Energy Strategies towards Sustainability: a comparative analysis of community energy plans from Sweden and Canada

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Abstract

This thesis examines community energy planning in Sweden and Canada with the aim of revealing strategies that move communities towards energy sustainability. Unsustainable energy activities are identified as major threats on both local and global levels. The challenges for energy systems are discussed and a possible scenario of a future community with sustainable energy production and consumption is presented. The literature review examines community energy planning guidebooks and key theoretical and methodological concepts including ingenuity, soft energy paths and backcasting from socio-ecological principles of sustainability. Following an analysis of energy supply and demand in a broad systems context, and a review of policies and programs supporting or hindering community energy planning, energy plans from eleven Swedish and eleven Canadian communities are evaluated. Characteristics of progressive energy planning as uncovered in the literature review form a framework for evaluating the visions, strategies and actions described in the plans. Sweden is recognized as an early player in community energy planning. Although Swedish energy plans do not contain all of the identified progressive strategies, national leadership and funding have played a role in Sweden's successes. More recent Canadian plans are found to be highly progressive, suggesting that Canadian communities who follow their plans can too be successful in transforming their energy systems towards sustainability.

Keywords

Community Energy Planning; Community Energy Systems; Sustainability; Backcasting

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Executive Summary

Energy activities taking place within Canadian and Swedish communities contribute to major threats to humanity such as air pollution and climate change. A vision for the future is one where community energy activities do not contribute to the systematic degradation of ecological and social systems. The challenge is to make community energy systems safe, affordable, convenient, reliable and equitable while also meeting principles, or conditions for socio-ecological sustainability.

This thesis identifies the *community energy plan* as the key strategic planning document for guiding a community's energy activities towards sustainability. A successful community energy plan incorporates a clearly articulated vision and effective strategies for making the vision a reality.

To carry out a comparative investigation of community energy plans from Sweden and Canada, the primary research question is asked: *How can strategic energy planning assist Swedish and Canadian communities to move towards sustainability?* Supporting questions enquire about the current energy supply mix and potential renewable energy sources in Sweden and Canada. A series of questions are raised concerning how communities describe success and what strategies and actions are typically found in energy plans. Tools described in the plans such as Decision Support Systems are investigated. And because community energy planning takes place within the broader context of national or federal policies and programs, these are also briefly examined.

To provide the necessary background, relevant literature is reviewed and key theoretical concepts and progressive energy planning strategies revealed in interviews with energy planning practitioners are identified. These findings and a basic discussion of Swedish and Canadian geography, energy resources and population are synthesized to form the basis for the primary research described herein: the analysis of selected Swedish and Canadian community energy plans.

Key theoretical concepts include Homer-Dixon's ingenuity model, the recognition that ingenuity is required in both social and technical domains to solve the increasingly complex problems faced by society. Another is the soft energy path or soft path strategies originally described by Amory Lovins.

A third theoretical concept is that of backcasting from scientifically-derived socio-ecological principles of sustainability. These ‘system conditions’ for sustainability are derived from the laws of thermodynamics. In this thesis these concepts are synthesized, forming a scientifically robust basis for the analysis of community energy plans.

Building on this theoretical foundation, progressive energy planning strategies used to evaluate the plans are categorized in two groups, those pertaining to the planning process and those pertaining to technical energy systems. For the purpose of our thesis, we define ‘progressive strategies’ as those that include the necessity of all stakeholders engaging in a community-driven process and sharing a common understanding of socio-ecological principles of sustainability. Having a common vision with defined goals in the context of a politically-supported process where all municipal departments are aware of and engaged in the process are also key determinates of a successful plan. Importantly, an integrated strategic plan for the whole energy system and detailed planning of concrete subsystem projects is warranted. Further, having a plan that looks over a long time frame, ideally upwards of 50 years, allows major infrastructure decisions to be anticipated and viewed as opportunities for increased efficiencies at the landscape scale. Finally, an iterative plan - one designed for continuous improvement with linkages with other municipal planning documents - is a key determinant of a successful community energy planning process.

Technical strategies for energy systems are also critical to the success of a community energy plan. These can include concepts of efficiency, dematerialization, and substitution as basic goals for transitioning the current energy system towards sustainability. A community’s energy system requires a plurality of solutions on both the supply and demand sides with diverse individual contributions to the energy supply, not unlike the way in which an ecosystem behaves. Being aware of the negative externalities associated with fossil fuels and other non-renewable energy resources such as uranium, a successful strategy for moving a community’s energy system towards sustainability is to opt for renewable energy technologies where feasible. Decisions made based on full cost accounting with an understanding of the tradeoffs can help support these choices that tend to be longer-term and more whole-systems in nature. Importantly, energy technologies selected should be flexible and relatively low technology. Energy generating installations should be matched in scale and geographical distribution to end-use needs.

Finally, progressive technical strategies include mitigation of energy demand through matching energy quality appropriately to end-use needs.

In applying these strategies to the analysis of the plans, it was found that Swedish plans contained some but not all of the strategies identified as progressive. Created in the context of a national law on energy planning, Swedish communities enjoy a simplified energy planning process and a clear jurisdiction over energy supply and distribution infrastructure. This reality and the fact that some Swedish communities have been planning their energy systems for almost 30 years would suggest that many process-related strategies do not need to be explicitly stated in Swedish community energy plans. Notably absent from the Swedish plans however, was public engagement in the energy planning process. In terms of technical strategies, Swedish plans were characterized by a move away from fossil fuels for heating and electricity generation and a move towards district energy systems fueled by biomass and waste. This combination of clear national leadership and progressive technical strategies reveals Sweden as an energy planning pioneer. Importantly, continuous monitoring activities in Swedish communities mean that the results of their energy planning activities can be quantified and reported back to the community to confirm if they were in fact successful.

In contrast, Canadian plans were found to contain numerous highly progressive strategies, but differed in their scope and objectives. Some of the progressive process-related strategies found in the Canadian plans included that the plans had political support from federal, provincial and municipal levels. Broad based community consultation often occurred, as did the commitment within the plans to inform stakeholders on an ongoing basis. From a technical perspective, Canadian plans generally included an assessment of the community's current energy demand and all plans contained efficiency measures on the demand side. The majority of the plans identified indicators to monitor their recommended actions. What differed were the types of plans reviewed: the majority but not all of the plans were single-issue plans focused on air quality and climate change written by municipalities participating in the Federation of Canadian Municipalities' Partners for Climate Protection (PCP) program. Other types of plans were comprehensive and sectoral. That these communities were motivated to write energy plans in the absence of a clear national or provincial government-led energy agenda suggests that clear leadership from the public sector combined with increased funding would be welcomed by municipalities. Following Sweden’s model, additional financial resources from higher levels of government would serve to assist communities in making the infrastructure investments necessary to achieve objectives set out in their energy plans.

Based on these examples of community energy plans from Canadian and Swedish municipalities, and backcasting from basic principles of socio-ecological sustainability, this thesis identifies principles and best practices in energy planning which communities in both countries can continue to use to move towards sustainability.

Glossary

ALEP	Advanced Local Energy Planning
BAU	Business as Usual
Bctf	Billion Cubic Feet
CBIP	Commercial Building Incentive Program
CCAF	Climate Change Action Fund
CEM	Community Energy Management
CEP	Community Energy Plan
CEPA	Canadian Environmental Protection Act
CETC	CANMET Energy Technology Centre
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
DSS	Decision Support System
FCM	Federation of Canadian Municipalities
GIS	Geographical Information System
GJ	Gigajoules
GHG	Green House Gas
Gt	Metric Gigatonnes
GVRD	Greater Vancouver Regional District
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
ICLEI	International Council for Local Environmental Initiatives
ICSP	Integrated Community Sustainability Plan
IPCC	Intergovernmental Panel on Climate Change
IIIEE	International Institute of Industrial Environmental Economics
IRP	Integrated Resource Planning
kg	Kilogram
kWh	Kilowatt hour
LAP	Local Action Plan
LCA	Lifecycle Assessment
MCDM	Multi-criteria Decision Making
MW	Megawatt
NAFTA	North American Free Trade Agreement
NGO	Non-Governmental Organization
NO_X	Nitrous Oxide
OECD	Organization for Economic Co-operation and Development
PCP	Partners for Climate Protection
PV	Photovoltaics

RES	Renewable Energy Strategies
R&D	Research and Development
SMEs	Small and Medium sized Enterprises
SO_2	Sulfur Dioxide
SUN	Sustainable Urban Neighbourhood
t	Metric tonnes
Tcf	Trillion cubic feet
TNS	The Natural Step
TREC	Toronto Renewable Energy Cooperative
WPPI	Wind Power Production Incentive
VOC	Volatile Organic Compounds

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Chapter 1 Introduction

1.1 The Current Reality

Energy, in the forms of electricity, heat and fuel, is integral to the functioning and security of modern society. Paradoxically, our insatiable consumption of non-renewable energy resources is contributing to threats to humankind: on the global level climate change and depletion of the oil supply pose perhaps the biggest challenges humanity has collectively faced to date. Two indirectly related trends that can be observed on the local level are urban sprawl and increasing air pollution. These four threats to ecological and human systems can be directly linked to our energy use. They point to the need for both dramatic improvements in energy efficiency at all scales and a transition to renewable energy technologies. This thesis begins with a brief description of these threats, to inform its subsequent inquiry into Community Energy Planning.

Two Global Trends

Climate Change - A broad consensus now exists among scientists that there is a link between anthropogenic activities and the broad range of impacts associated with climate change. Examples of potential impacts include increasing severity of damaging weather events, melting of the polar icecaps, and extinction of species. Climate change is now thought to be the paramount environmental threat we face. [1] Should we fail to act in a timely fashion could result in humanity's penultimate tragedy of the commons. [2]

Global warming, or the rising average temperature of the earth, is one outcome of climate change. It is not a direct result of the heat from production and use of energy. Rather, the warming of the Earth's atmosphere occurs more quickly when long wave radiation from the sun is trapped by excess carbon dioxide ($C0_2$) and other greenhouse gases (GHGs) including methane (CH_4) and chlorofluorocarbons (CFCs) in the atmosphere. In addition, gases such as sulfur dioxide (SO_X) and nitrous oxide (NO_X) contribute to acidification and eutrophication, harming plant life and, by extension, the earth's ability to assimilate atmospheric pollutants. The increase in GHGs in the atmosphere has been documented, and a link between increasing CO_2 concentrations and rising temperature has been established. [3]

And while energy-related activities are not solely responsible for global warming and the broader range of issues associated with climate change, they do form a large part of the problem, accounting for 86% of SO_X emissions, 78% of CO_2 and 23% of CH_4 emissions. [4]

Our insatiable thirst for energy is causing a systematic increase in concentrations of materials from the earth's crust, such as fossil-based greenhouse gases, in the biosphere. In just over a century, our fossil fuel consumption has reversed carbon sequestration processes that took place over millions of years. In fact, energy activities add some 7 Gt of CO_2 to the atmosphere annually and NASA estimates that as of 1999, anthropogenic aerosols produced largely from fossil fuel combustion and biomass burning accounted for 10% of the total atmospheric load. [5] With global fossil-based energy consumption increasing at approximately 2% per year [6], atmospheric loads of GHGs will continue to increase concomitantly. This is particularly serious because $C0_2$ and other GHGs have the potential to persist as long as one hundred years in the atmosphere. Gases released today accumulate and influence weather patterns and climate over the long term.

The earth's climate is a complex thermodynamic system. When a thermodynamic system is forced, few changes will be visible until a threshold is reached and the system switches, changing states quickly and dramatically. Due to the complexity of the earth's climate it is impossible to predict thresholds beyond which point the system will have been forced too far. Localized effects of climate change are already being felt both seasonally and in an increasing number of extreme weather events. Native peoples can attest to this, stating that they can no longer predict changes in the seasons or the weather as they could in former times. [7] Other indicators include glacial melting, higher temperatures, rising sea levels, more intense precipitation, droughts and biodiversity loss. [8] According to IPCC scientist Christian Azar, the foremost challenge is to stabilize our atmospheric $C0_2$ concentrations [9] *The Kyoto Accord* is only an incremental first step to this end, with 141 signatory nations committing to reduce their CO_2 emissions by certain percentages close to 1990 levels.

Depletion of the Oil Supply - Another systematic global trend, related both to energy consumption and climate change, is the depletion of the oil supply. The historic images of earth from space returned during the Apollo 11 space mission of 1969 and *The Limits to Growth* [10] study illustrate that the economy exists within the constraints of the biosphere. Yet popular discourse has lapsed into a collective amnesia, with the finite nature of the oil supply only in the past decade resurfacing in the popular media. [11] Both the global energy system and global economic system rely on inexpensive petroleum and petrochemical by-products; an increased awareness is needed surrounding our vulnerability to the increase in oil prices that will invariably occur as supplies dwindle.

In 2000, on a global scale, 77% of primary energy sources came from fossil fuels, 35.8% of that from oil, making it the world's single largest source of primary energy. [12] In real numbers as of mid 2005, we consume approximately 80,000,000 barrels of oil per day worldwide, a figure that is projected to increase by 2% per year. As consumption increases, oil and other non-renewable energy sources become increasingly scarce. This subject of discussion among geologists and petroleum economists is known as Hubbert's Peak, or the peak beyond which global oil production can only decline. [13] Although it may be difficult to pinpoint exactly when such a peak will happen, the concept is important in that it speaks to the finite nature of the global oil supply and non-renewable resources. We are extracting and using energy resources at rates faster than they can renew themselves.

Human factors contributing to rising consumption and decreasing supply of oil include increase in population and associated development with the flawed premise of limitless economic growth. The depletion of oil is not so much about when we might 'run out' of oil resources, but rather when will they become too expensive and therefore no longer practical for meeting our energy needs. The fact that oil, in May 2005 was hovering around $55 USD a barrel and by May 2006 had approached $75 USD a barrel is an indication that the availability of inexpensive energy may end sooner than expected. [14] Given our overwhelming dependence on oil, communities and indeed all of humanity are highly susceptible to economic and social dislocations as a result of a depleted oil supply and rising energy prices.

From a human rights perspective, the rising price of oil has implications for unable to pay more for fuel, electricity and heat. However, there are many for whom access to even basic energy services is the critical issue - in spite of humanity's high and unsustainable levels of energy consumption, worldwide, approximately two billion people have no access to electricity and two billion others have access to unreliable electricity.

An additional two billion people continue to cook with traditional fuels. [15] One indicator of the disparity in access to energy is that primary energy use per capita in industrialized countries is on average six times the primary energy use per capita in developing countries. [16]

On the global level these problems seem unmanageable. Yet community level actions such as strategic long term planning of land use, infrastructure, and energy systems can be effective for addressing the two global threats of climate change and the depletion of non-renewable energy resources.

Two Community Trends

Two readily identifiable local trends associated with the unsustainable consumption of energy that may also be addressed by community energy planning are air pollution and urban sprawl. Their existence also motivates the formulation of this thesis as they contribute to the aforementioned global threats yet are trends that can be addressed on the local level.

Air pollution - Air pollution causes human health problems and damage to ecosystems. Many of the same chemicals responsible for climate change including $C0_2$, CO, O_3, NO_X, SO_X, volatile organic compounds VOCs and particulate matter are found in the air surrounding our communities. When chemicals are released primarily through the combustion of fossil fuels from vehicles and industrial processes they react with sunlight and with each other, they create a toxic chemical soup or 'smog'. Effects on human beings include increased incidences of asthma, cancers, and morbidity among the very young and very old. It is estimated that 5,900 people die each year in eight major Canadian cities from air-pollution. [17] Air pollution is particularly acute in summer when temperatures are high. During the winter season, increased vehicle idling and wood burning for home heating emit additional particulate matter to the air. [18] Environmental effects of air pollution include the urban heat island effect in cities and acid rain that causes damage to vegetation and buildings.

Airborne contaminants are not restricted by political boundaries, therefore a regional ecosystem approach is also required to examine the air shed from both point and non-point sources of pollution. This is an ideal level on which to tackle air quality issues because emissions created from both point and non point sources originate within communities.

Urban sprawl – Low-density, single-use developments connected by large roads have spread out across the landscape in North America and Europe in recent decades. In addition to higher home heating costs due to the preponderance of single-family dwellings, sprawl also tends to foster a car-dependent population. Because houses are further apart, and streets are designed on a larger scale in a meandering fashion, walking is inconvenient. Trips by automobile are therefore necessary for meeting everyday needs. In more compact communities, some of the trips to work, schools and shops could be made on foot or by bicycle. Furthermore, the low density of residents in such areas makes public transportation less economically viable. Resulting service is not frequent enough to be convenient or transit stops are beyond practical everyday reach. Essentially, because the urban form is so spread out, sprawl leads to increased energy consumption. Consuming approximately 2.5 MJ per passenger kilometer, the single occupant vehicle is the least energy efficient among the forms of urban transportation. [19]

In addition to contributing to accumulation of petroleum and chemicals in the biosphere, sprawl contributes to the physical destruction of natural ecosystems as farmland on the urban fringes is converted into housing developments and strip malls. Evidence is mounting that urban sprawl has negative implications for human health, the sedentary lifestyle it promotes contributing to conditions such as obesity, diabetes and alienation. [20]

One form of sprawl originating in France and now commonplace throughout the EU and North America is the large format or 'big box' store developments located on the outskirts of towns and cities. Most easily accessed by car, these complexes increase the number of single purpose car trips and fuel consumption. [21] The study of energy expenditures related to sprawl is a relatively new subject, [22] and landscape-level features of density, land-use mix and transportation are now recognized as influencing all future energy choices made by the community. [23]

In addition to contributing to increased local air pollution, urban sprawl accelerates the depletion of the oil supply and other non-renewable resources and impacts on climate change. Our present energy activities and the damage they create occur on a local level and, cumulatively, are leading to disorder on a global scale. Change can and must be effected on a local level with a view to the global context.

1.2 The Vision

International Energy Association (IEA) authors Thomas Johansson and José Goldemburg clearly articulate the challenge for the sustainable development of energy:

> "For [energy] development to be sustainable…it must not compromise the prospects of future generations. Conventional sources of and approaches to providing and using energy are not sustainable by this definition…While it is imperative to find ways to greatly expand energy services…expansion must be achieved in ways that are environmentally sound, as well as safe, affordable, convenient, reliable and equitable. This, in essence, is the challenge of energy related policies for sustainable development". [24]

Although here Johansson and Goldemburg are referring to the need to expand energy services in developing countries, the principles of safety, affordability, convenience, reliability and equitability also apply to energy services in developed countries such as Sweden and Canada. What differs however is what constitutes 'energy services' in each of these two contexts. Whereas in developing countries energy services could mean basic electrification or access to safe cooking fuels, in Sweden or Canada, energy services refers to the whole range of services we derive from a variety of energy sources to ensure the continued functioning of our society. These include fuels for motive power or heating and electricity for running equipment and electronics.

In particular, because the developed world can access such a wide variety of energy services, and consumes more energy per capita in general, it must take responsibility for its energy activities. And because society and the economy are explicitly dependent on the biosphere, energy systems must be designed with both social and ecological sustainability in mind.

The challenge of achieving social and ecological sustainability has also been described at the basic principle level by Holmberg and Robèrt as well as Ny. [25] These principles have been used to form 'sustainability constraints'. Here they have been re-worded to reflect their application at the community level and integrated with characteristics of energy systems and urban form reflective of Goldemburg and Johansson:

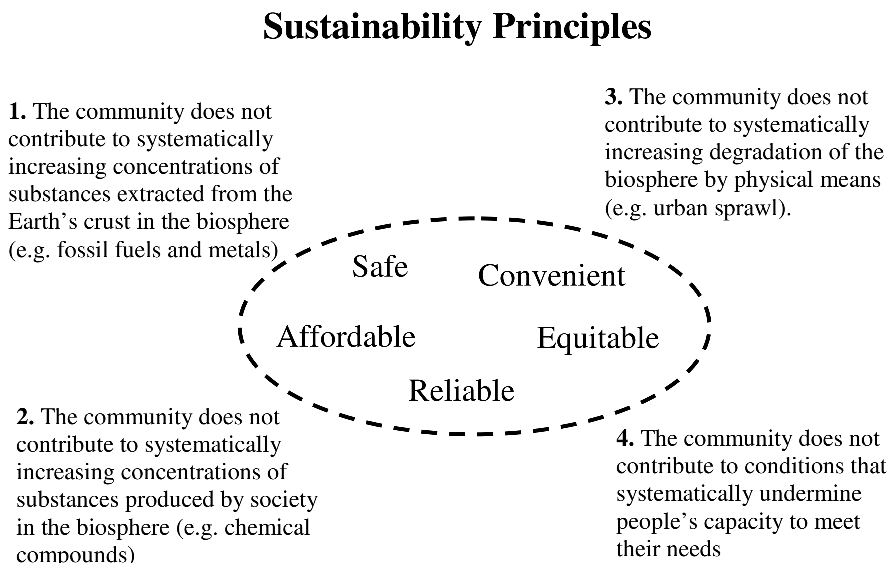

Figure 1.1. The Challenge for Sustainable Community Energy Systems.

Our present economic system contains a deeply rooted obstacle that has made transitioning to renewable energy technologies (RETs) difficult thus far. Environmental and social impacts, otherwise known as negative externalities, [26] are typically not included in fiscal accounting. Sources of energy upon which we currently rely are not priced according to their true *total cost* to both society and the environment. Due to the economic incentive of cheap energy, businesses and consumers choose traditional sources of energy such as fossil fuels by default.

A generalized vision of a community with sustainable urban form and energy systems - The following is a generalized description based on the above sustainability constraints and objectives that could be an example of success in community energy planning:

Imagine for a moment, a set of circumstances in the mid 21st century in a community that has been working towards a sustainable energy system and activities since the 1990s. In this community, a variety of systems have adopted to and benefit from becoming more energy efficient; businesses practice industrial ecology, the municipality is highly energy efficient in its operations, the housing stock has been largely retrofitted to conserve energy and bicycling, walking and public transit use are a higher proportion of the transportation modal share than personal vehicles. The results of these measures can be seen in healthier ecosystems, a robust economy and a strong social fabric. Such vitality is in part the result of strategic planning towards a sustainable community energy system. Energy in this community is derived from renewable sources and is efficiently utilized. Thanks to integrated land use and transportation planning, with appropriate densities and mixed land uses, many people walk, bike or use public transit, resulting in reduced transportation costs for individuals and improved public health. Mobility is made seamless by an integrated transportation system of streetcars, fuel cell buses, a car sharing system and taxis. Bicycle paths and cyclist friendly intersections, making cycling the most energy efficient way of getting around, the preferred mode for large numbers of people most of the year. [27] Most vehicles on the road are now flexi-fuel, fuel cells or hybrids. Together, these measures have led to improved air quality and traffic conditions throughout the community.

Homes and apartments are warm in the winter and cool in the summer, the result of district heating and cooling systems being powered by renewable energy sources such as biofuels and ground source heat pumps. New units are designed with energy efficiency in mind, having passive solar features and landscaping that shields from the wind and makes the most efficient use of rainwater. Inside, high efficiency appliances and recycled materials are used throughout. Through retrofitting, older dwellings have also been made more energy efficient.

Lower utility bills mean reduced energy costs for both households and businesses. To facilitate renewable projects and efficiency measures, banks make low interest loans readily available to those purchasing energy generating equipment. The local utility makes this an attractive option by enabling net metering. [28] In this way, individuals, co-operatives and businesses can earn money from producing their own energy from renewable sources and selling unused quantities to the grid. Some local farmers produce biogas for their farm vehicles and sell the surplus to filling stations.

Through good waste management practices this community endeavors to reduce the amount of waste going to landfill and ‘close the loop’ on industrial processes. For residential waste, a comprehensive recycling program is in place that includes composting and electronic waste.

Following principles of industrial ecology, certain industries have clustered together to utilize each other's waste products [29] in new processes and products. Together these initiatives have led to a significant reduction in the amount of waste going to landfill.

Utility companies have helped make sustainable community energy systems a reality by transforming their business models: no longer only selling electricity or heat from 'hard path' [30] sources such as nuclear or coal, they now offer services such as warmth, 'coolith' or illumination. They also design, install and maintain energy equipment and RETs. In the provision of energy services, more permanent jobs are created locally. [31]

Because less is spent on energy resources coming from outside the community, more money is redirected to people and places within the community. Empowered with additional financial resources, local government can make strategic investments in RETs and infrastructure that foster energy efficiencies. Ultimately, surplus funding can be redirected to other areas such as infrastructure, social services or the arts. Businesses can reinvest money saved through energy efficiency to develop new products or can transfer the value to their shareholders through increased profits. A better quality of life is possible for residents who have more income to spend or save.

