Community Energy Planning for Revelstoke BC: A Case Study

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ABSTRACT

A new approach to Community Energy Planning (CEP) was piloted in the City of Revelstoke, BC with partial funding from Natural Resources Canada. The CEP employed a disaggregated end use model for the entire community to permit accurate and precise forecasting of energy consumption. The model -the Tool-kit for Integrated Resource Accounting (TIRA) – is a forecasting and modeling software program developed by Sheltair Scientific. The CEP began by using community goals to create a logical framework for evaluating CEP scenarios. From the community goals, a number of objectives, targets and indicators were developed to ensure that options explored in the CEP were consistent with the broader community vision. Estimates of current energy consumption were developed for buildings, transportation, industry and infrastructure. Indicators were developed including financial, economic development, CO_2 emissions, and per capita energy use. One business as usual scenario and three alternate scenarios were developed. Scenarios were developed to assess the impact of new policies and programs, including:

- A district energy system
- The retrofit of older residential homes, and
- ESCO activity in the local municipal and school buildings.

A strategy was then proposed to integrate the CEP into the existing Official Community Plan. If adopted, the CEP is estimated to result in:

- an average reduction of household expenditures on energy by 7% over 20 years,
- 2 new local industries, with the creation of 26 full time jobs in Revelstoke,
- a reduction of per capita CO₂ emissions by 16% below 1996 levels, and
- cumulative savings on energy dollars spent in the community of approximately \$10 million.

The use of an end-use model and forecasting methodology proved valuable in educating the community, and creating more informative and politically acceptable scenarios. Preliminary results indicate that a CEP may help to facilitate adoption of district energy and other specific programs.

Table 1: Potential Benefits of Community Energy Planning

Community Energy Planning can contribute to:

- saving money on energy expenditures by households, businesses, the municipality, and other large energy users in the community;
- saving money on infrastructure capital costs by the municipality and taxpayers, including the provision of new infrastructure and expansion of existing infrastructure facilities;
- creating local jobs through direct and spin-off industries of new energy-related businesses, such as energy and water retrofit businesses and new energy supply businesses;
- reducing local air pollution;
- reducing greenhouse gas emissions which contribute to global warming; and
- sustainability through greater diversity and local control of resources.

Context

A Community Energy Plan (CEP) can improve the economic, environmental and social impact of many local government decisions. In fact, energy consumption is often a convenient measure of overall livability and sustainability. Higher non-renewable energy consumption leads to a lower quality of life over the long term.

An effective energy plan can also help a community develop "win-win" solutions for some of the most difficult challenges facing local governments. These include growth management, land use and transportation planning, economic development, and sustainability. Benefits to Revelstoke from the CEP are highlighted in Table 1.

The project commenced in the summer of 1997, and was complete by fall, 1997. However, the most recent year for which complete data was available was 1996. Therefore, the base year for the analysis is 1996.

Method

An important first step in conducting a Community Energy Plan is to generate support from the community and local decision-makers. The project team initiated the CEP by making a presentation to city staff and local community groups. As part of the presentations, community goals were clarified in order to make the results of the CEP relevant to the community. In order for City staff to "buy into" the work, feedback on all aspects of the project was elicited throughout the project and incorporated into the CEP.

To analyze resource flows and develop costs of different development scenarios, the project team adopted a tool-kit approach to performing the analysis of different development alternatives for Revelstoke. The backbone of this approach was Sheltair's own Tool-kit for Integrated Resource Accounting (TIRA) software. TIRA was used to create a range of development scenarios, and to analyze the associated physical resource use and lifecycle costs. The major strength of TIRA is its ability to model the resource flows and associated costs of buildings and infrastructure using a rigorous, bottom-up approach. A Geographic Information System (GIS) was also used to perform spatial queries for a range of indicators, and for developing maps for presentations. The TIRA method is presented in Figure 1.



Figure 1: TIRA Method

The toolkit incorporates well-validated models to estimate resource consumption. For example, DOE 2.1 is used for commercial building energy; the Canadian government's HOT2000 is used for residential buildings. Assumptions are transparent to the user, and can be altered if necessary to reflect community concerns. TIRA uses archetypes as a convenient method to model end uses. For

example, archetypes of buildings are customized by the user from a library of archetypes provided by the program.

Each building archetype statistically represents a portion of the stock, but can be accurately modeled as a single building for purposes of estimating resource consumption. The impacts of changes to individual technologies at the building level can be calculated for individual neighborhoods, or for the community as a whole. Similar archetypes exist for linear infrastructure, vehicles, and industries.

Data sources included:

- The electric and gas utilities for building energy consumption data
- The Assessment Authority and the City Building Department for building stock information
- The Motor Vehicle Branch for vehicle fleet information
- Statistics Canada and Ministry of Vital Statistics for demographic information.



