes in the size of local administrations. As well, funding for these activities needs to be provided. Difficulties in raising sufficient funding for current local government expenditures from local tax bases and other conventional provincial grants are already present. The burden of additional municipal expenditures resulting from the development of energy conservation programmes may require more financial support from provincial and federal governments. It is possible, though, that many of these programmes would pay for themselves.

The federal government and some provincial governments, primarily Ontario's, are making efforts to study and develop energy management programmes. A partial list of federal and provincial studies in these areas is provided in Table 5-2. Further federal initiatives are summarized in Table 5-3.

Observation of these two tables suggests to me that there is general interest from both federal and provincial governments on the one hand in developing a comprehensive approach to energy conservation with interest in urban form, land use patterns and energy-efficient societies. But on the other hand, federal action is not towards comprehensive management programmes, but towards more pragmatic concerns with energy end use sectors such as buildings, transportation, and industry.

TABLE 5-2

FEDERAL AND PROVINCIAL INVESTIGATIONS
INTO SECTORAL ENERGY USES

AUTHOR	TITLE	FOCUS
FEDERAL:		
Energy, Mines & Resources	*Energy Conservation in Canada: Program and Perspectives*	General Sources
	An Energy Strategy for Canada	General Sources
Chibuk, J. (MSUA)	Energy and Urban Form	Land Use Arrangements
Hailstone, P. (*HABITAT*)	Energy in Urban Planning	Land Use Arrangements
Kirkland, J.S. (MSUA)	*Residential Land Requirements in Urban Canada*	Land Use Arrangements
Connolly, J. (CMHC)	*Housing and Energy--Considerations for the Development of a Comprehensive Policy*	Building Form
National Research Council of Canada	*Proceedings: First Canadian Building Congress: Energy & Buildings*	Building Form
Associate Committee on National Building Code	*Measures for Energy Conservation in New Buildings*	Building Form
Berkowitz (EMR)	*Implementing a Solar Technology in Canada*	Alternative Tech.
Peters, Roger (EMR)	*Techniques of Community Energy Conservation*	Socio-Economic
Science Council of Canada	*Canada as a Conserver Society*	Socio-Economic
PROVINCIAL:		
Ontario Ministry of Energy	*Ontario Residential & Commercial Energy Demand Study*	General Sources
	Energy Conservation Opportunities for Municipalities	General Sources

TABLE 5-2 (Cont'd)

AUTHOR	TITLE	FOCUS
Carroll, J. (Ontario Housing)	"User Study Shows Resident Approach of Zero Lot Line Concept"	Land Use Arrangements
Cridland, P. (Ontario Housing)	"Human Settlement in Consumer Society"	Land Use Arrangements
Edmonton Regional Planning Commission	*Conserving Our Resources*	Land Use Arrangements
Hix, J. (Royal Commission, Ontario)	*Energy Demand for Future and Existing Land Use Patterns*	Land Use Arrangements
Energy Research Group (RC, Ont.)	*The Cost and Impact of Solar Energy Insulation in Ontario*	Building Form
Ont. Min. of Energy	*Energy Conservation in Public Buildings*	Building Form
Acres Shawinivn (RC, Ont.)	*Hydro Electric Potentials and Other Renewable Energy Sources Remaining in Ontario*	Alternative Tech.
	District Heating Study	Alternative Tech.
Carroll, J. (Ontario Housing)	"Solar Energy"	Alternative Tech.
	"Ontario Looks at European Style District Heating"	Alternative Tech.
Ont. Min. of Energy	*Perspectives on Access to Sunlight*	Alternative Tech.
Canadian Resourcecon (Ont. M.E.)	*Transportation Energy Demand Analysis for Ontario*	Transportation
Urban Transportation Development Corp. (Royal Commission)	*Moving Into an Energy Efficient Society*	Transportation

Source: Fred Curtis, *Considerations and Opportunities for Energy Conservation in Urban and Regional Planning: Conference Proceedings, March 9-11, 1979,* (Queen's University, Kingston: School of Urban and Regional Planning), BIBLIOGRAPHY.

TABLE 5-3

INITIATIVE FOR APPLICATION OF ENERGY CONSERVATION AND RENEWABLE ENERGY AT THE NATIONAL (FEDERAL) LEVEL BY ENERGY-USE SECTORS

	CONSERVATION	RENEWABLE ENERGY
INDUSTRY	- Improve operating and maintenance - Retrofit or existing processes	- Development and implementation of new processes
TRANSPORTATION	- Minimum fuel economy standards for automobiles - Shifts to higher efficiency modes - Speed limits (provincial jurisdiction)	- Substitution of telecommunications for physical transportation - Forest biomass development
BUILDINGS	- Reduced air infiltration, increased insulation levels, improved HVAC systems - CHIP - Energy codes - Improved information - Low energy building design awards - Improved heating system efficiencies - Heat pumps/thermal storage - Retrofitting - District heating	- Solar heating - Research & development - Thermal storage technology - Replacement cost pricing - Demonstration projects e.g. Saskatchewan house.
APPLIANCES	- Energuide labelling programme - Minimum efficiency standards	

Source: Summarized from J. T. Brett, "Update on Canada's Energy Picture --Considerations for Planning," in Fred Curtis, *Considerations and Opportunities for Energy Conservation in Urban and Regional Planning: Conference Proceedings, March 9-11, 1979*, (Queen's University, Kingston: School of Urban and Regional Planning), pp. 1.18-1.27.