By strategically planning their energy systems to be more sustainable, this community does its part to make the world a safer place. By including more renewable technologies in its energy supply mix, this community is less dependent on oil from contested regions. By reducing its emissions considerably, the community contributes less to climate change. This community also aims to be restorative by planting native trees and plants. This community's success can be attributed, at least in part, to its comprehensive community energy plan which has as its goal, a vision of a sustainable community energy system and energy activities.

1.3 Research Questions

From the foregoing description of the threats and the challenge of developing energy services within socio-ecological constraints emerges a research question inspired by a generalized vision of community energy sustainability.

How can strategic energy planning assist Swedish and Canadian communities to move towards sustainability?

i. What is the current energy supply mix and what renewable energy sources can be further developed in Sweden and Canada?

To establish the broader context within which communities are planning their energy activities, national energy strategies in the form of policies and programs are investigated by asking:

ii. What policies and programs support or hinder strategic energy planning?

In light of the system context and national energy policies and programs, the plans comparison of current Swedish and Canadian strategic community energy plans is facilitated by asking:

iii. How is success described in current community energy plans?

iv. What strategies and actions are contained in current community energy plans?

v. What tools are typically used in the development of community energy plans and subsequent monitoring activities?

These questions address the five levels of a generic five-level model for strategic planning in complex systems [32] a concept that will be explained in the literature review.

Definition of Terms

To operationalize these questions, a few terms require defining: *sustainable development, sustainability, energy planning, communities* and the concept of *being strategic*.

The most common definition of *sustainable development*, introduced by the World Commission on the Environment and Development, is "…development that meets the needs of the present without compromising the ability of future generations to meet their own needs". [33] This definition has gained acceptance in part because it is general and can be used to support a wide range of interpretations of sustainability, for instance, development that is economically sustainable. For this reason *sustainable development* has at times been denounced as a buzzword or too vague to operationalize. The basic definition however holds true.

Recognizing the urgent need for meaningful action to guide ecological and social systems towards *sustainability*, rigorous science-based principles were developed in an international scientific consensus process. Widely known as The Natural Step principles for sustainability, these principles have been designed to guide decision-making processes by establishing conditions for a sustainable society in the biosphere. They are stated as follows:

"In the sustainable society, nature is not subject to the systematic increase of…

i. …concentrations of substances extracted from the Earth's crust;
ii. …concentrations of substances produced by society;
iii. …degradation by physical means;

and, in that society…

iv. …people are not subject to conditions that systematically undermine their capacity to meet their needs." [34]

This understanding of socio-ecological sustainability leads to a shared awareness of activities that contribute to the disruption of natural cycles and increased social inequalities. These principles can serve to guide relevant inquiry, resulting in rigorous strategies and constructive actions being taken towards sustainability.

The principles for sustainability are situated within a five level framework for planning in complex systems; this five-level framework and the concept of backcasting will be explained further in the literature review appearing on page 38. Backcasting from sustainability principles may be applied in any sustainability planning process as a way of taking a whole systems perspective. Other tools and concepts for the sustainable development of energy systems that may be applied within this framework include Life Cycle Assessment (LCA) and software programs that model and optimize the energy system such as RETScreen, market allocation (MARKAL) and TIMES. (See *Appendix IV* for a list of energy modeling programs listed in the evaluated energy plans). Due to the complexity of the numerous energy systems within a community, multi-criteria decision making methods can also be used. [35]

Energy planning can be defined in many ways. On a broad scale, it is the planning for natural resource extraction and allocation as well as the production and distribution of electricity and thermal (i.e. heat) or embodied (i.e. fuel) energy. It can be project-based, for example when major energy utility projects are planned, built and operated. Following a hierarchy of energy related decisions [36], land use and infrastructure (e.g. energy and transportation infrastructure) choices have implications for all subsequent energy consumption, efficiency measures and the possibility of further transitions to renewable energy technologies. Energy planning also concerns site design, the energy efficiency of buildings, embodied energy in buildings, and transportation mode. The energy efficiency of equipment and appliances must also be considered. Waste management including recycling and waste-to-energy generation as well as water management are also related to energy planning. For the purposes of this thesis, energy planning will be considered in this holistic sense, a combination of the foregoing energy subsystems found within a community.

The term *planning* has been selected over that of *management* because, 1) energy *planning* is the term used in Sweden, 2) its usage reflects the necessary linkage with the discipline of urban planning, and 3) in contrast to management, planning implies a long-term, proactive approach to reducing energy consumption and promoting the uptake of renewable energy technologies.

Community denotes a "group of people living in the same locality and under the same government," [37] whereas the term municipality, refers to the governance of the community, or "[the] body of officials appointed to manage the affairs of the local political unit." [38]

Most villages, towns and cities referred to in this thesis are municipalities, however certain Canadian communities, such as Salt Spring Island and the Wha Ti First Nations reservation are not. Due to this discrepancy and because energy planning should be a collective effort, the term *community* will be used.

Because energy planning covers a broad range of energy sources and types of infrastructure, many kinds of community energy plans exist including *comprehensive plans, single-issue plans* and *sectoral plans*. In a strict whole systems application, community energy planning as a process should result in a comprehensive community energy plan that considers the community's present and future need for generation, distribution, and consumption of energy sources such as electricity, heat and fuel. [39] Included should be planning for utilities (electricity, heat, waste and water management), land use and transportation systems, site design and building efficiency, equipment and appliances, and waste management. Dematerialization, substitution and efficiency measures should be part of the strategy to "…reduce the overall energy footprint of the community." [40]

Other plans known as *single issue plans* [41] address individual energy issues within a community. One prominent example of this type of plan is the Local Action Plan (LAP) a product of the Canadian Federation of Municipalities (FCM), Partners for Climate Protection program (PCP). *Sectoral plans* address energy use in specific sectors such as housing. Comprehensive, single issue or sectoral plans may be integrated with a community's planning process and be linked to their official plan. For the purpose of clarity in this thesis, all plans will be referred to as *community energy plans* although their similarities and differences will be described throughout.

Dematerialization, substitution and efficiency measures should provide overall guidance for transitioning energy activities and systems towards sustainability. *Dematerialization* implies a reduction or elimination of a material used, an example being a reduction in the amount of uranium used for electricity generation due to reduced electricity demand. *Substitution*

involves replacing one material or energy source with another, for example replacing petroleum with renewable energy source(s).
Efficiency, the most commonly known of the three terms, involves maximizing output while minimizing input. Efficiency is also a means by which to achieve dematerialization.

Being strategic means planning or acting with the end or goal in mind. [42] In combining the terms *strategic* and *community energy planning*, we are able to conceive of community energy planning that is inherently oriented towards sustainability.

Based on the literature review and interviews with community energy planning experts, general strategies of a progressive community energy plan include:

- All stakeholders engaging in a community-driven process; [43] [44]
- Stakeholders sharing a common understanding of socio-ecological principles of sustainability; [45]
- The common vision creating a shared mental model with defined goals that allocate their resources for future considerations; [46]
- The planning process having political support; [47]
- All municipal departments being aware of and engaged in the process; [48]
- Integrated planning of the whole energy system along with detailed planning of concrete subsystem projects; [49]
- The plan projecting over a long time frame, ideally upwards of 50 years;
- The plan being designed for continuous improvement with feedback mechanisms; [50]
- Land use planning being integrated with energy planning. [51]

Progressive technical strategies are also critical to the success of the energy plan. These can include:

- Employing concepts of efficiency, dematerialization, and substitution as the basic goals for transitioning the current energy system towards sustainability;
- Developing a plurality of technical solutions on both the supply and demand sides; [52]
- Switching to renewable energy sources where possible;

- Diversifying with many small individual contributions to the energy supply
- Using flexible and relatively low technology; [53]
- Matching energy quality appropriately to end-use needs; [54]
- Matching energy generating installations in scale and geographical distribution to end-use needs; [55] and
- Basing decision- making on full cost accounting, with an understanding of the tradeoffs[56]

Chapter 2 Methods & Literature Review

2.1 Methods

Literature Review

Community energy planning is a broad concept with potentially far reaching implications for society, the economy and the environment. A literature review was therefore necessary to gain an understanding of definitions, key ideas, planning processes, renewable technologies and the concepts of efficiency, dematerialization and substitution.

Looking to the literature for ideas specifically on sustainable community energy planning reveals a limited number of sources. A broader net has been cast to include theories and methods of energy policy and sustainability that may be applied to community energy planning. Concepts reviewed include the hierarchy of energy related choices, integrated resource planning (IRP), the ingenuity model, soft energy paths, and a strategic planning framework that uses the method of backcasting from sustainability principles. These concepts are synthesized to form a new model for evaluating community energy plans which is subsequently used in this paper to analyze plans from Sweden and Canada.

The literature review is organized according to type and target audience. First reviewed are reports by major energy agencies and articles from recognized scientific journals geared towards academics and practitioners. The second type examined is guidebooks prepared by governmental organizations and NGOs intended for use by practitioners and community members. Books are a third type: accessible to a broader public, they provide key theoretical concepts to support the study and practice of community energy planning.

This literature review addresses the core concepts and underlying theories pertaining to community energy planning in a holistic sense. In reality, a comprehensive community energy plan could encompass all aspects of resource and utility planning, land use and transportation planning, waste and water management, building and site design and equipment use within a community. [57] Publications and projects carried out in these areas are too numerous to be reviewed in the context of this paper.

The evolving nature of community energy planning methodology involves identifying best practices in relevant disciplines and incorporating them into new and revised community energy plans, related planning tools and energy systems.

Interviews

Not all information on community energy planning has been published in journals, books or on the web due to the newness of the discipline. It was therefore necessary to supplement the literature review with information conveyed in interviews with key individuals. While it was not possible to interview energy planners from each community, individuals with broad overviews of community energy planning were consulted from national and federal government departments in both Sweden and Canada. In Sweden this was Bengt Larsén from *Boverket*, the Swedish Board of Housing, Building and Planning, in Canada, Michael Wiggin from Natural Resources Canada. Anders Mårtensson, a team member of the Strategic Environmental-Assessment of Local Energy-Systems project, Linköping University, Sweden and Doug Townsend, the Manager of Facilities in the town of Canmore, Alberta, Canada were also helpful in providing insight into energy planning

Analysis of Community Energy Plans

The main primary research component done in conjunction with this thesis was analysis of community energy plans from eleven Swedish communities and eleven Canadian communities. The objective of this investigation was to discover how strategic community energy plans can assist communities in moving towards sustainable energy systems. Plans selected were those that were readily available, either online or made available by a councilor or municipal staff member. Plans were included to represent a range of community sizes and geographically diverse locations in both Sweden and Canada. Both industry and non-industry dependent communities were included. In Sweden, where energy plans are more common, plans were selected from members of Eco-municipalities and from communities previously recognized for their efforts towards sustainability. In Canada, the western provinces are more familiar with energy planning, accounting for more plans being included from British Columbia and Alberta. A plan from an off-the-grid native reservation, Wha Ti, was also included in the Canadian sample.

Progressive measures identified in the literature review and interviews with energy planning practitioners were transposed into specific questions that formed the basis for the analysis of the plans. Immediately below are the main sub-questions; please refer to page 75 or the full list of questions and answers.

A whole systems perspective is established by asking these questions, repeated from the introduction:

i. What is the current energy supply mix and what renewable energy sources are presently in use and can be further developed in Sweden and Canada?

Other aspects included in taking a whole systems perspective are concepts of success, strategies and actions (including policies and programs that support or hinder community energy planning), and the tools employed. Four additional sub questions were posed as follows:

ii. What policies and programs support or hinder strategic energy planning?

iii. How is success described in current community energy plans?

iv. What strategies and actions are contained in current community energy plans?

v. What tools are typically used in the development of community energy plans is and subsequent monitoring activities?

The above sub-questions will be further divided to investigate the community energy plans in greater depth. The first group of three questions posed examined the visions of success. The largest group of questions pertained to strategies and actions described in the energy plans, falling into two categories: strategies for the planning process and strategies for the design of technical energy systems. A final question asked about tools used in conjunction with energy planning initiatives. The questions were specific, minimizing any subjectivity that could be introduced through paraphrasing from the plans or in translation from Swedish to English.

Taking successful energy planning strategies and processes from the literature and seeking them out in the plans is a positivist-empirical approach to examining planning processes embedded in socio-political systems. In reality, an energy plan is only as effective as the degree to which it is utilized in day-to-day planning activities within a municipality. The scope of this study should be made clear from the outset: a potentially successful community energy plan includes the progressive characteristics identified in the literature review and obtained through interviews with energy planning practitioners. The characteristics of progressive energy plans, as outlined on pages 19 and 20, are thought to be ones that could lead communities and their urban forms and energy systems towards sustainability.

The effectiveness of these plans in reducing energy consumption and promoting the uptake of renewable energy technologies in reality is outside the scope of this paper.[58] Further case studies investigating the actual implementation of energy plans and monitoring of energy would be a logical line of inquiry following from this research. Nevertheless, given the urgency of the threats, the newness of the discipline and the lack of literature on the subject, this thesis is an important intermediary step that will contribute to a greater understanding of effective community energy planning strategies. It is hoped that this contribution will speed the uptake of energy efficiency measures and the transition to renewable energy technologies.

2.2 Literature Review

Scientific Publications

The International Energy Agency - IEA authors Johansson and Goldemburg offer a description of community energy planning, with a vision of community infrastructure designed and built with function and energy efficiency in mind:

> "…community energy planning involves a process of comparing the infrastructure, energy supply, and environmental/social effects associated with alternative evolutionary paths for urban form and infrastructure. A deliberate effort to include energy considerations at the community land-use zoning and infrastructure-planning level can affect energy use and the resulting social costs, even over a

> relatively short time of one or two decades. Mixed land use decreases travel distances to work and shopping. Coordination of high density with public transit reduces the need for individualized transport such as taxis and personal vehicles. Integration of residential housing with commercial and light industrial activity increases the opportunities for efficient district heating and cogeneration of heat and power." [59]

This demonstrates that awareness exists on the international level about potential solutions community energy planning has to offer. The case is also made for knowledge transfer in energy planning from Northern European countries to North America where policy makers "…have largely overlooked the potential contribution of community energy management to sustainable energy policy." [60]

Journal Articles - Those commenting on community energy planning in a holistic sense include Jaccard, Failing and Berry (1997) and Nilsson and Mårtensson (2003). These sources, and the community energy planning guidebooks reviewed later in this section, provide insight into planning processes and options for technical systems. Inconsistencies in terminology (including *community energy planning* being referred to as *community energy management* and *municipal utility management*) and a wide variation in sectors addressed in energy planning, speak to the newness of the discipline. Despite these variations, the publications are unified in the view of the community as an effective level for energy planning.

Mark Jaccard, Lee Failing and Trent Berry, [61] use the term community energy management to describe a synthesis of pre-existing disciplines including urban design, industrial ecology, complete communities and green cities, and energy management concepts of energy cascading, demand-side management, and integrated resource planning. [62] Community energy planning is thus shown to be a transdisciplinary endeavor, drawing from many technical and planning domains. These categories allude to the larger academic disciplines of architecture and design and theories and methods from relevant social sciences such as geography and sociology.

Jaccard et al. tell us that traditional energy management concerns primarily energy used in buildings and equipment.

In an important departure from this, they describe a hierarchy of energy related choices, highlighting the implications decisions made at the scale of landscape and infrastructure have on subsequent energy consumption. "Urban form has a determining influence on the full cycle of energy use because density and land-use patterns affect the level of energy service requirements (eg. commuter distances), the design of intra-urban transportation systems, the character of energy transmission systems, the potential for waste heat utilization, and even the possibilities for alternative energy supply systems." [63] Figure 2.1 shows how decisions made at the initial stages of land use and transportation infrastructure planning affect all subsequent energy-related decisions in communities and associated resource consumption .

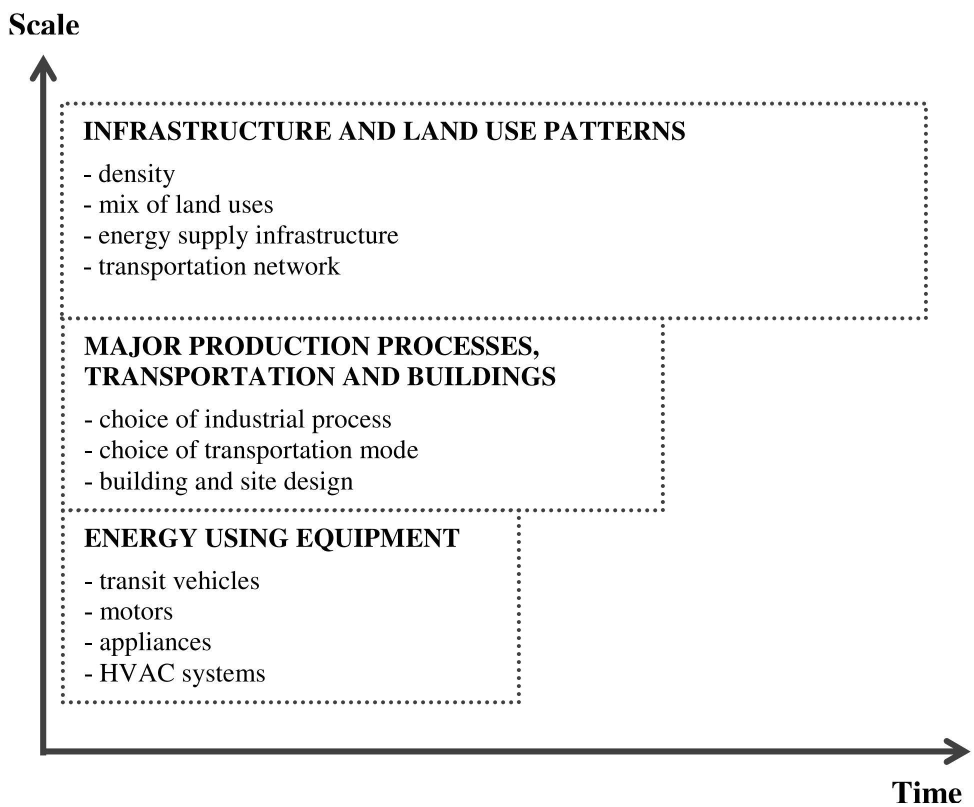

Figure 2.1. Hierarchy of energy related decisions
Source: Jaccard, Failing and Berry. 1997

In support of the hierarchy, the authors have this to say:

> "…there is growing awareness that the overall design of human settlements, be these neighborhoods, communities or entire regions, is also a critical determinant of energy and material throughput for a given economic system. Redesigning the urban form - notably in terms of infrastructure and land use patterns - can significantly affect the energy throughput – and associated wastes – of our economic systems, both by influencing the demand for energy services and by supporting new technologies for delivering those services."[64]

This multi-level hierarchy takes a whole systems approach and clearly illustrates that good land use and infrastructure planning is fundamental to the overall energy efficiency of a community; the greater the efficiencies at the landscape level, the greater the subsequent efficiencies that can be achieved. This is significant for communities everywhere, as energy efficiency implies greater economic prosperity and social and environmental sustainability.

Jaccard, Failing and Berry also describe several land use planning strategies and actions for communities to achieve greater energy efficiency. Communities can change zoning and use development charges and tax incentives to encourage specific kinds of development. They can also work with utilities. The article does not elaborate however on what to do with existing sprawled landscapes.

The Strategic Environmental Assessment of Local Energy Systems - Nilsson and Mårtensson, [65] organizers of the research project *The Strategic Environmental Assessment of Local Energy-Systems,* describe community energy planning as "…a process for effectively providing energy to the different sectors of a community (residential, commercial, industrial, transportation)." [66]

In the first phase of their research, the authors analyzed community energy plans from 12 Swedish communities in Östergötland. Questions were applied to the plans in four areas: the planning process, energy system characteristics, goals for the energy sector, and political measures for directing the local energy system. [67] The plans were similar in their focus on district heating and their general disregard for communication with the public. Their study analyzed the influential role played by national energy policy, in particular the fact that since 1977 Swedish communities have been required by law to develop energy plans.

The authors noted in their paper that the plans reflect three distinct periods in the evolution of Swedish national energy policy: reduction in oil dependency, phase-out of nuclear energy, and most recently, implementation of renewable energy technologies and sustainable development.

In the second part of their research, Nilsson and Mårtensson looked at energy plans in relation to national energy and environmental policies, spatial planning, decentralization, the deregulation of the electricity market, and Local Agenda 21 initiatives. The ‘real world’ situation was also examined in the various communities by tracking statistics on energy use and $C0_2$ emissions from 1996 to 2000. The third stage of the research involved analyzing one community, Kungälva, in greater detail focusing on improvements that could be made based on information gathered in the first two phases of the research.

In a telephone interview, Mårtensson identified characteristics of successful community energy plans:

- Community consultation early in the planning process;
- Consultation with all stakeholders;
- Existence of a community champion, someone knowledgeable with regards to community energy planning;
- Involvement of local authorities and awareness by all departments within the municipality about the energy plan;
- Integration of the energy plan into the spatial plan;
- Detailed implementation strategies in the plan itself. [68]

Significantly, Mårtensson also found that a community with a good energy plan is more likely to receiving funding for subsequent energy projects from the Swedish national government through the Local Investment Program (LIP) than communities with less well developed plans.

Multi Criteria Decision Making applied to sustainable energy planning – In an article entitled *Application of multi-criteria decision making to sustainable energy planning,* S.D. Pokehar and M. Ramachandran survey the literature, reviewing articles on numerous Decision Support Systems

(DSS) addressing various aspects of energy planning. Pokehar and Ramachandran summarize articles on renewable energy, energy resource allocation, building energy management, transportation energy systems, project planning and electric utility planning. Although the authors do not explicitly enquire about the kind of decision support available and practical for its use at the community level, the subjects considered in their review are all facets of community energy planning.

Multi-criteria decision making methods used in energy planning are normally one of three types: deterministic, stochastic or fuzzy. “These methodologies share common characteristics of conflict among criteria, incomparable units, and difficulties in selection of alternatives”[69] Decisions regarding the potential application of various areas of the energy system must take into account a large number of factors, competing interests, impacts and limitations.

According to the authors, specific MCDM methods commonly applied to energy planning include Analytical Hierarchy Process (AHP), Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE), the Elimination and Choice translating reality quantitative and qualitative (ELECTRE), Multi-Attribute Utility theory (MAUI) and fuzzy methods. AHP is described as being the most popular for prioritizing actions in energy planning; PROMETHEE & ELECTRE follow in popularity. Multi-objective optimization methods are used largely in energy resource allocation and electric utility planning. ALEP, which will be discussed in more detail in the next section, utilizes GIS to graphically represent and visualize large amounts of technical and environmental data.

DSS represent a synthesis of the decision support sciences, computer sciences and the advancement of knowledge on energy and related economic, environmental and social considerations. These models are highly complex, incorporating vast amounts of underlying data and having numerous assumptions built into their structures. Understanding the functionality and built in assumptions of a particular DSS is necessary in order to utilize this technology effectively. It should be noted that no MCDM method or DSS as yet incorporates backcasting from principles of sustainability.

Guidebooks

Transferring knowledge from scientists and early adopters is necessary for building energy planning capacity in communities. Guidebooks produced by government departments and NGOs serve this purpose showcasing successful projects designed by experts.

The Energy Aware Planning Guide - Produced in 1993 by The California Energy Commission, supports the creation of community energy plans:

> "A well-thought-out energy plan can help boost the local economy, reduce air pollution and other environmental impacts and provide a focal point for some of the most difficult local government issues including land use planning, transportation system design, affordable housing and air quality attainment."[70]

The guide includes worksheets for communities to assess their energy needs and plan for future consumption. Topics include energy uses, energy efficiency opportunities, and renewable resource opportunities. Each worksheet outlines the types of information required to complete the calculations and offers suggestions for obtaining the data. The guide also offers a comprehensive overview of California State energy policies, making practitioners aware of the regulatory framework within which they are operating. Success stories on energy efficiency, renewables and large-scale generation facilities are also featured, along with contact information for individual project managers.

Advanced Local Energy Planning (ALEP) (Effektiv energiplanering för ett hållbart samhälle) [71] is the result of an international collaborative effort to advance knowledge on energy planning. In recognition of the gap between scientific solutions and their use in practice, the IEA in conjunction with groups in Germany, Italy, Sweden and the Netherlands, carried out practical applications of the Linear Programming Optimization Model (MARKAL). The objective was to exchange experiences on the use of the model. The purpose of ALEP was to find a path towards local energy systems that were both economically and ecologically sustainable. The reality of limited financial and human resources are accounted for, as well as incomplete insight into the future economic, technical and social developments.