Figure 2: Energy Consumption by Sector

Scenarios are created by changing and remodeling the archetype descriptions at milestone years, and by changing the connections between building archetypes and the various supply and processing systems available to the neighborhood or community. By modifying the default archetypes and system templates from TIRA's extensive library files, users may quickly and accurately customize TIRA to describe their community. Buildings, transportation systems, industrial processes and infrastructure components were modelled to reflect the local conditions, and the interests and objectives of the community.

Applying the TIRA methodology, the project team adopted a four step methodology used in community integrated resource planning, and briefly described below.

- 1. Load the TIRA databases with default archetypes of buildings, transportation, and infrastructure.
- 2. Create a business as usual scenario for Revelstoke, including estimates of how well the scenario performs in terms of the indicators and targets developed.
- 3. *Create alternate scenarios*, to examine opportunities to improve the energy efficiency, livability and sustainability of Revelstoke through the utilization of a range of land use patterns, transportation alternatives, and building technologies.
- 4. *Develop a preferred option*, for future development in Revelstoke, based on a portfolio analysis of the different alternatives.

Revelstoke in 1996

Revelstoke is located on the Trans-Canada Highway approx. 565 km east of Vancouver. A map of the City is provided in Appendix 1. Revelstoke is situated in the Columbia Mountains in the interior wet belt, and receives heavy snowfall in the winter months. The snow season is typically from mid-

December to mid or late March. Revelstoke has an average of 4,225 heating degree days Celsius each year. The population estimate for the City of Revelstoke as of July 1, 1996 was 8,507 (B.C. Stats 1997), with an annual growth rate of approximately 1%.

The city and residents of Revelstoke spent approximately \$19 million dollars on energy in 1996¹, the base year of the study. On a per capita basis, energy consumption for the residential building and personal transportation sectors was about \$1280 per person per year. This corresponds to 8% of the average pre-tax income. Figures 2 and 3 illustrate the breakdown of energy consumption by sector and end use for Revelstoke in 1996. By providing information about how energy is being consumed, a Community Energy Plan helps decision-makers select those programs and policies most likely to reduce energy consumption and expenditures and to minimize the negative impacts on air, land and water.



Figure 3: Energy Consumption by End Use

The Role of Scenarios in Energy Planning

Sheltair used the Tool-kit for Integrated Resource Accounting (TIRA) to develop a number of scenarios of energy use in Revelstoke over the next 20 years. A "Business As Usual Scenario" was developed to model the most likely energy consumption pattern and resulting impacts in the absence of any major new initiatives.

TIRA was then used to examine how three alternative scenarios impacted energy use in Revelstoke. Scenarios are a way of describing and analyzing future conditions. By changing some variables-such as the rate of population growth or energy efficiency standards-and holding other factors constant, Revelstoke in 2016 can be described and modeled. Then, the consequences and impacts of policies and programs can be evaluated in terms of their impact on the community. In the case of Revelstoke local issues were combined with the community goals to develop the alternative scenarios examined.

Business As Usual for Revelstoke, 1996-2016

¹ These values are in Canadian 1996 dollars.

Figure 4 shows how energy consumption is likely to change over the next 20 years, assuming a "Business as Usual Scenario". Energy consumption and carbon dioxide emissions are summarized in Table 2. Total energy consumption is expected to increase from 1,480,000 GJ in 1996 to 1,550,000 GJ in 2016. Although Revelstoke's population increases by almost 11%, energy use increases by only 4.7%. This is because the new stock (buildings, vehicles, etc) adopted in the community between 1996 and 2016 is more energy efficient than the older stock that is being replaced. In addition, the older stock is becoming a smaller proportion of the overall stock.



Figure 4: Energy Forecast, 1996-2016, Business as Usual

On a per capita basis, the total annual energy use will decrease from 175 GJ in 1996 to 165 GJ by 2016. This change represents a 5.7% decrease in per capita energy consumption over twenty years. There represents a 3.1% increase in CO_2 emissions, and a 6.6% decrease in the per capita emissions. **Table 2:** Energy and Green house Gas Emissions, 1996 and 2016, Business as Usual

| | 1996 | 2016 | % Change |
|---|-----------|-----------|----------|
| Total Energy [GJ] | 1,480,000 | 1,550,000 | 4.7% |
| Per Capita Energy [GJ/capita] | 175 | 165 | -5.7% |
| CO ₂ equivalent [tonnes] | 74,500 | 76,800 | 3.1% |
| Per Capita CO ₂ equivalent [tonnes/capita] | 8.75 | 8.17 | -6.6% |

Alternate Scenarios for Revelstoke, 1996-2016

Three alternate scenarios were developed as part of the CEP. The alternate scenarios were developed to take advantage of local opportunities and overcome constraints identified through discussions with community decision makers and community representatives. The scenarios examined, their rationale and potential benefits are described below.