From the list of studies in Table 5-2 it can be seen that very few specifically address the issue of urban form and energy consumption. Chibuk's paper, *Urban Form and Energy: A Selected Review* and research by Middleton Associates are the most extensive Canadian works in this subject area and have been referred to extensively in Chapter 2. At the provincial level, the study of the Edmonton Regional Planning Commission is the only Canadian study this writer is aware of which considers impacts of urban form on an urban area scale.

The Regional Planning Commission's general review of future growth issues facing Edmonton concludes that a redevelopment approach is the best alternative for that city to pursue in its attempt to take advantage of existing infrastructure. Energy consumption is not a major focus of the Edmonton study. The potential for reducing energy consumption, however, is enhanced through opportunities offered by redevelopment. This is consistent with the evaluation of growth strategy alternatives for Calgary presented in Chapter 3 of this paper.

Table 5-3 lists some federal initiatives for energy conservation and renewable energy directed at the end use sectors. The summary is provided from the proceedings of a recent conference on energy conservation opportunities in urban and regional planning. The initiatives listed reflect the state of the art for energy conservation based on end-use sector energy demands. Whereas the Table indicates that a great deal of effort is put into energy conservation, there is still lacking the initiative from the federal government to introduce energy conservation programmes related to urban form factors.

The lack of both federal and provincial initiatives for conserving energy by addressing urban form factors creates the opportunity for advocating initiatives in this area. Section 5.5 discusses recommendations which senior governments might consider with regard to urban form and urban land policies.

5.5 Federal and Provincial Roles

This section discusses responsibilities and roles the federal and provincial governments may consider it advisable that they should assume in the interests of developing a comprehensive approach to energy conservation specifically addressing urban land policies.

Although urban form is known to influence energy consumption, currently there is a great deal of detailed information lacking in the area of urban end use energy consumption. Prior to the development or urban energy conservation programmes, more intensive investigations or urban energy consumption patterns should be undertaken.[14] At the federal level, assistance in providing technical advice and funding for municipal energy audits should be provided. Employment in municipal energy auditing positions with municipal planning or public works departments may be created through federal financial contributions. The federal Conservation and Renewable Energy Branch of the Department of Energy, Mines and Resources, perhaps in conjunction with Central Mortgage and Housing Corp., could administer such a programme. Further financial support for research at the universities may be helpful for the development and enhancement of methods for urban energy audits. For example, the research funded by the Department of Energy, Mines

and Resources and the Ministry of State for Urban Affairs at York University, Faculty of Environmental Studies has provided a method for modelling energy consumption patterns in the Toronto region.[15]

At a level different from information and research, the federal government should be encouraged to consider the development of a national urban policy.[16] Included in the urban policy should be a special area which focusses on the location of new urban developments in relation to others on a regional and national scale from an energy use and conservation perspective.

A major difficulty to overcome is the incompatibility of federal and provincial policies in areas such as regional growth and decentralization. For example, federal programmes such as DREE are concentrated in hinterland areas whereas provincial programmes of industrial decentralization are located in designated growth centres. Given the present debate on constitutional powers, it may be necessary that the provincial governments take more responsibility for the development of provincial urban policies, a course which may relegate the federal government's role to that of providing incentives which the provincial governments may adopt.

Clearly, the provincial governments' role in developing a comprehensive approach to energy conservation and urban land policies is significant. Provincial statutes presently regulating urban land use policies, such as planning and municipal acts, require energy impact assessments neither for existing developments nor for current and future subdivision proposals. It is suggested that there is an opportunity ...

> ... through the process of plan preparation and review, of making meaningful long run contributions in terms of energy savings. However, unless the energy consequences of proposed projects are considered at a sufficiently early stage in the planning process, many of the available opportunities for conserving energy will be lost ... basically an extension of environmental assessment (energy impact assessment) seeks to uncover the energy-related consequences of proposed plans or projects before they are implemented ...[17]

This process of assessment compares the energy requirements of proposed developments to the environmental setting of existing energy supply and use patterns in the urban area or region. This implies the earlier advanced necessity of conducting urban energy audits. The role of the provinces in assisting their municipalities in conducting these audits may be more important than thought at first glance. The requirements for energy audits and energy impact assessments have the potential of being initiated, implemented and regulated by such provincial legislation as municipal planning statutes.

A number of incentives from both the federal and provincial governments should be offered to municipalities to motivate them in energy conservation programmes. These should include:

- Provision of grants to develcp official plans and appropriate legislative mechanisms.
- Making available to municipalities, trained staff and resources.
- Sponsoring of good building designs.
- Development of model legislation (e.g. solar rights and energy conserving building codes).
- Direct subsidies to users and developers.[18]

Provincial governments should set conservation targets and emphasize priority energy management programmes. It is important to note that "... energy audits and surveys would be useful aids in this target-setting process, as they would establish an understanding of

patterns of energy supply and demand."[19]

Another area where the provincial government should take action is in legislative requirements for cities to prepare and review general plans. Chapter 3 describes a difficulty Calgary encountered in reviewing its general plan. If energy consumption is not raised as an issue at the municipal level, the provincial government should take responsibility for the public interest by ensuring that it receives appropriate attention.

Further to this, provisions in the application for subdivision and annexation, reviewed by respective provincial municipal affairs departments and regional planning commissions, should include accountings of energy consumption requirements. This recommendation would require development corporations and civic governments to consider urban form factors and energy consumption issues in their day-to-day activities.