The ALEP guidebook advocates planning according to the following four principles:

i. "Combine integrated long term strategic planning of the whole energy system [comprehensive analysis] with detailed planning of concrete subsystem projects;
ii. Utilize system analysis methods and computerized energy system models;
iii. Involve all relevant interest groups in the planning process;
iv. Set-up a plan for continuous improvement and monitoring. [72]"

The ALEP approach uses complementary 'big picture' and detailed subsystem views to analyze the behavior of the energy system and create comprehensive long-term energy plans. The ALEP planning process includes the creation of scenarios using software programs and the design of indicators and monitoring mechanisms.

Although the approach claims to be from a whole systems perspective, the ALEP planning process includes only the physical energy system, excluding ecological, social and cultural dimensions. This lack of a whole systems perspective could lead to the reduced resilience and adaptability of energy systems in the long term. Understanding the limitations of the methodology however can help the user to take a whole systems perspective by utilizing complementary methods as required.

The Swedish Guidebook for Sustainable Energy Planning (MILEN) *En hållbar local energistrategi [75]* is a set of 10 books used by communities to make energy planning current, concrete and environmentally sound. MILEN guidebooks provide instruction on determining the level at which analysis and energy planning should take place. Is the community considering a major overhaul of their energy system or can it afford only minor efficiency measures? Who participates in the planning process? In a municipal government, according to MILEN, this should include the departments of planning, operations, environment and health as well as electricity and waste utilities. External to the municipality, the community energy planning process should involve nearby municipalities in order to achieve regional synergies; local academic institutions and other organizations should also be included. MILEN does not refer to consultation with community members.

The Community Energy Association Toolkit - The Community Energy Association has successfully triggered a number of energy planning activities in the province of British Columbia, Canada. A toolkit is available online for communities wishing to engage in energy planning. [73] Significantly, it identifies three types of community energy plans: the single issue energy plan, the comprehensive energy plan, and the energy component approach. Nine motivational factors or goals are cited:

- To reduce energy expenditures by government and taxpayers;
- To save on capital and operating expenditures;
- To increase land values;
- To preserve non-financial land values;
- To reduce the cost of infrastructure;
- To reduce the noise and barrier effect;
- To reduce climate change due to GHG emissions;
- To reduce local pollution;
- To achieve social objectives.

The guide also suggests a process for creating a community energy plan:

- Build the energy team;
- Clarify community goals;
- Draw the energy profile;
- Take the message to the community;
- Identify energy opportunities;
- Create planning options;
- Evaluate and select a preferred plan;
- Make an action plan;
- Monitor the results (feedback loops to community and policy).

The community energy planning process as described by the CEA suggests a thorough and inclusive step-wise approach that communities wishing to create their own energy plans may follow, beginning with team-building and visioning. Taking the message to the community with the energy profile in hand is important as this step can reveal potential areas for energy efficiencies and reveal support or opposition to certain kinds of energy projects. Engaging the community in the process also serves to educate the public about community energy planning - with a high level of awareness energy planning efforts are more likely to have long term success.

Lastly, monitoring and feedback to policy and community are essential for continued success and community buy-in.

Community Energy Planning: a guide for communities - Natural Resources Canada (NRCan) is the branch of the Canadian federal government responsible for the sustainable development of Canada's natural resources. In addition to formulating national energy policy, it disseminates information and facilitates individual community energy projects. A guidebook has been produced entitled *Community Energy Planning: a guide for communities.* In it, the energy plan is situated in the context of other community planning processes:

> "A Community Energy Plan…offers a community the ability to retain continuity and consistency between its many, more detailed documents and programs. Its presence should simplify the development of the Official/spatial Plan and the secondary plans that support by describing the many interactions between those plans. The Community Energy Plan considers the use of energy as a driver for the decision making process towards the goal of a reduced energy footprint. The impact of energy use within a community… [Includes] the effects of spatial design and embedded resources within the built environment." [74]

The guide contains the following graphic which suggests how a community energy plan might be situated in relation to other municipal plans.

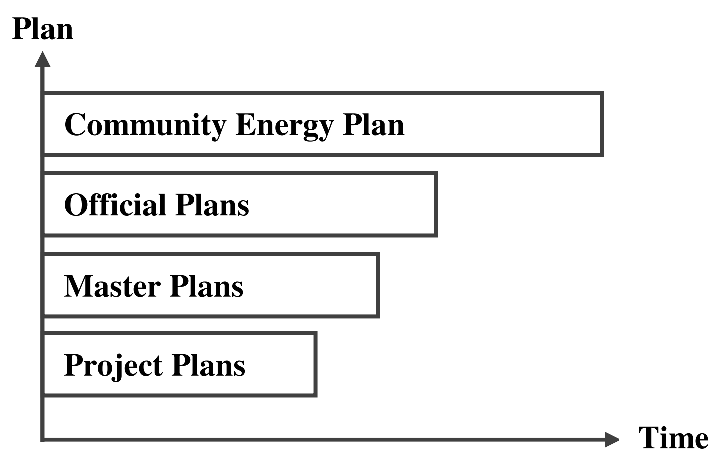

Figure 2.2. The community energy plan
Source: NRCan, Community energy planning guide 2004 (draft)

This is an idealized vision of community energy planning assuming the energy plan informs all or most municipal decisions. Barriers to this approach include municipalities lacking sufficient financial resources for infrastructure and energy systems and lacking jurisdiction over energy resources and usage.

As of 2005, no Canadian federal or provincial legislation required communities to produce energy plans. [75] It is perhaps for this reason NRCan advocates a grassroots approach in which a champion, possibly a member of the public, spearheads the effort. The guide aims to inform and support this champion and the planning team through the visioning and decision making process. Programs and project ideas for implementation are also discussed. This information dissemination approach taken by NRCan makes energy planning accessible to those communities unable to afford consultants to produce community energy plans on their behalves.

Books

Building Sustainable Energy System: Swedish experiences - Swedish literature on energy planning includes an informative and well-written collection of essays edited by Semida Silveira. [76] Twenty-five energy experts contributed chapters on clean technologies, strategies for improving energy efficiency, biomass, renewable liquid motor fuels, national economic policy and more. These provide valuable insights into Swedish energy sector developments and into the country's policies, research, and programs. Sweden is a role model in energy planning and is described as having "…made considerable progress in developing a sustainable energy path."[77] For example, in less than 10 years Sweden doubled its reliance on renewable energy sources [78].

Energy Revolution: Policies for a Sustainable Future - Howard Geller argues in this book that it is necessary to change present unsustainable energy use. Barriers to the adoption of RETs and efficiency measures exist on all levels. They include limited supply infrastructure, quality problems, misplaced incentives, lack of financing, purchasing procedures, pricing and tax barriers, regulatory and utility barriers and political obstacles. Solutions cited include policy instruments such as financing, regulation, market reform, planning techniques, information dissemination and training.
Geller also discusses Integrated Resource Planning (IRP), an innovative energy service model, where local utilities provide energy services such as heat, light and mobility in the most cost-effective manner possible, using a

mix of supply and demand side resources. In this way, energy efficiency options are thought of as resources, similar to supply options. The IRP method, which relates quite closely to soft energy paths to be discussed shortly, also allows for environmental costs to be added in "…selecting resources based on a more complete cost accounting than that occurring in the marketplace". [79] Utility companies may evolve their businesses by following this model and, in so doing, help create the conditions by which more consumers may choose electricity and heat generated from renewable sources.

Power: journeys across an energy nation - Canadian journalist, Gordon Laird traveled from the tar ponds of Sydney Nova Scotia [80] to the heart of oil country in Fort McMurray Alberta. *Power* tells the poignant tale of communities suffering from the impacts of unsustainable energy activities. An understanding of the tragic social and environmental consequences of fossil fuel and uranium production urges us to avoid repeating the mistakes of history and to seek alternative energy sources. When looking to the past, Laird also discovers that communities once relied on district energy systems, and proposes that those and other small scale distributed energy supply solutions could be appropriate for some communities:

"The answer, if there is one, appears to lie in locally based production and consumption of electricity: smaller, accountable and more efficient power. Depending on circumstances, small hydro, natural gas turbines, wind power and solar generation all offer alternatives to the mega-power networks first dreamed up during the 1950s. Curiously, the neighborhood networks of the future could look a lot like the original power systems of the early 1900s." [81]

Fueling the Future: how the battle over energy is changing everything –
A series of thought-provoking essays by leading figures in the Canadian energy debate, each chapter in *Fueling the Future* build upon Thomas Homer Dixon's ingenuity model. [82] Ingenuity, Homer-Dixon tells us

> "…consists of sets of instructions that tell us how to arrange the stuff in our world in ways that help us to achieve our goals." The ingenuity model responds to the increasing complexity of human society and decision-making. Societies are successful or not based on whether they are able to supply ingenuity to solve their

> problems; societies that cannot solve their problems face an ingenuity gap."

Homer-Dixon identifies two kinds of ingenuity, technical and social. Social ingenuity involves arranging people to form key institutions such as governments and markets. Social ingenuity is the more important of the two as "…it is a prerequisite for technical ingenuity. We don't get the technologies we want unless our economic institutions - especially our markets - reward innovators for the risks they take…." [83] This suggests the importance of initiating change in our social systems and planning processes to accommodate new energy technologies and techniques. Homer-Dixon describes our dependence on energy succinctly: "Energy is our lifeblood, without an adequate supply at the right time and places, our economy and society would grind to a halt." [84] As the availability and use of energy sources has implications for both environmental and social sustainability it is an important concept to which we must apply our ingenuity. Although community energy planning is not a subject of one of the essays in *Fueling the Future,* Homer-Dixon's ingenuity model neatly applies as community energy planning is a social process resulting in a plan that governs technical systems.

Soft Energy Paths – One notable article included in *Fueling the Future* "Soft Energy Paths" by Susan Holtz and David R. Brooks [85] recalls the soft path, developed by Amory Lovins. This concept was first articulated in an article appearing in the fall 1976 issue of Foreign Affairs entitled *Energy Strategy: the road not taken?* [86] In it, Lovins outlines two types of energy policies, the hard path and the soft path. On the hard path energy demand is met by building large infrastructure projects such as nuclear plants. Soft path strategies attempt to balance supply and demand side energy considerations, while giving preference to local renewable energy sources.

Holtz and Brooks describe five characteristics of technologies used in soft path strategies:

- Reliant on renewable energy flows – energy income not energy capital;
- Diverse, with many small individual contributions, each designed for maximum effectiveness in particular circumstances;
- Flexible and relatively low technology;
- Matched in scale and geographical distribution to end-use needs; and
- Matched in energy quality to end use needs… [87]

Importantly, the authors also outline five steps for soft path energy planning:

i. Build scenarios: establish the study's time frame and envision future scenarios;
ii. Study end-use demand: determine the quantity of energy that future society will require;
iii. Consider supply mix: technical analysis of the supply mix; matching of end use demand with soft technology supply options based on renewable sources as they become competitive and available;
iv. Backcast: question the feasibility of getting there from here given the technical and associated economics path needed to reach future scenarios;
v. Implement: examine the policies and programs required to achieve a desired scenario, given technical and economic considerations [88].

In developing the soft path, Lovins established a balanced way of examining both supply and demand side measures preferring the use of technologies having the least environmental impacts. This method offers a variety of strategies to meet energy demand, recognizing that there are no simple all-encompassing solutions. By focusing on a scenario, decision makers can decide what is politically and economically feasible and work towards that end with "choices based on a rigorous overview of a specific society's energy demand and supply in the future." [89]

Principles for Sustainability - The Natural Step (TNS) is an international NGO created to facilitate an ongoing dialogue on sustainability among scientists, decision makers in business, and public policy makers. Dr. Karl-Henrik Robèrt founded TNS in 1989 to discover solutions to unsustainable practices in society. Through his work as one of Sweden's leading cancer doctors, Dr. Robèrt became aware of the consequences of pollution and a degraded environment. TNS uses the metaphor of a funnel to describe the threats of declining ecosystem conditions and increasing pollution and population.

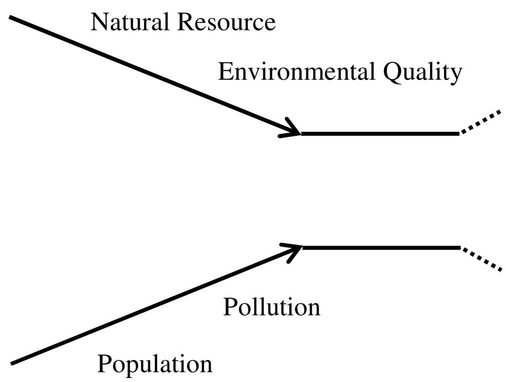

Figure 2.3. Metaphor of the funnel

In a bid to find a long lasting solution to unsustainable conditions, Dr. Robèrt decided to initiate a consensus process with other scientists. The four principles for sustainable development that resulted from this process are transdisciplinary, based in numerous sciences including those of systems thinking, thermodynamics, economics and in the concept of human needs. Recalling the principles for sustainability as they were translated to apply on the community level:

"In the sustainable society, the community does not subject nature to systematic increases of:

i. …concentrations of substances extracted from the Earth's crust;
ii. …concentrations of substances produced by society;
iii. …degradation by physical means;

and, in that society…

iv. …people are not subject to conditions that systematically undermine their capacity to meet their needs." [90]

These principles were designed to be general enough so as to form a common goal for decision making towards sustainability. They are used in combination with the backcasting technique. Backcasting involves planning backwards from a desired future situation [91] by creating strategies to get there. Interestingly, it is a method that was originally conceived of as 'energy backcasting' by John Robinson [92] from the University of British Columbia, an alternative to traditional forecasting in energy planning. Importantly, the TNS framework also consists of a generic five-level model used to structure information in a whole-systems perspective.

Figure 2.4. The five level model

Level I is the system. Gaining a 'whole systems perspective' involves situating the individual, within an organization, within society, within the biosphere. A structured understanding of the whole is required to know where to intervene in the system for the greatest effectiveness. Two related analogies are taking 'a bird's eye view' of a situation, or looking at a map. The four sustainability principles and the five-level model create a common understanding of sustainability and the various aspects in 'the system'.

Level II is the vision of success. It is comprised of the four sustainability principles (*system conditions*) and any other organization or project-specific goals. Sustainability principles are then translated to apply at the scale of application - in this paper, the community scale.
Progressive community energy plans contain vision statements and innovative practices, which ideally will be implemented in reality. Strictly speaking however, these visions don't always comply with the four system conditions. For communities however, they represent success and could arguably still contribute to moving the community towards sustainability even if they are not worded as such.

Level III consists of the strategies to reach the desired vision. Developed using backcasting, these strategies can subsequently be prioritized according to three strategic questions:

i. Does the measure bring us closer to compliance with principles of sustainability?

ii. Is the measure a flexible technical platform? Does it allow for further measures towards sustainability to be built upon it and not end in 'a blind alley'?
iii. Does the measure generate a sufficient return on investment?

Level IV consists of actions for implementing the strategies created in level III. These step-by-step, tangible and measurable actions help translate strategies from paper into the real world.

Finally, Level V is comprised of tools used to support the strategic planning process. Specifically, there are three kinds of tools: strategic planning tools, systems tools, and capacity tools. One example of a strategic planning tool is the community energy planning methodology itself. Decision Support Systems (DSS) that support multi-criteria decision-making can in a sense be thought of as all three of the tools as they contain information on the system and facilitate strategic planning while building capacity.

Synthesis of Literature Review Concepts

Following from the literature review, a few main ideas were used to structure the analysis of the community energy plans. These main concepts include the research method utilized by Nilsson and Mårtensson, The Natural Step framework and the ingenuity model.

To uncover key information in the plans, the method of asking questions employed by Mårtensson and Nilsson in their study of Swedish energy plans was selected. Because of the rigorous whole systems view that the TNS framework and the sustainability principles provide, the five level model for planning in complex systems was used to structure primary sub-questions and numerous more detailed questions following from those. The characteristics of successful energy plans and sustainable energy systems that were revealed in the literature review and interviews were then used to inform our detailed questions. Significantly, the ingenuity model informed two sets of questions at the strategy level, namely those concerning strategies for the planning process and strategies for the technical system.
Further to the strategy level, an interesting idea arose in the process of developing the analytical framework for the community energy plans: the dual socio-technical nature of ingenuity as described by Homer-Dixon situated with the metaphor of the funnel, used by The Natural Step to describe ever-declining ecosystem conditions and ever-increasing pollution

and population. The synthesis of these two key ideas shows community energy planning as a social process in the context of sustainability constraints, guiding the shift towards sustainable community energy systems. Social ingenuity, in the form of progressive community energy planning, is therefore essential to the adoption of energy technologies and demand side management techniques within communities to the end of reducing a community's dependence on non-renewable fossil fuels and lowering its contribution to air pollution and global warming.

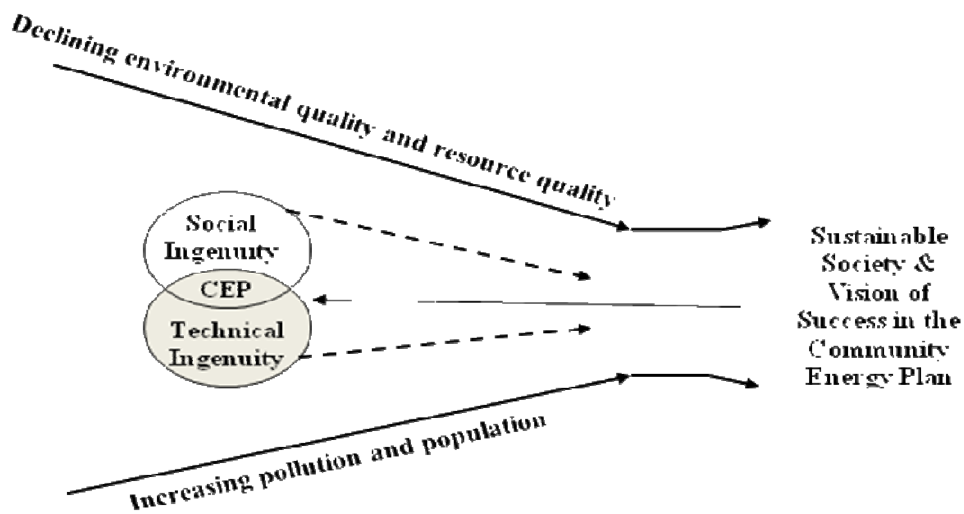

Figure 2.5. Social and technical ingenuity towards sustainability
Source: Robèrt K.H 2001, Homer-Dixon 2003

Chapter 3 Results

3.1 Research Questions

It is important to recall the main research question of this paper: *How can 'strategic energy planning' assist communities in Sweden and Canada to move towards sustainability?* This question was approached by structuring a suite of questions according to the five-level framework for planning in complex systems. This allowed for a comprehensive overview of constraints including resource availability, the visions communities have of success and the strategies, actions and tools adopted to work towards sustainable land use, infrastructure and energy systems.

To gain an understanding of 'the system', or the context within which energy planning is being done in Sweden and Canada, the question posed is: *What is the current energy supply mix and what renewable energy sources can be further developed in Sweden and Canada?* Because an answer was not solely derived from examining the plans, additional research was done drawing from secondary sources. This paper first presents a geographical profile of each country, followed by current energy resource profiles and potential renewable sources. Although the question of energy sources falls squarely on the 'supply side' soft path and IRP approaches suggest that to take a whole systems perspective on energy within communities, both supply and demand side features of the system must be considered. Thus a brief investigation into the demand side looks at the location, population and industrial dependence of the communities considered in this study.

In a slight departure from the exact structure of the five level model, it was thought important to first investigate the policies and programs of the Swedish national and Canadian federal governments that support or hinder energy planning. These were investigated by asking: *What policies and programs support or hinder strategic energy plans?*

Once the broader context for energy planning has been established, the plans are examined. First to understand of the concept of success in community energy planning, the following question arises; *how is success described in current community energy plans?*

Answers are found in the visions of success as stated in the plans. Each vision is evaluated by posing the following questions:

- Does the community energy plan have a vision?
- Who was involved in crafting the vision?
- Is the visions expressed in a manner consistent with sustainability principles?

Although strategies and actions are distinct levels in the five-level model, they were combined in one supporting question when evaluating the plans: *What strategies and actions are contained in current community energy plans*? To impart structure to the broad range of issues in energy planning that could be addressed through strategies and actions the ingenuity model was applied with thirty-six sub-questions relating to strategies for the planning process and twelve sub-questions relating to technical energy systems. Best practices uncovered in the literature review and interviews guided the creation of the questions.

Finally, to understand what tools communities use in support of their energy planning processes, it is asked: *What tools are typically used in the development of community energy plans and subsequent monitoring activities?*

In the following sections, the findings for each question are summarized and discussed. Results are summarized at the end of the section, followed by the conclusion and recommendations for future research.

3.2 The Systems level: Sweden and Canada

Figure 3.1. The five level model, system

Sweden and Canada are northern countries with cold climates and landscapes characterized by vast boreal forests, mountains, lakes and rivers. The distribution of populations in the two countries is similar – people are both spread out over large areas and concentrated in urban centers. Sweden and Canada therefore face many similar challenges in planning their energy systems. Economically the two countries are remarkably alike, both deriving 27% of their GDP from industry, 70% from services and 2% from agriculture. [93] Although politics of state differ between Sweden and Canada, social democracy and liberal democracy respectively, both countries are recognized as having excellent standards of living and strong social security systems.

Differences exist between Sweden and Canada with regards to resource opportunities. The presence or absence of various energy resources in the two countries mean that conditions differ in the areas of energy supply, availability and demand. Whereas Sweden has limited fossil fuel resources, Canada has extensive proven reserves. Sweden has no significant reserves of oil or natural gas and although Sweden has coal resources, it generally opts not to exploit them. Canada on the other hand is the seventh largest producer of oil and third largest producer of natural gas in the world. [94] This difference in natural resource profile and regional geopolitical situation, has produced distinct economic conditions in the two countries, as well as differences in national and provincial policies. The contexts for energy planning vary accordingly. To gain an understanding of energy supply contexts in which communities work the next section consists of a brief survey of energy consumption by source in Sweden and Canada. Following that a look at location, population and industrial dependence of the communities considered in this study provides a perspective on selected features influencing energy demand. A survey of recent national-level data on the energy supply mix describes available energy sources and, by extension, which sources communities are relying on locally. By sketching out the energy supply mix and having an understanding of sustainability, insight may be gained into which energy sources need to be dematerialized or reduced to within sustainable limits to move energy systems towards sustainability. The example of renewable energy sources already being tapped suggests successes that can be built upon further. Knowing what renewable energy sources such as sun and wind are readily available in both countries suggests other alternative sources of energy that could potentially be substituted.

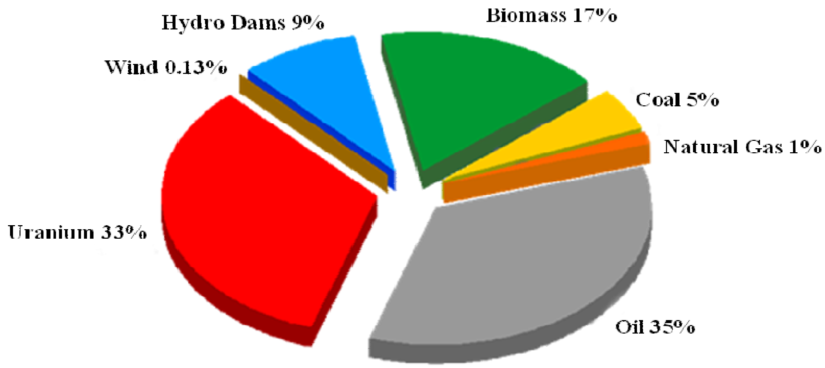

Figure 3.2. Sweden's primary energy sources
Source: Swedish Energy Agency, Energiläget 2004 OH p.5

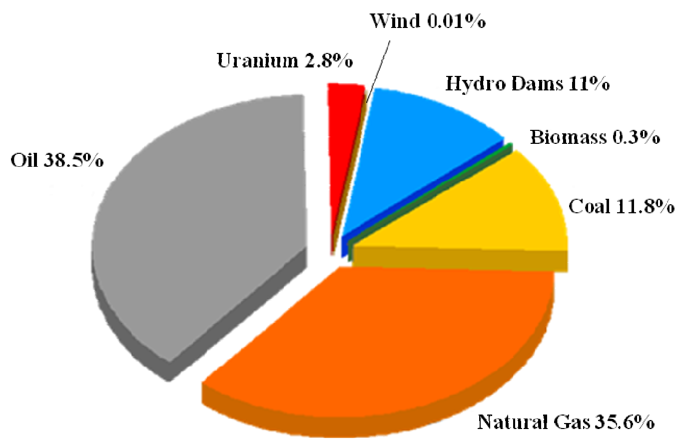

Figure 3.3. Canada's current energy sources
Source: Statistics Canada, 2004, Catalogue no. 16-201-XIE

3.3 Non-Renewable Sources of Energy Presently in Use

Petroleum

In 2004, fossil fuels constituted 41% of Sweden's primary energy supply. In that same year, Canada was 85.9% dependent on fossil fuels. The largest primary source of energy in both countries is petroleum-based fuels, Sweden and Canada deriving 35% and 38.5% respectively of their energy from this source. Sweden does not produce petroleum domestically although relies on it for transportation purposes. Canada's total oil production in 2004 was 3.1 million barrels per day (bbl/d), ranking it as the seventh-largest oil producer in the world. Primary oil reserves within Canada are found in the tar sands in northern Alberta and offshore under the Atlantic Ocean on Canada's east coast. Significant proven reserves have also been located under the Pacific off Canada's west coast, however a federal moratorium on development is in place. 99% of the crude oil exported by Canada goes to the United States, making Canada a significant source of oil for its neighbour. [95] Petroleum-based fuels are also used primarily for transportation in Canada and petroleum products are used in numerous additional energy applications including home heating, industrial purposes and for electricity generation. Canada generates 24,700 MW per year of electricity from oil and coal combined.