District Energy System for Revelstoke

Sheltair worked with a local Revelstoke engineering firm to develop a feasibility study of a District Energy System (DES). A map of the DES is shown in Appendix 1. The facility would to burn wood waste from local sawmills, and supply hot water for space and water heating to buildings in the downtown core, as well as process steam to industry, and heat to pasteurize water for the community. Several factors motivated the development of this scenario:

• Wood waste is available at low or negative cost from local saw mills.

- Local sawmills burn their waste wood in non air emission compliant incinerators with limited pollution control devices, or use landfills. There is currently no heat recovery from the incineration of the wood waste. On an individual basis, these wood processors are facing significant investment decisions to meet current air pollution regulations. Analysis showed there was enough wood waste from the local logging operations to meet the energy supply requirements of the proposed DES.
- Space heating for buildings in Revelstoke is one of the highest end use loads.(see Figure 2). Therefore, it offers one of the greatest opportunities for benefits from energy planning. Typically, buildings in Revelstoke are heated directly with propane, oil, electricity or wood furnaces or stoves. Consumers of fossil fuels in Revelstoke have been subject to significant price increases in recent years with limited capability of switching to alternative supplies. Those who can switch often go back to burning wood, which results in increased local air quality problems.

DES Scenario Benefits

The investment for the district energy system, including plant, distribution system, operating and maintenance has a payback period of seven years. In addition to the financial benefits, the district energy system has a number of additional benefits that are consistent with community goals. The system would:

- consume all wood residue in the area and eliminate existing wood incinerators, open burning and landfilling of wood waste;
- reduce atmospheric particulate emissions through the use of pollution control devices, resulting in improved air quality for Revelstoke;
- utilize a currently wasted resource;
- improve visibility and environmental aesthetics;
- reduce greenhouse gas emissions by 5.5% below baseline forecasts;
- increase resiliency of the energy supply through diversification ;
- increase money re-circulation inside the community; and
- creation of 20 full time equivalent positions per year in the community.

Residential Buildings Energy Retrofits

This scenario involved the development of a utility managed energy retrofit industry in Revelstoke that would retrofit older residential single family homes. The scenario was developed to address the issues of high annual energy consumption for older buildings, as well as the unstable price for propane service in the community.

Since the local propane distributor started providing service to homes in Revelstoke in 1991, the residential price of propane has increased by about 42%. Many residents originally switched to propane due to promises of lower fuel bills and stable prices. To avoid further price increases and price instabilities, many residents are now contemplating a switch back to oil, wood or electricity for water and space heating. Based on analysis used in this study, it was found that the most cost-effective way for residents to reduce energy costs and buffer themselves against unstable energy costs is to make their homes more energy efficient.

While the local propane distributor is frequently seen as the cause of the high costs for energy, there is an opportunity to utilize a new program launched by BC Gas called "Homeworks" to address this issue of high operating costs for homeowners. The Homeworks program includes:

- 1. A complete energy audit of a house using local contractors who are trained to perform energy audits on houses (local job creation), using sophisticated software and diagnostic tools.
- 2. A report showing the home-owner where energy is being consumed and the most cost effective ways to reduce their energy bills.
- 3. Optional financing through the utility to pay for energy retrofits.
- 4. Professional installation of energy saving measures.
- 5. A quality assurance program.



Figure 5: Potential to reduce energy consumption in homes.

Residential Buildings Energy Retrofits Scenario Benefits

The predicted energy savings from this scenario over the next 20 years is shown in Figure 5. It was found that:

- The archetypal older home in Revelstoke can achieve a 15% reduction in annual energy costs through an investment of approximately \$970. This translates into a payback period of approximately 4.7 years.
- Over the next twenty years, this scenario will save the accumulated equivalent of the energy consumed by the entire residential sector in one year. This corresponds to 428,000GJ.
- The reduction in energy consumption will result in a reduction of CO2 emissions by 3% in the community, below the baseline scenario, by 2016.
- Assuming the creation of 12 jobs for every \$1 million dollars spent² in the community, this scenario will create approximately four full time job equivalents.

Residential retrofit programs have been piloted in a number of communities in BC and are quite successful in saving energy, and reducing energy costs to home-owners. In some locations, the program has also included a water audit component, enabling communities to save both energy and water.

² BC Energy Aware Committee, A tool-kit for Community Energy Planning in BC, Pg.11, 1997

Retrofit of Institutional, Municipal and School Buildings

The Infrastructure and Institutional Buildings Energy Retrofit Scenario involved the implementation of energy retrofit programs for existing Municipal buildings, School District buildings, and Municipal Infrastructure. Using TIRA, Sheltair identified the retrofit of School District buildings, Municipal buildings and infrastructure as having the greatest potential for successful implementation.