Energy audits, and energy impact assessment offer alternative tools for implementation of the recommendations outlined above.

This discussion suggests two major (or general) areas for federal and provincial support: the development of municipal energy audits; and the development of complementary programmes and policies at national and regional levels which are directed toward energy conserving urban land policies. Table 5-4 provides an overview of their roles.

5.6 Summary and Conclusion

This chapter has presented a broad discussion of federal and provincial roles in developing an energy conserving urban land policy.

TABLE 5-4

FEDERAL AND PROVINCIAL ROLES IN DEVELOPING
MUNICIPAL ENERGY AUDITS AND URBAN LAND POLICIES

	ENERGY AUDITS	LAND USE POLICY
FEDERAL	Financial Staff & resources Research	National settlement policy Regional development policy Urban renewal Public transportation at regional level Administration
PROVINCIAL	Financial Administrative Conservation targets Staff & resources Model legislation	Energy impact assessment Decentralization policy Growth management policy Regional planning Official plan preparation

Discussions of the national energy budget and of current federal and provincial programmes were followed by an advocacy of energy audits and other incentives to develop energy conserving urban land policies.

A strong recommendation for federal and provincial support in developing municipal energy audits has been made, due to the need for understanding urban energy supply and demand patterns. The development of national and regional settlement policies is recommended as providing another level of energy management in order to establish an understanding of regional energy-use patterns. At the provincial level, the requirement for and assistance to incorporating energy conservation targets in official plans, and to the development of items such as energy impact assessments for new developments, have been made as a means of directing municipalities towards energy conserving land policies.

FOOTNOTES

[1]David G. Bettison, *The Politics of Urban Development*, Volume I, (Edmonton: The University of Alberta Press, 1975), pp. 16-17. The reader is encouraged to consult the above reference for an elaboration of provincial and federal roles in urban affairs, especially the section in the introduction, "The Relative Inconsequence of Provincial Decisions in Urban Affairs," pp. 9-18. The remaining chapters of this text elaborate on federal government programmes and policies influencing urban renewal, administration and finance, and city centres.

[2]*Ibid.*, p. 8.

[3]J. T. Brett, "Update on Canada's Energy Picture -- Considerations for Planning," in Fred Curtis, *Considerations and Opportunities for Energy Conservation in Urban and Regional Planning: Conference Proceedings, March 9-11, 1979*, (Queen's University, Kingston: School of Urban and Regional Planning), p. 1.6.

[4]An analogous example of these types of problems is documented in a study conducted by the Faculty of Environmental Design. This study investigated the social and environmental impacts on Vegreville, Alberta, associated with the location of an Environmental Sciences Research Centre in this rural community. The reader is referred to: *Environmental Research Centre and Laboratory, Vegreville: Impact Assessment.* A report analysing the probably social, economic, political and environmental impacts associated with the location of a scientific research centre and laboratory in the town of Vegreville, Alberta, prepared by members of the Faculty of Environmental Design at the University of Calgary for the Alberta Government Departments of Environment and Housing and Public Works, January, 1976.

[5]The reader is referred to *Time*, April 16, 1979, pp. 30-44 for an overview of Islam documented in a special report, "The World of Islam." The influence of Islam on OPEC policies was gleaned from a CBC documentary presentation on the programme, *Man Alive.*

[6]Ontario and Alberta are perpetually arguing the price of energy in interprovincial debate. Alberta has the energy supply and Ontario wants it. Alberta wants to sell Ontario the energy at current world prices for oil. Ontario insists that the price of Alberta's oil should be less than the world price. At the national level, taxes from the higher price for domestic oil are used to offset the cost of expensive imported oil through a special price equalization programme, the Oil Compensation Fund.

Saskatchewan and Alberta are both eager to develop energy resources within their provinces. Alberta would like to proceed with tar sands developments. Saskatchewan would like to proceed with uranium

mining in northern Saskatchewan as well as participate in tar sands development in the Western areas of the province. Federal assistance to these provinces is subject to political debate and establishing priorities as to which energy project comes on stream at which time.

[7]J. T. Brett, "Update on Canada's Energy Picture -- Considerations for Planning," in Fred Curtis, *Considerations and Opportunities for Energy Conservation in Urban and Regional Planning: Conference Proceedings, March 9-11, 1979,* (Queen's University, Kingston: School of Urban and Regional Planning), p. 1.28.

[8]Energy, Mines and Resources, *An Energy Strategy for Canada,* (Ottawa: Ministry of Supply and Services, 1976).

[9]G. V. Jump, and T. A. Wilson, "Macro-Economic Effects of the Energy Crisis, 1974-1975," (EVDS, 693.14 Reading File).

[10]J. T. Brett, "Update on Canada's Energy Picture -- Considerations for Planning," in Fred Curtis, *Considerations and Opportunities for Energy Conservation in Urban and Regional Planning: Conference Proceedings, March 9-11, 1979,* (Queen's University, Kingston: School of Urban and Regional Planning), p. 1.30.

[11]J.H. Chibuk, *Energy and Urban Form,* (Ottawa: Ministry of State for Urban Affairs, June, 1977), p. 8.

[12]*Ibid.*

[13]S. R. Tyler, "Report: Energy Conservation and Regional Planning," (University of Calgary: Faculty of Environmental Design, March 16, 1979).