Coal

The other main fossil fuel based source of energy is coal. Coal is the most abundant of all fossil fuels found on earth [96] and Sweden and Canada derive 5% and 11% respectively of their primary energy use from this source. Both countries produce coal, although Canada at higher volumes than Sweden. In 2004, Canada mined 65,993,000 tonnes of coal, 27,087,000 tonnes of which was exported. [97] The figure for Canadian domestic consumption is unavailable because with a limited number of companies in the market, this is considered confidential business information.

To meet energy needs into the 21st century and beyond, a supply mix that includes fossil fuels is required during the transition towards renewable energy technologies. Clean coal technologies are more desirable than conventional coal combustion. With combustion taking place at higher temperatures, clean coal technologies can significantly reduce GHGs, but not eliminate them entirely. Due to the cost of clean coal technologies, no clean coal plant has been built to date, the payback period being beyond what most utilities and businesses find acceptable. Although the technology exists, this demonstrates that economic conditions must be right to bring cleaner technologies to market. Importantly, when market conditions become conducive to developing more expensive clean coal plants, a thorough and transparent assessment will need to be done in each case where all stakeholders are included and all impacts are considered and decisions based on acceptable trade-offs. This should apply to all situations in which non-renewable energy sources are being considered as energy supply options.

Natural Gas

As shown in Figure 3.1, Sweden derives less than 1% of its supply mix from natural gas and is exclusively an importer of natural gas as it has no proven reserves or fields in production domestically. In 2002 Sweden imported 34.75 billion cubic feet (Bcft) of natural gas. In sharp contrast, 35% of Canada's primary energy supply is derived from natural gas. Canada is the third largest producer of natural gas in the world. In 2002, Canada produced 6.6 trillion cubic feet (Tcf) of natural gas and consumed 3.0 Tcf. [98]

In Canada, natural gas is used for heating purposes as well as for electricity generation. Natural gas occurs alongside petroleum in nature, a product of the decomposition of plants and animals over millions of years. Natural gas is finite in the biosphere and although cleaner than petroleum it also contributes to GHG emissions and poor local air quality. Prices of natural gas have also increased substantially as the supply becomes increasingly scarce. In fact, Canada's proven reserves are only 56.1 Tcf, which at sustained high levels of production were estimated in January 2005 to potentially be depleted within 8.6 years. [99]

Canada's reliance on natural gas makes the country vulnerable to increasing prices and potential supply disruptions, particularly if prices were to rise dramatically. Being reliant on natural gas is understandable given Canada's extensive natural gas resources however it is a little known fact that sustained high levels of production will deplete reserves in such a short time period. Furthermore, using natural gas for home heating ignores the basic principle of matching best source to end use – natural gas contains much more energy than is needed to elevate the temperature in a home by a few degrees. The scale on which Canadians in certain regions are dependent on natural gas for electricity generation implies vulnerability. The use of natural gas for generating motive power in a vehicle fares somewhat better in an energy balance analysis than the use of natural gas for electricity.

In doing this comparison of proportionate reliance on fossil fuels, it can be shown that while the two countries rely equally on petroleum, Canada is more reliant on both natural gas and coal than Sweden. This can be explained in part by the abundance of fossil fuel resources in Canada. In contrast, Sweden does not have any significant domestic production of oil or gas. Thus while it is to Canada's economic advantage to produce, sell and use oil, natural gas and coal, it is to Sweden's advantage to minimize its reliance on these sources, as they are expensive to procure from elsewhere. This fundamental difference in domestic availability of energy sources has implications for policy making.

Nuclear

Although Sweden is not as dependent on fossil fuels as Canada, it is significantly more dependent on uranium. Sweden obtains 33% of its primary energy from uranium, generating 64.199 BKWh in 2002. [100]Although uranium deposits exist in Sweden, to fuel Swedish reactors the radioactive substance is imported because producing it domestically is too expensive and costly for the environment. [101] Plans have been underway since 1980 to decommission Sweden's reactors. In June 2005 a second reactor, Barseback 2 in Skåne, closed [102] leaving 10 reactors, all of which are slated for decommissioning in the next few years. [103] Debate did surround the closing of the reactors however as nuclear is GHG free in comparison to the coal power plants from where energy was to be sourced otherwise.

Canada relies on nuclear for 2.8% of its total energy use, meeting approximately 15% of its electricity needs from this source. There are seven reactors in total, five in Ontario, one in Quebec and one in New Brunswick. In addition to mining uranium for domestic energy needs, Canada is an exporter of uranium for use in CANDU reactors and in medical applications. Approximately 25,000 people are employed in the nuclear industry in the country and as of 2005 the federal government was investing approximately $100 million per year in nuclear technology. [104]
Nuclear reactors are considered a hard path energy supply source; large amounts of capital and significant amounts of time are required to construct

them. As the technology has been developed and tested over many years, the risk of accident is low although still present. Large identifiable nuclear reactors are potential targets for terrorist activities, although the facilities are said to be extremely robust in design. Regardless of the relative security of the installations themselves, nuclear waste will continue to pose considerable risk to future generations as no proven way of dealing with it has been developed to date. In the short term, waste transportation and disposal operations are risky and expensive.

Thus, although Sweden currently relies more heavily on nuclear energy than Canada, there is a contrast in the directions their policies are taking. Sweden is aiming to reduce its dependence on nuclear while Canada with its proven uranium deposits and continued subsidies appears to have the incentive to maintain or increase reliance on this energy source.

Following from the sustainability principles outlined previously in this thesis, it is known that systematically increasing waste from both fossil fuels and uranium in the biosphere contributes to unsustainable conditions in ecological and social systems. Non-renewable sources will however continue to form an important part of the supply mix for the foreseeable future. Decision making based on sustainability principles in a whole systems perspective involving all stakeholders and on transparent and informed dialogue, can hopefully result in the negotiation of acceptable tradeoffs when non-renewable sources are being considered.

3.3 Present and Potential Renewable Sources of Energy

An understanding what renewable energy sources flow freely in the biosphere provides insight into supply options for communities transitioning away from present unsustainable levels of dependence on fossil fuels and nuclear. Those considered here include hydro, wind power, solar, tidal, biomass, geothermal and waste management practices.

Hydro

Sweden and Canada depend on large hydro dams for some of their electricity needs, with hydro comprising 9% and 11% of the primary energy supply in the two countries respectively.

Sweden currently generates an estimated 60 TWh from its existing hydro installations. [105] In the 1980s, Sweden made a decision to dam no additional rivers. The implication is that while 9% of the energy mix is supplied from hydro damns, large-scale hydro is not an option Sweden can pursue as it seeks to expand its portfolio of renewable energy supply.

Canada conversely, is the world's largest producer of hydropower, with an estimated 548.9 billion kilowatt hours (BkWh) produced and 487.3 BkWh consumed in 2002. The electricity grids between Canada and the United States are deeply integrated; in 2003, Canada exported 29.3 BkWh of electricity to the United States and imported 23.6 BkWh. In contrast to Sweden, Canada plans to continue development of hydro-electricity generation, with an estimated 34 371 MW potential capacity for future development. Hydro-electricity production was projected to increase by about 14 percent between 1995 and 2020. [106]

The energy derived from a large dam is theoretically renewable, but the wisdom of the option is questionable. Both Sweden and Canada have experienced serious environmental and cultural ramifications resulting from large dam projects. [107] Evidence suggests, for example, that methyl mercury contained in the ground in northwestern Quebec was introduced into the ecosystem in flooding, bio-accumulating in fish, large mammals and eventually the indigenous Cree population that consumed fish and bush meats. [108] Nevertheless, similar to the nuclear option, hydro power has come back in vogue lately because it produces significantly fewer GHGs than fossil fuel sources.

Fortunately, less invasive technologies have been developed to capture smaller amounts of energy from rivers. Smaller hydro and micro hydro river installations being significantly less invasive than large-scale dams, no alteration is required of the river for them to be effective. As of 2005, there was about 2000 MW of installed small hydro capacity in Canada. [109] These technologies represent a success that remote communities in both Sweden and Canada can build upon.

Small and micro hydro installations are an excellent supply option in locations where electricity is currently being generated with expensive diesel.

Wind

Wind is considered to be the source with the greatest potential for adding electricity generation capacity. Sweden has not reached its full potential for wind energy, particularly in the southern and western parts of the country. Interestingly, this can be attributed in part to the military which previously opposed wind installations for security reasons. Although the military is increasingly supportive of the idea, the public sometimes resists the expansion of wind capacity for reasons of aesthetics. [110] Wind energy can also be found offshore. Swedish electricity generating company *Vattenfall* is seizing this opportunity by investing 8 billion SEK a project in the Baltic that, when completed in 2010, will generate 2 TWh of electricity annually. [111]

Numerous additional wind turbines could be installed to expand Canada's supply of electricity. The wind Atlas of Canada indicates where sufficient wind potential resources exist. [112] In fact, in its 2005 budget, the Canadian government announced a quadrupling of the Wind Power Production Incentive (WPPI), triggering increasing investments in wind power projects facilitating the increase of the country's total wind capacity to 800Mw in 2005.

As in Sweden, there is public opposition to these projects in Canada. The opinion often expressed by those opposed is that the wind installations destroy the view of the landscape or that the windmills might disturb the migratory flight path of birds.

Sun Potential (kWh/m²/day)

0-1.0

Wind Potential (km/h)

- Level D (0-19)
- Level C (19-29)
- Level B (29-39)´

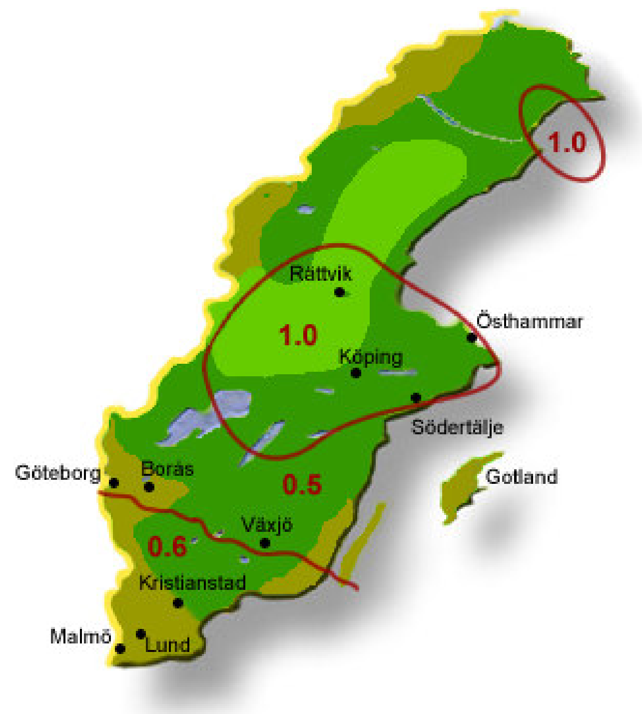

Figure 3.4. Wind and solar resources in Sweden
Source: Vattenfall [113] and Rupprecht & Patashnick Co. [114]

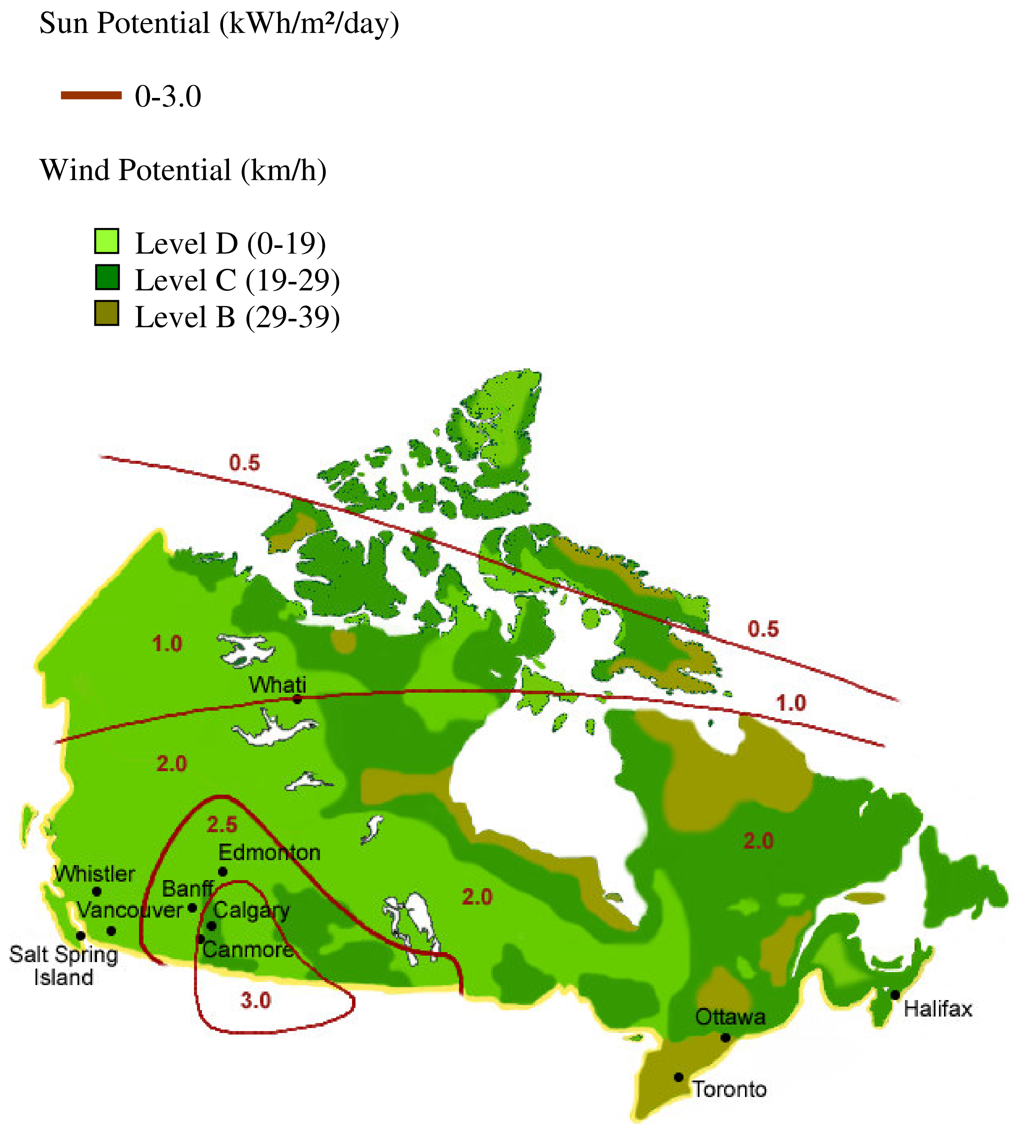

Figure 3.5. Wind and solar resources in Canada
Source: Environment Canada, Canadian Meterological Centre, 2002, Canadian Wind Atlas [115] and Rupprecht & Patashnick Co., Inc [116]

Solar

The most direct renewable source of energy is the sun. Its energy can be harnessed directly through active solar installations that generate electricity such as photovoltaics (PV), through solar thermal technologies for space or water heating, and through passive solar design features in buildings. Although Sweden is located north of 56° latitude, the potential still exists to harness energy from the sun for applications such as household appliances and signal lights (see Figure 4.3). Some buildings in northern Sweden are designed to take advantage of the natural light for part of the year.

The average North American household consumes 1kW of electricity per day, an amount that could be derived from the sun in the populated southern regions of Canada. PV systems could be installed for electricity generation on the roofs of houses and buildings and solar hot water heaters could be installed to meet the need for hot water. Measures such as these replicated in many households could alleviate the strain on the electricity grid during periods of peak demand and reduce a community's reliance on electricity produced from unsustainable sources.

On the demand side, passive solar design of homes and buildings can result in greater energy efficiency through reduced heating requirements and lower electricity use. Letting natural light into buildings can also have the added benefit of raising people's spirits; workers in buildings with plenty of natural light have been found to be more productive and have fewer sick days. [117] Multiple benefits can be had from free flowing solar energy.

Biomass

Notably, Sweden's second largest primary source of energy is biomass, accounting for 17% of total energy consumption. This can be attributed to the use of biomass in district heating systems. The forestry industry has also been particularly successful in 'closing the loop' by using waste products from their operations as fuel. Wood chips, and pellets are used to generate electricity, steam and heat, and these operations rely less on expensive fossil fuels as a result.

With 235 million hectares of forest available for harvest, a large resource potential exists in Canada for biomass. [118] Pine and spruce beetle infestations will mean an even greater availability of wood as companies rush to log to manage both affected and non-affected forest stocks. [119] Canada has a significant opportunity for the use of biomass as an energy source in expanded district heating systems, particularly in remote and northern communities. The industry in Canada currently receives subsidies for electricity and could benefit substantially from improved efficiency. Industrial energy efficiency has implications for the economic vitality of communities in general because when operations are inefficient companies are more vulnerable to other negative economic factors that affect their profit margins.

Biofuels

Renewable sources of energy for transportation can be derived from virtually any biodegradable material including waste, agricultural crops, vegetable oils, animal fats, wood waste and manure. These feed stocks can be converted to a type of biofuel that can be used to operate most vehicles on the road today, provided the vehicles undergo modification. These modifications and the need for fueling infrastructure are some of the issues associated with expanding the use of biofuels. Sweden with the help of such visionaries as Per Carstedt has already started a Biofuel Region where fifteen municipalities will eventually rely exclusively on biofuels for their transport energy. The long-term goal is to expand the Biofuel Region to include the whole country. [120]

Canada currently produces about 200 million liters of ethanol per year, which replaces about 0.03% of gasoline consumed. [121] Again, with fueling infrastructure and the commercial availability of vehicles, this renewable source could be greatly expanded. In addition to ethanol, other energy carriers such as biodiesel, hydrogen and electricity could also be used to power vehicular transportation. Research has been conducted by the Canadian federal government and many of its fleet vehicles have been converted to ethanol blends, although a widespread uptake of this technology has not occurred. As fuel prices rise, increasing numbers of people are investigating both alternative fuel options and hybrid electric vehicles.

Geothermal

Geothermal energy, or heat from the earth's crust trapped as steam and hot water, is one of the largest potential renewable energy sources in the world. Geothermal may be used for a variety of purposes including space heating, electricity generation and for recreation. The higher the heat gradient, the shallower the depth required for the desired heating or cooling effect; two other feasibility parameters are depth of seasonal freezing and in some locations the suitability of aquifers for groundwater extraction. [122]

In Sweden, geothermal is currently used for residential and commercial applications involving heat pumps with geothermal sources. [123] According to the Energy Information Administration's Sweden Country Brief in 2002 there were 4.405 Bkwh of geothermal generating capacity installed in Sweden.

Geothermal is also a large source of potential renewable energy in Canada. There are currently 55,000 geothermal installations in Canada in commercial, residential and institutional contexts. In 2000, Canada installed 377.6 MW of geothermal power which produced in total 1023 TJ/yr of energy [124].

Waste Management

As Einstein taught us, matter is energy. Disposal, recycling, waste to energy generation and methane capture are waste management options available to communities wishing to generate energy from waste.

Each Swede sends approximately 100 kg of solid waste to landfill per year. [125] Sweden recovers significant amounts of materials through comprehensive recycling and composting programs. Some communities such as Umeå incinerate waste to generate heat and electricity. [126] In response to an EU directive in January 2005, the country has now moved to a zero organics to landfill policy to further reduce the amount of energy lost through materials going to landfills.

In contrast, the average Canadian sends on average 750 kg of waste to the landfill per year, [127] seven and a half more times than the average Swede. Despite Canada's massive physical size, garbage dump location is a problem that plagues Canadian communities. The City of Toronto for example has been unable to find a citizen-sanctioned location within the province of Ontario to dump waste from the Toronto area. Instead the city's waste is sent to the American State of Michigan. Due to opposition to landfills and because energy can be derived from waste, waste to energy generation is a potentially attractive option.

Caution must be exercised in expanding waste to energy facilities however, with socio-environmental impacts being considered in the decision process. [128]

A source of energy that can be derived from landfills is the methane produced when garbage decomposes. A common method of dealing with this gas is through flaring or off-gassing when the gas is burned. In Canada, as of 1999, a total of forty-one landfills conducted landfill gas flaring programs nationwide [129]. While this technique reduces the amount of methane going into the atmosphere, the energy embodied in the methane is not captured and used. Kristianstad in Sweden, in contrast, extracts biogas from its landfill to use as transport fuel.

Of the Communities evaluated, Edmonton and Calgary have small projects that derive energy from waste. Calgary's Bonnybrook facility converts sewage waste into 11 million kWh of electricity annually. Energy recovery facilities remain an energy supply option for many Canadian communities to consider when market conditions are right.

Technologies currently exist to meet a significant proportion of energy demand from renewable sources. Supplying energy needs in an efficient, cost effective and more sustainable manner should lead to development in the renewable energy technology sector over the coming years. However, adoption of new technologies will occur only if government and business work to make the installation of energy systems affordable. This and consumer education programs will produce some of the shift from non-renewable to renewable energy sources.

A key challenge associated with many renewable sources of energy that cannot be overcome by technological availability or policy is that they are limited according to geography, climate and weather. The amount of energy produced by renewable energy technologies can also be variable, leading to difficulties in meeting base load requirements with renewables alone. The answer, therefore, lies not in one individual technology but in an appropriate supply mix and effective demand side management that will be further discussed in the next section.

Swedish Community Energy Systems

The physical energy systems of Swedish communities assessed in this research have the following general characteristics:

- District heating installations supply most heat energy needs;
- Electricity is derived from hydro, nuclear and sometimes biomass;
- Petroleum-based fuel is used predominantly for transportation;
- Most utilities are partially or wholly publicly owned.

Växjö is a notable exception, deriving most of its electricity and heat from biomass sources.

Canadian Community Energy Systems

Canadian community energy systems vary regionally according to geography and resource availability. In British Columbia, 90% of electricity generated comes from hydro dams, while the adjacent province of Alberta has very limited hydro capacity but extensive coal and natural gas resources. Ontario relies on a mix of coal, hydro dams and nuclear power for electricity generation while New Brunswick on the east coast uses oil as its primary source for both electricity and heating. Energy resources fall under provincial jurisdiction, and most communities in Canada have limited influence over how electricity is generated. Most heating needs in Canada are met using natural gas, depending on how readily available this fuel is in a particular community. District heating and cooling has been installed in two communities in this study, Vancouver, where the system serves a small area of the downtown district and Toronto whose deep-water cooling system cool buildings in the downtown core in the summer months, reducing reliance on conventional air conditioning. Although district heating and cooling is not available to meet home heating and cooling needs in the majority of Canadian communities, it represents a viable technology that could be implemented to a greater extent in both major urban and remote contexts. The availability of grant money would speed the adoption of this technology as up-front capital costs are high.