Similar to the residential retrofit program explored above, there are Energy Service Companies (ESCOs) that provide energy retrofit services to larger buildings. An ESCO will:

- perform a detailed energy audit on a building,
- examine the most cost effective energy retrofit options,
- pay the cost of retrofitting the building,
- perform the work, and
- share in the savings from reduced energy bills to retrieve their initial investment.

After the ESCO has received their portion of the energy savings over a fixed time period, the building owners (the city of Revelstoke and the school board in this case) continue to keep the savings over the life of the building.

Energy Service Companies will only finance and carry out energy retrofit projects if they are of sufficiently large scale to be financially viable. Through discussions with several of the largest ESCO's working in BC, it was determined that the energy retrofit of both Municipal and School District facilities at the same time would be required to make the scenario viable.

Scenario Benefits from Retrofit of Institutional, Municipal and School Buildings

| Buildings Considered | -City Hall | | |
|-------------------------------------|--------------------------------------|--|--|
| _ | -Community Centre | | |
| | -Ice/Curling Forum | | |
| | -Public Works Yard Firehall, Schools | | |
| Infrastructure Considered | Sewage Treatment | | |
| | -Street/Traffic Lights | | |
| Current Energy Consumption | 49,778 GJ/Year | | |
| Range of Energy Saving | 10% - 34% | | |
| Total Energy Savings | 9,000 to 12,400 GJ/Year | | |
| CO2 Reduction | 184 to 266Tonnes/yr | | |
| Current Energy Costs (\$/Year) | \$554,000 | | |
| Energy Cost Saving (\$/Year) | \$120,000 to \$157,000 | | |
| Payback Period | 7 to 10 years | | |
| Net Present Value | \$955,000 to \$1,435,000 | | |

Direct benefits to the Municipal government from energy retrofits are summarized in Table 3. **Table 3:** Impact of Municipal and School Retrofit

Overall Impact of Community Energy Plan

Table 4 and Figure 6 highlight the projected energy savings between 1996 and 2016 from cumulative implementation of the 3 alternate scenarios developed above. Assuming all three scenarios are implemented by the year 2016 there will be an annual decrease in energy consumption of approximately 57,000 GJ per year below business as usual projections.

| Indiaator | 1004 | Ducinos Ac | Comparito |
|---|-----------|-------------|-----------------|
| indicator | 1990 | Dusiness As | Composite |
| | Baseline | Usual- 2016 | Scenarios- 2016 |
| Total energy consumed per year by community [GJ] | 1,486,000 | 1,550,000 | 1,493,000 |
| Per capita energy consumed per year (excluding industrial | 162 | 154 | 147 |
| processes) [GJ] | | | |
| Total tonnes of greenhouse gas emissions per year in CO2 | 74,500 | 76,800 | 69,900 |
| equivalents - by community | | | |
| Per capita tonnes of greenhouse gas emissions per year in | 8.8 | 8.17 | 7.43 |
| CO2 equivalents | | | |
| Per Capita energy operating expenditures per year in 1996 | \$1,250 | \$1,260 | \$1,170 |
| dollars - by households | | | |
| Net ongoing full time job equivalents resulting from | 0 | 0 | 26 |
| implementation of the energy plan | | | |
| Percentage of energy supplied by locally and operated | 0 | 0 | 8% |
| energy producers | | | |
| Number of new industry types that are locally owned and | 0 | 0 | 2 |
| operated resulting from energy plan | | | |

 Table 4: Impact of Implementing Revelstoke Community Energy Plan

Most noticeably, implementation of all scenarios of the Community Energy Plan will lead to: an average reduction of household expenditures on energy by 7%



Figure 6: Impact of Community Energy Plan

- the creation of 26 full time jobs,
- the creation 2 new local industries
- a reduction of per capita carbon dioxide emissions by 16% below 1996 levels.
- The displacement of 75,000 GJ per year of fossil fuel to renewable energy by the combustion of wood waste

In addition, the cumulative savings on energy dollars spent in the community between 1996 and 2016 are approximately \$10 million dollars.

Status of CEP Recommendations

As of the Spring of 1998, implementation of the Community Energy Plan is moving forward. The City of Revelstoke has formally endorsed the recommendations of the CEP. As such, the City has agreed to participate in developing the DES as a funding partner, and is considering the use of ESCOs to reduce the cost of local infrastructure. Additional funding partners and an ownership structure are now being finalized for the DES In addition, a Residential Buildings Energy Retrofit program was established in early 1998, and is now active in the community improving the performance of the residential building stock.

Appendix 1: Maps of Revelstoke



Figure A The City of Revelstoke