[14]This writer is aware of two methodological approaches for investigating urban energy consumption. W.A. Ross has drafted a framework for measuring energy use in cities. The Ross model is based on conventional sectoral accounting which provides a total annual energy consumption future for cities derived from the sum of residential, industrial and commercial, and transportation energy end uses. This draft is untitled and unpublished, dated 78-07-05. Patterns of energy use of six municipalities in Metropolitan Toronto have been documented in a York University Study. Similar in concept to the Ross model, four sectoral methods are used to quantify the total annual energy consumption by summing commercial, industrial, transportation and residential end uses of energy. G. Desfor, G. Hare and L. Hass describe these methods employed for a municipal energy audit in "Patterns of Urban Energy Utilization," in Fred Curtis, *Considerations and Opportunities for Energy Conservation in Urban and Regional*

Planning: Conference Proceedings, March 9-11, 1979, (Queen's University, Kingston School of Urban and Regional Planning), pp. 2.0-2.27.

[15]Fred Curtis, *Considerations and Opportunities for Energy Conservation in Urban and Regional Planning: Conference Proceedings, March 9-11, 1979,* (Queen's University, Kingston: School of Urban and Regional Planning), pp. 2.0-2.27.

[16]The reader is referred to David G. Bettison, *The Politics of Urban Development,* Volume I, (Edmonton: The University of Alberta Press, 1975) for a discussion of a Canadian urban policy presented in Chapters 6, "Urban Policy for Canada, 1969 to 1971," and 7, "The Federal Direction, 1935 to 1971, and Some Conclusions." The complexities of development of such a broad policy are elaborated on here.

[17]C. Rabenda, "Energy Impact Assessment: What Can Planners Learn From the California Example," in Fred Curtis, *Considerations and Opportunities for Energy Conservation in Urban and Regional Planning: Conference Proceedings, March 9-11, 1979,* (Queen's University, Kingston: School of Urban and Regional Planning), p. 9.0.

[18]M. Miloff, N. Singer, and G. Hare, "Municipalities and Energy Management," in Fred Curtis, *Considerations and Opportunities for Energy Conservation in Urban and Regional Planning: Conference Proceedings, March 9-11, 1979,* (Queen's University, Kingston: School of Urban and Regional Planning), p. 4.9.

[19]*Ibid.,* p. 4.10.

CHAPTER VI

SUMMARY AND RECOMMENDATIONS

6.1 Purposes

The scope of this paper is broad and this chapter is intended to summarize the material presented in the preceding chapters. Recommendations which follow from, or which have been identified in, other sections of this paper are reiterated for the reader's benefit.

6.2 Energy Consumption in Canada: A Problem of Cities

Canada's annual per capita consumption of energy is one of the highest in the world. Canada's end uses of energy are largest in the industrial, transportation and residential sectors. These are primarily urban end uses.

The evolution of urban settlements in Canada is the result of the pursuit of the national goals of economic development and progress. Foreign, national and provincial government policies have all influenced the establishment and development of Canadian cities. The problem of energy consumption in Canada is therefore a problem of cities.

While Canadian cities have been successful in achieving higher national goals, the consumption of energy so necessary for a city's survival has taken place without monitoring the amount of, or the rate of, energy consumption. Furthermore, Canada's urban growth has occurred without investigation as to the impacts of unchecked energy consumption on the urban future.

The consideration of using urban land policy as a means of reducing urban energy consumption is proposed in Chapter I. General guidelines for desirable urban land policies, an assessment of the feasibility of their implementation, a case study of urban land policy and analysis, and an overview of federal and provincial governments' roles are discussed in the following chapters.

6.3 Urban Form Factors Influencing Energy Consumption

The relationship between urban form and energy consumption is discussed in Chapter II. Land-use parameters, land-use arrangements, urban shape, intracity travel and the delivery of services have an impact on urban energy consumption. The ability of urban land policy to reduce energy consumption through controlling urban density, urban pattern and shape, and urban land-use arrangements is potentially enormous.

Recommendations for desirable energy-sensitive urban land policies are also discussed in Chapter II and summarized in Section 2.10. They are:

1) Urban form should be developed at higher densities in residential, commercial and industrial sectors.

2) Urban areas should be of 50,000 to 100,000 people. They should be either compact rectangular or concentric form and arranged in polucuclear, linear or concentric patterns and shapes.

3) Urban land-uses should be mixed and integrated.

6.4 An Assessment of the Feasibility of Formulating and Implementing an Energy-Sensitive Urban Land Policy

Chapter III presents a discussion of formulating and implementing an energy-sensitive urban land policy. Policy-making models are

discussed along with descriptive models of urban political systems and policy constraints.

The policy-making models are the rational, incremental and mixed-scanning. The most realistic policy-making approach for formulating an energy-sensitive urban land policy appears to be that of mixed-scanning. In the mixed-scanning model of policy formulation, the goal of an energy-sensitive urban land policy is recognized to be in competition with other urban goals which are simultaneously demanding the attention and resources of municipal governments. Therefore, unless more attention and resources are directed twoards an energy-sensitive urban land policy, the move towards such a goal will be very slow and, optimistically, gradual in its implementation.

A discussion of political demand and support for an energy-sensitive urban land policy is presented in Section 3.5. A description of policy constraints impacting on an energy-sensitive urban land policy is also presented with the assistance of a constraint model developed by D. D. Detomasi.