Lovins, the authors of Cities Plus, the Swedish ALEP guidebook, and officials from Natural Resources Canada agree that a key ingredient of a good community energy plan is that the time frame be long. Since the lifespan of urban infrastructure and physical components of energy systems such as power plants and transmission lines is long, plans that look fifty to hundred years down the road over the lifecycle of these investments, are the most strategic. By taking a view to the long-term, major changes in infrastructure can be seen as opportunities to be planned for accordingly. It is true that most energy systems in existence today are based on technology that is one hundred years old. [130]

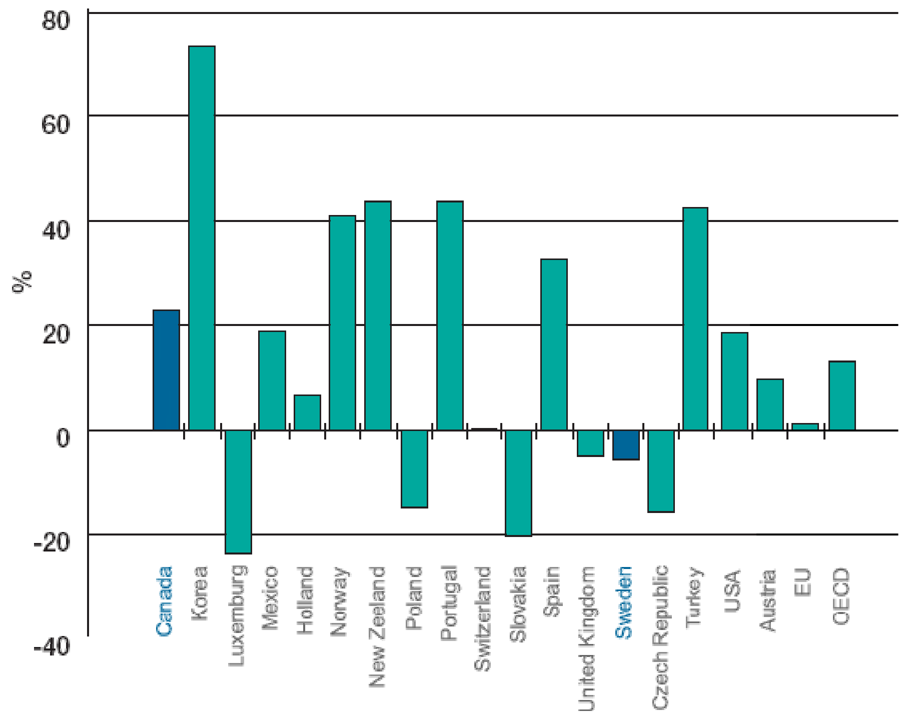

Figure 3.6. CO_2 emissions from 1991 to 2001 for Sweden & Canada
Source: Swedish energy agency, Energiläget 2004 p.5

Understanding how both countries have fared in terms of their attempts to reduce contributions to CO_2 is also relevant. Being dependent on different energy sources has resulted in different levels of CO_2 emissions for the two countries in the years since the *Kyoto Accord* was originally negotiated. The degree to which strategic community energy planning has contributed to these difference in CO_2 emissions is beyond the scope of this thesis. CO_2 emissions is an example of an indicator that could be monitored in the context of community energy planning processes and aggregated on a national scale.

3.4 The Demand Side

Following from the soft energy path strategies presented earlier, it is known that measures on both the supply and demand sides are required in order to achieve sustainable energy systems. To meet energy needs from renewable sources and technologies alone, a considerable improvement in demand side efficiencies will be required.

Gaining an appreciation of the features within a community that predicate types and volumes of energy demand involves understanding a multiplicity of factors such as topography, transportation infrastructure, mix of land uses and density. Because the scope of this thesis is broad, only a few variables influencing a community's energy demand are considered, namely latitude, size, and industry dependence.

Table 3.7. Population of Swedish and Canadian municipalities

Community	Latitude	Population	Industry Dependent
Halifax	42º	359 183	yes
Ottawa	43º	774 072	no
Toronto	43º	2 481 494	yes
Salt Spring Island	49º	10 000	no
Vancouver	49º	545 671	no
Banff	50º	7 135	no
Whistler	51º	8 896	no
Canmore	51º	10 792	no
Calgary	51º	878 866	no
Edmonton	53º	666 104	no
Lund	55º	101 423	no
Malmö	55º	269 142	no
Kristianstad	56º	75 592	yes
Växjö	56.5º	75 036	no
Gotland	57.2º	27 661	yes
Borås	57.5º	98 776	no
Gothenburg	57.5º	481 410	yes
Södertälje	58º	80 405	yes
Köping	58.5º	24 677	yes
Östhammar	58.5º	80 405	no
Rättvik	59º	10 864	yes
Wha Ti	60º	500	no

Latitude of the communities provides an indication of weather and climactic conditions. Canadian communities evaluated are for the most part below 55° N latitude and experience four distinct seasons, with very cold temperatures in winter and warm or hot temperatures in summer. Energy systems and buildings must be designed accordingly to meet seasonally variable heating and cooling needs. The one northern community considered in this study is Wha Ti, N.W.T. Located close to 60° N latitude it experiences an artic barren land climate with very cold temperatures most of the year. Vancouver and Salt Spring Island are also distinct from the rest of Canadian communities evaluated, enjoying the temperate climate of Canada's west coast.

All communities evaluated in Sweden are located above 55° N latitude. The climate in northern Europe is known to be milder due to the effects of the jet stream and thermohaline circulation in the oceans. However, since Swedish communities examined here are significantly further north, the climate in which they are situated today can be considered comparable to many Canadian communities. Their energy systems and buildings must also be prepared for extreme cold but because Sweden is much further north, air conditioning demand in summer is significantly lower.

Latitude alone does not dictate the climate conditions, however a more northerly or southerly latitude does influence energy demand in a given region. Communities face considerable uncertainty surrounding the effects of climate change. Canadian communities are expected to face a range of challenges that vary regionally and include increased severe storms, the risk of flooding, and soil subsidence as the permafrost melts. For Swedish communities, it has been said that with increased fresh water content and reduced salinity in the oceans resulting from melting glaciers and icecaps, it is possible that the thermohaline circulation in the North Atlantic could shut down. This could result in a significant cooling in Europe, making Swedish communities colder than they already are. It is not know when this could occur, but what is known is that when it does it could happen relatively quickly. [131].Swedish and Canadian planners must respond now to these and other potential climate change impacts and plan infrastructure and social services accordingly.

Criteria in the determination of appropriate energy strategies include size and industry dependence. Communities labeled as industry dependent are those having industry-sector energy demand at least a quarter more than residential, commercial and transport levels of energy demand.

Table 3.8. Electricity consumption

Island Communities	**Total (kWh/capita)**
Gotland	29 334 [132]
Salt Spring Island	29 639 [133]
Northern Communities	
Wha Ti	22 460 [134]
Rättvik	19 944 [135]
Large Communities with little industry	
Malmö	28 400 [136]
Lund	27 754 [137]
Växjö	37 916 [138]
Borås	34 404 [139]
Calgary	29 000 [140]
Ottawa	N.A.
Vancouver	38 330 [141]
Large Communities with heavy industry	
Gothenburg	44 231 [142]
Toronto	48 140 [143]
Halifax	79 300 [144]
Edmonton	N.A

3.5 Policies and Programs that hinder and support the CEP

Another set of features that influence community energy planning activities are those found in the political landscape. Although community energy planning takes place on the local level, it is beneficial to examine its practice within the context of federal or national and, in the case of Canada, provincial government policies and programs. It was thought to be important to provide some detail on this subject prior to the analysis of the plans to provide context on the broader strategies within which communities are planning their energy activities.

Policies are strategies devised by governments to create the conditions for objectives to be met. Policies, and the programs that flow from them, can either be supportive of community energy planning or act as a disincentive for communities to evaluate and change their energy activities. A brief overview is presented of key national policies, government departments, their programs and associated organizations in Sweden and Canada. Policies and programs supportive of community energy planning can have the following characteristics:

- Are based on sound science [145]
- Promote a common understanding of socio-ecological principles of sustainability; [146]
- Provide information and financial resources to support technical innovation and community energy planning processes [147]
- Promote aligned national/federal, län/provincial and municipal decision making [148]
- Look over the long term;
- Contain feedback mechanisms; [149]
- Advise a switch to renewable energy sources where possible;
- Recommend that decision making be based on full cost accounting with an understanding of the tradeoffs;[150]

Swedish National Energy Policy

The Swedish national government has long demonstrated its commitment to the environment and citizens and is considered to be in the vanguard of environmental projection. Its policies and programs could be said to be very supportive of community energy planning activities.

The first law requiring municipalities to develop community energy plans was introduced in 1977. [151] Oil price shocks had exposed Sweden's vulnerability due to its dependency on foreign oil and so oil reduction was the primary objective .The law also encouraged the implementation of solar, heat pumps and hydro; nuclear capacity was also increased at this time. In 1985, the law was revised as Sweden began phasing out nuclear power. Importantly, the government also legislated the integration of energy planning into the municipal comprehensive planning process [152] and encouraged renewable energy.

In 1997, the law on community energy planning was revised again with emphasis on the effective use of energy and low impacts on health, the environment and climate. With the continued phase-out of nuclear, subsidies were provided by the national government for district heating and wind power.

Based on the economic imperative of reducing dependence on fossil fuel supplies, the Swedish government enacted legislation that would see the use of science and technical ingenuity to both reduce Sweden's energy consumption and increase its renewable energy capacity. And while it can't be said that the legislation promoted a common understanding of socio-ecological principles of sustainability, it can be said that the concepts it contained such as match of best source to end use and energy cascading helped move energy activities towards sustainability. By creating a law, the Swedish government created the conditions that, with the help of information and financial resources, enabled communities to learn about and practice community energy planning. By taking a national approach that would be applied to all communities, the Swedish government promoted an alignment of national/federal, län/provincial and municipal decision making. And because community energy planning involves looking to the future to plan for more efficient and robust energy systems and planning techniques, such legislation also fostered a longer-term perspective. This legislation was revised several times, indicating responsiveness to changing conditions.

Sweden's Environmental Objectives – The central piece of Swedish national environmental policy is its *Environmental Objectives,* enacted in 1995. Originally 15 in number, an additional objective on biodiversity, was adopted in November 2005. They define the aims of Swedish environmental policy and provide a coherent framework for environmental programs and initiatives at national, regional and local level.

Those objectives relating to energy planning in a holistic sense include 'Reduced Climate Impact' and 'A Good Built Environment.' Other *Objectives* relating to energy activities are 'Sustainable Forests,' 'A Protective Ozone Layer' and 'A Safe Radiation Environment.'

By setting out clear objectives based in science for everyone to work towards, the Swedish government has created a policy context that is goal-oriented by describing what environmental characteristics are desirable.

This promotes a common understanding of socio-ecological sustainability, fosters aligned national, *län* and municipal decision making and supports a long term perspective. The publication of associated reports delivers information that can assist municipalities, businesses and residents in planning their energy activities in such a way as to be goal oriented towards the objectives. The objectives are tracked and reports periodically released, thereby providing a monitoring function using indicators that highlight trends in progress towards or movement away from the objectives. [153] And because the switch to renewable energy sources where possible is a key means to reduce the impact of energy activities on environmental systems, the objectives can and have been interpreted to justify fostering increased implementation of renewable energy technologies. Having the objectives in place also promotes more holistic decision making as they represent goals that can be included towards a full cost accounting.

Boverket - The Swedish board of Housing, Building and Planning, or *Boverket,* is the national government agency responsible for implementing Sweden's *Environmental Objective* number fifteen, 'A Good Built Environment.'

Boverket's mission is stated as follows:

> "Everybody shall be provided with the prerequisites to live in good housing at a reasonable cost and in a stimulating and secure environment within a long-term sustainable framework. The housing and built environment shall contribute to equality and worthy living conditions, and especially foster a good environment for children and young people to grow up in. Ecological, Economic and Social sustainability shall constitute the basis for all activity in planning construction and management." [154]

Boverket is also mandated to track energy issues in communities and dwellings. Rigorous technical research on building and community design and renewable energy technologies, is conducted as a part of their programs, meaning that the research and information developed is based in sound science. The agency communicates the results of its work to the public, which can be considered a feedback mechanism.

Having a central agency responsible for both housing research community planning and the environmental objective most closely associated with the domain makes Boverket a focal point for research and planning expertise on community planning in Sweden. This promotes aligned national/federal, *län*/provincial and municipal decision making. [155]

The long-term Swedish focus on community energy planning has been accompanied by appropriate financial incentives, meaning that many communities have been planning their energy systems in some way for almost 30 years. As such, they have had the time to develop comprehensive strategies and take concrete actions, as is evident from looking at the plans and energy systems. Even communities that have begun their activities more recently will have benefited from established practices in the other communities.

Taxation Measures in Sweden - Following from its commitment to the Kyoto accord, and the scientific consensus surrounding climate change, Sweden has instituted a national tax on CO_2, commonly referred to as a carbon tax. This tough but forward looking measure provides a clear fiscal incentive for national, län and local actors to reduce CO_2 emissions. Sweden has realized that to promote sustainable energy use, energy resources must be priced according to their true value, including the social and environmental costs associated with their use. [156] CO_2 taxation [157] was enacted in the early 1990s, in conjunction with a major tax reform that also saw taxes reduced in other areas such as income tax. [158] Having this model of taxation that creates incentives towards good behavior and disincentives towards bad behavior, Sweden is regarded as being "…at the forefront in terms of applying tax shifts as part of a policy package aimed at sustainable development." [159] $C0_2$ taxation promotes a switch to renewable energy sources, because renewable energy technologies are an important means of reducing reliance on CO_2 intensive fossil fuel based forms of energy. The feedback mechanism resulting from taxation measures can be considered the public's reaction in the form of changing energy consumption patterns. [160]

Local Investment Programs (LIP) - Administered by the Swedish EPA, LIP consisted of 6.2 billion SEK in grants for sustainable development initiatives at the local level. [161] Between 1998 and 2002, LIP funded 1800 initiatives in 161 municipalities, over half of all Swedish municipalities. [162] Approximately one third of projects that received funding were energy-related, making it a significant source of funding from the national level government directly to communities for their energy systems. Examples of projects funded include the expansion of district heating systems, biomass based combined heat and power facilities and energy efficiency initiatives in homes and buildings. [163]

The aims of LIP are:

- To achieve environmental improvements in Swedish municipalities;
- To increase investment in sustainable infrastructure and technology;
- To improve knowledge about ecological sustainable development;
- To help to ensure that sustainability is given higher priority in local efforts;
- To encourage all actors in society to work together to achieve sustainable development;
- To create job opportunities.

LIP goals encompass the criteria that make for supportive policies for sustainable living by being based in science and supporting technical innovation, including in renewable energy technologies, through investment. They explicitly promote ecological sustainable development and in so doing foster a longer term perspective. Extensive investments in infrastructure for the purposes of reducing the ecological impact of energy systems and human impacts over the long term could be said to be decisions made based on full cost accounting, with an understanding of the tradeoffs.

Deregulation in Sweden - The Swedish electricity market was deregulated in 1996. Deregulation in Sweden has resulted in lower electricity prices. Investments in energy efficiency initiatives have also declined. [164] Thus while deregulation has been good for consumers of electricity, it has resulted in a financial disincentive to energy conservation. Less information is also now communicated to the public on energy efficiency. [165] Thus government must play the new role of removing market barriers to energy efficiency. This is accomplished through dissemination of information and the establishment of a certification system [166]

Sweden's Regional Policies and Programs - In Sweden, regional departments or *län*, are responsible primarily for healthcare and transportation. The regional government behaves as a support department for municipalities in the region.

For example, if some communities were considering wind farms, the regional governments would support a study on the wind potential for the region and provide this information to the communities in the area. [167]

Swedish Eco-Communities is an NGO whose main function is to assist communities in becoming more sustainable. Participating communities disseminate information on sustainability, including technical information and case study examples. Importantly, a common set of indicators has been developed for communities to monitor and compare their progress.

Canadian Federal Programs and Strategies

To repeat the supporting research question: *What government programs or policies support or hinder strategic energy planning?*

In contrast to Sweden, as of 2005 no legislation existed in Canada requiring communities to produce energy plans. Rather, direction on and responsibility for community energy planning can be traced to all three levels of government, federal, provincial and municipal. On both the federal and provincial levels, numerous pieces of legislation and many programs cover a wide range of issues relating to energy. Most of the legislation pertains to resource extraction; these laws are listed in *Appendix II* According to the Canadian constitution, while the federal government has jurisdiction over national energy policy, the provinces own energy resources and have jurisdiction over land use planning.

The federal government departments and agencies having mandates relating to energy include Natural Resources Canada, Environment Canada, Infrastructure Canada, and The Canada Mortgage and Housing Corporation. Because The Federation of Canadian Municipalities represents the interests of all municipalities at the federal level, selected energy-related programs it administers will also be discussed. Since reviewing all of the federal programs relevant to energy planning would be a thesis in itself, examples of programs will be used to illustrate characteristics that either support or hinder strategic community energy planning. Programs selected will be evaluated on the same criteria used to evaluate the broader Swedish context. Provincial policies and the role deregulation has played will be discussed briefly at the end of the section.

Natural Resources Canada – Programs and research being carried out by Natural Resources Canada are supportive of community energy planning.

Programs which fund energy efficiency included the EnerGuide for Houses program, the R-2000 standard and CBIP. EnerGuide for Houses is a home energy retrofit program that transfers information and offers a rebate incentive to Canadian home owners. This program has resulted in over 200,000 home energy audits being completed, contributing directly to energy efficiency on the community level. While this program does not further a strict concept of socio-ecological sustainability given that it promotes the continued utilization of fossil fuel heating sources, it does facilitate improved energy efficiency. Provincial and municipal governments as well as utilities have initiatives linked to the EnerGuide program.

Complementary to the EnerGuide for Houses program is the R-2000 standard, an energy-efficiency guide for both new home construction and home renovation projects. In the domain of commercial buildings, the Commercial Building Incentive Program (CBIP) provides up to a 25% rebate for the additional costs associated with the design of an energy-efficient building. The Energy Star standard for appliances, adopted from the United States, provides guidance to consumers on the purchase of appliances, through a recognizable brand indicating a high standard of energy efficiency.

In addition to these programs, Natural Resources Canada undertakes federal science and technology research at its CANMET Energy Technology Centre (CETC). The Sustainable Buildings and Communities group, within CETC, produced the community energy planning guidebook reviewed in the literature review section. In addition, CETC partners on energy system demonstration projects and community energy planning processes such as the Sustainable Urban Neighbourhoods (SUN) pilot project, through contribution agreements.

The various programs, standards and research being carried out by NRCan could be described as supportive of community energy planning as they are based in science, and provide information to Canadians and in some cases funding towards more sustainable energy activities. Because provincial and municipal programs were linked to the EnerGuide audits, it could be said that at least one NRCan program promotes aligned decision making between various levels of government.

Infrastructure Canada - Infrastructure Canada has a mandate to "…[coordinate] federal efforts to build a "new deal for cities and communities." As a department, it also makes strategic investments in sustainable infrastructure projects through partnerships that meet local community needs.

Within infrastructure Canada is the Cities Secretariat, which ensures that a cities and communities view is taken in all policies and programs developed by the federal government. Funding mechanisms related to community infrastructure include the Canadian Strategic Infrastructure Fund, the Municipal Rural Infrastructure Program. Gas Tax funds, derived from the federal tax on gasoline, were available to communities as of 2006. Eligible projects will include energy systems and sustainable transportation infrastructure.

Like NRCan, Infrastructure Canada's programs are developed through research, and provide information and financial resources to support innovation in community energy planning. They promote aligned national and municipal decision making and promote a long term perspective. Gas Tax funds will be another source of funding to subsidize renewable energy technology projects.

Environment Canada – Environment Canada is the federal government department responsible for action on climate change. The major program initiated to date is the One Tonne Challenge. This program promotes behavior change by providing Canadians with information and tools to reduce their carbon emissions. The challenge is for each Canadian to reduce his or her carbon emissions by one tonne per year. This program is based in science, and in providing information about climate change fosters a long term perspective, it is a voluntary initiative with no financial incentives attached other than those resulting from energy savings. While it does demonstrate a certain degree of federal leadership it does not explicitly promote a switch to renewable energy technologies. Given the voluntary and incremental nature of this program, it is uncertain the degree to which it will be effective at getting Canadians to reduce their GHG emissions.

The Federation of Canadian Municipalities - The Green Municipal Funds are federal money transferred to municipalities to fund sustainable development in areas relating to the reduction of GHG emissions, improved local air, water and soil quality and renewable energy. It was announced in the 2005 federal budget that the fund would receive an additional $300 million Canadian. [168] The Green Funds represent a significant source of funding to municipalities. The application and review process ensures that projects are technically sound and that they promote sustainability and build capacity in communities for energy planning.

Partners for Climate Protection (PCP) is a network of 124 municipalities and regional governments across Canada working towards GHG emission reductions. The PCP program is the Canadian component of the climate change program from the International Council for Local Environmental Initiatives (ICLEI). There are five milestones in the PCP process, the achievement of which builds local capacity for energy planning. Municipalities may obtain a 50% grant from Green Municipal Funds towards the completion of milestones 1 through 3, one of these being the creation of an energy plan. Communities generally begin with a municipal operations energy plan that can later be extended to the whole community.

7 out of 11 plans reviewed in this thesis were written in conjunction with the PCP process demonstrates the degree to which the program has built capacity for community energy planning in Canada. The program transfers information and financial resources and promotes a common understanding of the importance of energy issues in climate change mitigation. That said, the program does promote a single-issue perspective on energy planning as it looks primarily at the air quality and climate change impacts of energy activities.

The HEAT software associated with the PCP program promotes tracking of a community's GHG inventory over time. This monitoring activity could possibly promote decisions based on full cost accounting. Because renewable energy technologies often provide a significant source of GHG reductions, the PCP program promotes the switch to renewable energy sources where feasible.

Canadian Federal Activities that Hinder or Detract from Community Energy Planning - While selected government department and programs have been discussed that support community energy planning and, by extension, a move towards sustainability, there are also functions of government that, from a perspective of strict socio-ecological sustainability, could be said to hinder community energy planning efforts.

One significant issue is federal support of non-renewable resource extraction through subsidies. Estimated federal tax subsidies to the oil and gas sector are $1.4 billion per year, with the majority occurring in the form of tax breaks under *Canada's Income Tax Act*. From 1996-2002 these subsidies totaled approximately $8 billion. [169] Accordingly, commodities such as gas are not priced according to their true value. As a result, other levels of government, businesses and consumers alike may be more likely to make decisions that are inefficient in their use of energy resources.

And while scientific research does inform these investments, such as those associated with improved efficiencies in oil sands production, it is science that facilitates non-renewable resource extraction. This furthers environmental destruction and tears the social fabric and as such is not supportive of socio-ecological sustainability Although Alberta in particular is benefiting in the short term financially, there will be longer term, perhaps unforeseen impacts, not the least being those associated with climate change.

The manner in which federal sustainable development strategies are organized can also be said to be not supportive of community energy planning. (See *Appendix* I for a list of SD strategies) In contrast to Sweden's *Environmental Objectives* that guide all national Swedish government departments, municipal governments and citizens towards sustainability, each Canadian federal government department has its own sustainable development (SD) strategy. These numerous initiatives result in significant duplication of efforts between departments. Furthermore they represent a missed opportunity to provide a single clear and consistent sustainability message to the federal government, Canadian businesses and the general public. The strategies are written on three year time frames means that also they do not explicitly look over the long term. Often designed using a triple bottom line model, they do not necessarily guide actions towards sustainability. The SD strategies do not explicitly provide information to communities to support technical or process innovation as they are mainly internal documents. The SD strategies do however contain feedback mechanisms insofar as they are renewed on a three year basis and federal employees are consulted in their development. Natural Resources Canada's strategy specifically supports the transition to renewable energy technologies through a key commitment to double renewable energy technology systems' (RETS) electrical capacity in Canada.[170] The fact that these Sustainable Development strategy documents exist, signals a shift to promoting decisions made based on full cost accounting.

Provincial Government –Due in part to Canada's massive physical size, the provinces have considerably more responsibilities than the Swedish *länstyrelsen* or *läns*. This intermediate level of government directs energy planning in Canada including through control over natural resources, energy supply infrastructure, planning activities and transportation. A brief examination of these provincial powers and associated programs follows: Each province regulates its own energy resources. Oil and gas as well as mineral and timber claims are leased to companies for a period of time, during which the companies may extract resources while paying royalties to the government. The provincial governments attempt to balance economic considerations with other land use needs such as those of local populations and wildlife.

Significantly from the perspective of landscape and infrastructure decisions, the provinces are also responsible for providing direction to municipalities on land use planning. Each province directs communities on planning issues through a provincial statute such as a Municipal Act or similarly entitled document although, as of 2005, very little direction related to landscape and infrastructure was being provided to communities. [171] Similar to provincial energy policies, provincial land use planning rules and regulations also go a long way to setting the strategic context for energy planning within communities. One example is the 2005 revision of the Ontario building code.