6.5 Urban Land Policy Analysis: Growth Strategy Options and Energy Consumption

A detailed discussion of the formulation of urban land policy for Calgary, Alberta is presented in Chapter IV. The methods of generating, evaluating and selecting a growth strategy employed by the City of Calgary are discussed. An application of the policy-making models described in Chapter IV to the process of policy formulation indicate that the models are not mutually exclusive. Some aspects of each model are useful in describing some feature of a single policy-formulation process.

Opportunities for reducing energy consumption in Calgary presented themselves in the development of growth strategies. An assessment of the Balanced Growth and Compact City strategies indicated that the latter was the least energy consumptive. Several factors and constraints influencing the formulation and selection of a growth strategy for Calgary were identified using the policy-making models described in Chapter III.

6.6 Provincial and Federal Governments: Powers and Policies

An examination of Canada's energy budget and demand for oil in Chapter V reveals how Canada's large per capita energy consumption ratio exacerbatesnational economic problems. These economic problems include: a large balance of trade deficit; a restrained gross national product; a higher rate of inflation; and, greater levels of unemployment. Provincial governments should have equal interest in conserving energy since the national economic repercussions from high energy cost and consumption will be experienced in provincial economies, and in the cities of ten provinces.

Federal and provincial governments should take a stronger lead in providing assistance to municipal governments for the development of energy-sensitive urban land policy.

Specifically, the federal government should provide assistance for research and modeling of urban energy end use on a sectoral basis for individual cities. Financial assistance for the staffing of municipal administrations from federal sources are recommended to develop and implement desirable policies. The federal government should also evaluate the energy consumption requirement of the present pattern

of urban settlement with a view towards the development of national and regional settlement policies to reduce energy consumption. Since urban renewal presents a great opportunity for energy conservation, the federal government should lend assistance to municipalities for such projects.

Recommendation for provincial governments are also presented in Chapter V. Provincial support should be given to municipalities for energy audits, energy impact assessments and administration. Provincial governments should also take leadership roles in the development of legislation regulating municipal plan preparation, as well as develop their own energy conservation targets.

SELECTED BIBLIOGRAPHY

Abelson, Philip H. "Intercountry Energy Comparison." *Science* 199: 4329. February 10, 1978, p. 606.

Bauer, Raymond A., and Gergen, Kenneth J. *The Study of Policy Formulation.* New York: Free Press, 1968.

Bettison, David G. *The Politics of Canadian Urban Development.* Edmonton: The University of Alberta Press, 1975.

Bourne, Larry S., Mackinnon, Ross D., Siegel, Jay, and Simmons, James W. *Urban Futures for Central Canada: Perspective on Forecasting Urban Growth and Form.* Toronto: University of Toronto Press, 1974.

Chibuk, John H. *Energy and Urban Form.* Ottawa: Ministry of State for Urban Affairs, June, 1977.

_____. *Urban Form and Energy: A Selected Review.* Ottawa: Ministry of State for Urban Affairs, July, 1977.

City of Calgary. *The Calgary Plan.* (Proposed), Planning Department, June, 1977.

_____. *The Changing Population of Calgary.* (Background Paper No. 1), April, 1976.

_____. *The Economy of Calgary.* (Background Paper No. 2), May, 1976.

_____. *Transportation in Calgary.* (Background Paper No. 3), May, 1976.

_____. *Housing in Calgary.* (Background Paper No. 4), April, 1976.

_____. *The Role of the Downtown.* (Background Paper No. 5), July, 1976.

_____. *Leisure Time Activities In Calgary.* (Background Paper No. 6), April, 1976.

_____. *Growth in Calgary.* (Background Paper No. 7), July, 1976.

_____. *The Role of the General Plan.* (Background Paper No. 8), July, 1976.

_____. *Financial Resources.* (Working Paper No. 1), August, 1976.

_____. *Development and Policy Constraints.* (Working Paper No. 2), September, 1976.

_____. *Provisional Guidelines for the Development of A Strategic Monitoring System.* (Working Paper No. 3), February, 1977.

_____. *Techniques to be Used in the Generation and Evaluation of Alternative Strategies.* (Working Paper No. 6), September, 1976.

_____. *Generation of Alternative Growth Strategies.* (Working Paper No. 7), December, 1976.

_____. *Identification of Objectives and Population Groups for the Goals Achievement Matrix.* (Policy Discussion Paper No. 1), October, 1976.

_____. *The Evaluation of Alternative Strategies for Calgary.* (Policy Discussion Paper No. 3), January, 1977.

_____. *The Adopted Strategy.* (Policy Discussion Paper No. 4), May, 1977.

Curtis, Fred. *Considerations and Opportunities for Energy Conservation In Urban and Regional Planning: Conference Proceedings, March 9-11, 1979.* Queen's University, Kingston: School of Urban and Regional Planning, 1979.

Curtis, Virginia. *Land-Use Policies.* Chicago: ASPO, 1970.

Dahl, Robert A. *Modern Political Analysis.* Englewood Cliff: Prentice-Hall, 1963.

Desfor, Gene, Miloff, Michael, and Hass, Laurence. *Urban Form and Energy Consumption.* Toronto: Middleton Associates, March, 1979.

Edmonton Regional Planning Commission. *Conserving Our Resources.* Edmonton: The University of Alberta Press, 1975.