Deregulation – In Canada, Energy resources and energy supply infrastructure fall under the jurisdiction of the provinces. As a result, deregulation has occurred on a provincial level with two provinces, Alberta and Ontario, in the process of restructuring and converting their energy markets from Crown Corporations to a private and deregulated energy industry. Limited deregulation has also taken place in the province of Quebec.

Following deregulation, the governments of both Ontario and Alberta had to move to put a price cap on rising electricity rates. The price cap has had the effect of not giving consumers the incentive to switch to new providers in an expanded market, as the price of electricity does not vary greatly from one provider to another. A positive aspect of deregulation has been that customers can choose to pay more for "green" electricity. In this context, it could be said that deregulation has been supportive of community energy planning by providing higher energy prices and choice to consumers. Moves by politicians specifically to cap electricity prices could be said to provide a disincentive to energy efficiency, although arguably the public and businesses require protection from rapidly increasing energy prices.

Municipalities – As previously mentioned, Canadian municipalities are the responsibility of the provinces in which they are situated and receive much of their direction from that level. All decisions made on the local level are subject to the provisions of the provincial Municipal Act. Municipalities are directly responsible for a wide range of services including land use planning, waste collection, water treatment, local public transit, fire and sometimes police protection, libraries and economic development.

Each municipality is responsible for creating an official or community plan under the auspices of the aforementioned Municipal Act. Official plans are policy documents that articulate overall the vision for growth within the community and associated policies and objectives for development. They also structure secondary plans such as master plans and provide direction for zoning by-laws and subdivision standards. [172]

In their present form, community energy plans are not legally binding. The importance of community buy-in into the energy planning process and resulting plan is stressed by NRCan: "Municipalities have been given few powers or mechanisms with which to enforce their plans…to maximize any potential for implementation, a Community Energy Plan must reflect the collective desires and ambitions of the community as much as those of the elected officials….it is the community that must invest in the product, either in the built environment or in lifestyle changes." [173]

3.5 The Success level

Figure 3.9. The five level model, success

Shared visions towards sustainability - Now that an understanding of some of the dynamics of 'the system' within which communities are planning their energy supply and demand has been gained, it is time to take a closer look at the community energy plans themselves. Following from the five-level model for planning in complex systems, the analysis of the plans begins with an examination of their vision statements. Having a vision, or a definition of success, is an integral part of moving towards sustainability. To analyze the visions found in the plans, the following main question was posed: *How is success described in current community energy plans?* In other words, does the community energy plan have a vision? Who was involved in creating the vision? Finally, does the community's vision address sustainability principles as outlined by The Natural Step? (see page 37 for list of sustainability principles)

Table 1.10. Visions of success in Swedish CEPs

Questions	**Lund**	**Borås**	**Rättvik**	**Malmö**	**Gotland**	**Kristianstad**	**Växjö**	**Östhammer**	**Köping**	**Södertälje**	**Gothenburg**	**Summary**
Does the community energy plan have a vision?	Y	Y	Y	Y	Y	N	N	Y	N	N	N	N=5 Y=6
If so who was involved in creating the vision?												
Elected Officials	Y	Y	Y	Y	Y	Y	N	Y	N	N	N	N=4 Y=7
Business Community	N	N	N	N	N	N	N	N	N	N	N	N=11
Utility Companies	N	N	N	N	N	N	N	N	N	N	N	N=11
Public	N	N	N	N	N	N	N	N	N	N	N	N=11
Does the community's vision address sustainability principles as outlined by TNS?												
System Condition 1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y=11
System Condition 2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y=11
System Condition 3	Y	Y	N	Y	Y	N	N	N	Y	Y	Y	N=4 Y=7
System Condition 4	N	N	N	N	N	N	N	N	Y	Y	Y	N=8 Y=3

Swedish visions for Community Energy Systems

Six Swedish energy plans stated visions for their energy systems. While some communities included this directly in their plans, it was also common for a community to have a separate vision document. For example, Gothenburg's 2050 Plan contained a document for their energy and transportation systems but their vision was not included in the city's CEP. Swedish communities with a separate vision document typically included more stakeholders in the visioning process than were typically included in the energy planning process. This was done through a yearly workshop held to create a vision for their community or subsystem. A common element among the Swedish plans with regards to the visioning process was the involvement of municipal officials.

Some of the visions in Swedish community energy plans were found to be ambiguous. Six of the eleven plans analyzed in this study, those of Malmö, Gothenburg, Kristianstad, Lund, Gotland and Köping, stated goals for their community's energy system in place of a vision. In some cases, community energy planning law was mentioned and national goals described, followed by local community goals. This illustrates that the directive for energy planning came from the national level. The vision of success was thus articulated by national policy and shared by communities as expressed in their energy plans. [174] The only sectoral plan, that belonging to Växjö, did not contain a vision, describing only strategies and actions.

Most of the visions addressed ecological principles of sustainability. A few addressed its social aspects. Three plans addressed ecological principles, and two addressed social sustainability. Of the three visions found in *Appendix I*, two mentioned the elimination of fossil fuels, and two mentioned the importance of public education and awareness about energy planning. These considerations reflect the need to become sustainable with regards to fossil fuel resource use, in line with the first sustainability principle. The importance of raising awareness in society with regards to energy planning could be described as consistent with the fourth principle of social sustainability.

Table 3.11. Visions of success in Canadian CEPs

Questions	Halifax	Toronto	Salt Spring Island	Vancouver	Banff	Whistler	Canmore	Calgary	Edmonton	Wha Ti	Ottawa	Summary
Does the community energy plan have a vision?	N	Y	Y	N	N	Y	Y	Y	Y	N	Y	N=4 Y=7
If so who was involved in creating vision?												
Elected Officials	N	n/c	n/a	N	N	Y	n/c	n/c	Y	N	n/c	N=4 Y=2 n/a=1 n/c=4
Business Community	N	n/c	Y	N	N	Y	n/c	n/c	Y	N	n/c	N=4 Y=3 n/c=4
Utility Companies	N	n/c	N	N	N	Y	n/c	n/c	Y	N	n/c	N=5 Y=2 n/c=4
The General Public	N	n/c	Y	N	N	Y	n/c	n/c	Y	N	n/c	N=4 Y=3 n/c=4
Does the community's vision address sustainability principles as outlined by TNS and defined earlier in this thesis?												
System Condition 1	N	Y	Y	N	N	Y	N	N	N	N	N	N=8 Y=3
System Condition 2	N	Y	N	N	N	Y	N	N	Y	N	N	N=8 Y=3
System Condition 3	N	Y	N	N	N	Y	Y	N	N	N	N	N=8 Y=3
System Condition 4	N	Y	Y	N	N	Y	Y	Y	Y	N	N	N=5 Y=6

Canadian visions for Community Energy Systems

Seven of the Canadian community energy plans included vision statements. Canadian plans typically listed stakeholders that attended the planning meetings in an appendix. For example, the Whistler, B.C. plan clearly acknowledged the many stakeholders involved in the visioning process for their energy system.

As one would expect, the vision statements typically reflected the purpose for which the plans had been written. Comprehensive plans tended to have broader vision statements whereas GHG action plans typically contained incremental reductions as their primary objective and statement used in place of a broader vision.

The Greater Vancouver Regional District comprehensive energy plan presented a vision describing a sustainable energy system consistent with soft path strategies, with features including "…energy cascading, renewable energy based, appropriate quality and appropriate matching of energy quality to end use." This vision could be interpreted as being consistent with sustainability principles. Interestingly, Vancouver produced two energy plans, one by the Greater Vancouver Regional District (GVRD) and another by the City of Vancouver itself. The former clearly stated a vision and guidelines while the latter presented steps to reaching its vision.

Toronto's vision included technical ideas that address numerous energy sub-systems within the community including infrastructure, buildings, and the best match of energy quality to end use. They were stated in such a way as to advocate a sustainable community energy system which, over the 25 years from when the plan was written in 1999, aimed to reduce Toronto's per capita energy demand to 25 % of current levels – an ambitious target. Importantly, Toronto's vision explicitly stated that major infrastructure improvements represented opportunities for increasing energy efficiency. Toronto's vision also addressed social sustainability by clearly expressing the need for people to have easy access to services. While Toronto's vision was the most lengthy and detailed of the visions reviewed, it can also be described as the most progressive according to the vision questions and strategy criteria used here, since it took a whole systems approach and was highly ambitious.

Edmonton's vision, and the visions of five other Canadian communities considered in this study who have created Local Action Plans (LAP)s, referred to the reduction of GHG emissions.

The implication of using an emissions reduction target in place of a broader vision is that, from a strict sustainability perspective, the problems the plan attempts to solve will continue into the future. By setting a reduction target, these visions allow for the continued deployment of non-renewable energy resources which, if done systematically and by ever increasing populations, would continue to add GHGs to the atmosphere, thereby continuing the community's contribute to climate change.

Of the seven communities who included a vision in their plans, two produced visions consistent with all four sustainability principles. Significantly, Whistler's Energy & GHG report defined the term sustainability according to a principled definition.

3.6 The Strategy Level

Figure 3.12. The five level model, strategy

Strategies in Swedish and Canadian Community Energy Plans - In addition to a general understanding of energy sources, technologies, and a plausible vision of success, a good energy plan must also contain strategies to guide the actions it has selected if the goals are to be met.

Before analyzing the strategies, the types of plans studied are presented. Tables 5 and 6 list the communities whose plans were included in the analysis, the type of plan each community wrote, the areas of focus each plan addressed and the years in which the plans were written.

Table 3.13. Types of energy plans in Swedish communities

	Type of Plan			Area of Focus						
Community	Comprehensive	Sectoral	Local Action Plan	Land Use Planning	Household Efficiency	Industrial Efficiency	Renewable Technology	Transportation	Waste Management	**Year**
Gothenburg	Y			Y	Y	Y	Y	Y	Y	2005
Malmö	Y				Y		Y	Y		2000
Lund	Y			Y	Y		Y	Y	Y	2001
Växjö		Y			Y	Y	Y			2003
Kristianstad	Y			Y	Y	Y	Y	Y		2004
Gotland	Y				Y	Y	Y			2005
Rättvik	Y				Y	Y	Y	Y		2000
Borås	Y			Y	Y	Y	Y			2003
Södertälje	Y				Y	Y	Y	Y		2004
Östhammar	Y				Y	Y	Y			2003
Köping	Y				Y		Y		Y	2003

Table 3.14. Types of energy plans in Canadian communities

	Type of Plan			**Area of Focus**																
Communities	Comprehensive	Sectoral	Local Action Plan	Transportation	Waste & Environment	Site Design	Green building	Land use planning	Energy Supply Systems & Efficiency	Food & Agriculture	Education	Energy Investments	Renewable Energy	GHG Reduction	Water Conservation & Water ways	Demonstration Projects & Open Space	**Year**
Whistler	Y			Y				Y	Y								2004
Banff			Y	Y	Y	Y	Y										2003
Canmore			Y	Y	Y	Y	Y	Y									2005
Salt Spring Island	Y			Y			Y			Y							2005
Wha Ti	Y						Y		Y		Y	Y		Y			2004
Halifax		Y					Y					Y	Y				2004
Edmonton			Y	Y	Y		Y										2001
Calgary			Y				Y						Y	Y	Y	Y	2004
Ottawa		Y		Y			Y	Y					Y				2004
Toronto	Y					Y	Y		Y			Y	Y				2004
Vancouver	Y			Y	Y				Y	Y		Y		Y	Y	Y	2004

The following section presents review findings according to the list of questions following the literature review and interviews. Questions were divided into two categories: planning process and technical systems. Results and analysis for planning processes are presented first and strategies for energy systems presented second. Results from the Swedish plans are discussed first and results from the Canadian plans then compared and contrasted. The questions below were used to analyze the plans:

<u>Strategies for the planning process</u>

Which Stakeholders are engaged?

- Who is the Champion for the plan?
    - member of the public (P), city counselor (CC), city staff (CS)

- Is the methodology for the planning process described?

- Who spearheaded the planning process?

    - municipality (M) or the public (P)
- Who wrote the plan?
    - consultants (C), city staff (CS) non-governmental organization (NGO)?

- Which of the following stakeholders were involved?
    - Elected Officials
    - City Staff
    - Public
    - Energy Utilities
    - Renewable Energy Providers
    - Business Community
    - SME's
    - Large Corporation
    - Commercial
    - Industrial

What political support exists for the planning process?

- Is the plan endorsed by city council?

- Is the plan endorsed by regional council?
    - Is län/provincial support provided in the form of information?
    - Is län/provincial support provided in the form of funding?
    - Is national/federal support provided in the form of information?
    - Is national/federal support provided in the form of funding?

Do stakeholders share a common understanding of socio-ecological principles of sustainability?

- Does the plan define sustainability?

- What definition of sustainability is contained in the plan? The Natural Step (TNS), or Brundtland (B)?

- Are alternative possibilities/scenarios for development described in the energy plan?

Does the plan discuss the importance of thinking globally while acting locally?

- Will the goals within the plan meet local, national and/or international goals?
- Has the community assessed their current energy demand?
- Has the community assessed their global impact or "footprint" or contribution to GHGs?

How does the plan allow for long term strategic planning of the whole energy system?

- When did the community produce its first energy plan?
- What time frame does the plan cover?
- Does the plan have a prioritization method for strategies and actions?
- Is there a clear process for following up on specified goals in the plan?
- Is the responsibility for following up on goals designated?
- Does the plan include ways to fund current and future projects?
- Does the plan include indicators to measure proposed actions or monitor the status of the energy system?

How is the plan designed for continuous improvement?

- How often is the plan revised?
- Does the plan include informing stakeholders on an ongoing basis?
- Does the plan include consulting stakeholders on an ongoing basis?

Are there feedback mechanisms to the plan and to the community?

- Are the results of community consultations processes used to inform plan revisions?

- Are the results of monitoring used to inform plan revisions?

How is the plan integrated with other planning documents?

- Is the plan linked to other municipal plans?

- How does the energy plan inform these other plans?

Strategies for the energy system

Are concepts of efficiency, dematerialization and substitution included in the plan?

- Does the plan include efficiency measures on the supply side?

- Does the plan include dematerialization of any of the following:
  - NG
  - Petroleum
  - Coal
  - Uranium

- Does the plan include substitution of any of the following?
  - Wind
  - Geothermal
  - Strategies for the energy system
  - Hydro
  - Solar
  - Biomass
  - Biofuels

Are solutions presented on the demand side?

- Does the plan include:
  - Compact land use planning with good transportation links
  - Energy efficiency in residences
  - Energy efficiency in businesses
  - Energy efficiency in industrial
  - Energy efficiency in governments and institutions

Does the plan advocate matching energy quality to end use?

Does the plan describe matching generation facilities in scale and geographical distribution to end use needs?

Does financial assessment in the plans consider the cost of other externalities such as health costs, job creation?

Is detailed planning of concrete sub-system projects carried out?

Does the plan use any DSS software or program such as MARKAL, MODEST, SCADA, to plan the subsystems in detail?

Summaries of Results of Analysis of the Planning Process

Methodology and Stakeholders

Swedish communities create energy plans in order to comply with the law. Municipal staff members are responsible for writing and revising the community's energy plan and as such are the stewards of the plan. Champions are therefore not essential to the production of energy plans in Swedish communities. This was reflected in the fact that no Swedish plan contained references to the involvement of champions. In contrast, six of eleven Canadian community plans evaluated, identified a champion. These champions included city staff members, counsellors, and members of the public.

Canadian communities are not required by law to produce energy plans. Only recently have municipal acts or similar provincial documents guiding land use planning begun to give direction on energy planning. In Ontario, the introduction of Bill 51, the Planning and Conservation Land Statute Law Amendment Act, 2006 eased the rules such that the planning process could be improved, in part through being more responsive to energy considerations. Two examples include greater allowance for sustainable design and increased public participation in community planning. Due to the relative newness of the discipline in Canada, knowledgeable leaders are needed to push community energy planning. The fact that five Canadian plans did not mention a champion does not necessarily mean that such individuals were not involved and critical to the process in these communities.

With the exception of three communities, descriptions of the energy planning process were not found in the other eight Swedish energy plans. In contrast, nine out of the eleven Canadian communities clearly described the process they used to create their plan. Because Swedish communities have been writing plans since the early as the 1980s, the planning methodology may be contained in an earlier plan or related document. In contrast, community energy plans have only recently come on the scene in Canada, explaining why more communities would need to include this type of information in their plans. Communication of such process methodology at an early stage in the development of community energy planning as a discipline is necessary to foster a community of knowledgeable practitioners. Since there is no law in Canada that mandates municipalities to create energy plans, the municipalities in this study can be characterized as being progressive for having created plans.

Ten Swedish communities indicated that the municipal staff had primary responsibility for creating the plans. As mentioned previously, Swedish communities generally dedicate staff to work on a community's energy plan. *Boverket* raised the point that with deregulation and the sale of municipal energy systems, energy planning expertise in some cases no longer resides within the municipality, but with the private utility companies. This devolution may be reflected in Swedish community energy plans as they undergo future revisions.

On the other hand, six of the Canadian plans reviewed were written by consultants. This was explained in some plans that said no energy planning expertise existed among municipal staff to do this work. Meanwhile other municipalities could not afford to dedicate staff to work on an energy plan. Plans from the larger communities, including Vancouver and Edmonton were written by city staff, revealing a greater capacity in large urban centres. This variance in authorship of the energy plans reveals the need for capacity building activities both amongst municipal staff and consultants in this domain, particularly in medium and small communities.

From the community energy plans and guidebooks such as those of the Community Energy Association, NRCan and the California Energy Aware Guide, a list was devised of stakeholders that could be involved in the early stages of the planning process. Potential stakeholders fall roughly into six groups: elected officials, city staff (including planners, engineers, architects and designers), the public, energy utilities, renewable energy providers, and the business community (including SMEs, large corporations, commercial and industrial).

Swedish communities consistently involved municipal officials, city staff, energy utilities, large corporations and industry in the process of creating their community energy plans. Two Swedish plans clearly stated the involvement of renewable energy providers. Most of the Swedish communities either own the utilities themselves or are, as in the case of Malmö, the utility's largest customer. Including the utilities in the energy planning process is therefore natural. No Swedish plan mentioned public involvement. Since it is common for municipal staff to produce the energy plans in Swedish communities, a significant level of expertise in this domain exists, making community consultation less of a priority.

Eight Canadian communities included elected officials in the energy planning process, including a tribal representative in Wha Ti. One community, Salt Spring Island, was an exception in that, not technically a municipality, it did not have a municipal representative involved to create a community energy plan. Halifax's plan consisted of a community sustainability assessment, within which the community's energy system was analyzed. [175] The plan did not indicate that municipal officials were involved in this assessment, but that they would be involved in developing the subsequent regional energy plan. [176] Calgary and Ottawa did not include a list of who was involved in the creation of their energy plans, making an analysis of involvement impossible in these cases. It was assumed however that city staff had some hand in the creation of the plan as no other potential stakeholders were mentioned.

Eight out of eleven Canadian plans involved the public in the consultation process. Two of the three other communities engaged the public as a part of a broader strategic planning process. Most communities do not own their energy utilities, explaining why only six communities involved the utilities in the planning process. Seven Canadian communities surveyed indicated the involvement of members of the business community, with only Vancouver, Edmonton and Toronto specifying which types of businesses were involved. No plan mentioned the involvement of Small and Medium sized Enterprises (SMEs). Although the role of universities and NGOs was not considered as a part of this thesis, as the discipline of community energy planning gains importance it would be natural that communities would seek partnerships to carry out planning and monitoring activities.

Because this study was based solely on plan content, it was not possible to ascertain the true extent to which these various stakeholder groups were actually engaged in the process. The nature and level of involvement of the various stakeholders groups are important topics not to be overlooked in any energy planning process.

Political Support for the Planning Process

All eleven Swedish municipalities evaluated in this study endorsed their energy plans. The absence of a regional level of government in Sweden explains the lack of endorsement of the energy plans from this level. Similarly, most Canadian municipalities endorsed theirs, with the exception of Salt Spring Island and Wha Ti. It was recommended in the Wha Ti community energy plan that the document be officially accepted by its governing body. Eight Canadian municipalities having regional governing bodies were supported in their planning by this higher level of government. One community did not have a regional government and a further two plans made no reference to regional endorsement.

Information support was provided by the *Län,* the approximate equivalent of the provincial government in Canada, to five of the Swedish communities; [177] for example the Blekinge *Län* conducted a regional feasibility study for wind energy and made the data available free of charge to its municipalities. [178] Funding from the *Läns* was mentioned in five of the Swedish plans evaluated. Rättvik is located in the Dalarnas *Län* where there is a regional program called GDE-Net that supports strategies of energy efficiency and renewable energy technology deployment. The Swedish national government offers funding directly to municipalities for community energy planning through its LIMP and KLIMP program. Four Swedish energy plans acknowledged the funding.

Information for Community Energy Planning initiatives from provincial governments in Canada was mentioned in eight of the eleven reviewed plans. Five Canadian communities received funding from their respective provinces. Significantly, the Canadian federal government provided information support to ten communities and funding support to all eleven of the communities.

The majority of communities in Sweden and Canada received support in varying forms from all three levels of government indicating an important awareness and support for energy planning initiatives. The specific types of information provided and projects funded would be an insightful area of inquiry, particularly in light of the Canadian Gas Tax initiative. An exploration of support on a province by province basis would be useful as it is the provincial governments who have jurisdiction over both energy resources and land use planning regulations in Canada.

A Common Understanding of Sustainability

Surprisingly, only three Swedish community energy plans contained definitions of sustainability, all of which were similar to the Brundtland definition. Instead, most Swedish energy plans provided technical definitions for sustainable energy systems. Most of the plans surveyed in this study mentioned that energy should come from renewable sources and have a limited impact on the environment. For example, the energy plan of Borås described a 'long-term sustainable society where the usage of energy becomes increasingly efficient and is extracted from renewable sources; i.e., an ecologically sustainable energy system'. Kristianstad's vision spoke of fostering 'long-term sustainable development, with local closed- loop cycles fulfilling both national and local environmental goals and securing access to energy'.

Six Canadian plans defined sustainability, three of the definitions being Brundtland-type and three resembling the TNS sustainability principles. The remaining communities may have excluded definitions for a variety of reasons, one being that the energy plans were sub-documents of larger strategic planning processes. An example of this is Ottawa's Air Quality Management Plan, a subsidiary plan to the City's 2020 official plan.

Several communities did not define *sustainability* possibly because the discussion occurred in a related municipal document or that agreement on a definition could not be reached This omission would allow strategies and actions to be flexible; however, in the absence of a clear definition the community runs the risk of decision-making that perpetuates poor environmental and human health conditions resulting from unsustainable energy activities. Ultimately, a clear definition of the term is recommended. Because they are based in the laws of thermodynamics, and are general enough to be used in a backcasting process, The Natural Step sustainability principles are appropriate for use in Community Energy Planning processes and can be used in conjunction with other commonly accepted methods for operationalizing sustainability including possibly Factor X reductions, Ecological Foot Printing and ISO environmental reporting systems.

Thinking Globally While Acting Locally

Most Swedish communities considered in this study were working towards goals articulated by Agenda 21 and Sweden's 15 environmental objectives. Some Swedish communities also complied with EU environmental standards and regulations. In Canada, most of the communities evaluated created Local Action Plans as a part of the FCM's Partners for Climate Protection program. The main goal of this program and type of plan is to reduce green house gases to meet Canada's commitment to the *Kyoto Accord.* It could therefore be said that both Swedish and Canadian plans were written in the spirit of larger goals and accords, advocating local action within a global context.

Another part of understanding a community's impact in a global context involves assessing the current energy demand and associated impacts, such as GHG emissions. Ten of eleven Swedish energy plans assessed their current energy demand and seven of the eleven assessed their global footprint or contribution to GHGs. Further to this, almost all Swedish plans created future scenarios that could be considered more sustainable than a Business as Usual (BAU) scenario. All Canadian plans evaluated here had assessed their current energy demand, evaluated their global impact specifically with regards to GHGs and provided alternate development scenarios as a part of their plans.

Long-term Strategic Planning of the Whole Energy System

Swedish communities began producing energy plans in the 1970s. Of the plans reviewed here, three were produced in the 1980s (one each in 1980, 1986 and 1987), three in the early 1990s (two in 1990 and one in 1991) and three late in the 1990s (one in 1997 and two in 1999). The original date of publication was not given in the remaining three plans.