Etzioni, Amitai. *The Active Society.* New York: Free Press, 1968.

Faludi, Andreas. *A Reader in Planning Theory.* Exford: Pergamon, 1973.

Hartle, D.G. *A Theory of the Expenditure Budgetary Process.* Toronto: University of Toronto Press, 1976.

Harwood, Corbin C. *Using Land to Save Energy.* Cambridge: Ballinger, 1977.

Hawkins, Brett W. *Politics and Urban Policies.* Indianapolis: Bobbs-Merrill, 1971.

Jacobs, J. *The Economy of Cities.* New York: Random House, 1969.

Kolter, Milton. *Neighbourhood Government.* Indianapolis: Bobbs-Merrill, 1969.

Miles, Simon, Cohen, Sharon, and Curt, de Koning. *Developing a Canadian Urban Policy*. Toronto: Interment, 1973.

Mumford, Lewis. *The City in History*. New York: Harcourt, Brace and World, 1961.

Planning Advisory Service. *Toward a More Effective Land-Use Guidance System*. Chicago: ASPO, 1969.

Plunkett, T.J., and Betts, G. M. *The Management of Canadian Urban Government*. Kingston: Queen's University Press, 1978.

Richardson, Boyce. *The Future of Canadian Cities*. Toronto: New Press, 1972.

Rygole, Dirk. *Energy and Urban Form: The Need for Energy Conscious Urban Planning*. The Johns Hopkins University, Baltimore: Centre for Metropolitan Planning and Research, 1978.

Schipper, Lee, and Lichtenberg, Allan J. "Efficient Energy Use and Well Being: The Swedish Example." *Science* 194: 4269. December 3, 1976. pp. 1001-1013.

Sennett, R. *Classic Essays on the Culture of Cities*. New York: Appleton-Century-Crofts, 1969.

Solesbury, William. *Policy in Urban Planning*. Oxford: Pergamon, 1974.

Stelter, Gilbert A., and Artibise, Alan F.J. *The Canadian City: Essays in Urban History*. Toronto: McClelland and Stewart, 1977.

Tyler, Stephen R. "Report: Energy Conservation in Urban and Regional Planning." Faculty of Environmental Design, University of Calgary, March 16, 1979.

Weber, M. *The City*. New York: The Free Press, 1958.

White, Lynn, Jr. *Dynamo and Virgin Reconsidered*. Cambridge: MIT Press, 1968.

APPENDIX A

PROBLEMS AND OBJECTIVES USED IN GENERATION OF ALTERNATIVE GROWTH STRATEGIES

OBJECTIVES	PROBLEMS
1. To provide for the continuing moderate rate of growth of the City in a manner that does not strain the City's resources and in a manner that minimizes the impact of new development on existing communities.	The population of Calgary is growing rapidly, due to relatively high rates of both natural increase and net inward migration. Too rapid a rate of increase could strain the capacity of the City to cater for the needs of its citizens in respect of housing, employment and various services.
2. To encourage development that will lead to the more efficient utilization of public and private investment in all parts of the city.	At present, population growth is largely being accommodated in new outer suburbs, where the infrastructure is little developed. In contrast to those areas, many older parts of the city are experiencing population decline, with the result that the existing investment in various public and private facilities is being under-utilized.
3. To make more efficient use of land.	Inefficient use is made of some land within the City's boundaries. There are large vacant and developable sites - many of them serviced - which have not been built on because of speculative hoarding of land, obsolete tax regulations, financing difficulties or planning problems.
4. To seek ways of reducing the rate of increase in the cost of undeveloped land in and around Calgary.	The cost of undeveloped land is high and increasing rapidly in and around Calgary.
5. To continue the policy of encouraging the diversification of Calgary's economic base.	Calgary's economic base is heavily dependent on the oil and natural gas industries. To a large extent, these industries owe their presence in Calgary to the existence of a finite and rapidly depleting local natural resource base. The long-term stability of the City's economy must therefore be regarded as problematic.
6. To seek ways of reducing the rate of increase of house prices.	House prices in Calgary have risen dramatically in the past two to three years, making it increasingly difficult for first-time buyers to purchase their own homes.

OBJECTIVES	PROBLEMS
7. To seek ways of assisting 'first-time buyers' to purchase their own homes.	
8. To encourage innovations intended to reduce the cost of housing.	
9. To ensure that housing is provided for all sectors of the housing market.	Certain sections of society must be regarded as being outside the commercial or private housing market, either because their incomes are too low or for one of a number of other reasons. Nevertheless, they have a need for housing, even though there may be no effective demand in a commercial sense.
10. To increase the density of residential development.	The density of residential development in Calgary is relatively low (10 to 15 persons per acre), and is generally felt to be too low to be compatible with the ideals of using land and providing services efficiently.
11. To ensure that sufficient housing is made available to cater for the projected household population.	Projections suggest that household formation rates will continue to exceed population growth until the mid-1980's, thus placing even greater pressure on the demand for housing.
12. To investigate the possibility of obtaining additional funds and providing more incentive for rehabilitation schemes.	Funds and incentives for urban rehabilitation (which mainly come from the senior-government sponsored Neighborhood Improvement and Residential Rehabilitation programs) are limited and fall far short of meeting the potential for rehabilitation. In addition, the existing tax structure is a positive, if minor, disincentive to rehabilitation and improvement schemes.
13. To encourage a more dispersed pattern of social housing.	At present, 'social housing' is concentrated in certain parts of the City. This is environmentally and socially damaging, and helps to arouse opposition to social housing projects in areas which fo not have any at the moment.