Plans by Canadian communities were produced more recently, four having been written in 2005, three in 2004 and one each in 2003, 2001 and 1999. Possible reasons for Canadian communities taking longer to begin producing energy plans include the abundance of cheap non-renewable domestically available energy resources and, for many communities, ample land over which communities could sprawl. Energy efficiency, renewable energy technologies and more compact urban form have not until recently become 'top of mind' issues in the context of urban planning. Coupled with little direction specifically on energy planning from either provincial or federal levels, it could be said that only the most progressive communities see the challenges and opportunities on the road ahead and are writing energy plans to address these. The Gas Tax agreements and changes to various pieces of provincial legislation mean that higher levels of government in Canada are now beginning to require Canadian communities to produce energy plans.

Regarding the plans' time frames, Swedish plans were characterised by long term planning, with five communities having plans over fifty year time frames and the remaining plans projecting twenty-five years into the future. Of the Canadian communities surveyed, plans written by Whistler and Edmonton looked ahead sixty and fifty years respectively. Interestingly, the City of Vancouver's energy plan covered a seven- year period despite their regional sustainability and energy plan looking at a 100 year time frame. [179] The remaining five Canadian community plans projected over 10 years or less. This wide variation in the timeframes of the plans again reflects the fact that Community Energy Planning is being carried out by individual communities and, until such a time as Gas Tax agreements are implemented, has not been uniformly directed by a higher order of government. Also, it is not surprising that five of the Canadian plans covered a shorter time frame of ten years or less. This timing is more of a known quantity for municipal decision makers, in particular for politicians who may be in office for only two or three years. It is known from the hierarchy of energy-related choices that looking over a longer time frame of upwards of fifty years reflects more accurately the massive energy implications of decisions pertaining to infrastructure, density, mix of uses and energy systems. The 50-60 year plans could therefore be said to be more visionary in their consideration of potential energy supply options and demand side management techniques.

Prioritization methods for actions contained in the plans were found in three Swedish plans. In contrast, most Canadian energy plans described the methods employed to prioritize their actions. This promotes transparency yet allows some flexibility when it comes time to carry out the actions. Prioritization of the actions themselves would indicate a more thought-out plan, potentially one strategically capitalizing on short, medium and long term opportunities.

With regards to funding, four Swedish plans included details on funding of present and future actions pertaining to the energy system. Plans from seven Swedish communities did not contain information on funding for specific actions possibly because energy planning is often funded from the national level. If Swedish plans are being revised every four years, including specific details on funding mechanisms and arrangements might not be possible or desirable in a document intended to guide the energy system over a period of more than a few years. Another possibility is that in the case of utility-owning municipalities, financial information related to the energy system is contained in separate documents.

Again in contrast, ten out of eleven Canadian community energy plans clearly demonstrated how actions contained in their plans were being funded and also what department or persons were responsible for implementing the actions. Because property taxes and service fees are the only mechanisms most Canadian municipalities have to generate revenues, the municipalities typically have limited resources with which to build and maintain vast amounts of physical infrastructure and provide social services. It could be said therefore that clearly articulating how actions will be funded is a critical determinant of success of a community energy plan in the Canadian context.

Because measuring progress is both an integral part of determining whether past actions have had the desired impact and set a community up for receiving future funding, the question of indicators to monitor actions and the status of their energy systems needed to be posed. Surprisingly, six

Swedish community energy plans contained no mention of the use of indicators. It is not possible to say however from the plans alone whether indicators are being used by Swedish communities but only that they were omitted from the plans. In contrast, nine out of the eleven Canadian energy plans evaluated clearly defined indicators to monitor their progress and energy systems.

A further essential point is whether the results of indicator monitoring are subsequently being used to revise the plan and inform stakeholders. Monitoring selected indicators following energy planning activities is essential for understanding the long-term success of strategies and actions and fostering a continued awareness of the community's energy needs.

Continuous Improvement of Community Energy Plans

Typically, Swedish community energy plans are updated annually and revised every four years following the election cycle. This was not always reflected in the plan review, likely because if it is written into law or typically done on a certain time frame, some communities though it not necessary to state the time frame. Of the plans that did, one plan indicated a five-year interval, three plans a four year time frame and a single plan was to be revised on an annual basis.

While the three plans on a four year time frame are consistent with Swedish national law, the other two plans show some variation in the interpretation of the law: the community revising their plan on an annual basis appears to be exceeding the law's requirements, whereas the community revising their plan on a five year basis could be said to be loosely interpreting the law.

Five Canadian plans were silent on the topic of plan review. Toronto, Edmonton and Ottawa will review their plans annually and Salt Spring will review its plan every four years. Again this lack of consistency amongst Canadian plans reflects the community- level nature of the effort. And despite the plans on the whole being overwhelmingly progressive, plan revision is one area where the community energy plans reviewed in this study could be substantially improved.

With regards to stakeholder involvement, there is an important distinction between informing versus engaging the public: one implies a transfer of information from the planners to the public whereas engaging the public implies a more participatory interaction in which planners and other staff solicit information from the public for input to public consultation processes.

Five of the evaluated Swedish energy plans mentioned informing stakeholders yet only three promised continuing stakeholder engagement. This perhaps suggests less direct involvement of the public in Community Energy Planning efforts in Sweden. It should be recalled though that the sample size of this study was small; results are not necessarily representative of all Swedish communities.

In contrast, ten Canadian plans incorporated informing stakeholders on an ongoing basis and five specified regular stakeholder engagement. The fact that ten of the Canadian plans surveyed showed that community members need to be informed indicates that at least among the communities surveyed there is a high level of awareness of this important endeavor. That a further five plans went on to say that the community would be engaged on a continual basis demonstrates that inclusive planning can be written into the planning documentation.

To gain a truthful appreciation of the degree to which the community was informed, engaged and consulted, interviews would need to be carried out with community members enquiring about their experiences with their energy planning process.

As for the amount of information contained in the plans, it could be that because of less direction was coming from a higher level of government the community would need to include more process-related information in their plans. While this would have the benefit of giving individual communities more flexibility, it also means that there is less consistency between planning processes and things such as indicators on a higher level. Fortunately however the tendency in the plans in this sample was to go further in terms of informing and engaging the public.

Feedback Mechanisms in the Plans and to the Communities

In the Swedish plans reviewed, six mentioned using the results of monitoring to inform future iterations of the plans. Since the energy utilities are often a municipal corporation, it is common practice for Swedish municipalities to monitor their energy systems, using indicators to ascertain how the operations have changed and ideally improved in efficiency from one year to the next. Ideally, this information would be used to revise the energy plans although this was not explicitly stated in every plan.

Seven Canadian communities mentioned the use of the results of monitoring to inform future energy plans. The predominant monitoring technique mentioned in the community energy plans was the use of indicators.

In terms of using the results of community consultation processes to inform future plan revisions, four Swedish plans mentioned using these results to feed back to the plans. Five Canadian communities did the same.

The need for community energy planning decisions to be based on sound scientific information suggests that there should be a more explicit link between information from monitoring of energy, social and ecosystems and how that information feeds back to the plans. Also, integrating information from a broad range of disciplines to inform energy planning offers a more comprehensive overview of the effects of particular actions on the system. With numerous indicator projects already underway, new and massive data collection efforts are not always required when pre-existing datasets can be drawn upon.

Two examples in Canada would be the Canadian Information System for the Environment and the Federation of Canadian Municipality's Quality of Life Reporting System. Armed with knowledge obtained through monitoring and indicator initiatives, communities will be in a better position to make informed decisions about their energy systems, land use planning practices and energy efficiency measures. A more complete discussion of the use of indicators in community energy plans is a topic that warrants further study.

Another area this thesis does not consider is the monitoring activities of utilities and how this information is shared with municipal planners and politicians. In Canada, in provinces where deregulation has occurred, utilities are private entities and this information is sometimes considered to be confidential. In addition, the utilities sell energy, not energy services, and so the incentive is to continue to sell electricity and natural gas as opposed to achieving desired energy services through a suite of supply and demand side solutions.

Integration of the Energy Plan with Other Planning Documents

Five Swedish community energy plans indicated links to transportation plans and to larger plans that encompasses all community systems. Linking energy plans to larger plans avoids redundancy as individual plans discuss specific topics while informing the other plans. This explicit linking of the various plans within Swedish municipalities also goes a long way to explaining why numerous community energy plans were lacking specific pieces of information being sought in this thesis.

Five Canadian communities produced GHG management and air quality plans as their energy plans. This demonstrates that many communities view energy issues through the lens of climate change and air quality. Energy activities however have much broader implications on environmental, economic, and social systems.

Four Canadian community energy plans were either linked to their respective community transportation plans or goals for the transportation sector were included in the energy plan. Only two plans indicated connections to land use or municipal plans. Two community energy plans were linked to residential, commercial and industrial plans. Lastly, some plans were associated with food and agriculture and business plans.

Like the Swedish plans, three Canadian community energy plans reviewed were part of broader municipal or environmental plans. Notably, Vancouver’s plan was linked to numerous other plans and the city created an internal committee to coordinate the linkages of these plans with the energy plan.

An important subject for further research is the degree to which energy-related information is explicitly taken into account in community decision making. What information is considered? In what situations are energy or energy costs the deciding factors in decisions? What Decision Support Systems (DSS) support the systematic integration of energy information into the decision situation?

As with many of the other questions in this paper, the question of linkages with other plans was not clearly addressed in the community energy plans themselves. Several Swedish plans indicated no linkages with other planning documents. This could be because of the direction from the national level which clearly stipulates that the energy plan be linked with other municipal plans. As such the link would not need to be explicitly stated in the plans. The more important question of whether the linkages were actually used in practice to inform decision making on the project and day to day level resulting in energy and transportation systems as well as land use planning was not investigated.

Summary of Analysis of Strategies for the Energy System

Now that community energy planning processes contained in the plans have been presented, the next area to consider is successful strategies for transitioning the physical components of an energy system towards sustainability. Recurring themes in the literature on sustainable energy systems are those of efficiency, dematerialization and substitution. [180] Supporting questions asked about the supply side and the demand side of the energy system.

Supply Side Solutions

Eight Swedish plans reviewed contained strategies to increase efficiencies on the supply side of their energy system. These included changing the scale of the energy system for greater efficiency and switching fuel sources, for example using biomass instead of oil to fuel a larger cleaner energy system. Kristianstad has several small scale biomass plants but is in the process of building a larger and more efficient system.

Energy sources of interest for dematerialization are petroleum, coal and natural gas. Among the Swedish plans, no community discussed reducing or eliminating natural gas from its energy system. This is probably due to the fact that natural gas is more efficient and is seen as an acceptable transition fuel, despite the fact that Sweden does not have a domestic supply. In contrast, without exception, all Swedish energy plans included the elimination of both petroleum and coal from their energy systems. Only four Swedish communities mentioned the dematerialization of uranium in their plans.

All Swedish community energy plans included biomass and biofuels whether already in use or being considered; wind, solar, were also extremely popular, with ten out of eleven communities having implemented or considering technologies to take advantage of these sources. None of the evaluated Swedish plans mentioned building hydroelectric dams.

In having control of their energy supply infrastructure, Swedish communities are able to better manage the efficiency of their energy supply systems and have the ability to select the preferred alternative energy source. Indeed, many Swedish communities have already taken steps to ensure that they are transitioning their energy supplies away from petroleum, coal and in some cases uranium. Although the Natural Step sustainability principles were not explicitly mentioned in all of the plans reviewed in this study, given that they are essentially common knowledge amongst Swedes, it is possible that they did in some way inform the understanding that decision makers had of their energy supply options and their attendant environmental and social ramifications and benefits.

Looking to the Canadian plans, six included actions to increase efficiencies on the supply side of energy systems, such as using more efficient boilers in municipal facilities and using cleaner burning fuels.

Unlike Swedish communities, the majority of Canadian communities often do not enjoy direct control of the sources of energy upon which they depend. This was stated succinctly in Vancouver's energy plan "Vancouver should advocate for the more aggressive implementation and broader accessibility of alternative energy with the GVRD, BC Hydro and the Province of British Columbia." Municipal government actively attempting to dialogue with the responsible authorities may bring about change in this regard.

In spite of certain municipalities not having control over their energy utilities, some Canadian plans were found to contain the goal of eliminating the usage of certain fossil fuels within the community. Energy plans belonging to Toronto, Halifax and Canmore, stated the goal of eliminating the use of natural gas. Specifically, Canmore had a strategy to eliminate natural gas as its main source for space heating. The Canmore plan also investigated the use of natural gas as a transitional automotive fuel until biofuels became readily available. Six Canadian plans involved strategies to eliminate petroleum as a source of energy supply. Three communities planned to eliminate coal as an energy source.

Small hydroelectric and solar technologies seemed to be the most popular renewable options in replacing fossil fuel sources in nine and eight Canadian communities respectively. Seven Canadian plans determined the feasibility of wind energy. Six plans included actions to explore geothermal and five discussed biomass sources to meet heating needs, although these were found to be somewhat vague. Six Canadian energy plans contained strategies to increase the availability and affordability of biofuels for vehicles. In the same way Canada has been endowed with significant non-renewable natural resources, the country also has substantial, and in some cases limitless renewable resources. The availability of these resources varies regionally according to geography and climate. Individual communities must gain an understanding of renewable energy supply options available to them as an early but essential step in transitioning away from non-renewable to renewable sources and technologies.

Demand Side Solutions

Most of the actions listed in the energy plans addressed efficiency on the demand side of the energy system. Thus the supporting questions all relate to actions that increase the efficiency in the residential, commercial, industrial, and institutional sectors. A further question concerns methods being employed in land use planning to promote efficiency.

All but one of the Swedish energy plans reviewed list efficiency measures for the demand side of their energy systems. Most Swedish plans contain actions that predominantly address ways of increasing efficiency in the residential and industrial sectors as well as in institutional buildings. Only five Swedish plans list actions to enhance the efficient use of land and transportation systems. Similarly, five Canadian community energy plans list actions to optimize their use of land and transportation systems. All the Canadian plans list efficiency measures on the demand side for various sectors. The 'low hanging fruit,' or actions that can be readily carried out from the Canadian plans, for the most part aim to increase the efficiency of the municipal operations. This is reflective of the tendency within Canada to begin energy efficiency by 'getting the municipal house in order' before rolling out programs to the broader community. The rationale for this is that once successes can be demonstrated, initiatives are more likely to be successful on a larger scale.

Matching Energy Quality to End Use

In both Sweden and Canada, nine out of eleven communities reviewed in the course of this study indirectly or directly advocate matching energy quality to end-use. This demonstrates that the majority of those involved in writing energy plans are aware of this important concept that can serve to guide decisions in both new installations and retrofits, in particular with regards to heating systems.

Matching Generation to End Use

Nine Swedish plans described matching generation facilities according to their geographical location in order to meet end use most efficiently. In contrast, only six Canadian communities investigated possibilities associated with renewable energy options for their specific geographical location.

Full Cost Accounting

Items or intangibles not normally valued in the current economy, such as health impacts and loss of biodiversity, are included when full cost accounting methods are used. Most of the Swedish energy plans did not explicitly state any criteria or method to account for externalities. Gotland however quantified the monetary value of jobs and businesses generated from their largest project, a wind farm. Gotland also assessed the environmental and visual impact of this wind farm on the community. Five of the Canadian energy plans contained sets of criteria through which certain externalities are included in the final cost or budget estimates. Translating externalities into financial language that the business sector, governments and the public can assist in overcoming some of the barriers associated with transitioning energy systems towards sustainability.

3.7 Actions

Figure 3.15. The five level model, action

The following table lists comparative and unique areas of activity in Swedish and Canadian energy planning.

Table 3.16. Action areas addressed in Swedish and Canadian plans

Swedish Community Energy Plans	**Canadian Community Energy Plans**
▪ Spatial planning ▪ Household energy consumption and efficiency ▪ Renewable energy projects ▪ Transportation ▪ Information dissemination ▪ Economic and technology assessment tools ▪ Optimizing energy systems ▪ District heating expansion ▪ Fossil fuel reduction ▪ Match supply to end use ▪ Measuring the efficiency of infrastructure.	▪ Spatial planning ▪ Buildings energy efficiency retrofits ▪ Feasibility studies for renewable energy projects ▪ Transportation ▪ Information dissemination ▪ Monitoring mechanisms ▪ Municipal operations ▪ Fossil fuel reduction ▪ Capacity building ▪ Supporting good behavior ▪ Funding creation

Differences in actions taken by Swedish and Canadian communities

Historically, Swedish plans created between 1977 and 1985 generally targeted oil reduction, energy efficiency in buildings and the use of heat pumps. These goals were achieved through actions including informing different sectors on how to decrease energy consumption, increase the efficiencies of their processes, and how to optimize building efficiency by looking at the heating system and improving insulation. [181]

The majority of Canadian energy plans recommended actions that are similar to these early Swedish plans. Actions in Canadian plans included building efficiency, fossil fuel reduction (by energy efficiency use and replacement with other fuels), and public education. Canadian communities are only now beginning to look at pilot projects of alternative fuel and power generation. Actions proposed by Canadian plans also included the purchase of green energy certificates. This may reflect that some Canadian communities did not themselves own generating facilities.

Some progressive Swedish communities discussed the optimization of their whole energy system; subsystems also considered for optimization included the district heating and transportation systems, as well as renewable generation sources and employment opportunities related to energy efficiency. An example is Lund which optimized the heating system of one of its community pools by switching from district heating to solar. Understanding where Swedish communities are in relation to Canadian communities of comparable size provides clues as to possible future actions for Canadian communities.

Looking at the implementation process for the actions contained in all plans indicates that Canadian communities have a long road ahead in the proposed transformations of community energy systems. While eight communities out of eleven provided clear details of their action plans and monitoring schemes, only three plans had a way of prioritizing their goals. The prioritization of actions is necessary if communities are to strategically move their energy systems towards sustainability. Another observation was that ten of the plans began by implementing actions first in municipal operations, with the intention of implementing successful actions in the rest of the community at a later date.

3.8 Tools

Figure 3.17. The five level model, tools

As discussed in the literature review, planning tools can be used by decision makers to ensure that preferred actions take strategic steps towards compliance with sustainability principles and other objectives. A tool is essentially any aid at any stage in the decision support process, from the low tech pen and paper method, through guidebooks, to higher tech software to model or monitor an energy system, create technical scenarios, and/or identify the optimal system within a budget. Tools such as maps and other visualization methods can also be used to engage and inform the public. Sophisticated DSS that support multi-criteria decision-making are particularly useful to structure large amounts of information. When these systems enable a spatial output and structure information in a visual and holistic manner, they are known as Spatial Decision Support Systems (SDSS). The analysis in this paper examines tools described in the Swedish and Canadian community energy plans.

A tool could be useful for addressing one or more levels in the five level framework for planning in complex systems. In both the development of the energy plan, in particular in public consultation and in planning the details of various energy subsystems, a variety of tools were used, although they were not necessarily mentioned in the plans.

Briefly, examples of these tools include Ecological Footprinting, Factor X, [182] ISO 14001, Natural Capitalism and Life Cycle Management models. Tools also include visual aids created in programs such as Auto CAD or Pro E that may be used to recreate what the landscape may look like with renewable technologies such as wind turbines. To narrow the scope for this thesis and to reflect that energy planning is highly complex and technical, only Decision Support Systems are considered in the tool analysis section.

Only one Swedish plan mentioned a Decision Support System: Gothenberg's local energy utility used MARKAL software. It enables them to keep track of their energy generation and usage among many other things. The information gathered from using this tool is then shared with the municipality.

Five Canadian community plans mentioned using either standards or DSS to assist in planning. The City of Toronto's energy plan mentioned only "software programs and hardware tools" without specifying which platforms were being used. The Town of Whistler used two modeling tools including EMME/2, a travel demand forecasting model, as well as MetroQuest. Edmonton used ISO standards for their city operations and Ottawa's Air Quality Management Plan stated that the city is using City Green, a GIS based analytical tool that assess the contribution of forest cover to air quality, energy conservation and GHG reduction.

The presence of these programs in the plans indicates that communities were using software modelling programs to plan various energy sub-systems. The case of Ottawa is of particular interest in that a DSS was being used for urban forestry purposes. This could be considered an energy subsystem as the presence of forest cover would mitigate the impacts of the city's energy activities. It would seem natural that utilities also used a range of DSS tools however this information was not contained in the plans.

Software tools are expensive and the capacity to use them does not always exist in Canadian and Swedish municipalities. As such, consultants, for example experts in MARKAL, are sometimes hired to design energy subsystems. Larger communities with more resources and increased capacity often use such programs to gain a better picture about the energy flows in their communities.

Conclusions

In asking the question "*How can 'strategic energy planning' assist communities in Sweden and Canada to move towards sustainability?"* this thesis attempted to identify the community as an effective level for addressing pervasive threats such as global warming, the impending oil crisis, air pollution and urban sprawl. Broadly speaking, these are indicators that our biosphere is in decline, sounding the alarm that there is an urgent need to revolutionize the way we attain the services that energy provides.

Communities can rise to meet these complex challenges through strategic community energy planning. By making energy systems and urban environments safe, affordable, convenient, reliable, equitable and within the earth's carrying capacity in terms of use of non-renewable resources, substances produced by society and the sustainable use of ecosystems, it is possible to address on a local level the multiple threats we collectively face. The laws of thermodynamics pertain directly to energy and ultimately constrain all sustainable ecological and social systems. It is therefore appropriate to suggest that communities should plan their energy activities with the laws of thermodynamics in mind. Having a vision of a sustainable energy future, with associated strategies and actions informed by rigorous sustainability principles, is thus a preferred decision making method.

At the broad systems level this paper demonstrated that although conditions in Sweden and Canada are similar, the approach to energy planning has differed. Part of the difference lies in the availability of non-renewable natural resources. Reliant on fossil-fuel imports, Sweden has the incentive to conserve whereas Canada, endowed with extensive fossil fuel resources, does not. Both Sweden and Canada were shown to be dependant to varying degrees on oil, natural gas, coal and nuclear. Similar resource dependencies and geographical profiles indicate similar opportunities for improving energy efficiency and transitioning to renewable energy technologies. Both countries also have opportunities to expand their wind, solar, biomass, biofuels, geothermal and waste-to-energy generation. Sweden has already taken significant steps in this direction, resulting in 17% of their primary energy needs being met through biomass. Lessons on transitioning energy systems can and should be transferred from Sweden to Canada.

A vision for the sustainable energy system of the future is one where energy activities in communities do not systematically contribute to the degradation of ecological and social systems. Visions of success in line with socio-ecological principles of sustainability can include deriving energy from renewable sources, and planning for land use and infrastructure, to make all future energy consumption within the community as efficient as possible. To assure that all sites, buildings, transportation systems and production processes be as efficient as possible and to achieve the greatest efficiency of the energy systems, energy sources should be best matched to end use, such as the use of waste heat from industrial processes in a district energy system. The end goal of energy services is to assist people with meeting their needs. Therefore visions that lead the way to success can and should also reflect the important attributes of being safe, affordable and equally accessible.

The presence of a vision, either within the energy plan or in a related document, was identified as being important to the potential success of a given energy plan. It was found that Swedish community energy plans had visions for sustainable energy systems. Concepts of success and goals originating from a national level were also identified. This consistent nation-wide approach shows strong national leadership. Although the visions contained in the Swedish energy plans did not always reflect the four principles for socio-ecological sustainability, it could be said that similar understandings of 'the right thing to do' are inherent in Swedish community energy planning. This can be attributed to the clear, consistent and science-based direction provided by the *15 Environmental Objectives* as well as directives to reduce oil consumption, transition to renewable energy technologies as found in national energy planning law.

In contrast, visions found in Canadian community energy plans varied considerably, depending on the type of plan that was being written and whether the visions were consistent with sustainability principles. Stakeholders were more involved in the visioning process in Canadian communities than in Swedish ones suggesting that the process was more inclusive. A further study on people's impressions of their involvement in the energy planning process would be required to draw valid conclusions on this point.

In this thesis, the community energy plans was identified as the key strategic planning document for guiding a community's energy activities towards sustainability. These plans are products of social and technical ingenuity or the broad formula for what is necessary to solve the increasingly complex problems faced by our society. For a community energy plan and by extension energy planning activities it contains to be successful, the plan needs to state a clearly articulated vision and effective strategies to achieve the vision. After conducting a literature review and interviews with energy planning practitioners, progressive energy planning strategies were identified. These were categorized into strategies pertaining to the planning process and those pertaining to technical energy systems.

Specific progressive strategies for the community energy planning process include engaging all stakeholders in a community-driven process and sharing a common understanding of socio-ecological principles of sustainability. Having a common vision with defined goals in the context of a politically-supported process where all municipal departments are aware of and engaged in the process are also key determinates of a successful plan. Importantly an integrated long term strategic plan for the whole energy system and alongside detailed planning of concrete subsystem projects is warranted. A plan that looks over a long time frame, ideally of upwards of 50 years, allows major infrastructure decisions to be anticipated and viewed as opportunities for increased efficiencies at the landscape scale. Finally an iterative plan, one designed for continuous improvement with linkages with other municipal planning documents, is an important aspect of the community energy planning process.