OBJECTIVES	PROBLEMS
14. To ensure that adequate transportation facilities are available to all social groups.	Some groups in the community have a relatively low degree of mobility. Either they find the cost of travel within the City too high, or they do not have ease of access to existing transportation facilities. Low-income families and the physically handicapped are both within this category. In addition, the cost of transportation strains the resources of the education system.
15. To encourage a shift towards public transit by investing more energy and resources in the development of improved public transportation facilities.	Although determined efforts are being made to change the balance, the present urban transportation system still gives priority to the private car rather than public transit. Particularly so far as the journey-to-work is concerned, it is doubtful if this emphasis can be sustained in the long run without incurring unacceptably high social, environmental and economic costs.
16. To provide a better spatial balance of transportation services throughout the City.	The present urban transportation system is spatially unbalanced. Some areas are better served than others by the road network, and only parts of the City have access to such services as 'Blue Arrow', 'Express' and 'Dial-a-Bus'.
17. To minimize traffic congestion.	If present trends continue, traffic congestion will increase appreciably in the forseeable future, as the existing road capacity becomes fully utilized.
18. To minimize conflicts between the transportation system and other activities and land uses.	Conflicts are common between the transportation system and activities and land uses adjacent to transportation corridors. Some arise because heavy volumes of traffic undermine the peace, safety and cohesion of residential areas. Others occur because of environmental and ecological damage sustained as a result of transportation activities.
19. To ensure adequate provision for long-term transportation needs.	Long-term transportation needs are not always adequately considered.

OBJECTIVES	PROBLEMS
20. Improve the part of the transportation system that serves the Downtown.	The rapid growth of office developments has placed a heavy strain on transportation systems serving the Downtown.
21. Encourage office development outside the Downtown, in either a nucleated or dispersed pattern.	
22. Encourage a more balanced range of activities and land uses in the Downtown.	The relative importance of the Downtown as a retail and residential centre is continuing to decline, resulting in a loss of vitality and attractiveness.
23. To discourage traffic, which does not need to, from entering the Downtown.	Traffic congestion and other problems in the Downtown are aggravated by vehicles using the City centre as a short-cut to other places.
24. To minimize the loss of better quality agricultural land to urban development.	Urban development has consumed, and is consuming, some of the better quality agricultural land in the vicinity of Calgary.
25. To encourage the conservation of buildings, groups of buildings and sites of archaeological, historical social or architectural value.	Buildings, groups of buildings and undeveloped sites of archaeological, historical, architectural and social value are being demolished and otherwise lost, often by default.
26. To minimize air and noise pollution.	The greater part of the atmospheric pollution affecting Calgary is attributable to the motor vehicle, and it also appears to be largely responsible for noise pollution. The amount of air and noise pollution in Calgary is reaching disturbing levels.
27. To conserve the natural environment in and around Calgary.	Large parts of the natural areas in and around Calgary are being threatened by development, or, where they have been set aside for public use, are being over-used.
28. To provide opportunities for recreational activity on a greater number of levels.	The City only provides certain levels of recreational activity - i.e. its main emphasis is on the amateur level.

OBJECTIVES	PROBLEMS
29. To maximize the level of services from available revenues.	The City's total annual expenditure is fast increasing, viz; 1971-72 - 12%, 1972-73 - 14%, 1973-74 - 17%, 1974-75 - 30%. Present Council policy is to keep property tax increases within the Federal "Anti-Inflation Guidelines", but if total revenues cannot keep pace with expenditure, then a reduction of the level of services is inevitable.

APPENDIX B

A DESCRIPTION OF THE BALANCED GROWTH STRATEGY

This strategy, which may be described as one of balanced growth, is a hybrid formed from a number of the existing Strategies.

The Balanced Growth Strategy is essentially an amendment to Strategy D, the strategy aimed at obtaining maximum efficiency of investment and resources. It is composed of the following:

a) The non-spatial policy package attached to Strategy D (This is described in detail in Policy Discussion Paper No. 2 as amended).

b) A spatial distribution as indicated on the attached map and which may be summarized as follows:

Location of Population Growth:	Built-Up Area	32,000
	Northwest	15,000
	North	30,000
	Southeast	20,000
	South (Midnapore)	29,000
	South (Livingston)	15,000
	TOTAL	141,000

This total of 141,000 exceeds the 127,000 population total referred to in Policy Discussion Paper No. 2 as being the amount required to meet the City's projected growth needs to 1996. This figure is reached because it is recommended that the 1996 population allocation to the Strathcona area be reduced by 14,000. This means that the 1996 population figure for Strathcona will now be 26,000 people, a figure which will not require substantial major road improvements in the area east of Sarcee Trail in the plan period.

Location of Employment Growth: It is assumed that the Downtown will continue to remain the major office employment centre in Calgary and will have 85-90,000 workers by 1996.

Transportation Requirements: This strategy will require the standard road improvements described on Pages 76 and 77 of Policy Discussion Paper No. 3 as amended by the deletions mentioned in paragraph 7.3.

Strategy A: Compact City

This strategy emphasizes a compact form for the city with higher densities within the existing built-up area and limited outward expansion. Public transit is favored over the car with an emphasis on light rail transit where it is viable, improved transportation to the Downtown and a more limited role for the car in the inner city.

The function of the Downtown is strengthened by maintaining its role as the major employment centre and by increasing the proportion of shopping, recreational and cultural uses in the Downtown. The strategy makes the Downtown core more compact and more oriented to pedestrian movement.

To achieve the more compact city that the strategy advocates, it would be necessary to increase residential densities throughout the city and particularly within major transit corridors especially along the Macleod Trail corridor to the south and the Crowchild Trail corridor to the northwest. The strategy stresses greater efficiency of land use by encouraging a greater mixture of land uses and housing types and more multi-purpose buildings. New development would be concentrated in as few locations as possible so as to engender greater efficiency and to conserve agricultural land.

As this strategy emphasizes more development within the existing city, a primary aim in allocating the 127,000 additional people by 1996 was to accommodate a sizable proportion of it within the existing urban area over and above those committed by virtue of development already approved. This could be achieved by:

(a) developing vacant land that is not committed,

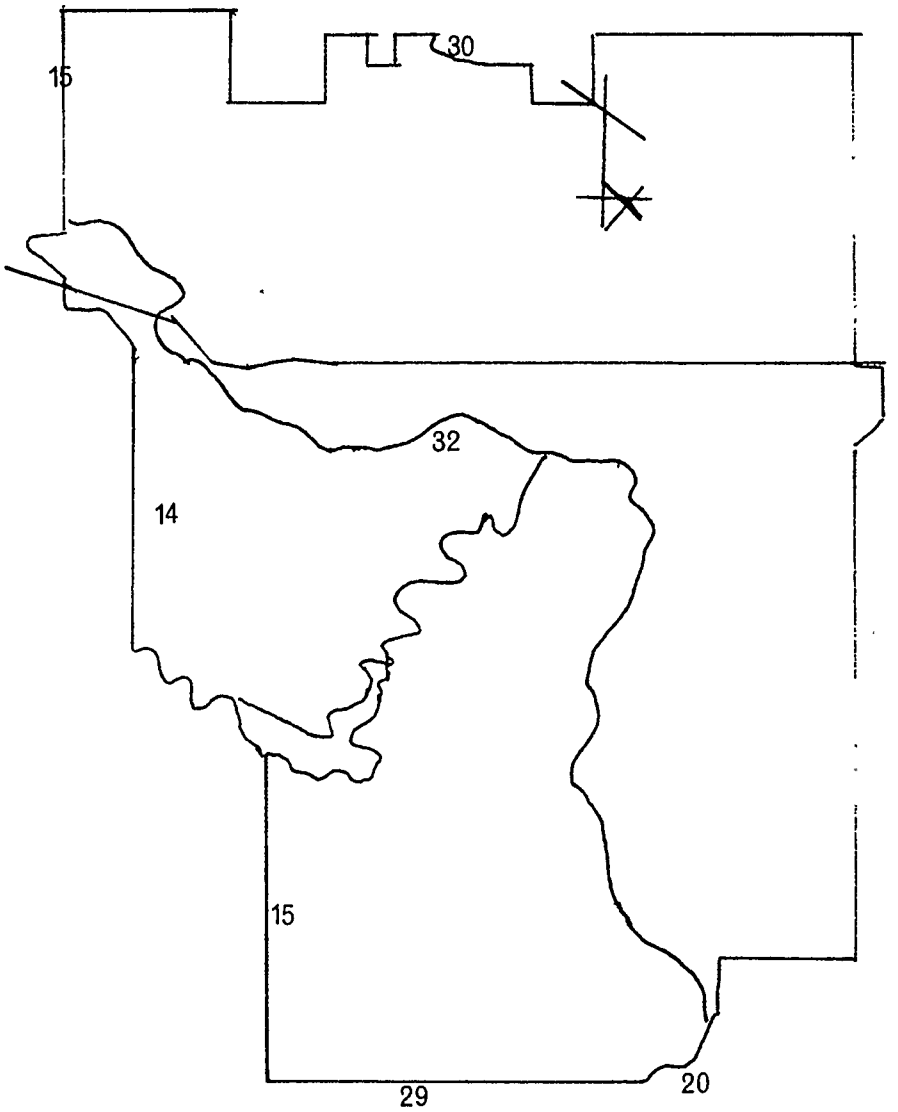
(b) developing land used at a low intensity for residential purposes, e.g. some drive-in theatre sites and surface car parks,

(c) redevelopment of some existing residential areas at a higher density.

A study was undertaken of the existing built-up area of Calgary to get a rough idea of potential that exists within the three categories referred to above. The results of the study, which are summarized in Appendix 7, show that from a preliminary examination there would appear to be the potential to accommodate a further 109,000 within the urban fabric. Applying the 25% reduction factor used for the committed development, this means that there is room for about 80,000 extra people within the existing urban area. This population has not been allocated to specific sites; just to the existing built-up area as a whole; if the strategy is selected as the preferred one a more detailed study will be undertaken to allocate the people to specific sites.

To accommodate the balance of 47,000 people new areas outside the existing built-up area would have to be opened up. It is suggested that such areas should concentrate on the two mass transit corridors proposed to the south and to the northwest. Consequently the additional population has been allocated to the area immediately adjoining the northwest end of the corridor (24,000) and immediately adjoining the south end (23,000).

BALANCED GROWTH: New Population Distribution (thousands)



COMPACT CITY : New Population Distribution (thousands)