Technical strategies for energy systems are also critical to the success of a community plan. These can include the concepts of efficiency, dematerialization, and substitution as basic goals for transitioning the current energy system to a more sustainable one. And similar to the way in which an ecosystem behaves, a community's energy system requires a plurality of solutions on both the supply and demand sides with diverse individual contributions to the energy supply. Being aware of the negative externalities associated with fossil fuels and other non-renewable energy resources such as uranium, a successful strategy for transitioning a community's energy system towards sustainability is to opt for renewable energy sources where possible. Decisions made based on full cost accounting, with an understanding of the tradeoffs can help support these choices, which tend to be longer-term and more whole systems in nature. Importantly energy technologies selected should be flexible and relatively low technology. Energy generating installations should be matched in scale and geographical distribution to end-use needs.

Progressive technical strategies to mitigate demand for energy include matching energy quality appropriately to end-use needs. Finally, sustainability has to be both local and global for all countries to be successful.

Energy plans that contain these process and technical strategies are more likely to result in successful energy planning, making communities more resilient and secure in an energy-constrained future. When the plans were measured against these progressive characteristics, the analysis revealed that the Swedish plans did not contain the same number of progressive characteristics as did the Canadian plans. This could be attributed to a clear direction from the national level in Sweden and associated funding support for carrying out energy planning efforts in this manner. In contrast, Canadian community energy plans differed considerably in their scope and objectives. Although there was a lack of consistency in the plans, they contained numerous progressive characteristics. The approach taken here suggests that the Canadian communities reviewed in this study are on the road to sustainable energy systems, provided they stay true to their visions and work continuously to achieve the objectives laid out in the plans. Although a reasonable amount of information support comes from the Canadian federal government in particular, communities could benefit from more direction, perhaps in the form of regulation and increased funding for energy systems and infrastructure. Evidence from Sweden would suggest that clear direction, combined with financial support, could serve to be a major catalyst in energy planning efforts. The information and financial support associated with the Gas Tax initiative looks promising in this regard.

However much momentum and dedication exists in communities, and however much information and financial support are disseminated from higher levels of government, it is also crucial that practices that either directly or indirectly hinder community energy planning efforts be reformed. One example described in this paper was tax subsidies to the oil and gas industry. Purchasing decisions guided by subsidized fossil fuel prices indirectly act as barriers to decisions that support energy efficiency and renewable energy technologies at scales ranging from subdivision and transportation system design to appliance choice.

The built urban form, energy systems and the energy choices that flow from these things contributes to unsustainable processes on a global scale. With this understanding, the community becomes an excellent level for analysis and action towards sustainability. Communities are the context within which the vast majority of humanity lives their lives and in a sense can be considered the basic unit of human organization in a globalized world. If Swedish and Canadian communities strategically plan their land use, infrastructure, buildings and equipment to be energy efficient and prefer energy derived from renewable source, local economic, environmental and social benefits will be realized and a significant contribution will be made towards energy sustainability.

4.1 Recommendations for Future Research

Ongoing research is required in numerous domains to add to the body of knowledge and to build capacity for community energy planning efforts. This research will be most useful if it is subsequently utilized in planning processes and urban design and energy technology projects. As community energy planning represents a synthesis of technical and social ingenuity, because much effort has already been put in to technical energy systems and efficiency measures, particularly on the building and equipment scales, more effort should be directed to understanding the social mechanisms that facilitate the uptake of these technologies.

Specific questions for further research that arose out of this thesis include:

- What strategies are available to transform the energy systems and landscapes of communities and neighborhoods that already have inherently inefficient built urban form such as urban sprawl?

- A more in depth understanding could be had of the experiences of individual communities. What do qualitative research methods such as interviews with local energy practitioners and the general public reveal about their experience in the planning process? What do trends in energy consumption reveal following the implementation of energy planning processes?

- What is the nature of information and financial support provided by higher levels of government to communities? Support provided by the various Provincial governments within Canada is one possible area of investigation.

- What information dissemination methods are successful at engaging the public in the community energy planning process? What methods have been not so successful? Why?

- What has been the specific influence of deregulation on community energy planning? Is there a case to be made for or against deregulation for the purposes of community energy planning towards sustainable energy systems?

- What has been the experience of utility companies operating in a deregulated energy market, pursuing a service oriented business model informed by the concept of integrated resource planning? What lessons can be learned that could be useful to utility companies elsewhere?

- What is the nature of people's behavior within certain urban environments? How do these environments influence people's energy-related decisions?

- How can Combined Heat and Power (CHP) technologies be used to transition energy systems towards sustainability?

- How can Swedish district heating successes be best transferred to the Canadian context?

- What actions can be taken to increase the energy efficiency of water and waste water management systems?

- What indicators have communities already identified in their community energy plans? Is there consistency among them? What aspects of the energy system or the planning process do they measure?

- Which presently available tools or Decision Support Systems facilitate the integration of energy-related information and decision making? What is the most relevant energy-related information? At what stages in the decision making process is this information most useful?

More research is also required on the linkages between urban form and energy consumption; understanding the human behavior component, or how people make energy-related decisions, is also important at this juncture, perhaps more so than technical fixes that make energy consumption more efficient.

4.2 Epilogue

By the time this thesis was being edited for a final time in mid-2007, since 2005 when information in this thesis was obtained and formulated, community energy planning initiatives in both Sweden and Canada had advanced considerably. In both cases, this could be attributed to the momentum for energy planning within communities and in part to new or continued support from the Swedish national or Canadian federal government.

The Local Investment Program (LIP) from the Swedish national government influenced many communities to build a strong platform for sustainable development and increased awareness surrounding energy issues amongst politicians and the general public within communities. Although this program ran until 2002, by May 2007, final reports had been written on 176 projects, with numerous additional projects still in progress.

After the Local Investment Program ended, a new program was set up in 2003 called KLIMP. Its aim is the reduction of CO_2 emissions and to this end grants are disbursed in the areas of waste management, energy generation (residential, industry, production and distribution), information and transportation.

Between 2003 and 2007 the KLIMP program achieved a reduction of 310 000 tonnes of CO_2 and an energy efficiency of almost one TWh. Most of the projects were in biogas facilities from waste and the use of biogas as fuel for transportation in southern Sweden. All projects under both the LIP and KLIMP programs, including their actions and process stages, are found in a database call MIR. The MIR database works as a resource for interested parties to consult when designing and carrying out new projects.

A feedback mechanism is incorporated insofar as the Swedish Environmental Protection Agency, who is responsible for ensuring these projects are validated, also promotes the use of the information resource for members and actors.

This continued support from the Swedish national government to the municipalities, both in the form of information and funding, means that innovation in community energy planning is fostered on a continual basis and significant efficiencies are being achieved.

The major Canadian federal program beginning to lend significant additional federal support for energy planning efforts beginning in 2006 is the Gas Tax Initiative. Whereas at the original time of writing this program had only just been announced, in 2007 the program was expanded to run to 2010. Projects eligible for Gas Tax funding include energy systems and sustainable transportation infrastructure. In order to be eligible for Gas Tax funds, communities are required to produce integrated Community Sustainability Plans (ICSPs). One component of these ICSPs is an energy plan. Spurred by the incentive of accessing additional infrastructure funding, many communities are beginning to write these comprehensive strategic plans. Communities can utilize socio-ecological principles in their development and are expected to write the plans over a minimum 35 year time frame. One issue for communities already ‘ahead of the curve’ in terms of energy planning, is having their plans accepted as ICSPs or components of ICSPs, energy plans produced as a part of the PCP program being one example. The Gas Tax program promotes an integrated decision making between the federal and municipal levels.

Recently there has been movement towards legislation that requires improved energy efficiency as municipal acts or similar provincial documents guiding land use planning, begin to give direction on energy planning. In Ontario for example, the introduction of Bill 51, the Planning and Conservation Land Statute Law Amendment Act, 2006 eased the rules such that the planning process could be improved, in part through being more responsive to energy considerations. Two examples include greater allowance for sustainable design and increased public participation in community planning. Among communities surveyed those who made significant advancements in their energy planning activities included Calgary, Halifax and Toronto.

The City of Calgary engaged in a multi-stakeholder collaborative consultation process resulting in the Imagine Calgary plan, setting out

Calgary's vision for a sustainable city looking 100 years into the future. This initiative is a perfect example of how a community can build on its existing energy planning activities to create a comprehensive plan that in addition to energy, addresses a wide range of sustainability issues. Complemented with an entire team within the city and 44 stakeholder organizations that are being engaged on an ongoing basis, The City of Calgary has good prospects of ensuring its plan is a living plan and that actions outlined will be taken.

The Regional Municipality of Halifax is currently undertaking a community energy planning initiative. After sending out an RFP for a community energy plan, multiple consultants submitted a combined application, recognizing that the skill set required to respond to the RFP could be met only by collaboration. This illustrates the multi-disciplinary nature of community energy planning and that engineering firms, private consultancies and communities alike must be innovative.

Appendix

Appendix I: Swedish Energy Acts and Laws

National Swedish Law of Community Energy Planning [1977:439, 1998:836]

This law requires communities to have an energy plan that describes the production, distribution and consumption of energy. This plan should include several stakeholders and organizations so that all parties are involved and work together to solve energy issues.

Table 1. Development of the Swedish environmental policies and legislation

1969	The Environmental Protection Act is introduced to reduce emissions, pollutions and noise
1972	A policy on spatial planning and the management of land and water is presented
1984	A program for reducing air pollution and acidification is presented by the Swedish government
1987	The Planning and Building Act is introduced The Act on the management of the natural resources is introduced The WCED report on sustainable development is presented
1988	A new long-term and comprehensive environmental policy is presented
1991	An environmental policy is presented which states that a living environment should be the basis for all Swedish policy
1992	The Rio-conference on sustainable development
1993	A report on "kretsloppsanpassning" is presented and a new policy on waste management is introduced
1998	New environmental goals are presented, aiming to promote ecological sustainable development
1999	A new environmental code is introduced

Nilsson. J, Tyskeng S., 2003. *The scope of municipal energy plans in a Swedish region: A review of energy and environmental issues in the plans*. Linköping University: Linköping, Sweden.

Appendix II: Canadian Energy Acts and Laws

The following Canadian federal government departments have sustainability strategies:

Atlantic Canada Opportunities Agency
Canada Border Services Agency
Canada Revenue Agency
Canadian Environmental Assessment Agency
Canadian International Development Agency
Department of Agriculture and Agri-Food
Department of Canadian Heritage
Department of Citizenship and Immigration
Department of the Environment
Department of Finance
Department of Fisheries and Oceans
Department of Foreign Affairs and International Trade
Department of Health
Department of Human Resources and Social Development
Department of Indian and Northern Affairs
Department of Industry
Department of Justice
Department of National Defense
Department of Natural Resources
Department of Public Works and Government Services
Department of Transport
Department of Veterans Affairs
Department of Western Economic Diversification
Economic Development Agency of Canada for the Regions of Quebec
Office of the Auditor General
Parks Canada Agency
Public Health Agency of Canada
Public Safety Canada (PS)
Public Service Human Resources Management Agency of Canada
Treasury Board of Canada Secretariat

Federal

Alternative Fuels Act;
Canada-Newfoundland Atlantic Accord Implementation Act;
Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act;
Canada Oil and Gas Operations Act;
Canada Petroleum Resources Act;
Co-operative Energy Act;
Dominion Water Power Act;
Electricity and Gas Inspection Act;
Energy Administration Act;
Energy Efficiency Act;
Energy Monitoring Act;
Energy Supplies Emergency Act;
Hibernia Development Project Act;
Indian Oil and Gas Act;
National Energy Board Act;
Northern Pipeline Act;
Nuclear Energy Act;
Nuclear Fuel Waste Act;
Nuclear Liability Act; Nuclear Safety and Control Act;
Oil Substitution and Conservation Act;
Petroleum and Gas Revenue Tax Act

Newfoundland and Labrador
Canada-Newfoundland and Labrador Atlantic Accord Implementation (Newfoundland and Labrador) Act;
Electrical Power Control Act, 1994;
Environmental Protection Act;
Gasoline Tax Act;
Hydro Corporation Act;
Lower Churchill Development Act;
Mineral Act;
Mineral Holdings Impost Act; Mining Act;
Mining and Mineral Rights Tax Act, 2002;
Petroleum and Natural Gas Act;
Petroleum Products Act;
Public Utilities Act;
Public Utilities Acquisition of Land Act;
Undeveloped Minerals Area Act;
Water Resources Act

Prince Edward Island Electric Power Act;
Electrical Inspection Act; Energy Corporation Act; Gasoline Tax Act;
Mineral Resources Act; Oil and Natural Gas Act; Petroleum Products Act

Nova Scotia
Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act;
Coal Mines Regulation Act;
Electrical Installation and Inspection Act;
Energy Resources Conservation Act;
Energy-Efficient Appliances Act;
Environment Act;
Gas Distribution Act;
Mineral Resources Act;
Nova Scotia Power Finance Corporation Act;
Nova Scotia Power Privatization Act;
Nova Scotia Power Reorganization (1998) Act;
Petroleum Resources Act;
Petroleum Resources Removal Permit Act;
Pipeline Act;
Public Utilities Act;
Underground Hydrocarbons Storage Act

New Brunswick
Bituminous Shale Act;
Electrical Installation and Inspection Act;
Electricity Act;
Electric Power Act;
Energy Efficiency Act;
Gas Distribution Act, 1999;
Gasoline and Motive Fuel Tax Act;
Gasoline, Diesel Oil and Home Energy Oil Pricing Act;
Mining Act;
Oil and Natural Gas Act;
Ownership of Minerals Act;
Pipe Line Act;
Public Utilities Act;

Quebec
Building Act;
Gas, Water and Electricity Companies Act;
Mining Companies Act;
Mining Duties Act;
Act respecting the conservation of energy in buildings;
Act respecting the energy efficiency of electrical and hydrocarbon-fuelled appliances;
Act respecting the exportation of electric power;
Hydro-Québec Act;
Mining Act;
Act respecting petroleum products and equipment;
Environment Quality Act;
Act respecting the Régie de l'énergie;
Act respecting municipal and private electric power systems;
Fuel Tax Act

Ontario
Electricity Act, 1998;
Energy Efficiency Act;
Environmental Protection Act;
Fuel Tax Act; Gas and Oil Leases Act;
Gasoline Tax Act; Mining Act;
Mining Tax Act;
Ministry of Energy Act;
Oil, Gas and Salt Resources Act;
Ontario Energy Board Act, 1998;
Ontario Mineral Exploration Program Act;
Power Corporation Act;
Public Utilities Act

Manitoba
Energy Act;
Energy Rate Stabilization Act;
Environment Act;
Gas and Oil Burner Act;
Gasoline Tax Act;
Gas Pipe Line Act;
Gas Allocation Act;
High-Level Radioactive Waste Act;
Manitoba Natural Resources Development Act;
Mines and Minerals Act;
Mining and Metallurgy Compensation Act;
Mining Claim Tax Act;
Mining Tax Act;
Motive Fuel Tax Act;
Natural Gas Supply Act;
Oil and Gas Act;
Oil and Gas Production Tax Act;
Public Utilities Board Act;
Water Power Act

Saskatchewan
Crown Minerals Act;
Department of Energy and Mines Act;
Electrical Inspection Act, 1993;
Electrical Licensing Act;
Environmental Assessment Act;
Environmental Management and Protection Act, 2002;
Ethanol Fuel Act;
Freehold Oil and Gas Production Tax Act;
Fuel Tax Act, 2000;
Gas Inspection Act, 1993;
Home Energy Loan Act;
Mineral Resources Act, 1985;
Oil and Gas Conservation Act;
Pipelines Act, 1998;
Power Corporation Act;
Public Utilities Easements Act;
Rural Electrification Act;
SaskEnergy Act

Alberta
Alberta Energy and Utilities Board Act;
Coal Conservation Act;
Coal Sales Act;
Electric Utilities Act;
Energy Resources Conservation Act;
Freehold Mineral Rights Tax Act;
Fuel Tax Act;
Gas Distribution Act;
Gas Resources Preservation Act;
Gas Utilities Act;
Hydro and Electric Energy Act;
Mines and Minerals Act;
Natural Gas Marketing Act;
Natural Gas Price Administration Act;
Natural Gas Price Protection Act;

Oil and Gas Conservation Act; Oil Sands Conservation Act; Petroleum Marketing Act; Pipeline Act; Public Utilities Board Act; Rural Electrification Long-term Financing Act; Rural Utilities Act; Small Power Research and Development Act; Water, Gas, and Electric Companies Act **British Columbia** Coal Act; Coalbed Gas Act; Electrical Safety Act; Energy Efficiency Act; Environment Management Act; Environmental Assessment Act; Gas Safety Act; Gas Utility Act; Geothermal Resources Act; Hydro and Power Authority Act; Hydro and Power Authority Privatization Act; Hydro Powers Measure Act; Mineral Land Tax Act; Mineral Tax Act; Mineral Tenure Act; Mines Act; Mining Right of Way Act; Mining Tax Act; Natural Gas Price Act; Oil and Gas Commission Act; Petroleum and Natural Gas Act; Pipeline Act; Utilities Commission Act; Vancouver Island Natural Gas Pipeline Act **Yukon Territory Energy Conservation** Assistance Act; Fuel Oil Tax Act; Gas Burning Devices Act; Gasoline Handling Act; Oil and Gas Act; Public Utilities Act; Yukon Development Corporation	**Northwest Territories** Electrical Protection Act; Environmental Protection Act; Environmental Rights Act; Gas Protection Act; Natural Resources Conservation Trust Act; Northwest Territories Power Corporation Act; NWT Energy Corporation Ltd. Loan Guarantee Act; Petroleum Products Tax Act; Public Utilities Act; Public Utilities Income Tax and Rebates Act **Nunavut** Electrical Protection Act; Environmental Protection Act (Nunavut); Environmental Rights Act; Gas Protection Act; Natural Resources Conservation Trust Act; Nunavut Power Utilities Act; NWT Energy Corporation Ltd. Loan Guarantee Act; Petroleum Products Tax Act (Nunavut); Public Utilities Act (Nunavut); Public Utilities Income Tax Rebates Act

Source: Department of Justice of Canada, n.d., http://www.legis.ca/en/index.html

Appendix III: Vision statements

Swedish Communities Visions of Success

Community	Vision Statement
Rättvik	The community energy system shall be within the framework of sustainability. The production, distribution and consumption of energy resources shall be efficient, with low CO_2 emissions, and come from renewable sources. The use of fossil fuels should also be eliminated. Within the community, local energy capacity should supply consumer demands. The people of Rättvik shall stay informed about energy issues. The community itself must act like a role model.
Östhammar	The community wants to promote a sustainable, ecological-friendly energy system. A priority is to substitute oil used for heating purposes.
Borås	A sustainable energy system is about quality of life. Energy consumption becomes increasingly efficient and is extracted from renewable sources. It is important to disseminate information to the public regarding the production, distribution and consumption of energy, including within the transportation sector.
Malmö	The energy plan has feedback loops for safety, efficiency, environmental impacts, and suitable to new situation (flexible platform). The goal to achieve a cyclic society (to produce the amount of energy that the biosphere can support and consume what is available.) 1. Share mental model of goals with the public

	2. Develop a long term plan to use renewable sources for heating and electricity 3. Guidelines on how to be efficient with the available resources to reduce the impacts on climate and land use from production facilities 4. Promote better use of energy and natural resources in households 5. Make energy available so it meets the needs in a safe way
Gothenburg	Sustainable development that will make it possible for future generations to meet there needs without compromising the needs of people today.
Kristianstad	To foster long-term sustainable development, with local 'closed loop' cycles which fulfill both national and local environmental goals at the same time securing access to energy.

Canadian Communities Visions of Success

Community	Vision Statements
Banff	To place Banff's vision in context, the plan defines a Community Energy System as ``… district systems where heat and sometimes electricity are generated at a central source for distribution underground via insulated pipes to a series of buildings."[183] As its vision, Banff's energy plan for 2020 is where the communities GHG emission levels meet and/or are 6% below their 1990 levels.[184]
Canmore	Canmore's vision consists of three principles: 1) To maintain a strong sense of community; 2) To protect environmentally sensitive areas; and 3) Economic well being. [185]

Community	Vision Statements
Edmonton	"Edmontonians have accepted the challenge of reducing greenhouse gas emissions and are adopting measures and lifestyles that significantly reduce the production of greenhouse gases. GHG emissions reduction is being achieve beyond Canada's international commitments and the long-term transition toward sustainable energy use will have been completed by 2050. " [186]
Salt Spring Island	[To] "...become a model "green" community for managing the environmental impacts of energy, maximizing public awareness of energy issues, promoting efficient energy use and stewarding the development of on island, sustainable energy supplies."[187]
Toronto	"Over the next 25 years, most of Toronto's building stock and infrastructure will be renovated, overhauled, and retrofitted capturing the full economic and environmental benefits available...Per capita energy demand will be 25% of current levels, while amenity, comfort and health conditions will be greatly improved. The City's infrastructure will be far less energy intensive and intrusive. District energy systems integrating industrial, commercial, institutional, and residential energy exchanges will predominate the dense development areas. These systems will utilize various forms of renewable energy supply…Many smaller buildings will integrate photovoltaic and solar heating into their walls and roofs... Our industry will be prosperously supplying local markets while exporting know-how. Materials will be repeatedly recycled or regenerated through farms and forests with nutrients returned to their soils. People will be able to conveniently access their services and goods and travel on foot, bike, public transit, and zero-emission vehicles.

Community	Vision Statements
	The vast areas of asphalt will have largely diminished giving way to green space, intensified mixed use and urban agriculture. Many flat roofs will become gardens and a biodiverse, low-maintenance; green infrastructure will provide continuous greenways and productive forests and marshes, replacing our storm sewers. Our microclimate and air quality will be as good as pristine retreats that will obviate the expeditions to cottage country. Toronto will be a place that people love calling home—healthy, prosperous, secure, and delightful."[188]
Greater Vancouver Regional District	"A sustainable system would have the following characteristics: two-way, service-orientated, cascading, renewable energy-based, appropriate quality, and integrated, with the appropriate matching of energy quality to end-use needs… Renewable energy sources fulfill the region's energy needs, with non-renewable energy resources conserved and used only for high-value uses… A diverse range of sources, and an energy system designed for optimum efficiencies to avoid significant impacts on the climate. The energy system must provide services that are affordable, equitable, resilient, and adaptive to changing market conditions…A key component of this system is cooperative long-term energy planning with neighbouring regions exchanging resources, to maximize efficiencies and increase sustainability for all…"[189]
Calgary	"Calgary, in the year 2024… has grown…the population is 1.25 million. We live closer to where we work, relying less on our cars for the shorter work trips and more on transit, walking and cycling. While the car remains the dominant choice of travel for

	Calgarians, investment in transit has resulted in a higher level of service and usage...

Community	**Vision Statements**
	We have slowed the rate of the outward growth of the city, making a conscious effort to intensify our neighbourhoods…” [190] for Calgarians, investment in transit has resulted in a higher level of service and usage... We have slowed the rate of the outward growth of the city, making a conscious effort to intensify our neighbourhoods…” [[191]]
Whistler	“Whistler’s vision is to become the first sustainable resort community in the world. The WES identifies five equally important priorities for this vision: Building a stronger resort community; Enhancing the Whistler experience; Moving toward environmental sustainability; Achieving financial sustainability; Contributing to the success of the region.”[192]
Ottawa	“…our vision [is] to be the cleanest and smartest city in Canada in the tending to our air and in the management of our energy use habits.”[193]

Appendix IV: Tools

Salt Spring Island
The Model National Energy Code for Buildings MNECB is a tool to evaluate and achieve energy performance for new buildings
http://www.oee.nrcan.gc.ca/commercial/technical-info/tools/software-new.cfm?attr=20

Whistler
EMME/2 Travel Demand Forecasting Model, Envision Tool

Edmonton, Calgary
Environmental Management System (EMS) ISO 14001

Ottawa
City Green – GIS database and decision support system to monitor urban forest cover

Gothenburg
MARKAL

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http://www.sfbike.org/download/copenhagen/bicycle_account_2004.pdf

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GVRD/cities[PLUS] plan is a broader sustainability plan on a regional scale. A question for further study would be the synergies that could be achieved in energy planning on a regional scale and the GVRD would make an excellent case study for this analysis.

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